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I. A PRELIMINARY NOTE ON SOME NEW SPECIES OF COPEPODA.

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(With Plates IX—X.)

The following species of Copepoda, hitherto unknown to science, were obtained in two collections. The first of these is a large and extremely interesting collection made by members of the Zoological Survey of India during their survey of the Chilka Lake.[1] The Copepoda present an interesting mixture of freshwater and true marine forms. I give below a list of the various species that I have been able to identify from the Chilka collection :—

Family CALANIDAE.

Genus *Paracalanus*, Boeck.
Paracalanus crassirostris (Dahl).
Genus *Acrocalanus*, Giesbrecht.
Acrocalanus similis, Sewell.

Family CENTROPAGIDAE.

Genus *Pseudodiaptomus*, Herrick.
Pseudodiaptomus lobipes, Gurney.
Pseudodiaptomus hickmani, Sewell.
Pseudodiaptomus binghami, Sewell.
Pseudodiaptomus annandalei, sp. nov.
Pseudodiaptomus tollingeri, sp. nov.
Genus *Diaptomus*, Westwood.
Diaptomus cinctus, Gurney.

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Family PONTELLIDAE.

Genus *Labidocera*, Lubbock.
Labidocera pavo, Giesbrecht.
Genus *Acartia*, Dana.
Acartia centrura, Giesbrecht.
Acartia spinicauda, Giesbrecht.
Acartia southwelli, Sewell.
Acartia chilkaensis, sp. nov.

[1] See *Mem. Ind. Mus.*, Vol. V.

Genus *Acartiella*, Sewell.
Acartiella major, sp. nov.
Acartiella minor, sp. nov.

In addition there were present examples of *Cyclops*, *Euterpe*, *Oithona*, and numerous Harpacticids and nauplii that I have up to the present been unable to identify.

The second collection is a smaller one made by Dr. Gravely, Assistant Superintendent, Zoological Survey of India, in the backwater at Cochin, and contained another new species of the genus *Acartiella*, namely *A. gravelyi*, sp. nov.

It is particularly interesting to me to be able to record and describe three new species of the genus *Acartiella*; this genus was created by me (Sewell, 1914, p. 245) to accommodate two species from the Rangoon River estuary and the Gulf of Mannar respectively, and the occurrence of other species in such widely separate localities as Cochin and the Chilka Lake leads one to expect that the genus will prove to be represented throughout the brackish and estuarine waters of India.

Family CENTROPAGIDAE.

Genus **Pseudodiaptomus**, Herrick.

Pseudodiaptomus tollingeri, sp. nov.

(Plate X, fig. 8.)

Examples of both sexes were present in the Chilka Lake collection and in a collection from Port Canning in the Gangetic delta.

♀. Total length = 1·34 mm.

The proportional length of cephalo-thorax and abdomen—
60 : 40 = 100.

The head and 1st thoracic segments are fused as are also thoracic segments 4 and 5. The anterior extremity presents a uniformly rounded forehead and the rostrum consists of two short stout spines.

The posterior thoracic margin is armed with a single spine situated towards the dorsal surface and ventro-laterally there is a rounded projection fringed with hair.

The abdomen consists of four segments, having with the furca the following proportional lengths:—

33 : 19 : 19 : 9 : 20 = 100.

The first three segments are each furnished with a row of spines along the dorsal part of the posterior margin, and in addition the 1st or genital segment bears a transverse row of needle-like spines across the ventral aspect anterior to the genital opening, and two transverse rows of fine spinules on the dorsal surface. The furcal rami are symmetrical and bear five setae, of

which the central or 3rd one is expanded proximally to form a spear-shaped base as in *P. binghami* ♀.

Mature females carry a pair of egg-sacs each containing 7 or 8 ova.

The 1st antennae.—When folded back the antenna reaches to the posterior end of the genital segment; it consists of 21 segments, having the following proportional lengths:—

Segments 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10 : 11 : 12 : 13 : 14 : 15 : 16 : 17 :
60 : 43 : 19 : 26 : 24 : 39 : 24 : 24 : 34 : 49 : 55 : 62 : 64 : 64 : 65 : 61 : 48 :
18 : 19 : 20 : 21.
48 : 52 : 59 : 70 = 1000.

The 2nd antenna has the form usual in this genus, but resembles that of *P. hickmani* in that it is armed with a row of fine spines on the terminal segment of the endopodite.

The maxilliped consists of the usual two basal segments and a terminal portion of five segments.

Basal 1 is provided with a stout spine-like seta at its distal end. Basal 2 bears 3 setae on its margin and is armed with a palisade of needle-like spines.

The 1st pair of legs have the usual structure, both exopod and endopod being composed of three segments.

Basal 1 is armed with a row of spines on its external margin about the middle of its length; exopod 1 bears a spine which projects as far as or a little beyond the distal end of the segment; exopod 2 is unarmed; exopod 3 bears two needle-like marginal spines and a delicate end-spine which is not quite as long as exopod 2 and 3 together.

The endopod reaches to a point a little beyond the middle of exopod 3.

The 2nd pair of legs.—Basal 1 bears two transverse rows of spines on its outer margin and basal 2 bears a few scattered spines externally.

The 3rd pair of legs.—There is a row of spines on the proximal part of basal 1, and a few spines distally on the same segment. Basal 2 bears three or four spines.

The 4th pair of legs.—There is a transverse row of spines on basal 1 near the distal margin, but basal 2 is unarmed.

The 5th pair of legs.—Each consists of a three-jointed exopod only. The 1st segment bears a few small spines on its outer border about the middle of its length and is armed internally with an oblique row of spines. The 2nd segment is produced at its distal internal angle in a lamelliform process which terminates in a sharp point: externally there is a single small needle-like spine. The 3rd segment bears three spines and is produced externally in a bluntly rounded process: of the three spines, the outer is long and curved and in length is nearly equal to the whole limb; it is finely serrated along both borders: the middle spine is straight, about half the length of the outer one and is serrated on both margins: the inner spine is somewhat curved and is short and

stout with coarse serrations on its inner, and fine teeth on its outer border.

Specimens from the Chilka Lake differ slightly from the above description, which is taken from Port Canning specimens. They are slightly smaller and on the 2nd segment of the 5th pair of legs there is a corona of fine spines on the external part of the distal margin.

♂. Total length = 1·20 mm.

Proportional length of cephalo-thorax and abdomen—

63 : 37 = 100.

The cephalo-thorax resembles that of the ♀. The abdomen consists of five segments: the 1st segment is short and unarmed: the 2nd and 3rd segments are armed with a complete circle of spines around the posterior margin and in addition bear a transverse row of spines on the ventral surface: the 4th segment bears only the distal ring of spines and segment 5 is unarmed. The proportional lengths of the abdominal segments and furca are as follows:—

13 : 20 : 19 : 17 : 9 : 22 = 100.

The furcal rami are symmetrical and bear five setae of which the 3rd resembles the others and is not expanded as in the ♀.

The 1st antennae.—That of the left side is unmodified as in the ♀: the segments have the following proportions:—

Segments	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21.
	65	54	19	32	38	22	24	27	27	43	54	59	65	65	65	59	48	48	51	59	76 = 1000.

On the right side the antenna is modified to form a grasping organ: the segments have the following proportional lengths:—

Segments	1	2	3	4	5	6	7	8-10	11	12	13	14	15	16	17	18	19	20-21.
	75	53	22	19	19	19	11	68	19	26	30	64	64	68	56	113	105	169 = 1000.

Segments 13 to 17 are considerably swollen; segment 17 bears a tooth-plate that extends the whole length of its upper margin and overlaps the succeeding segment; segment 18 is armed with a tooth-plate that terminates distally in a sharp point; segment 19 bears two spine-like tooth-plates, of which the proximal is about half the length of the distal, and this latter extends to the extreme limit of the segment.

All tooth-plates are stained a brown colour.

The 2nd antennae, mouth-parts, and swimming legs are as in the ♀.

The 5th pair of legs.—The right leg consists of four segments: the 1st segment (basal) is produced internally in an angular projection bearing at its internal angle a double process, the outer part rounded and the inner truncated and provided with a seta. Exopod 1 is produced at its distal external angle in a prominent

spine; exopod 2 is much dilated and bears a few spines on both internal and external margins; exopod 3 in shape closely resembles the corresponding joint in *P. lobipes*; about the middle of its length it is dilated the dilatation being fringed distally with spines, and it terminates in a long curved simple process.

The left leg consists of only three joints: of these the 1st (basal) bears a row of spines on its external margin and internally is produced into two processes which represent the remains of the endopod—the innermost is long and simple and the outer process is a broad flat plate terminating in two spines. Exopod 1 is provided with a row of needle-like spines on the proximal part of its inner margin, and externally it is produced at its distal end in a short stout spinous process, while the distal border is armed posteriorly with a row of spinules; exopod 2-3 (the terminal segment) bears a row of needle-like spines on the proximal part of its inner margin and externally it carries a large doubly-serrated spine; the terminal part of the joint is bent sharply on itself and terminates in three unequal processes.

Pseudodiaptomus annandalei, sp. nov.

(Plate X, fig. 9.)

Examples of both sexes were present in the Chilka Lake collection. I have much pleasure in dedicating this species to Dr. N. Annandale, the Director of the Zoological Survey of India.

♀. Total length = 1·18 mm.

Proportional length of cephalo-thorax and abdomen—

71 : 29 = 100.

The head and first thoracic segments are fused, as also are thoracic segments 4 and 5: the forehead when viewed from above forms a sharply rounded prominence: the rostrum consists of two spinous processes. The posterior thoracic margin is rounded and is armed with a comb of 6-8 coarse curved teeth, and the last thoracic segment also bears laterally a double row of small spines.

The abdomen consists of four segments; of these the 1st is very nearly symmetrical and is produced on either side in a large recurved spine, but there are no spines on the posterior margin; segment 2 is armed with a row of very small spines on the posterior margin dorsally; segment 3 is armed with a corona of spines on the dorso-lateral part of the posterior border, which spines are somewhat larger laterally than on the dorsal surface.

The furcal rami are symmetrical and bear five setae which are short and stout and the 3rd seta is much dilated: all the setae and the inner margin of the furcal rami are fringed with bristle-like hairs. The proportional lengths of the abdominal segments and furca are as follows:—

40 : 14 : 14 : 9 : 23 = 100.

Mature females bear two egg-sacs each containing 6-8 ova.

The 1st antenna when folded back reaches to the posterior end of the genital segment of the abdomen. It consists of 21 segments having the following proportional lengths:—

Segments	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	65	44	22	31	31	44	22	22	31	51	57	61	63	62	65	57

17	18	19	20	21.
48	51	51	57	65 = 1000.

All the antennal setae appear to be bristle-like and devoid of plumose hairs.

The 2nd antenna is similar to that of *P. hickmani*.

The maxilliped consists of two basal joints and an end portion of 5 segments. Basal 1 bears distally a stout serrated spine; basal 2 is fringed with a palisade of spines.

The 1st pair of legs.—Basal 1 is armed with a transverse row of small spines on its external margin, and a second row about the junction of the proximal and middle thirds of the segment; basal 2 also bears an oblique row of spines. The exopod and endopod are each of three segments; exopod 1 bears a small marginal seta that barely reaches to the distal end of the segment.

The 2nd and 3rd pair of legs.—Basal 1 bears a transverse row of spines on the proximal part of the outer margin; basal 2 bears a longitudinal row of spines on its outer margin.

The 4th pair of legs.—Both basals are devoid of spines.

The 5th pair of legs.—Each consists of a three-jointed ramus: the 1st segment bears a row of spines on its outer surface: the 2nd segment is armed at its distal external angle with a single marginal serrated spine, and there is no trace of any internal lamelliform process such as is found in *P. tollingeri* and *P. lobipes*: the 3rd segment bears a small marginal spine and three end spines, of which the outer is by far the longest and stoutest and is serrated on both margins.

♂. Total length = 1·09 mm.

Proportional length of cephalo-thorax and abdomen—

67 : 33 = 100.

The male appears to differ very considerably from the female for the posterior thoracic margin is rounded and is totally devoid of spines, with the single exception of a small spine situated towards the dorsal end of the posterior margin. The abdomen consists of five segments having with the furca the following proportional lengths:—

11 : 22 : 20 : 17 : 9 : 21 = 100.

The 2nd, 3rd and 4th segments are each armed with a complete circle of spines on their distal margins and in addition the 2nd segment also bears a transverse row of small spines on both dorsal and ventral surfaces. The furcal setae are coarsely fringed as in the ♀, but the 3rd seta is not expanded: there is a very small dorsal accessory seta.

The 1st antennae.—That on the left side is unmodified and has the following proportional lengths of the segments:—

Segments 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10 : 11 : 12 : 13 : 14 : 15 : 16 :
65 : 55 : 25 : 30 : 30 : 42 : 20 : 20 : 30 : 38 : 50 : 55 : 62 : 63 : 65 : 58 :
17 : 18 : 19 : 20 : 21.
47 : 55 : 55 : 60 : 75. = 1000

The right antenna is as usual modified to form a grasping organ: the various joints have the following proportional lengths:—

Segments 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8-9 : 10 : 11 : 12 : 13 : 14 : 15 : 16 : 17 :
68 : 50 : 17 : 14 : 15 : 13 : 9 : 50 : 15 : 20 : 22 : 26 : 64 : 57 : 61 : 57 :
18 : 19 : 20-21.
128 : 117 : 194 = 1000.

The "endabschnitt" consists of two joints only and the knee-joint lies between segments 18 and 19: segments 13 to 17 are swollen; segment 17 bears on its anterior margin proximally a rounded chitinous plate; segment 18 has a tooth-plate which extends for $\frac{3}{4}$ of the length of the segment; segment 19 bears two spine-like tooth-plates, the proximal being short and armed with curved teeth.

The 2nd antennae, mouth-parts and swimming legs are similar to those of the ♀.

The 5th pair of legs.—The right leg consists of three segments. Exopod 1 is produced internally in a spinous process and is armed with a transverse row of spines on its outer margin; exopod 2 is prolonged internally in a lamelliform plate bearing two spine-like processes, a proximal short and claw-like and a distal one much longer and straight; exopod 3 is curved, terminating in a sharp point and bears a single seta on its inner margin. The left leg consists of three segments; exopod 1 is produced internally in a large irregularly triangular plate; exopod 2 is produced internally in a stout spinous process at the base of which is a short stout spine; exopod 3 bears a serrated spine on its outer margin and terminates in two sharp chitinous teeth.

Pseudodiaptomus binghami, Sewell.

Associated in the Chilka Lake collection with large numbers of *P. binghami* ♀ and a few examples of *P. lobipes* were several unknown males. The female *P. binghami* was described by me from a collection made in the Rangoon River estuary, and I believe that the following form is the hitherto unknown ♂ of this species:

♂. Total length = 0·86 mm.

Proportional length of cephalo-thorax and abdomen—

64·5 : 35·5 = 100·0.

The head and 1st thoracic segment are fused, as also are thoracic segments 4 and 5. The forehead presents a uniform

rounded curve. The posterior thoracic margin is rounded and is armed towards the dorsal surface with a single spine.

The abdomen consists of five segments, which have with the furca the following proportional lengths:—

$$11 : 20 : 18 : 18 : 9 : 24 = 100.$$

Segments 2, 3 and 4 are each provided with a ring of spines on the posterior margin.

The furcal rami are symmetrical: the 3rd seta is not enlarged in this sex—a condition that is also found in *P. annandalei* and *P. tollingeri.*

The 1st antennae when folded back reach to the posterior thoracic margin. The left antenna is unmodified and resembles that of the ♀. I give below the proportional lengths of the various segments, and, as in my original description the terminal joints were missing, I also give the proportional lengths of the various segments in the corresponding appendage of the female for purposes of comparison.

Segments	1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10 : 11 : 12 : 13 : 14 : 15 :
♂	78 : 52 : 23 : 32 : 33 : 45 : 23 : 23 : 26 : 39 : 46 : 52 : 58 : 58 : 62 :
♀	78 : 39 : 19 : 28 : 28 : 39 : 22 : 22 : 28 : 39 : 48 : 50 : 59 : 62 : 64 :

	16 : 17 : 18 : 19 : 20 : 21.
♂	58 : 49 : 52 : 55 : 58 : 78 = 1000.
♀	62 : 53 : 56 : 59 : 67 : 78 = 1000.

The right antenna is as usual modified; the various segments have the following proportional lengths:—

Segments	1 : 2 : 3 : 4 : 5 : 6 : 7 : 8-9 : 10 : 11 : 12 : 13 : 14 : 15 : 16 : 17 :
	82 : 55 : 20 : 17 : 17 : 14 : 20 : 31 : 27 : 21 : 21 : 31 : 62 : 68 : 75 : 62 :

$$\frac{18 : 19 : 20\text{-}21}{103 : 103 : 171} = 1000.$$

Segment 17 bears a tooth-plate which overlaps the proximal end of the following segment; segment 18 bears a tooth-plate; segment 19 bears two teeth plates. The tooth-plate on segment 17 is unarmed; that on segment 18 has rounded cusps and the tooth-plate on segment 19 bears spine-like teeth on its proximal portion only, the distal part being smooth.

The 2nd antennae, mouth-parts and swimming legs are identical with the corresponding appendages of *P. binghami* ♀.

The 5th pair of legs very closely resemble those of *P. lobipes* with which this form was associated in the collection. The right leg: basal 1 carries a rounded eminence on its margin; basal 2 bears a similar projection; exopod 1 is produced in a long spine which is serrated on its inner margin only; exopod 2 is produced internally in a blunt chitinised tubercle; exopod 3 is curved and slender; its inner margin is produced about the middle of the length of the segment in a flattened plate, which at its upper angle bears a small rounded tubercle; below the tubercle the margin is armed with a series of small spines and above it the distal margin bears 3 teeth; beyond this plate the distal part of the

segment is claw-like and is serrated on its margin. The left leg: basal 1 is produced in a long claw-like process, terminating in a point; exopod 1 bears a distal marginal spine; exopod 2 and 3 forms a flattened leaf-like plate, broader than in *P. lobipes* and on the outer margin is a short sharp spine serrated on both borders; the inner margin of the plate is smooth.

Family PONTELLIDAE.

Genus **Acartia**, Dana.

Acartia chilkaensis, sp. nov.

(Plate IX, figs. 1-5.)

Examples of both sexes were present in the Chilka Lake collection.

♀. Total length = 0·75 mm.

Proportional length of cephalo-thorax and abdomen—

74 : 26 = 100.

The head and 1st thoracic segment are separate: thoracic segments 4 and 5 are fused. The posterior thoracic margin is rounded and is armed with a series of small spines.

The abdomen consists of three segments; of these the 1st and 2nd are armed on the dorsal part of the posterior margin with a row of minute spinules. The furcal rami are symmetrical; the 2nd furcal seta is much longer but not any stouter than the rest; the 5th seta arises about half-way along the outer margin of the ramus.

The abdominal segments and furca have the following proportional lengths:—

39 : 19 : 17 : 25 = 100.

The 1st antennae when folded back reach to the middle of the 1st abdominal segment. The segments have the following proportional lengths:—

Segments	1	2-6	7	8-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25.
	51	95	15	51	29	36	29	58	58	36	55	70	58	51	66	48	66	44	29 = 1000.

Segments 16, 17 and 19 are all armed with a transverse row of minute spines on the distal part of the posterior margin. There are no spines on any of the basal segments.

The 5th pair of legs.—These closely resemble those of *A. centrura*; the basal segment bears a long marginal seta, and the distal portion is dilated basally and is then produced in a curved spinous process with a small notch in the outer margin about the middle of its length.

♂. Total length = 0·70 mm.

Proportional length of cephalo-thorax and abdomen—

75 : 25 = 100.

The cephalo-thorax resembles that of the ♀.

The abdomen consists of 5 segments, having with the furca the following proportional lengths:—

10 : 31 : 20 : 6 : 14 : 19 = 100.

The abdominal segments are all devoid of spines and the 2nd furcal seta is not appreciably longer than the others.

The 1st antennae.—This appendage when folded back does not quite reach as far as the posterior thoracic margin. The distal segments have the following proportional lengths:—

$$\text{Segments } \frac{13 : 14 : 15 : 16 : 17 : 18 : 19\text{-}21 : 22\text{-}25.}{37 : 43 : 31 : 37 : 82 : 85 : 85 : 159.}$$

Segment 17 bears a spine-like tooth-plate which projects beyond the distal border over the following segment; segment 18 bears a palisade of fine needle-like spines on its anterior border; segment 19 bears two spine-like tooth-plates and carries a single long seta at its distal end.

The 2nd antenna resembles that of *A. centrura*.

The maxilliped resembles that of *A. southwelli*.

The 5th pair of legs.—The right leg forms the usual claw; basal 1 bears a stout seta; exopod 2 is produced internally in a roughly quadrilateral plate, and exopod 3 is curved and is armed with a spine on its inner margin and a terminal spine. The left leg: exopod 1 is produced internally in a rounded projection from the base of which arises a seta; exopod 3 is curved and rounded at the top and bears a long seta on its inner margin.

Similar examples of the ♂ were obtained in both collections: it is interesting to note that the specimens from Cochin are somewhat larger than those from the Chilka Lake measuring 0·82 mm. in total length and furthermore the abdominal segments are armed, segments 2, 3 and 4 all bearing a row of minute spines on the posterior margin dorsally. As, however, the specimens agree in all other particulars, I am inclined to regard this as a local variation; a very similar state of affairs exists in specimens of *A. southwelli* obtained from the Gulf of Mannar and the Chilka Lake.

Genus **Acartiella**, Sewell.

Acartiella gravelyi, sp. nov.

(Plate IX, fig. 7; Plate X, figs. 1, 4 and 5.)

Several examples, of both sexes, were present in the collection from Cochin.

♀. Total length = 1·4 mm.

Proportional length of cephalo-thorax and abdomen—

62·8 : 37·2 = 100.

The head and 1st thoracic segment are separate, as also are thoracic segments 4 and 5.

The anterior end of the head presents a uniformly rounded "forehead" and the rostrum is absent. The posterior thoracic margin is rounded and unarmed. The abdomen consists of three segments, of which the 3rd is extremely short, so short that it gives the appearance of a two-jointed abdomen. The furcal rami are not symmetrical, that on the right side being the longer.

The abdominal segments and furca have the following relative lengths:—

$$35 : 41 : 5 : 19 = 100.$$

The genital swelling forms a well-marked projection on the ventral aspect of the 1st abdominal segment. The 2nd furcal seta is stouter and considerably longer than the rest; the 5th seta arises from the external margin, at the junction of the middle and distal thirds of the segment, and there is a well-developed accessory dorsal seta.

The 1st antenna when folded back reaches to the middle of the 2nd abdominal segment. As in other members both of this genus and of the genus *Acartia*, the proximal segments of the antenna tend to become fused together: as the line of demarcation between segments frequently runs in a spiral round the antenna, the least change in position gives a totally different length measurement for any given joint. So far as I can make them out the following are the proportional lengths of the various segments in this species:—

Segments $\frac{1 : 2\text{-}4 : 5\text{-}6 : 7 : 8\text{-}9 : 10 : 11 : 12 : 13\text{-}14 : 15 : 16 : 17 : 18 : 19 : 20 :}{53 : 120 : 37 : 42 : 50 : 32 : 24 : 26 : 66 : 37 : 79 : 55 : 55 : 63 : 50 :}$
$\frac{21 : 22 : 23 : 24 : 25.}{53 : 40 : 55 : 42 : 21 = 1000.}$

Segments 2 to 4, 5 and 6, 8 and 9 and 13-14 appear to be fused together and segment 15 is also partially fused with the preceding segment. Many of the segments bear oblique rows of fine hair-like spines on their posterior surface.

The 2nd antenna has the same peculiar form as in *A. tortaniformis* (*vide* Sewell, 1912, p. 347 and pl. xxi, fig. 4).

The mandible bears four teeth of which the 1st is separated by an interval from the remaining three as in *A. tortaniformis*.

The maxilliped very closely resembles that of *A. tortaniformis*: the end joint bears the same four spinous processes, but the basal segment is armed with a row of 10-12 small spines instead of four large ones.

The 1st pair of legs.—Each consists of a two-jointed basal portion, a three-jointed exopod and a two-jointed endopod. Exopod 1 and 2 are devoid of marginal spines; exopod 3 bears one long seta-like marginal spine and the usual end-spine. On the inner margins the segments of the exopod bear 1, 1, and 5 setae respectively.

The 2nd pair of legs.—The exopod is three-jointed; exopod 1 bears a small marginal spine and one internal seta; exopod 2 has no marginal spine but bears one internal seta; exopod 3 bears a

marginal and an end-spine and carries five setae internally. The endopod is two-jointed Endopod 1 bears two and endopod 2 seven setae.

The 3rd pair of legs.—The basal portion is two-jointed. The exopod consists of three joints; exopod 1 bears a claw-like marginal spine and one seta; exopod 2 has no spine and one seta; exopod 3 bears one marginal spine, one end-spine and five setae. The endopod is two-jointed, the joints bearing 2 and 7 setae respectively.

The 4th pair of legs.—The basal portion is two-jointed. The exopod consists of three joints; exopod 1 bears a claw-like marginal spine and one seta; exopod 2 bears a claw-like marginal spine and one seta; exopod 3 bears a claw-like marginal spine and one end-spine, and there are 5 setae. The endopod is two-jointed; the joints bearing 3 and 7 setae respectively.

The 5th pair of legs.—Each consists of a basal segment bearing an external seta, and as is usual in this genus a single-jointed exopod and endopod.

The exopod is curved and ends in a sharp point: about midway along its external margin is a single small spine, and the distal fourth of the inner margin is finely serrated. The endopod is about ½ the length of the exopod and also terminates in a sharp point, and on the distal part of the external margin bears four teeth.

♂. Total length = 1·16 mm.

Proportional length of cephalo-thorax and abdomen—

64·6 : 35·4 = 100·0.

The head and thorax are the same as in the ♀.

The abdomen consists of five segments and the furca: of the abdominal segments the anal is very short and the 2nd and 3rd are by far the longest.

The furcal rami are very slightly asymmetrical, the right ramus being slightly the longer: the furcal setae are similar to those of the ♀.

The proportional lengths of the segments and furca are as follows:—

11 : 22 : 21 : 11 : 3 : 32 = 100.

The 1st antennae.—That of the left side is unmodified and resembles that of the female, though in several cases the segments are not as completely fused, thus rendering it possible to determine the lengths of individual segments:—

Segments	1	2-4	5-6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25.
	44	103	33	18	24	12	36	36	27	36	36	41	84	62	62	68	54	56	47	59	44	18 = 1000.

The right antenna is modified to form a grasping organ; the various segments have the following proportional lengths:—

Segments $\frac{1 : 2\text{-}4 : 5 : 6 : 7 : 8\text{-}10 : 11 : 12 : 13 : 14 : 15 : 16 : 17 : 18 : 19\text{-}21 :}{41 : 120 : 35 : 17 : 18 : 111 : 23 : 23 : 44 : 35 : 44 : 47 : 73 : 111 : 108 :}$

$$\frac{22\text{-}25.}{150 = 1000.}$$

The knee-joint is situated between segments 18 and 19 and the "endabschnitt" consists of two joints only. Segments 2 to 4 and 8 to 10 are fused; the 13th to 17th segments are somewhat dilated, though not markedly so; the 17th segment bears a tooth-plate which does not extend beyond the distal extremity of the segment; the 18th segment bears a tooth-plate and has two fang-like spines distally as in *A. tortaniformis*, and the 19th segment has two tooth-plates. All the tooth-plates are furnished with fine teeth.

The 2nd antenna, mouth-parts, and swimming legs are similar to those of the ♀.

The 5th pair of legs.—Each leg consists of a single ramus. The right leg possesses four segments; of these the basal one is produced distally in a pair of rounded wing-like flaps, which overlap the proximal part of the next segment; the 2nd segment carries a single seta on its external margin; the 3rd segment bears a single seta on its internal margin, and the 4th distal segment is pointed and claw-like and bears a single seta on its inner margin. The left leg consists of the common basal segment and three free segments; the 1st segment bears a single bristle externally; the 2nd segment is armed with a small marginal spine distally on the external margin, and the terminal segment bears a single marginal spine on its external border, a small spine on its internal margin and terminates in two unequal spines.

I have much pleasure in dedicating this species to Dr. F. H. Gravely, Assistant Superintendent, Zoological Survey of India, by whom the collection from Cochin was made.

Acartiella major, sp. nov.

(Plate IX, fig. 8 and Plate X, figs. 2, 3 and 6.)

Numerous examples of both sexes were present in the Chilka Lake collection.

♀. Total length = 1·41 mm.

Proportional length of cephalo-thorax and abdomen—

67 : 33 = 100.

The head and 1st thoracic segment are separate: thoracic segments 4 and 5 are fused.

The head presents a rounded anterior surface, and the posterior thoracic margin is rounded and unarmed. The rostrum is as usual absent.

The abdomen consists of three segments, having with the furca the following proportional lengths:—

39 : 31 : 8 : 22 = 100.

The 1st abdominal segment bears a slight rounded prominence posteriorly near the right border.

The furcal rami are symmetrical, and the furcal setae are five in number, of which the 2nd is longer and stouter than the others.

The 1st antennae.—The proportional lengths of the various segments are as follows:—

Segments $\frac{1 : 2\text{-}4 : 5 : 6 : 7 : 8\text{-}9 : 10 : 11 : 12\text{-}13 : 14 : 15 : 16 : 17 : 18 : 19 :}{64 : 108 : 32 : 37 : 23 : 44 : 23 : 25 : 71 : 34 : 37 : 44 : 57 : 57 : 71 :}$

$\frac{20 : 21 : 22 : 23 : 24 : 25.}{54 : 54 : 44 : 57 : 44 : 20 = 1000.}$

There are oblique rows of hairs on segments 7 to 18 very like the rows of fine spines on the segments of the antenna in *A. tortaniformis*.

The 2nd antenna is of the same form as in *A. tortaniformis*.

The 1st and 2nd maxillae are as figured.

The maxilliped terminates in the usual segment bearing four long spines, but on the margin of the 1st segment there are only 2 spines.

The 1st pair of legs.—This appendage closely resembles that of *A. gravelyi* but differs in that exopod 3 bears two fine hair-like marginal spines as well as the usual end-spine.

The 2nd-4th pair of legs.—As in *A. gravelyi*.

The 5th pair of legs.—Each basal segment carries a marginal seta; the exopod is long and curved, terminating in a sharp point; the inner margin is serrated along the distal ⅓, and on the outer margin is a single spine: the endopod is quite short, being only ¼ the length of the exopod, and it bears 2 or 3 teeth distally on its outer margin.

♂. Total length = 1·25 mm.

Proportional length of cephalo-thorax and abdomen—

$$65 : 35 = 100.$$

The abdomen consists of five segments, having with the furcal rami the following proportional lengths:—

$$11 : 21 : 18 : 9 : 5 : 36 = 100.$$

The furcal rami are not quite symmetrical, the right one being slightly the longer: the furcal setae are as in the ♀.

The 1st antennae.—That on the left side is unmodified as in the ♀ and its terminal joints have the following proportional lengths:—

Segments $\frac{11 : 12 : 13 : 14 : 15 : 16 : 17 : 18 : 19 : 20 : 21 : 22 : 23 : 24 : 25.}{27 : 34 : 34 : 34 : 34 : 48 : 62 : 66 : 70 : 52 : 55 : 39 : 55 : 39 : 20.}$

The segments are furnished with oblique rows of hairs as in the ♀.

The right antenna is modified to form a grasping organ: segments 13 to 17 are somewhat expanded and the knee-joint is situated between segments 18 and 19. The "endabschnitt" consists of two joints only; segments 19 to 21 and 22 to 25 are fused together.

The proportional lengths of the end segments are as follows:—

$$\text{Segments } \frac{13 : 14 : 15 : 16 : 17 : 18 : 19\text{-}21 : 22\text{-}25.}{45 : 48 : 41 : 48 : 57 : 123 : 109 : 140.}$$

Segment 17 bears a tooth-plate that slightly overlaps the following segment; segment 18 bears a tooth-plate and is armed with the usual two fang-like spines distally; segment 19-21 bears two tooth-plates, both of them spine-like, the distal being much the longer and overlapping the next segment; segment 19-21 also bears two setae, a terminal one and a small one about the middle of the length of the toothed surface. All tooth-plates are provided with fine needle-like teeth; on the proximal plates these are long, but on the distal plate of segment 19-21 they are very short.

The 5th pair of legs.—On the right side the basal joint is produced in a double flat process, the outer division being sharply pointed and the inner one rounded and wing-like. Each leg consists of three segments having the form typical of the genus.

On the right side exopod 1 bears a marginal seta; exopod 2 bears a single internal seta and exopod 3 terminates in a sharp point and bears a single seta on its inner margin.

On the left side exopod 1 bears a marginal seta; exopod 2 carries a distal marginal spine, and exopod 3 bears one marginal spine and three end-spines.

Acartiella minor, sp. nov.

(Plate IX, fig. 6 and Plate X, fig. 7.)

Examples of both sexes were present in the Chilka Lake collection.

♀. Total length = 1·14 mm.

Proportional length of cephalo-thorax and abdomen—

$$67 : 33 : = 100.$$

The head and 1st thoracic segment are separate and thoracic segments 4 and 5 are fused.

The forehead presents a rounded curved surface and the rostrum is absent; the posterior thoracic margin is rounded and devoid of spines.

The abdomen consists of three segments, having with the furca the following proportional lengths:—

$$31 : 20 : 26 : 23 = 100.$$

The furcal rami are asymmetrical, that of the right side being the longer; the furcal setae are as in *A. gravelyi*, the 5th seta arising from the external margin about the middle of the segment, while the 2nd seta is much longer than the rest.

The 1st antennae.—This resembles that of *A. gravelyi*; when folded back it reaches to the middle of the 1st abdominal segment.

The various joints of the antenna have the following proportional lengths:—

Segments	1	2-4	5	6	7	8	9-10	11	12-14	15-16	17	18	19	20	21	22	23	24	25.
	46	101	38	19	39	43	58	37	89	78	56	58	68	52	54	43	58	43	20 = 1000.

Segments 2 to 4, 9 and 10, 12 to 14 and 15 and 16 are respectively fused together. There are no spines on any of the segments.

The 2nd antennae, mouth-parts and swimming legs are as in *A. gravelyi*.

The 5th pair of legs have the form typical of the genus. The exopod is unserrated and is 3 to 4 times the length of the endopod which is short and pointed and is unarmed.

♂. Total length 1·07 mm.

Proportional length of cephalo-thorax and abdomen—

65 : 35 = 100.

The head and thorax are similar to those of the ♀.

The abdomen consists of five segments, having with the furca the following proportional lengths:—

10 : 20 : 16 : 10 : 6 : 38 = 100.

The furcal rami are nearly, though not quite, symmetrical, the right ramus being slightly the longer.

The 1st antennae.—That of the right side is modified to form a grasping organ. The proximal segments are so irregularly fused that it is almost impossible to determine their limits of demarcation. Segments 13 to 17 are somewhat swollen, and the knee-joint lies between segments 18 and 19. The "endabschnitt" consists of two joints.

The proportional lengths of the distal segments are as follows:—

Segments	13	14	15	16	17	18	19-21	22-25.
	47	47	47	47	66	109	105	134.

Segment 17 bears a tooth-plate that projects as a spine over the proximal end of segment 18; segment 18 bears a tooth-plate and two fang-like spines distally; segment 19-21 bears two spine-like tooth-plates of which the distal is much the longer and projects beyond the end of the joint; distally, segment 21 bears a single long seta. All the tooth-plates are armed with fine needle-like teeth.

The left antenna when folded back reaches to the hind end of the 3rd abdominal segment; it is unmodified as in the ♀. The proportional lengths of the distal segments are as follows:—

Segments	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25.
	13	33	38	38	38	44	61	55	65	53	57	41	61	41	19.

The *mouth-parts and swimming-legs* are as in the ♀.

The 5th pair of legs.—The basal segment is produced on the right side in a single stout conical process which overlaps the

proximal end of exopod 1. On the right side, exopod 1 is a stout segment bearing a single seta on its external margin; exopod 2 bears a rounded prominence on its inner aspect about the middle of its length, from the summit of which a seta arises; exopod 3 is curved, tapering to a point and bears a single seta on its inner border.

On the left side exopod 1 bears on its inner margin distally a single small spiniform process; exopod 2 bears a single small marginal spine distally; exopod 3 bears a small spine on its outer border, on the inner margin is a single small seta, and terminally are three unequal spines.

The original species of the genus *Acartiella*, *A. tortaniformis* (Sewell) was discovered in a collection from the Rangoon River Estuary (Sewell, 1912, p. 346), and all these new species occur in similar localities where the water is brackish: it is interesting to note the association of *Pseudodiaptomus binghami*, Sewell, with *Acartiella major* and *minor* in the Chilka Lake collection, for the only other locality in which *P. binghami* has hitherto been found is the above-mentioned Rangoon River Estuary.

The only truly marine form in this genus is *Acartiella kempi*, Sewell, which occurs in the Gulf of Mannar, and it is exceedingly interesting to note that this species in some respects tends to approximate to species both of the genus *Tortanus*, a purely marine genus, and of the genus *Acartia* in which many of the species are truly marine: thus in all other members of the genus the 2nd antenna has the peculiar flattened form which I described and figured originally in my description of *A. tortaniformis* (*Acartia tortaniformis*, Sewell, 1912, p. 346 and pl. xxi, fig. 4), but in *Acartiella kempi* it presents the form commonly found in species of the genera *Acartia* and *Tortanus*; again the 5th pair of legs in *A. kempi* ♂ is different in form from the corresponding appendage of other members of the genus in that it possesses a long process on the segment exopod 1 of the right leg, and further there is no process on the basal joint of the same leg, a condition that approximates to that found in the genus *Tortanus*: as regards the length of the abdomen *Acartiella kempi* ♀ nearly approximates to the genus *Acartia*. The known forms of this genus form a distinct series in respect of the proportional length of cephalo-thorax and abdomen, and I give the varying proportions below together with the proportion in two species of *Acartia*:—

♀ Species.	Cephalo-thorax.	Abdomen.
Acartiella tortaniformis ..	1·5	1·0
Acartiella gravelyi ..	1·7	1·0
Acartiella major) *Acartiella minor*) ..	2·0	1·0
Acartiella kempi ..	2·5	1·0
Acartia chilkaensis ..	2·85	1·0
Acartia southwelli ..	3·5	1·0

I give below an identification table by means of which the various species of the genus *Acartiella* can be distinguished from each other :—

I. ♂ and ♀.	(*a*) 4th and 5th thoracic segments separate	*A. gravelyi.*
	(*b*) 4th and 5th thoracic segments fused	vide II.
II. ♂ and ♀.	(*a*) 2nd antenna normal; *Acartia*-like.	*A. kempi.*
	(*b*) 2nd antenna having the flattened form typical of the genus ...	vide III.
III. A. ♀.	(*a*) 5th leg : endopod ⅓ length of exopod and both serrated	*A. tortaniformis.*
	(*b*) 5th leg : endopod short, ¼ length of exopod :—	
	(1) Exopod serrated on inner margin	*A. major.*
	(2) Exopod unarmed on inner margin	*A. minor.*
III B. ♂.	(*a*) Basal of right leg produced in a single process.	
	(1) A short triangular plate ...	*A. minor.*
	(2) A long narrow process ...	*A. tortaniformis.*
	(*b*) Basal of right leg produced in two processes, one rounded and the other triangular	*A. major.*

REFERENCES TO LITERATURE.

Sewell, 1912.—" Notes on the Surface-living Copepoda of the Bay of Bengal, I and II." *Records of the Indian Museum,* Vol. VII, Part IV, No. 29.

Sewell, 1914.—" Notes on the Surface Copepoda of the Gulf of Mannar." *Spolia Zeylanica,* Vol. IX, Part XXXV.

EXPLANATION OF PLATE IX.

FIG. 1.—*Acartia chilkaensis*, sp. nov., 1st pair of legs.
,, 2. ,, ,, ,, 2nd-4th pair of legs.
,, 3. ,, ,, ,, maxilliped.
,, 4. ,, ,, ,, 5th pair of legs ♀.
,, 5. ,, ,, ,, 5th pair of legs ♂.
,, 6.—*Acartiella minor*, sp. nov., 5th pair of legs ♂.
,, 7. ,, *gravelyi*, sp. nov., 5th pair of legs ♂.
,, 8. ,, *major*, sp. nov., 5th pair of legs ♂.

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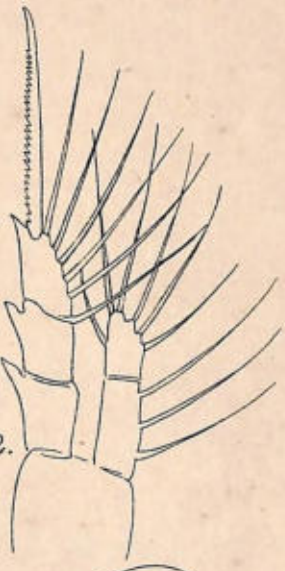
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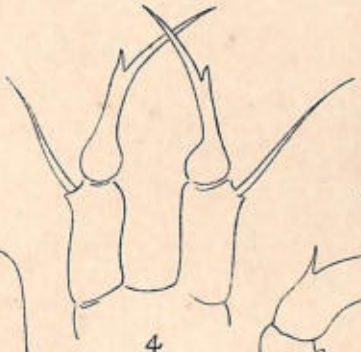
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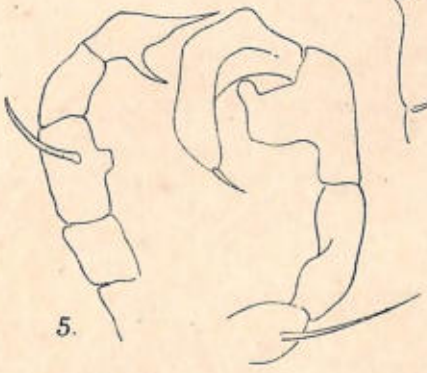
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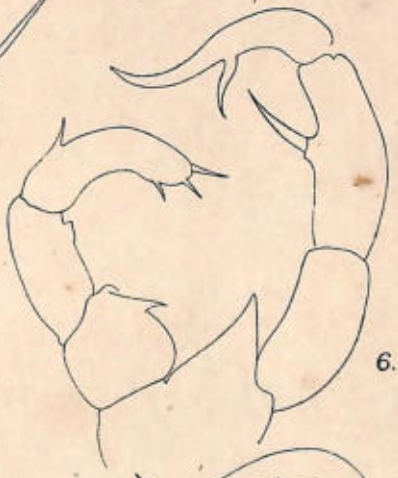
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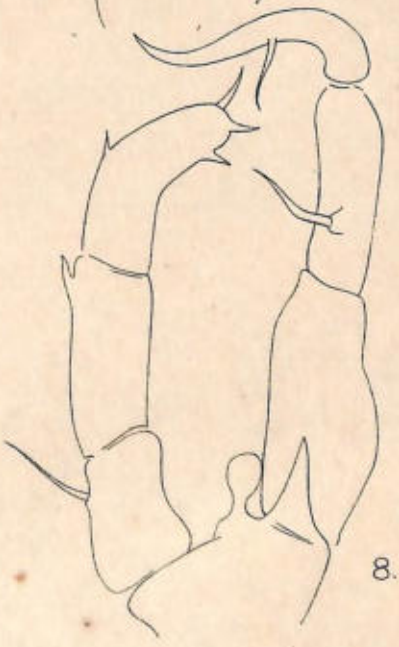
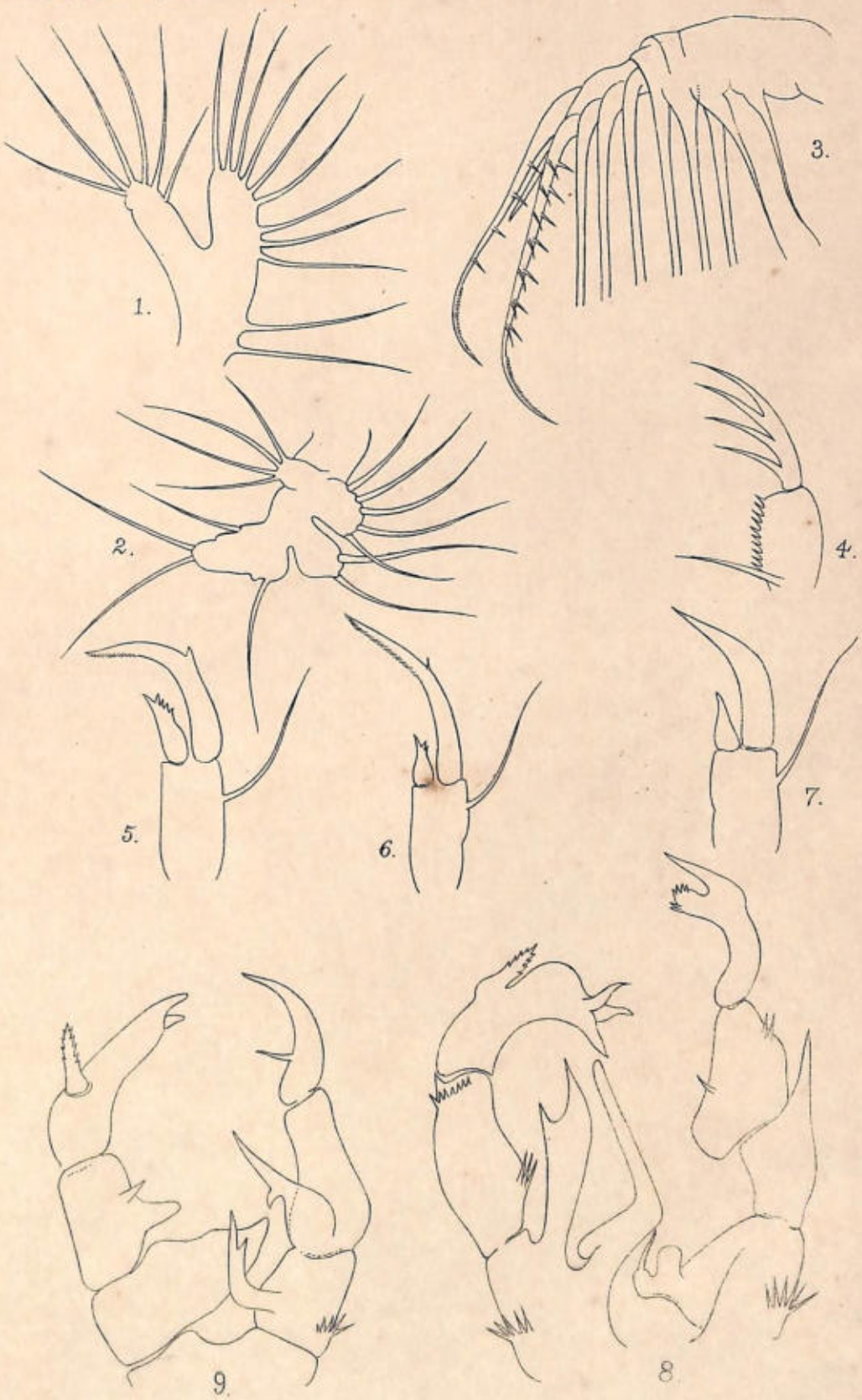

8.

EXPLANATION OF PLATE X.

FIG. 1.—*Acartiella gravelyi*, sp. nov., 2nd antenna.
,, 2. ,, *major*, sp. nov., 1st maxilla.
,, 3. ,, ,, ,, 2nd maxilla.
,, 4. ,, *gravelyi*, sp. nov., maxilliped.
,, 5. ,, ,, ,, 5th leg ♀.
,, 6. ,, *major*, sp. nov., 5th leg ♀.
,, 7. ,, *minor*, sp. nov., 5th leg ♀.
,, 8.—*Pseudodiaptomus tollingeri*, sp. nov., 5th pair of legs ♂.
,, 9. ,, *annandalei*, sp. nov., 5th pair of legs ♂.



R.B.S./S. del. A. Chowdhary lith.

II. NOTES ON THE INDIAN GLOW-WORM [*LAMPROPHORUS TENEBROSUS* (Wlk.)]

By C. A. PAIVA, *Assistant, Zoological Survey of India.*

[Read at the Fifth Indian Science Congress, Lahore, January, 1918.]

(With Plate VIII.)

The present paper is based on personal observations made during the months of August, September and October, 1917. Although the Indian glow-worm is quite common in most parts, especially during the rainy season, when snails, which form its natural food, abound, and although a good deal is known of the structure of larvae of the family and also something about their habits, no detailed account of the natural history of any particular species of Indian glow-worm seems to have been recorded. As is well known, these creatures are entirely nocturnal in their habits and spend the entire day in a state of rest or sleep from which it is almost impossible to awaken them. As soon as the light begins to fade they wake up from their slumber and wander forth in search of food. In their natural surroundings they are probably obliged to search a good deal before they find their food, as those, which I have had under observation, although supplied with a number of snails, always took some time before they secured a snail each. They can walk rather fast and when in quest of food the head is protruded as far as possible with the antennae, which are retractile, extended to their fullest extent.

My specimens were kept in breeding cages 12″ × 10″ × 8″ made of wood with perforated zinc sheeting and glass sides and door. Snails were constantly supplied to them.

Description of full-grown larva.

Length 60 to 65 mm. greatest breadth 19 mm.

Shining black, a rather broad yellowish ochraceous margin on the lateral areas of the thoracic and abdominal segments. The dorsal segments of the thorax and abdomen are composed of chitinous, somewhat flattened plates, partially overlapping each other, that of the pronotum concealing the head. Head protrusible, shining black, flat above, with a deep, central, V-shaped emargination bordered with light brown on anterior margin; mandibles dark red, their inner areas black, very robust, curved, rather bluntly pointed, not overlapping each other, but in the earlier stages these overlap each other to a great extent and are acutely pointed apically, base of mandibles broad with a strong blunt

tooth on inner margin, just below this tooth on the upper, flattened part of the mandible there is a patch of dense, silky, recumbent, light brown hairs, a shallow groove on the inner margin of each mandible along its attenuated portion, mouth light brown with two brushes of silky hairs interspersed with a few spinose hairs, visible only from above. Antennae three-jointed, basal joint whitish, very stout, a little shorter than second which is longest, second joint whitish with a dark line on its inner area, third joint very short, light brown, a few stiff, brown hairs at the apex of the second and on the third joint. Eyes very small, situated a little within the lateral margins of the head, almost immediately behind the bases of the antennae. Pronotum black, with two longitudinally oblique, discal fasciae, broadened anteriorly and narrowed posteriorly, extending from the anterior margin to a little before the middle of the disk and the lateral margins broadly yellowish ochraceous, lateral and posterior areas of disk rugose, anterior margin rounded, lateral margins oblique, the sides slightly recurved, posterior lateral angles rounded, the posterior margin slightly concavely sinuate near middle, a narrow longitudinal sulcation on middle of disk which extends nearly throughout the dorsal segments, a rather deep, oblique depression on each side of central area of disk; meso- and metanotum broader than pronotum, discally black and strongly rugose, with some pits or depressions, lateral areas similar in colour to those of pronotum, lateral margins almost straight, posterior margins very slightly concavely sinuate. Abdomen with the first seven segments black, the greater part of their posterior lateral areas broadly yellowish ochraceous and their lateral and posterior areas faintly rugose, the posterior margins of the sixth and seventh segments are broadly concavely sinuate, their posterior lateral angles being obtusely rounded, eighth segment much smaller than preceding segments, black with a whitish patch on each antero-lateral area, ninth segment almost entirely black with a very fine pale yellow line bordering its posterior margin, which is almost semicircular, its lateral margins rounded. Underside black with the head beneath light brown, margined with black. Membrane connecting sternal segments milky white. The ventral surface of each of the second abdominal segments to the ninth bears four longitudinal ridges, each ridge being furnished with a brush of short, stiff brownish hairs or bristles, which are easily broken off. A cluster of soft filamentous processes, which can be protruded at will, situated at the apex of the abdomen. The use of this appendage is explained on p. 22.

The first larva that attracted my attention was one brought by Dr. N. Annandale from Rambha, in the Ganjam district of the Madras Presidency in August, 1917. As soon as it woke up from its day's sleep it protruded its head about a quarter of an inch beyond the pronotum and commenced walking quickly about the floor of the cage in search of a snail. On finding a snail it examined it carefully and if it found that the snail had retracted

itself into its shell it sat on the shell with its head towards the opening and waited till the animal emerged in order to find out what was on top of it. The moment the snail appeared the larva made a sudden grab at its body and if it succeeded in obtaining a firm grip it allowed its head to be dragged in by the snail until it could go no further, then it commenced its meal, at first coiling itself round the shell and then lying on one side with the shell between its legs. It moved its mandibles sideways continuously while it fed. This operation lasted till there was nothing left of the snail and sometimes occupied a couple of hours Often when a snail was on the move it was attacked by the larva, but either out of self-defence or from the result of a bite withdrew itself into its shell and secreted a quantity of frothy matter, which the larva invariably sucked up. This, however, did not prevent the larva from continuing its attack, for as soon as it cleared this frothy secretion it inserted its head into the shell, seized the snail, and gradually devoured it. Occasionally it threw out some part of the snail's body, and in one instance I saw it come back to the spot where it had thrown out some refuse, as it were, and eat up what it had a moment ago apparently rejected.

The number of small snails (*Macrochlamys indica*) usually devoured in one night was about four, but on one or two occasions I found two empty shells of a small-sized *Achatina fulica* besides four smaller shells. It is doubtless the case that these creatures spend the whole night either eating or searching for food, for at half past four one morning I saw the larva walking about the cage with its luminous organ glowing very brightly as if it were looking for food. It may also have been possible that it was looking for a place of repose for the day.

On the 17th August at about 8.30 P.M. after I had put out all the lights I approached the cage stealthily, with a candle which I lit quickly. I found the larva standing with its fore-legs resting on the side of a watch-glass containing water. Its head was extended up to the water's edge and its mandibles and palps were being moved rapidly to and fro in the water. This went on for some time and though I placed the lighted candle inside the cage in order to watch it more closely, the larva did not seem to be affected. It occasionally thrust its head further into the water, moving it from side to side all the time. The manner in which the larva cleaned itself was very interesting. It usually rested its fore-legs on the receptacle containing water and protruded its head to its fullest extent into the water and moved its mandibles and palps rapidly to and fro. After some time it left the water and walked away a short distance where it lay on its side and rolled itself up. It appeared as if it were preparing to sleep after having had a drink of water. But this was not the case. It had been busy with its toilet. Having completed washing its mouth-parts in the water it now laid down to clean its body. It extended the filamentous appendage at the posterior end of its body, consisting of a number of soft, slender, retractile, sticky-looking objects which form

a sort of brush when extended; this was pressed closely first against each ventral segment, being drawn in its expanded state across the segment. After each segment had been cleaned this organ was retracted only to be placed on the next and succeeding segments, until all, but the one bearing the organ, were cleaned. This process of cleaning was applied to every part of the body in turn, always beginning from the anterior part. First the centre of the ventral segments was cleaned, then the right and left lateral areas. Having cleaned the underside it moved off to another spot where it remained in a standing position and cleaned the dorsal segments. The only segment it could not clean was the apical one of the abdomen as it could not be reached. After having finished cleaning its body thoroughly it went back to the water and appeared to drink, as its jaws and palps were almost stationary. I left the cage in perfect darkness for a quarter of an hour. When I returned I found the larva perched on top of a small stone, which was lying at the bottom of the cage, apparently asleep. I left it thus for the rest of the night. By the morning of the 21st the larva had dug a round hole about an inch and a half in diameter in the soft earth at the bottom of the cage, adjoining a small stone on which I had seen it perched the night before. In this hole it coiled itself up and remained so for the rest of the day. During the night of the 21st it began to enlarge this hole and by the morning of the 22nd it had gone well under the earth. Through a small hole the larva could be seen. It was still in its larval state. All the snails in the cage were thrown away. At 7.15 P.M. the same day the larva commenced to close up the opening through which it could be seen and which had been used for the purpose of throwing out mud excavated from the interior of the hole. Small quantities of earth were held between the mandibles and carried towards the opening. The earth was gently stuck into the side at the bottom of the hole; gradually it was carried to the top of the hole; on reaching the opening it was thrust with some force against the side, which caused the earth at the top to fall inwards, but just sufficiently to diminish the size of the opening. Continuing in this manner the larva succeeded in closing the opening entirely. It was now completely enclosed in its "dug-out." By the morning of the 23rd it had gone further under the earth and could be seen asleep through a large opening a little distance away from the one which it had closed up the night before. Apparently it had spent the night either in increasing the size of its "dug-out" or in going further underground, the large opening having been made for the purpose of placing the excavated earth outside. At 7 P.M. on the 23rd it was still asleep. The light of a candle made it glow faintly, but it did not move. On the morning of the 24th it was in the same position as on the night before. At about 4 P.M. on the 24th it glowed for a short time. On the windows being opened it ceased to glow. By dusk it commenced to close up the opening, which was accomplished in the same manner as explained before. On

the 25th it could not be seen at all. On the 26th some earth was removed by me causing an opening through which it could be seen lying perfectly still on its side. In order not to disturb it I placed a small stone on top of the opening. On the 27th I touched the larva with a match stick, which it seemed to resent as it moved and glowed. The opening was left uncovered from 5 to 8.30 P.M. during which time it glowed continuously. Nothing took place on the 28th and 29th. On the morning of the 30th the doors of the room were all closed and the room was in perfect darkness. I removed the stone which covered the opening and a faint glow was visible, which gradually died away. Noise of any kind, even talking, caused it to glow, though very slightly. In the evening I introduced another similar larva into the cage. This larva was sent by the Deputy Commissioner of Angul, Orissa. It appeared much larger than the other which had hidden itself in a "dug-out." The Angul larva behaved in exactly the same manner as the one from Rambha, devouring snails every night, having no regard to size or species. Nothing of special interest happened till the 5th September, when I noticed an empty shell of *Macrochlamys* stuck at the entrance of the "dug-out" in which the Rambha larva was. I removed the shell and found that the larva had changed its position and appeared to occupy more room than it had done during the past week or two inside its "dug-out." It also appeared as if it had eaten the snail, the shell of which was at the opening. Up to 6th September the two larvae were in one cage. On this day after dusk the larva from Angul walked about the cage and in its wanderings it came across the entrance to the "dug-out" of the other larva. It stopped a while at the entrance, peered into the "dug-out" and on seeing a light inside, it remained quite still with the anterior portion of its body almost covering the opening. The larva in the "dug-out" glowed all the time, sometimes more brightly than at others. This, however, did not scare away the Angul larva, which, after a while, began to make its way into the "dug-out." Presuming that this would terminate in one larva eating the other, I pulled the Angul larva away. The other larva had in the meantime protected itself from attack by turning its dorsal surface towards the opening of the "dug-out," thus offering a hard surface to the Angul larva in case of attack, and also barring the entrance to the "dug-out." Once pulled away the Angul larva did not further attempt to enter the abode of the other larva although the opening was left open all night. As an alternative it seized a medium-sized *Achatina fulica*, this being the second specimen of that species which it had eaten during the 6th. On the 7th September the Angul larva was placed in a separate cage. On the evening of the 8th I found the hole, in which the Rambha larva had been, empty. It (the larva) had changed its skin, which I afterwards discovered, was its last but one moult, and now appeared much larger. On leaving its "dug-out" it went forth in search of food. I had left a medium-sized *Achatina* in the

cage and it was not long before it commenced devouring it. Inside the "dug-out" were pieces of its cast skin, and on the side, at the furthest end, two of the largest dorsal plates were stuck hard up against it. On the 9th there were no snails left from the supply put into the cages on the 6th. On the 10th some large specimens of *Achatina* were put into the cages. These larvae seemed to prefer the larger snails, but if they were unable to overcome these, they readily devoured the smaller ones. At about 9 P.M. on the 10th the Angul larva was observed digging a hole in the soft earth at the bottom of its cage. This was accomplished by small quantities of earth being carried between the mandibles and deposited some distance away from the hole. On the first night the hole was not completed, only a slight depression having been made in which the larva passed the night and where I found it on the morning of the 11th. After sunset on the 11th both larvae walked about their cages, presumably looking for food. The Angul larva did not devour any snails, but tried either to get under a very large *Achatina* or to get hold of its body but the snail was too tough to allow the larva to fix its jaws in its body. The earth at the bottom of the cages appeared very dry, so I poured some water on it and as soon as the larvae found everything around them in a moist condition, they each left off what it was doing. The Angul larva's attempts having proved unsuccessful, it gave up attacking the large *Achatina* and betook itself to its pit or depression where, after cleaning its body, it retired for the night by 9.30 P.M. The Rambha larva took advantage of the water in its cage and began to clean itself. On the 12th this latter larva had managed to overcome a large *Achatina*, which it devoured. During the night the Angul larva had dug itself well under the soft earth. This was done in precisely the same manner in which the Rambha larva had done preparatory to moulting. Nothing worthy of note took place from the 13th to the 20th, the Rambha larva continued to eat and the Angul larva remained hidden underground. On the 21st morning I made a small opening on the top of the "dug-out" in which the Angul larva was, and I saw it still in its larval state. I covered up this opening with a tin cover so as to shut out all light. At 7.30 P.M. I uncovered the opening and found that the Angul larva had cast its larval skin and the creature now appeared almost milk white, the only visible black spots being the stigmata situated on the segment containing the luminous organs. The insect was now very sluggish and though handled a good deal with a tea-spoon, in order to secure the cast skin intact, it did not attempt to protrude its head or even move its legs. It glowed very brightly when touched. This was the pupal stage. On the 22nd the pupa was in the same state and its glow was now continuous. It remained so till the 27th when it cast its pupal skin between 3 and 4 P.M. The pupal skin is quite different to the last larval skin. The last larval skin resembles the larva exactly, both in texture

and appearance, while the pupal skin is quite flimsy and transparent throughout. Both these skins were carefully removed and are preserved in the collection of the Zoological Survey of India.

After casting its pupal skin the insect became quite sluggish and did not seem affected by being handled. It did not attempt to walk. It lay quietly on its side and glowed only when touched or when any loud noise was made. Its glow, however, did not last long. The Rambha larva continued to eat snails from the 23rd to the 27th, until it gradually decreased its food to a single snail a night. It now refused to touch even the smallest snail. At about 6-15 P.M. on the 28th the insect from Angul, which had now been transformed into an adult female *Lamprophorus* emerged from its "dug-out" and took up its position near one of the sides of the cage. Here it lay slightly on one side and turned up the posterior end of its body and glowed very brightly. On a light being shone on its cage the glow of the insect gradually died out and it commenced to walk round the cage. It made several attempts to get out of the cage, but finding no exit, it tried to get under a stone in the vain hope of finding an opening there. Seeing it so restless I placed the cage on an exposed window sill. Had there been any males of its species flying in the neighbourhood they would certainly have been attracted to the cage by its bright glow, although the moon was shining brightly and the skies were clear. On the morning of the 29th the female had got under a tin cover which was placed in the cage, and remained there for the rest of the day. Its milky colour had now changed to a very pale ochraceous on the middle of the first nine dorsal segments, the margins of which were pale yellow. The dorsal plates now appeared more flat than rounded. The ventral surface remained creamy white. The adult female cleans itself in the same manner as does the larva. Up to the 12th October the female had walked about the cage every night exhibiting its light at intervals in different parts of the cage. On one occasion I opened the door of the cage and it immediately walked out. After going a short distance it stopped, turned up the posterior end of its body and began to glow very brightly. Having glowed for a few minutes it attempted to go further off, but I put it back into its cage and it kept on glowing at various parts of the cage. It ate nothing, although a number of snails were placed in the cage. A little water was put in the tin cover in the cage for the snails to drink. The next morning the female was found inside the water, apparently drowned. I rescued it and placed it under the tin cover, leaving no water in the cage. It remained very quiet and listless during the day, but by evening it had revived and was walking about the cage as usual. During the night, that is the night it strayed into the water, it had layed four globular, pale yellowish eggs measuring about 3 mm. in diameter. It continued to lay eggs every night up to the 14th. In all it laid fifteen eggs. These eggs were luminous and could with ease be counted at the bottom of the cage in pitchy darkness. The luminosity of the eggs

did not appear to last for more than one night. On the afternoon of the 14th the female appeared very sluggish and apparently lifeless. Its colour too had changed to a dark brown.

The following is a description of the female taken immediately after death:—

Dark brown. Dorsal segments greatly arched, shining, faintly, transversely rugose, especially on the lateral areas; posterior margins of the abdominal segments narrowly ochraceous; some large irregular patches on the disk of the meso- and metanotum also pale ochraceous; lateral margins of all the dorsal segments narrowly shining black; a distinct, short, central, longitudinal carina on anterior area of pronotum which is posteriorly bifurcate, and beyond this is a narrow central longitudinal sulcation continued to about the metanotum; the lateral areas of each dorsal segment with some shallow pits or depressions. Legs and underside dark castaneous, with the central discal area of the abdomen brownish ochraceous; apical margins of all the abdominal segments clothed with a few short stiff, spinose hairs, which are very easily broken off; underside of femora and tibae of all the legs armed with short stiff yellowish hairs; apical joint of tarsi very long, as long as or longer than the remaining joints together. Antennae composed of six joints of which the basal joint is very stout, the second joint long, longer than the remaining joints together; these are very short and subequal in length; some stiff hairs on the antennal joints, the most conspicuous of all being two rather long ones at the apex of the second joint, and a single, long, curved one at the inner side of the apical joint; the palps are also hairy; jaws large, strongly curved, overlapping each other, pointed apically, black and shining on their distal half and reddish-brown on their proximal half. Eyes small, blackish, situated at the base of the antennae.

The larva from Rambha had eaten nothing for at least ten days. The earth at the bottom of its cage was damped and some water placed in a watch-glass. It was evidently very thirsty for it immediately went to the watch-glass and drank a good deal of water. During the night of the 11th October it tried to dig itself under the damp earth, but it did not make much progress. On the evening of the 12th it dug diligently for an hour or so until it made quite a deep pit. The excavated mud was carried in small quantities and placed first a little distance away from the hole and as the hole began to get deeper and the insect was able to get inside, it began to close up the entrance in the same manner as has been explained when referring to the Angul larva. It eventually hid itself entirely from view and I left it so till the 24th October when I noticed a change had commenced to take place. The larva had begun to cast its final larval skin, but this it did in a very awkward and certainly unusual manner, for insect larvae do not, as a rule, cast their skins piece-meal. First the three dorsal plates of the thorax were cast off, then the first dorsal plate of the abdomen and so on till all the dorsal plates had been

got rid of. It seemed greatly affected when any light shone on it. On the 25th morning the ventral plates still appeared to be uncast. Something seemed to have gone wrong with this creature as it lay on its back till the 28th, glowing very gently when exposed to view, either during the day or at night, but its moult was not completed. On the 29th it had discoloured altogether and had no resemblance, as far as colouration was concerned, to the pupa of the Angul insect. Its glow even began to be very irregular and faint. It was still limp and I took it out of its "dug-out." Several pieces of its larval skin still adhered to its ventral surface, especially over the stigmata. This probably caused asphyxia and the creature eventually died. I cannot assign any other reason for its death. It had lived under the same conditions as the larva from Angul, in fact it had been so well fed that it grew to an enormous size and prior to its leaving off eating it looked almost cylindrical. From the very beginning this larva seemed to have had some difficulty in ridding itself of its skin when moulting. At its last but one moult its larval skin was cast piece-meal, whereas in the case of the Angul specimen the larval and pupal skins were cast intact.

A point worthy of note is that I had never observed these larvae to glow during the day if undisturbed, though kept, for the most part, in a semi-dark room. The admission of strong sunlight did not even affect them, but any sound, however slight, caused them to glow immediately. After dusk the larva, when in the "dug-out," glowed continuously all night and the rays of light passing through the opening of the "dug-out" diverged to a great extent, reminding one of the rays of a search-light, for any object coming within these rays was enormously magnified. With regard to the glowing of the larva there is a difference in the use of the luminous organ when the creature is in the open and when it is in a hole. In the former condition it glows with both its luminous organs if it apprehends any danger, but in the latter state it only glows with that part which is uppermost and in a line with the opening of the "dug-out," the light being sufficiently strong to be seen at a great distance. The terminal sucker has been said to serve as an organ of locomotion, an organ of respiration, and an organ accessory to feeding. Of the first two there may be no doubt, but I have never seen a larva smear its head with any secretion preparatory to attacking a snail. Mr. C. J. Gahan says, "It is well known that Lampyrid larvae use the terminal sucker to clean their heads and limbs from the slime of the snail after having fed on the latter." This, which seems to be its chief use, I have explained fully on page 22. The luminous organ, as far as I have been able to observe, is used chiefly as a means of defence in the larva and as a means to attract the males in the adult female These larvae belong to that group of Malacoderms in which the female is larviform and the male is winged. The light emitted by these insects, both males and females, is not intermittent, but a bright steady glow. In that

group in which the light is intermittent and subject to rapid diminutions and increase of brilliancy, the males and females are both winged and are our true "fire-flies," which are generally seen in swarms.

Another very interesting point is the manner in which these glow-worms bury themselves underground. In both the specimens I had in captivity I noticed that they began digging at the middle of the cage. As soon as the insect got well underground it closed up the hole by which it entered and which had been used to throw out the excavated mud; it then gradually enlarged the burrow and extended it towards the further end of the cage until it met with an obstacle, in this case the wooden frame of the cage, which prevented further progress in a straight line. On meeting with this obstacle, the excavation was continued for a short distance to the left along the frame-work of the cage, where a comparatively large compartment was made, large enough to hold the insect in comfort and to allow perfect freedom of movement. Once the insect enclosed itself in this "dug-out" all light was shut out as no opening was visible. For the purpose of observation I made openings in the "dug-out" of both specimens and kept the light out by covering these openings with tin covers. From the foregoing observations I am inclined to believe that these insects, being entirely nocturnal in habits, dig burrows in which they spend their lives, resting in them during the day and coming out only at dusk in search of food. In captivity, when there is no hole for them to hide in during the day, they invariably seek some dark corner of the cage and partially bury their heads either at the side of the cage or alongside some object such as a stone or even a large shell. In these burrows they must also change their larval and pupal skins; but when the time for pupation arrives these burrows must be extended for some distance, the female or even the male must find its way out by making a fresh opening. These burrows must also be used by the females for resting during the day, for the Angul specimen always went back to its shelter under the tin cover and remained there all day, only coming out after dusk.

I have compared the full-grown larva and the adult female which I have successfully bred from it, with larvae and females of various species of Malacoderms from various localities in the collection of the Zoological Survey of India and I find that my specimens agree with those of *Lamprophorus tenebrosus* (Wlk.) collected by Drs. N. Annandale and F. H. Gravely in Ceylon. This species, besides being known from Ceylon, has also been recorded from Pondicherry; Dharwar, "taken during the rains"; Madura; all recorded by Gorham. Among the unnamed Malacoderms in the collection of the Zoological Survey of India there is a male *Lamprophorus* collected by Dr. N. Annandale, at Balugaon, Puri district, Orissa (21-30-vii-1913). This specimen agrees exactly with males of *L. tenebrosus* from Ceylon in the above collection.

EXPLANATION OF PLATE VIII.

Larva of *Lamprophorus tenebrosus* (Wlk.).

FIG. 1.—Full-grown larva.

,, 2.—Head from above (enlarged).

,, 3.—Left mandible, dorsal view (enlarged).

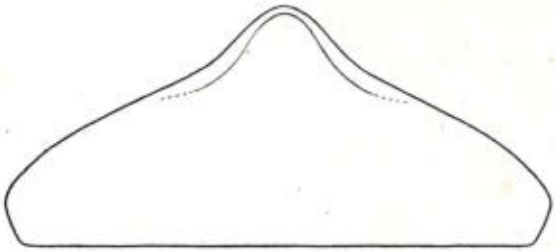
,, 4.—Left maxilla, ventral view (enlarged).

,, 5.—Labium, ventral view (enlarged).

,, 6.—Hypopharynx, ventral view (enlarged).

,, 7.—Mentum, ventral view (enlarged).

,, 8.—Submentum, ventral view (enlarged).



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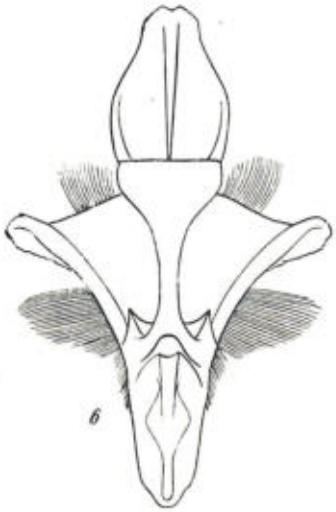

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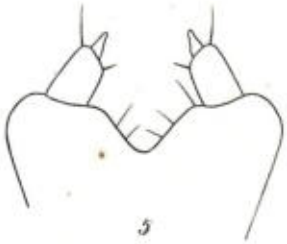

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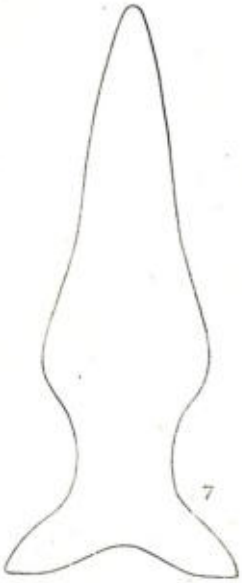

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LARVA OF *LAMPROPHORUS TENEBROSUS*, Walk.

III. INDIAN LAND PLANARIANS.

By R. H. WHITEHOUSE, *M.Sc., Professor of Zoology, Government College, Lahore.*

(With Plate XI.)

INTRODUCTION.

Until the present time the land planarians of India have been almost entirely neglected, while the Ceylon forms have been the subject of considerable attention; but it is hoped that the beginning thus made will develop into a comprehensive treatment of these animals which flourish abundantly in all parts where moisture is plentiful.

It was only to be expected that most of the collection would prove to be new; planarians, both land and freshwater, are strikingly local especially the latter; dry areas of any great extent prove complete barriers to their dispersal.

Previous records of Indian land planarians are rare, incomplete and uncertain. *Bipalium smithi* (v. Graff) is described, but with no figure, in von Graff's "Monographie der Turbellarien—Landplanarien" 1899 and references are made there also to some three or four others which, however, must be regarded as doubtful. Reference might be made to the so-called *Bipalium ferudpoorense* (E. P. Wright) and it is conjectured by Bell that Ferudpoor is a mis-spelling for Firozpur in the Punjab; but this is most unlikely, since Firozpur is in one of the driest and hottest parts of India, and scarcely a place likely to yield land planarians.

The following account is purely systematic, but it is hoped before long to begin anatomical details of the various forms, a work which will do much to clear up any doubtful points; for colour patterns are frequently variable, often due to the age of the specimens. At present it would be unsafe to make any general conclusions regarding distribution; what is known in each case is stated when dealing with each species.

Bipalium proserpina (Humbert).

(Plate XI, figs. 1 to 10.)

Indian Museum Collection Nos. ZEV $\frac{67.08}{7}$; ZEV $\frac{67.03}{7}$; ZEV $\frac{67.07}{7}$; ZEV $\frac{67.09}{7}$; ZEV $\frac{67.10}{7}$; ZEV $\frac{67.13}{7}$; ZEV $\frac{67.14}{7}$; ZEV $\frac{67.22}{7}$.

This planarian was previously reported from Ceylon only, but its distribution is now found to be quite extensive in India, specimens having been taken at Tenmalai, Maddathoray (Travancore)

and Cochin in Southern India, North Bengal, Lebong and Kurseong in the Eastern Himalayas, Naini Tal in Kumaon, Western Himalayas as well as in Ceylon. The specimen from Lebong may be doubtful since it is headless, but the trunk markings are characteristic of *B. proserpina*, and the doubt is lessened by the fact that the planarian fauna of the Eastern Himalayas is known to include this species. Thus *B. proserpina* will probably prove to be one of the most widely distributed land planarians in India.

The species has been fully described by v. Graff in his monograph and repetition is unnecessary; however, an interesting feature of those collected is the extent of the variation of the colour pattern apart from the mere differences of shade. The typical colouration exhibits a pair of closely approximated central black stripes, which on the head expand into a crescentic patch broken only by a middle club-shaped extension of the thin pale stripe which separates the median black lines; and a prominent black band extending from the 'neck' and following the edge of the trunk to the extremity (fig. 1).

The variations involve such changes in the typical pattern as follow:

The median lines may coalesce into a single broad band; associated with this, the central club-shaped expansion on the head remains, though it may be reduced (fig 2).

The same two lines may be quite faintly shown, and indicated only as broken lines; with this variation, the head pattern remains characteristic (fig. 3).

The median lines may be absent, and in this case the dark crescentic head patch appears as an unbroken tract (fig. 4).

In some cases the median stripes may be more strongly marked than the laterals (fig. 5).

The lateral bands may vary in breadth and usually are stronger when the median ones are weaker; and vice versa.

The lateral bands may be split along their whole length to form a pair on each side (fig. 6).

As regards the head pattern, the crescentic patch may be only faintly indicated (figs. 7, 8); and in one specimen with coalesced central lines, a forked design is produced, owing to the median lighter piece opening out anteriorly (fig. 9).

Pelmatoplana sarasinorum (v. Graff).

(Plate XI, figs. 11 and 12.)

Indian Museum Collection No. ZEV "".

Dr. Gravely records that a specimen of this animal from Ceylon was very dark above and paler beneath, with a dark mid-dorsal line. The preservative has doubtless removed some pigment and has also caused strong contraction of the body so that the dorsal surface has become concave; this latter feature is, however, undoubtedly not natural, the animal, in life, being practically cylindrical.

Its characters agree closely with v. Graff's specimens collected by M. Sarasin in 1883 in Ceylon. It is only half the size of the largest of those described by v. Graff, measuring about 36 mm. in length, and is unfortunately broken into two pieces. The upper side is brownish with a paler area along each side of the mid-dorsal line; the characteristically narrow ambulacral surface extends to the extreme anterior end round which are the fairly numerous eyes.

Bipalium smithi (v. Graff).

(Plate XI, figs. 13 and 14.)

Indian Museum Collection Nos. ZEV $\frac{6\,6\,7\,8}{7}$; ZEV $\frac{6\,7\,0\,1}{7}$; W $\frac{9\,3}{1}$; W $\frac{9\,4}{1}$.

Historically, the most interesting land planarian collected in India is *B. smithi*, since it was the first described from this country with any degree of certainty. The other few mentioned previous to 1914 were all vaguely described, and the accounts are practically useless. However, though he did not figure *B. smithi*, v. Graff describes it in his monograph and I have myself examined the specimen in the British Museum.

The species has, I believe, been found at least four times since; in its original home by Lord Carmichael and Dr. Gravely at Darjiling, and once by Major Bennett at Lebong in the same district.

The British Museum specimen measures 60 mm. in length, but the specimens found since are somewhat smaller; the measurements of the largest complete specimen are:—

Length of the body	45 mm.
Breadth of the body	6 mm.
Breadth of the head lobe ..	7 mm.
Breadth of the ambulacral surface ..	2 mm.
Thickness of the body	3 mm.
Position of the mouth from the anterior end	24 mm.
Position of the genital opening from the anterior end	36 mm.

The specimen from Lebong is much larger, though incomplete, and is probably longer than the British Museum specimen.

The dorsal colour is variable; the deeper layers of the skin contain a bluish-black pigment which is usually masked by a brown colour on the surface closely resembling a mucus, and which is undoubtedly more pronounced in spirit preserved specimens. Thus there may be a predominence of one or the other of these colours and frequently a somewhat patchy appearance is shown. The best preserved specimen is distinctly dark, mostly bluish-black, but paler on the head. The eyes form a diffuse black rim to the edge of the head lobe.

Ventrally, the colour is definitely characteristic; it is light brown except for the ambulacral surface which, along the centre, is creamish brown, while each side has a bluish-green tinge.

Bipalium floweri (v. Graff).

(Plate XI, figs. 15 and 16).

Indian Museum Collection Nos. ZEV $\frac{6871}{7}$; ZEV $\frac{6704}{7}$; ZEV $\frac{6705}{7}$.

This is one of the larger land planarians of Ceylon; it was first collected by Mr. E. E. Green at Punduloya, Rambodda, and the specimen is now in the British Museum.

It has again been found by Dr. Gravely in Pattipola and on the Horton Plains at an altitude of 7,000 ft. One of the Pattipola specimens is the largest yet collected, being 78 mm. long and 8 mm. broad.

The dorsal head pattern is characteristic; a prominent black band follows the periphery of the head lobe and parallel to this band is an orange stripe, which in turn is followed by another dark band which passes gradually into the dark brown colour of the trunk; the trunk colouring lacks pattern and is an even dark muddy brown.

Ventrally, the general surface is somewhat paler than the dorsal side, especially on the head; the latter has a thin dark line at the extreme edge terminating at the angle of the lappets. The ambulacral surface is cream coloured and at the anterior end its raised central portion is a distinct light brown.

Dolichoplana feildeni (v. Graff).

(Plate XI, figs. 17 and 18.)

Indian Museum Collection No. ZEV $\frac{6711}{7}$.

This species is most interesting from the fact that it is an exception to the general rule that land planarians are local in distribution, having been taken in Java, Ceylon and the Barbadoes. As v. Graff remarks, except for *Placocephalus kewensis*, which is cosmopolitan, it is the only land planarian that is found in the Oriental and Neotropical regions. It was previously recorded from Ceylon having been collected by Mr. E. E. Green and preserved in the British Museum.

The Indian Museum specimens, collected by Dr. Gravely, were taken at Peradeniya, Ceylon, in June 1910; they are about the same size as Green's specimens, measuring about 47 mm. in length and 3 mm. broad; the Javanese specimens are said to attain even a length of 300 mm. in the living condition, though the same individuals shrink to 77 mm. when preserved. It is therefore safe to assume that the Ceylon forms are capable of an extension to 150 mm. The species is described as being extremely active, exhibiting excessive contractions in its movements.

There is some variety in the general colour; the Javanese type is said to be yellowish while those from Ceylon are, at least in the preserved state, dark brown, though in life the same animal may be distinctly light coloured. Six longitudinal black stripes are distinguishable; a pair of median lines, very closely approxi-

mated and very fine; and two pairs of lateral stripes, the inner pair of which are much the strongest of all. Ventrally, the brown colour is continued from the dorsal side, except for the ambulacral surface which is grey; in light coloured varieties this contrasts with the general surface as darker, but where the brown pigment is is marked, the ambulacral surface appears lighter in contrast.

Bipalium diana (Humbert).

(Plate XI, figs. 19 and 20).

Indian Museum Collection No. ZEV $\frac{87}{2}$.

Three specimens of this species, one only of which is complete, were collected by Dr. Gravely at Peradeniya, Ceylon. They are typical forms corresponding exactly with those already recorded from the same and other localities in Ceylon by a number of observers.

Dorsally, it is brownish-grey with mottlings of black; a closely approximated median pair of black lines runs the whole length of the body, expanding on the head to a crescentic marking; the pale stripe of ground colour between the median lines swells out to a club-shaped form on the middle of the head. The extreme edge of the head lobe is black with numerous eyes and the band between them and the black patch is devoid of mottling.

On the ventral side, the colour is grey with a cream ambulacral surface having a light brown centre.

The species is easy to recognize in older specimens, though in the young forms it is said to have lateral dark bands along the body, which are lost in older animals.

Bipalium giganteum (Whitehouse).

Indian Museum Collection No. ZEV $\frac{8652}{2}$.

Previously recorded from Dibrugarh, Assam, this species was again taken in N.E. Assam at Tezpore by Major T. E. Spragge White. The tube contained three broken pieces of a specimen which is however still incomplete.

Bipalium andrewesi, n. sp.

(Plate XI, figs. 21 and 22.)

Indian Museum Collection No. ZEV $\frac{8680}{2}$.

Only a single specimen of this attractive planarian was taken by Mr. Andrewes on the western slopes of the Nilgiri Hills at an altitude of 2000-3000 ft. in August 1911. In build, the animal is small and sturdy with a comparatively small head lobe. Its measurements are as follows:—

Length of the body	..	10 mm.
Breadth of the body	..	3 mm.
Breadth of the head lobe	..	4 mm.
Breadth of the ambulacral surface	..	1 mm.

Position of the mouth from anterior end .. .. .. 6 mm.
Position of the genital opening not distinguishable.

The general ground colour of the dorsal side is a dark reddish-brown, though the markings upon it cover the greater part of the surface. Three longitudinal black stripes run from the 'neck' to the posterior extremity, a median broad band and a pair of less broad laterals at the edge of the body; all unite at the 'neck' in a narrow black transverse band. The head is slightly paler than the brown of the trunk, with a crescentic black band, which normally is probably continuous across the head, though in the specimen examined it is interrupted on the left side. The eyes are arranged along the extreme edge of the head lobe.

Ventrally, the animal is a dull drab brown, with a darker shade at the outer edge and also next to the ambulacral surface; this latter is very pale with a darker central stripe. The under side of the head is paler than the other parts and has a dark crescentic band corresponding to the black mark above.

Cotyloplana nilgiriense, n. sp.

(Plate XI, fig. 23).

Indian Museum Collection No. ZEV $\frac{6620}{7}$ B.

This is the second member of the genus to be found in India, and was taken in the Nilgiri Hills along with *Bipalium andrewesi*. The measurements of the larger of the two specimens are:—

Length of the body .. (about) 12 mm.
Breadth of the body .. .. 3 mm.
Position of the mouth from anterior end .. .. .. 6 mm.
Position of the genital aperture from the anterior end .. .. 9 mm.
Breadth of the ambulacral surface .. .. (about) ·5 mm.

Above and below the creature is of a greyish colour with touches of brown in parts; dorsally there is a single median black line passing from one extremity to the other and tapering suddenly at the head, which is somewhat lighter in colour. Round the anterior extremity of the ventral surface of the head is a slightly raised and fairly thick "lip," forming a type of sucker characteristic of the genus. The ambulacral surface is very narrow, appearing only as a pale line along the ventral side.

Bipalium brunneus, n. sp.

(Plate XI, figs. 24-26.)

Indian Museum Collection Nos. ZEV $\frac{6671}{7}$; ZEV $\frac{6695}{7}$.

This handsome planarian was collected at Bagarkote in Kumaon in the Western Himalayas, and in the Cochin State,

S. India; it must therefore have a wide distribution in India and will probably be found in many other districts eventually.

The following description refers in particular to No. ZEV $\frac{6671}{7}$ from Bagarkote at an altitude of 3,000 ft. which is the largest specimen.

Length of the body	58 mm.
Greatest breadth of the body ..	9 mm.
Thickness of the body	3 mm.
Breadth of the head lobe ..	6 mm.
Breadth of the ambulacral surface ..	3 mm.
Position of mouth from the anterior end	24 mm.
Position of the genital opening from the anterior end	33 mm.

The ground colour of the dorsal surface is a warm rusty brown with three longitudinal dark stripes, a median and a pair of laterals. The median stripe is prominent and jet black, extending from the extreme anterior to the posterior extremity, and widening slightly above the pharyngeal and genital regions. The lateral stripes are of diffuse black pigment and broader than the median, extending from the 'neck' to the posterior end of the body. The eyes are closely packed to form a thin jet black line round the edge of the head lobe; they are also found distributed generally over the head region.

The ventral surface, except for the creeping area, is a dull rusty brown with a greyish outer edge along the whole length but not sharply marked off from the brown. The ambulacral surface is purplish-grey, the middle being raised into a ridge; the mouth and genital openings are prominent and from them respectively protrude the frilled pharynx and genital organ.

The other specimen differs in minor particulars.

No. ZEV $\frac{6695}{7}$ from near the Forest Tramway in Cochin State at an altitude of 300 ft. is 17 mm. long and its dorsal colouring is of the same pattern as that of the specimen described above, with the following exceptions: The lateral bands are jet black and not diffused; the median line ends in a club-shaped expansion on the head, which is otherwise pale. These differences are such as may be met with in young specimens; it is characteristic of land planarians that stripes tend to disappear with age, a feature constantly illustrated in the case of *Bipalium diana*.

Pelmatoplana rotunda, n. sp.

(Plate XI, fig. 27).

Indian Museum Collection No. ZEV $\frac{6671}{7}$ B.

One specimen of this Geoplanid was procured along with *Bipalium brunneus* at Bagarkote in Kumaon, Western Himalayas, at an altitude of 3,000 ft., in June 1914.

The animal is small and very blunt at each end; in transverse section it is almost circular. Its measurements are:—

Length of the body	15 mm.
Breadth of the body	3·5 mm.
Thickness of the body	3 mm.
Breadth of the ambulacral surface ..	1 mm.
Position of the mouth from anterior end	7 mm.
Position of genital opening from anterior end	11 mm.

The dorsal coloration is an even moderately light brown covering a deeper black pigment. The ventral surface is slightly darker except for the very prominent ambulacral surface, which is white with a fairly dark median line, and which extends from one extremity to the other. The eyes could not be distinguished with certainty, though on one side there is a somewhat paler circular patch in the middle of which one of a pair of eyes may be situated.

Bipalium splendens, n. sp.

(Plate XI, figs. 29-31.)

Indian Museum Collection No. ZEV $\frac{6002}{7}$; ZEV $\frac{6710}{7}$.

This beautiful planarian is found at Kurseong in the Eastern Himalayas and Cherrapungi in Assam; the measurements of the larger specimen are as follows:—

Length of the body	90 mm.
Breadth of the body . ..	4·5 mm.
Breadth of the head lobe ..	3 mm.
Breadth of the ambulacral surface ..	1 mm.
Position of the mouth from anterior end	45 mm.
Position of genital aperture from anterior end	54 mm.

The upper surface is flat while the lower is slightly arched; the head is flat and small being only a little wider than the 'neck' and narrower than the greater part of the trunk, the body tapers gradually towards the posterior end. Judging from the wrinkling of the body in the preseved animal, it would appear capable of considerably greater extension in life.

The colour pattern on the upper side of the trunk consists of three longitudinal jet black lines, one median, and a pair of laterals, at the extreme edge of the body, on a ground colour which differs in the two specimens, in one a creamish yellow and in the other chestnut brown; at the pharyngeal region the median line widens to double its ordinary width, and a slight thickening also occurs over the genital region. The lateral lines, narrower than the median, cease at the 'neck,' while the median one expands into a knob-like termination on the head. The whole of the upper side of the head has a deeper shade than the rest of the body

The eyes are not numerous and are placed round the edge of the head lobe rather more to the ventral side.

Ventrally, the ground colour is similar to that of the dorsal side; the ambulacral surface is pale yellow, and on each side of it is a diffused black line, extending from the 'neck' to the extreme posterior, the under side of the head is a little darker towards the outer edge.

Pelmatoplana himalayense, n. sp.

(Plate XI, figs. 32-34).

Indian Museum Collection No. ZEV $\frac{87}{7}\frac{49}{}$; ZEV $\frac{86}{7}\frac{67}{}$; ZEV $\frac{86}{7}\frac{94}{}$; ZEV $\frac{87}{7}\frac{18}{}$; ZEV $\frac{87}{7}\frac{17}{}$.

This species is represented by three specimens, only one of which, collected by Dr. F. H. Gravely, is well preserved; the other two were the first to be found, on 15th July 1907, at Kurseong, E. Himalayas, while Dr. Gravely's specimen was taken in the same district between Darjiling and Soom on 14th June 1914. All were taken at an altitude of 5,000-7,000 ft.

The animal is a comparatively fragile creature, beautifully marked in black and brown stripes and of the usual Geoplanid form. The measurements are approximations only, since the animal is much coiled and liable to break if uncoiling were attempted.

Length of body .. .. 123 mm.
Breadth of body .. .. 4 mm.
Breadth of ambulacral surface .. 1 mm.
Position of the mouth, about half-way along the body.
Position of the genital opening, from mid-way to two-thirds the distance from the mouth to the posterior extremity.

The colour pattern consists of five jet black longitudinal bands alternate with four narrow stripes of a median brown colour; of the black bands, the median is the broadest, the inner lateral somewhat narrower, while the outer lateral, at the edge of the body, is but a thin line. All the brown stripes are of similar width. As the anterior end is reached, the black bands gradually acquire a more or less equal strength and end abruptly and evenly at the posterior border of a brown collar encircling the neck region. From the collar forwards the head is of a dark grey colour, sufficiently dark as to make it impossible to distinguish the presence or absence of eyes.

Ventrally, the colour is similar to the brown of the dorsal side, except for the ambulacral surface, which is white and slightly protuberant.

Bipalium sylvestre, n. sp.

(Plate XI, fig. 35 and 36).

Indian Museum Collection No. ZEV $\frac{86}{7}\frac{95}{}$B.

This planarian, of which one specimen only was taken in the Cochin State near the Forest Tramway, is a very dark form and

only at the anterior portion can the markings be followed. The measurements are:—

Length of the body	50 mm.
Breadth of the body	5 mm.
Breadth of the head lobe ..	6 mm.
Breadth of the ambulacral surface ..	2 mm.
Position of the mouth from anterior end	28 mm.

Position of the genital opening not visible.

The colour of the dorsal surface is a very dark brown; three longitudinal black lines are present, a median thin line reaching to the 'neck' and a pair of broader lateral lines at the edge of the body. These laterals are continued round the contour of the head a little removed from the edge and thickest near the lappets. On the head and alongside the lateral bands is a black mottling.

Ventrally, the colour is a warm brown at the outer edge, gradually becoming paler as the ambulacral surface is reached; the latter is pale with a brown central line throughout its length, and it ends abruptly at the 'neck.' The under side of the head is darker than the rest of the ventral surface.

Pelmatoplana maculosa, n. sp.

(Plate XI, figs. 37 and 38).

Indian Museum Collection No. ZEV $\frac{87.05}{7}$B.

One specimen only of this planarian was found by Dr. Gravely at Pattipola, Ceylon. Its measurements are:—

Length of the body	45 mm.
Breadth of the body	5 mm.
Breadth of ambulacral surface, about	·75 mm.
Position of mouth from anterior end	23 mm.
Position of genital opening from anterior end	31 mm.

The ground colour of both the dorsal and ventral sides must, strictly speaking, be regarded as a warm brown with heavy black mottlings on the dorsal surface. The mottling, however, is so dense as to make the dorsal colouring more easily described as black with irregular small brown splashes; these markings are dendritic, with a tendency to parallel arrangement with numerous cross connections. Extending from one extremity to the other is a median thin brown line, that is, a narrow portion of the grouud colour uninterrupted by black pigment. The black marking is practically continuous on each side of the median stripe and also at each side of the body where the colouring of the dorsal and ventral surfaces is sharply marked off. No eyes can be distinguished.

The ambulacral surface is pale and narrow, about one-fifth the width of the body, extending to both extremities; it is grooved throughout its length, with a darker pigment at the bottom of the

groove, though it is difficult to say how much this may be due to the effect of the preservative.

Pelmatoplana striata, n. sp.

(Plate XI, figs. 39-41).

Indian Museum Collection No. ZEV^{87,92}B.

Two specimens of this planarian were taken by Dr. Annandale at Maddathoray in Travancore from beneath rotten wood in the jungle in October 1908; both specimens are of about equal size, measuring 42 mm. in length and 5 mm. in breadth; the ambulacral surface is very narrow being less than a millimetre broad. Neither the mouth nor the genital opening can be seen probably owing to the fact that there is a groove running along the middle of the ambulacral area, and the apertures being situated at the bottom are invisible. However, the pharyngeal swelling, 20 mm. from the anterior end. would place the mouth at about half way along the ventral side, with the genital opening not far away. No eyes can be distinguished.

The general colour is a rather pale grey brown; six longitudinal dark stripes run from end to end; (1) a pair of closely approximated lines separated only by an extremely thin pale line; they are jet black and prominent; (2) an inner lateral, and (3) an outer lateral line on each side of equal strength and not much darker than the ground colour. Between the middle pair and the inner laterals is a pale creamy white area. Ventrally the colour is similar to the general colour of the dorsal side, except for the pale narrow ambulacral surface, which extends to both extremities.

Bipalium indica, n. sp.

(Plate XI, figs. 42 and 43.)

Indian Museum Collection Nos. ZEV $\frac{6662}{7}$; ZEV $\frac{6663}{7}$; ZEV $\frac{87,93}{7}$; ZEV $\frac{87,18}{7}$; ZEV $\frac{1231}{7}$.

This planarian has been found in Calcutta and at Coimbatoire in Southern India; it appears to be the commonest land planarian in the Calcutta district. and it will no doubt be found to have a somewhat extensive distribution in this country.

From the number of specimens collected, the length of the body may be put down as from 30 mm. to 40 mm. and the breadth from 3 mm. to 5 mm.; the head lobe is a little wider than the trunk; the mouth is situated about half the distance along the body, and the genital opening roughly half way between the mouth and the posterior extremity.

The dorsal colouration varies in different animals and in different parts of the same animal from a pale biscuit brown to a darkish dull brown; sometimes the body is distinctly patchy but usually the colour is even. There is an indication of a median pale stripe, but it is usually no more than an indication, except in

dark specimens, since it becomes lost in the general colour; at the 'neck' however it is always well marked owing to the presence in this region of dark pigment in the form of an indefinite band with which the median stripe contrasts strongly. The dorsal side of the head is pale and numerous eyes can easily be distinguished along the edge; the eyes are also crowded at the 'neck.'

Ventrally, the colour is similar to the dorsal side, though usually paler; the ambulacral surface is white

EXPLANATION OF PLATE XI.

FIGS. 1-9.—*Bipalium proserpina*. Variations in head and trunk markings; Fig. 1 typical pattern.

FIG. 10.—*Bipalium proserpina*. Ventral surface in the region of the mouth. The dark edge to the central pale ambulacral surface is not always marked.

,, 11.—*Pelmatoplana sarasinorum*, × 2. Dorsal view of the anterior end.

,, 12.—*Pelmatoplana sarasinorum*, × 2. Ventral view of the anterior end.

,, 13.—*Bipalium smithi*, nat. size. Dorsal view of the entire animal.

,, 14.—*Bipalium smithi*, nat. size. Ventral view of a portion of the trunk. Ambulacral surface cream, bordered with pale transparent green; rest rusty brown.

,, 15.—*Bipalium floweri*, × 2. Dorsal view of the anterior end.

,, 16.—*Bipalium floweri*, × 2. Ventral view of the anterior end.

,, 17.—*Dolichoplana feildeni*, × 2. Dorsal view of the anterior end.

,, 18.—*Dolichoplana feildeni*, × 2. Ventral view of a portion of the trunk.

,, 19.—*Bipalium diana*, × 2. Dorsal view of the anterior end. The lighter area round the median lines is not always present.

,, 20.—*Bipalium diana*, × 2. Ventral view of the anterior end.

,, 21.—*Bipalium andrewesi*, × 2. Dorsal view of the entire animal.

,, 22.—*Bipalium andrewesi*, × 2. Ventral view of the anterior end.

,, 23.—*Cotyloplana nilgiriense*, × 2. Dorsal view of the entire animal.

,, 23*a*. *Cotyloplana nilgiriense*, × 2. Ventral view of the anterior end.

,, 24.—*Bipalium brunneus*, nat. size. Dorsal view of the anterior end.

,, 25.—*Bipalium brunneus*, nat size. Ventral view of the anterior end.

,, 26.—*Bipalium brunneus*, nat. size. Dorsal pattern of the trunk.

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R. B. Whitehouse, del. Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1918.

INDIAN LAND PLANARIANS.

FIG. 27.—*Pelmatoplana rotunda*, × 2. Ventral view of the entire animal.

,, 29.—*Bipalium splendens*, × 2. Dorsal view of the anterior end.

,, 30.—*Bipalium splendens*, × 2. Dorsal pattern of the trunk in the region of the pharynx.

,, 31.—*Bipalium splendens*, × 2. Ventral view of the trunk.

,, 32.—*Pelmatoplana himalayense*, × 3. Dorsal view of the anterior end.

,, 33.—*Pelmatoplana himalayense*, × 2. Dorsal pattern of the trunk.

,, 34.—*Pelmatoplana himalayense*, nat. size. Ventral view of part of the trunk.

,, 35.—*Bipalium sylvestre*, × 2. Dorsal view of the anterior end.

,, 36.—*Bipalium sylvestre*, × 2. Ventral view of the anterior end.

,, 37.—*Pelmatoplana maculosa*, nat. size. Dorsal view of the anterior end.

,, 38.—*Pelmatoplana maculosa*, nat. size. Ventral view of the anterior end.

,, 39.—*Pelmatoplana striata*, nat. size. Dorsal view of the anterior end.

,, 40.—*Pelmatoplana striata*. Details of the dorsal pattern of the trunk.

,, 41.—*Pelmatoplana striata*, nat. size. Ventral view of the anterior end.

,, 42.—*Bipalium indica*, × 2. Dorsal view of the anterior end.

,, 43.—*Bipalium indica*, × 2. Ventral view of the portion of the trunk.

IV. STUDIES ON INFUSORIA.—II.

On two new species of *Holophrya*, Ehrbg.

By Ekendranath Ghosh, *M.Sc.*, *M.D.*

The genus *Holophrya*, Ehrbg. may be briefly diagnosed as follows:—Infusoria with cylindrical to spherical body entirely and uniformly covered with cilia arranged in close meridional rows. Cytostome antero-terminal or rarely slightly lateral, rounded or rarely slit-like. Cytopharynx generally present and without rod-apparatus, absent in a few species. Macronucleus one, sometimes two or numerous macronuclei. C.V. one or more, then either scattered or arranged in longitudinal rows. Division by transverse fission. Free-swimming, freshwater and marine.

The above diagnosis does not include the species *H. multifiliis* considered by Schewiakoff (5) to belong to this genus. Being parasitic and having a complicated life-history, it is left in a genus of its own under the name *Ichthyophthirius multifiliis*, Fouquet.

Holophrya bengalensis, sp. nov.

The species may be diagnosed thus:—Cylindrical with rounded ends, slightly stouter posteriorly; the cilia are long. Cytostome small and circular, at anterior end; cytopharynx absent; macronucleus broadly fusiform and placed in the middle of the body near one side; C.V. single, subterminal, placed close to one side. Length 0·075 mm.; breadth 0·037 mm.

A single specimen was found in vegetable infusion.

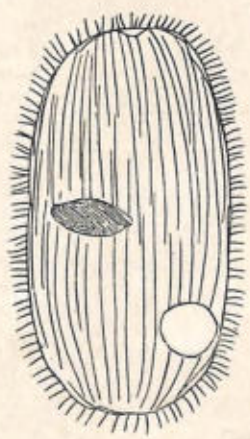

Fig. 1.—*Holophrya bengalensis*, sp. nov.

Holophrya annandalei, sp. nov.

The species may be diagnosed as follows:—Cylindrical, rounded at both ends, three times longer than broad; cytostome antero-terminal and circular in outline; cytopharynx a slight depression; ciliary striae faint; macronuclei two in number and spherical in shape, one placed in the middle on one side and the other towards the anterior end. C.V. single, placed at the junction of the anterior and middle third of the body on one side. Length 0·15 to 0·22 mm.

Several specimens were found in a vegetable infusion. Unfortunately the drawing of the animal is lost.

The species of *Holophrya* may be tabulated in the following synopsis:—

a. Numerous C.V., one postero-terminal and others in 1-2 longitudinal rows.
  a^1. 2 longitudinal rows of C.V.; macronucleus oval. *H. lieberkuhnii*, Schout.
  b^1. One longitudinal row of C.V.; macronucleus ribbon-shaped; body oval ... ... *H. coleps*, Schout. (6)
b. C.V. one or 2, postero-terminal or not.
  a^1. C.V. one.
    a^2. C.V. central; a tuft of long cilia round the mouth; macronucleus elongated and curved ... ... ? *H. pogonias*, Smith.
    b^2. C.V. placed at the junction of the anterior and middle thirds of the body on one side; macronuclei two, spherical; body cylindrical; cytopharynx a slight depression ... *H. annandalei*, n. sp.
  c^2. C.V. posterior.
    a^3. Ciliary striae oblique; body ovate; macronucleus ovate and subcentral. *H. ovum*, Ehrbg.
    b^3. Ciliary striae parallel to the long axis of the body.
      a^4. Cytostome slit-like and lateral near the anterior pole; body rounded in front and pointed behind ... *H. heterostoma*, Beardsley.
      b^4. Cytostome circular in outline and terminal or subterminal.
        a^5. Cytostome wide and occupying the entire truncate anterior end of the body.
          a^6. Body elongately oval; anterior end obliquely truncate; cytopharynx indistinct, with a few rods; macronucleus elongated and curved ... ... *H. tarda*, Quenn.
          b^6. Body oval; macronucleus long, cylindrical and twisted ... *H. curvilata*, Smith.
        b^5. Cytostome not so.
          a^6. No cytopharynx.
            a^7. Body elliptical.
              a^8. Macronucleus elliptical or spherical; body length 0·035 mm.; C.V. posterior and terminal ... ... *H. simplex*, Schew.
              b^8. Macronucleus horseshoe-shaped; body length 0·105 mm. ... ... *H. indica*, Bhatia (2)
            b^7. Body cylindrical; macronucleus fusiform in the middle of the body and lateral; C.V. near the posterior end and lateral ... *H. bengalensis*, n. sp.
          b^6. With cytopharynx.
            a^7. Circumoral cilia always directed forwards; macronucleus with a "binnenkorper" ... *H. etra* Svec.
            b^7. Circumoral cilia not so.
              a^8. Body elliptical or spherical; longitugdinal striae connected by transverse lines; macronucleus elliptical, with trichocysts ... ... *H. nigricans*, Lauterb.

b^8. Body cylindrical; no trichocysts; no transverse lines.
a^9. Cytostome terminal; cytopharynx short and funnel-shaped.
a^{10}. Numerous macronuclei; length = 5 times the breadth ... ... *H. oblonga*, Maupas.
b^{10}. Single oval macronucleus; length > breadth. *H. marina*, Quenn.
b^9. Cytostome lateral, near anterior pole; cytopharynx extending to middle of the body; a single elliptical macronucleus ... *H. edentata*, Schout.

b'. C.V. 2, postero-lateral; macronucleus big and oval; cytopharynx absent; body spherical to elliptical ... ... *H. haplostoma*, Andre.

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V. CONTRIBUTIONS TO A KNOWLEDGE OF THE CHILOPODA GEOPHILIMORPHA OF INDIA.

By F. SILVESTRI (*Portici, Italy*).

(With 39 text-figures.)

The Chilopoda Geophilomorpha described up to date from India (including Burma) are the following :—

Lamnonyx spissus, Wood. Burma.
,, *castaneiceps*, Haase. Andamans.
,, *punctifrons* (Newp.), from many localities.
Orphnaeus brevilabiatus (Newp.), from many localities.
Eucratonyx meinertii (Pocock). Mergui Archipelago; Burma, etc.
Himantosoma typicum, Pocock. Mergui Archipelago; Burma.
,, *porosum*, Pocock. Burma.
Disargus striatus (Pocock). Madras.
Polyporogaster indicus (Mein.). Kulu.
,, *insignis* (Mein.). Kulu.
? *Himantaricun doriae*, Pocock. Burma.

In the collection of the Indian Museum kindly sent me for examination by the Director of the Zoological Survey of India I have found specimens of 19 species or varieties, which are described in this paper with some others of the same genera or related genera of the Oriental and Malaysian regions preserved in my collection.

The rich material of the genus *Lamnonyx* has permitted me to make a revision of the species and related genera of the group, and has shown that *L. punctifrons*, Newp. from India, or at least the form considered as such by me, is restricted so far as we know to the East of South India; *L. insularis* (Lucas), which is distributed through tropical Africa, extends its range to W. India and in a varietal form to South India and Malaysia; *L. maxillaris* (Gerv.) is a cosmopolitan species in tropical and subtropical regions and has also been introduced into hot-houses of Europe. The remainder of the species of the genus *Lamnonyx* have a restricted area of distribution.

The genus *Lamnonyx* is represented in India by nine forms (species and varieties) out of 22 described up to date, and is a prevalent genus both for number of species and frequency of specimens.

After *Lamnonyx* the genera *Polyporogaster* and *Mesocanthus* have respectively three and four species in India, while the first

has a species in North Africa and two in North-West Asia, and the second has a species in North Africa and one variety of the same represented in East Africa and West India.

The genus *Himantosoma* is known up to date only from India and Malaysia and *Eucratonyx* from India and New Britain.

Subfam. *DICELLOPHILINAE.*

Geophili maxillares ex p. Gervais, *Ann. Sc. nat.* (2), VII, p. 178 (1837); *Id., Ins. Apt.* IV, p. 308 (1847).
Dicellophilidae, O. F. Cook, *Proc. U.S. Nat. Mus.* XVIII, p. 61 et p. 73.
Mecistocephalinae, Attems, *Zool. Jahrb. Syst.*, XVIII, p. 207 (1903).
Placodesmata, Mecistocephalidae, Verhoeff, Bronn's *Klass. u. Ord. Chilopoda*, pp. 270, 271 (1908).
Mecistocephalidae, Brölemann, *Arch. Zool. exp.* (5) III, p. 307 *et seq.* (1909); Ribaut, *Chilopoda*, in *Voyage Alluaud et Jeannel en Afrique or.* (1911-1912), p. 17 (1914).

Lamina cephalica longior quam latior, pedes maxillares magna pro parte haud tegens sutura frontali discreta. Antennae plus minusve attenuatae; labrum tripartitum parte media quam laterales multo minore plus minusve bene unidentata, partibus lateralibus margine nudo vel ciliato (setis instructo). Mandibulae laminis pectinatis in plerisque generibus numerosis, in gen. *Arrup*, Chamb. duabus, instructae. Maxillae primi paris subcoxis coalitis vel linea mediana divisis, malis utrimque duabus subaequalibus, integris parte distali attenuata, plus minusve arcuata, subhyalina. Maxillae secundi paris subcoxis coalitis vel linea mediana divisae, palpo (praeter subcoxas) 4-articulato articulo quarto unguiformi vel 3-articulato ungue nullo.

Lamina basalis subtrapezoidea, angusta, partim quam lamina cephalica plus minusve angustior; lamina praebasalis indistincta. Pedes maxillares longi, bene armati, subcoxarum lineis chitineis nullis.

Segmenta pedifera suprascutellis nullis, praescutello magno, sterna antica parte postica sat longa, gradatim angustiore in segmento sequenti intromissa et interne a margine postico usque ad medium sternum spissitudine longitudinali chitinea antice bifurcata vel non fulcro *entosternali* vel *furca* appellata, instructa sunt; sterna omnia poris ventralibus destituta.

Segmentum ultimum pediferum subcoxis plus minusve inflatis et poris numerosis instructis, pedibus (subcoxis exclusis) 6-articulatis, elongatis, ungue nullo.

Appendices genitales plus minusve distincte biarticulatae.

Pori anales duo.

Segmentorum numerus uniusquisque speciei constans.

Pulli ex ovo segmentorum numero adulti nascunt, segmenti praegenitalis subcoxis poris destitutis vel poro uno instructis, poris analibus magnis vel permagnis.

Familiae huic genera haec pertinent: *Dicellophilus*, O. F. Cook; *Lamnonyx*, O. F. Cook; *Megethmus*, O. F. Cook; *Arrup*,

Chamb.; *Prolamnonyx*, Silv. (*Tygarrup*, Chamb. forsan = *Dicellophilus*, O. F. Cook.).

CONSPECTUS GENERUM.

1. Subcoxae segmenti praegenitalis (ultimi pediferi) permagnae segmentum praecedente amplectentes ... *Megethmus.*
   Typus: *M. microporus* (Haase). Luzon.
2. Subcoxae segmenti praegenitalis ad latera segmenti praecedentis haud vergentes.
   3. Palpi maxillares ungue distincto instructi.
      5. Lamina cephalica spina antica infera sublaterali instructa ... ... *Lamnonyx.*
         Typus: *L. punctifrons* (Newp.). India.
      6. Lamina cephalica spina antica infera sublaterali destituta ... ... *Dicellophilus.*
         Typus: *D. limatus* (Wood).
   4. Palpi maxillares ungue nullo.
      7. Mandibulae laminis pectinatis numerosis instructae; maxillae primi paris subcoxis coalitis ... ... *Prolamnonyx.*
         Typus: *P. holstii*, Poc. China; Japan.
      8. Mandibulae laminis pectinatis duabus instructae; maxillae primi paris subcoxis mediis divisis ... ... *Arrup.*
         Typus: *A. pylorus*, Chamb. California.

ON THE FAMILY NAME HERE USED.

Newport in 1842 described the genus *Mecistocephalus* basing it upon the following species: (i) *Mecistocephalus ferrugineus* (C. Koch); (ii) *M. maxillaris* (Gerv.); (iii) *M. punctifrons*, Newp. etc. Newport did not indicate the type species of the genus, but O. F. Cook proposed to consider the first, viz. *Mecistocephalus ferrugineus* as the type, notwithstanding the fact that C. L. Koch in 1847 erected the genus *Pachymerium* for this species. Following this rule O. F. Cook founded in 1895 the genus *Lamnonyx* for the reception of *M. punctifrons* and allied forms and the genus *Dicellophilus* for *M. limatus* (Wood) of California. On the basis of this arrangement O. F. Cook named the family Dicellophilidae from *Dicellophilus*. Pocock in 1898 considered *M. punctifrons* as the type of *Mecistocephalus*, after C. Koch had taken out *M. ferrugineus*. Attems in 1903 refused in part to follow Cook and Pocock and considered, very wrongly, the species *M. carniolensis* as the type of the genus *Mecistocephalus*. This species was unknown to Newport, at any rate when he proposed the genus *Mecistocephalus*. Attems accepted the genus *Lamnonyx* with *L. punctifrons* as type species, and he therefore named the subfamily Mecistocephalinae. Verhoeff (1908), Brölemann (1909) and Ribaut (1914) followed Attems, but gave the group family rank.

Chamberlin (1914), with Pocock in 1898, noted that *M. ferrugineus* having been removed from *Mecistocephalus* as the type of *Pachimerium*, C. Koch (1847), *Mecistocephalus*, Newport must remain with the type species *M. punctifrons* and not *M. carniolensis*, which was not included by Newport in the list.

I prefer in similar cases to follow the view of Cook, assuming as type of the genus the first species ascribed to it by the author of the genus; in my opinion, therefore, *Mecistocephalus*, Newport has *M. ferrugineus* as type species and cannot be included in this family, which takes its name from another genus proposed by Cook, viz. *Dicellophilus*.

ON THE CHARACTERS FOR DISTINCTION OF GENERA AND SPECIES.

In this family good characters for the distinction of the genera are the form of the maxillary palps, the presence or absence of a spine on the underside of the anterior sublateral region of the epicranium, and the development of the subcoxae of the pregenital segment. I could not find any basis for the distinction of genera in the form of the teeth of the pectinate laminae of the mandibles, nor in the presence or absence of setae on the lateral parts of the labrum. Such characters have been retained as of great importance in the distinction of species, together with that of the relative length of the head, the number and form of the teeth of the maxillipedes, the form of the sternal furca, of the sternum and the number of pori on the subcoxae of the pregenital segment.

I note that the relative length of the epicranium has its value, but not an absolute value, because it appears to me to be variable in some degree and sometimes very variable on account of mutation or aberration. I, therefore, think it is not to be considered of first importance and cannot serve for the distinction of species, if not observed in a good series of specimens. This view has been followed by me invariably and a case I consider as an aberration is briefly discussed in the description of *Lamnonyx maxillaris*.

The colour also is very variable in the genus *Lamnonyx* and has, therefore, not been used by me for the distinction of species or of varieties.

ON GEOGRAPHICAL DISTRIBUTION.

The genera of Dicellophilinae known up to date are especially distributed from Japan and China to New Guinea, Malaysia and India.

Western North America has two genera with three species and Europe only one species, belonging to one of the North American genera, viz. *Dicellophilus*.

Tropical Africa has a species, *L. insularis* (Lucas), which extends to India, and in some places *L. maxillaris* (Gerv.), which is actually tropocosmopolitan and has been introduced into the Canary Is. and into Madeira, Paris and Hamburg.

South America, if we exclude *Tygarrup intermedius*, Chamberlin, described as coming from British Guiana but collected in pots of plants in Washington, has only the tropocosmopolitan *L. maxillaris*.

The centre of formation and distribution of genera and species of Dicellophilinae has certainly been somewhere between Japan, New Guinea and India.

Gen. **Lamnonyx**, O. F. Cook.

(Figs. I—XXIII).

Mecistocephalus ex p. Newport, *Proc. Zool. Soc. London*, 1842, p. 178; *Id.*, *Trans. Linn. Soc. London*, XIX, p. 429 (1844); Wood, *Tr. Amer. Phil. Soc. Philad.* XIII, p. 176 (1829); Meinert, *Nat. Tidsskr.* VII, p. 92 (1870); *Id.*, *Pr. Amer. Phil. Soc.* XXXIII, p. 212 (1885); Chamberlin, *Bull. Mus. comp. Zool. Cambridge, Mass.* LVIII, p. 209 (1914).
Lamnonyx, O. F. Cook, *Proc. U.S. Nat. Mus.* XVIII, p. 61 et 74 (1895); Attems, *Zool. Jahrb. Syst.* XVIII, p. 210 (1903); Verhoeff, Bronn's *Klass. u. Ord. Chilopoda*, p. 273 (1908); Ribaut, *Chilopoda*, in *Voyage Alluaud et Jeannel en Afrique or.* (1911-1912), p. 17 (1914).

Corpus postice attenuatum.

Lamina cephalica longior quam latior, sutura frontali discreta, genarum angulo antico interno ad labrum in processum acutum producto, superficie antica infera sublaterali externa in spinam producta. Antennae attenuatae.

Labrum tripartitum parte mediana angustiore, margine cetero nudo vel ciliato; mandibulae laminis pectinatis numerosis instructae superficie externa nuda; maxillae primi paris subcoxosterno medio diviso, mala externa et interna subaequalibus simplicibus, parte proximali bene chitinea et setosa, parte distali curvata, incolori, nuda; maxillae secundi paris subcoxosterno integro, palpo (ungue incluso) 4-articulato, ungue parvo vel perparvo.

Lamina basalis subtrapezoidea, angusta, haud multo postice latior quam longior.

Pedes maxillares flexi marginem frontalem superantes, subcoxis et articulis 2-4 plerumque armatis.

Tergita longitudinaliter bisulcata, praetergito segmenti primi pediferi perparvo obtecto, praetergitis ceteris magnis.

Sterna antica sulco mediano a parte postica usque parum ante medium sternum pertinente integro vel antice bifurcato. Praescutellum (paratergitum) quam scutellum spiraculiferum majus, scutellis ceteris vide fig. I, 9.

Segmentum ultimum pedigerum sterno bene evoluto, subcoxis poris numerosis instructis, pedibus (subcoxis exclusis) 6-articulatis, inermibus.

Pori anales duo.

Species typica: *Mecistocephalus punctifrons*, Newport.

Habitat.—Regiones tropicales et subtropicales; in hemisfaero australi etiam regiones temparatae.

Praeter species hic a me descriptae, generi huic pertinent etiam: *Lamnonyx angusticeps*, Ribaut, Africa or.; *L. japonicus* (Mein.), Japonia.

CONSPECTUS SPECIERUM HIC DESCRIPTARUM.

A. Pedum paria 49.
1. Sterna antica sulco mediano postico c. ad dimidium sternum bifurcato impressa.
3. Sternorum anticorum furca (semper in segmento decimo considerata) angulum acutum formans ... ... *L. punctifrons* (Newp.).

a. Mandibularum laminae pectinatae dentibus proximalibus quam distalibus parum diversis (a laminae dimidia parte ad basim gradatim parum minoribus).

c. Mandibularum margo internus integer, capite longiore quam latiore c. ut 75 : 45 ; segmenti ultimi sternum trapezoideum ... ... *L. punctifrons*, s. str.

d. Mandibularum margo internus brevi spatio serrato, caput, servata proportione, parum latius et segmenti ultimi pedigeri sterni latera minus convergentia ... ... *L. punctifrons* v. *sulcicollis* (Tom.).

b. Mandibularum laminae pectinatae dentibus proximalibus quam distales multo minoribus ... ... *L. punctifrons* v. *heteropus*, Humb.

4. Sterna antica furca angulum subrectum vel obtusum formante.

5 Sterna antica furca angulum subrectum vel parum obtusum formante.

7. Labri margo nudus ; mandibularum margo internus ad laminam primam integer vel subinteger ; laminarum pectinatarum dentes proximales sat magni quam distales gradatim parum minores ... ... *L. insularis*, Lucas.

var. Pedes primis paris quam idem formae typicae c. 1/4 longiores ... ... *L. insularis* v. *orientalis*, nov.

8. Labri margo totus breviter ciliatus ; mandibularum laminae tantum in apice dentatae, margine cetero setis brevissimis instructo.

9. Pedes maxillares ungue terminali valde uncinato et dentibus articulorum 2-4 etiam uncinatis ... ... *L. uncifer*, sp. nov.

10. Pedes maxillares ungue terminali moderate arcuato et dentibus articulorum 2-4 haud uncinatis ... ... *L. subgigas*, sp. nov.

6. Sterna antica furca angulum valde obtusum formante.

11. Labri margo submedianus setis brevibus instructus.

13. Segmentum ultimum pediferum sterno ante apicem paullum angustiore ; mandibulae lamina prima 11-dentata ... *L. superior*, sp. nov.

14. Segmentum ul imum pediferum sterno ante apicem multo angustiore ; mandibulae lamina prima 16-dentata ... *L. superior* subsp. *pallida*, nov.

12. Labri margo submedianus nudus.

15. Mandibularum laminae pectinatae dentibus proximalibus perparvis ... ... *L. cephalotes*, Mein.

16. Mandibularum laminae pectinatae dentibus proximalibus quam distales parum minores.

17. Corporis longitudo ad mm. 40 ... ... *L. maxillaris* (Gerv.).
18. Corporis longitudo quam dicta (mm. 40) major ... *L. cephalotes* v. *subinsularis*, nov.

2. Sterna antica sulco mediano antice haud bifurcato impressa.
19. Corpus ad mm. 50; sternum segmenti ultimi pediferi subtrapezoideum postice parum angustiore; subcoxae ejusdem segmenti poris numerosis instructae ... ... *L. rubriceps* (Wood).
20. Corpus ad mm. 20; sternum segmenti ultimi pediferi ante apicem angustiore; subcoxae ejusdem segmenti poris paucis (c. 15) instructae ... ... *L. modestus*, sp. nov.

B. Pedum paria minus quam 49.
21. Pedum paria 45.
23. Pedum maxillarium articulus secundus dentibus duobus armatus; sternum segmenti ultimi pediferi trapezoideum sat latum ... ... *L. spissus* (Wood).
24. Pedum maxillarium articulus secundus dente uno apicali armatus sternum segmenti ultimi pediferi angusto, lateribus gradatim parum convergentibus ... *L. diversidens*, sp. nov.
22. Pedum paria 47 ... ... *L. tahitiensis* (Wood).

C. Pedum paria magis quam 49.
25. Pedum paria 51 ... ... *L. gigas* (Haase).
26. Pedum paria 57 ... ... *L. diversisternus*, sp. nov.
27. Pedum paria 59 ... ... *L. smithi* (Poc.).
28. Pedum paria 65 ... ... *L. mirandus* (Poc.).

Lamnonyx punctifrons (Newp.).

(Fig. I).

Mecistocephalus punctifrons, Newport, *Proc. Zool. Soc.* 1842, p. 179; *Id.*, *Tr. Linn. Soc.* XIX, p. 429, pl. xxxiii, fig. 17 (1845); Gervais, *Ins. apt.* IV, p. 310 (1847); nec auctorum.

♀ Corpus supra latericium plus minusve fusco variegatum, subtus testaceum, capite rufo, antennis pallide rufis et pedibus ochraceis vel melleis.

Lamina cephalica c. 3/7 (75 : 45) longior quam latior, sat grosse et sparse punctata lateribus postice parum convergentibus.

Antennae gradatim attenuatae, articulo sexto duplo longiore quam ad apicem latiore, articulo ultimo etiam duplo longiore quam latiore, articulis 1-5 setis brevioribus et brevibus, articulis ceteris a sexto gradatim setis magis numerosis et brevioribus instructis.

Labrum medium incisum unidentatum margine cetero integro vel vix lobulato; mandibulae laminis pectinatis 9 10, quarum prima 6—7-dentata, mediana 20—30-dentata dentibus proximalibus gradatim parum minoribus, externe ad laminam ultimam processibus duobus plus minusve profunde bifidis, margine interno ad laminam primam integro, angulatim aliquantum producto; maxillae primi et secundi paris vide fig. I, 7-8.

Pedes maxillares flexi marginem frontalem spatio sat magno superantes, subcoxis coalitis parum latioribus quam longioribus,

antice incisione profunda et dentibus duobus obtusis instructis, articulo secundo externe c. 1/3 quam interne longiore dentibus duobus obtusis, quorum inferior parum minor est, instructo, articulis duobus sequentibus dente parvo obtuso, ungue terminali longo bene arcuato, integro, ad basim tuberculi obtusi instar parum producto.

Sterna furca typica angulo acutum formante et setis brevissimis numerosis instructa.

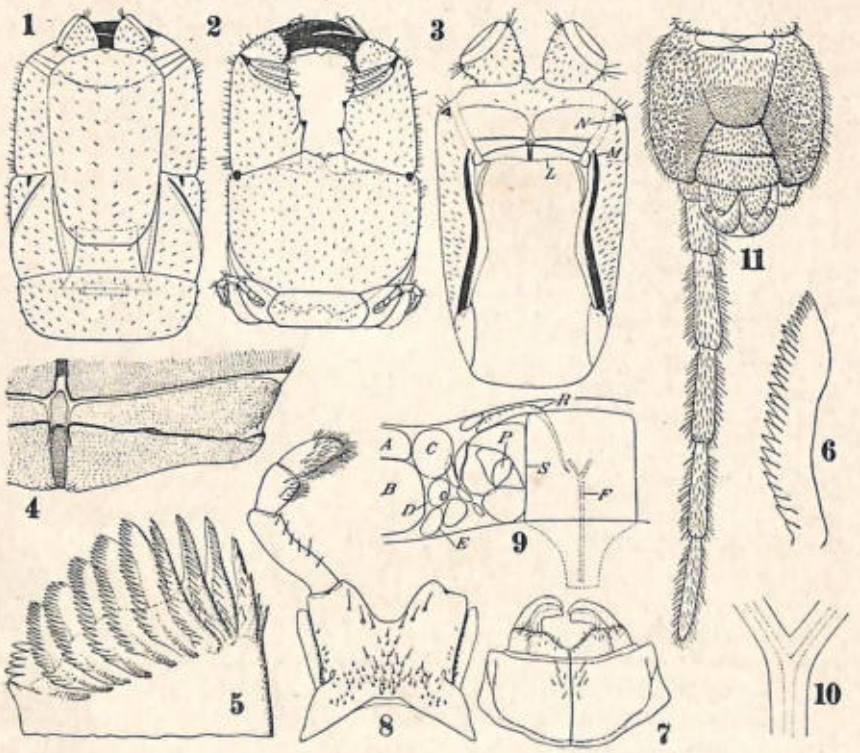

FIG. I.—*Lamnonyx punctifrons*: 1. caput et trunci segmenta primum et secundum prona; 2. eadem supina; 3. caput, praeter appendices, supinum; 4. labrum; 5. mandibulae pars distalis; 6. ejusdem lamina pectinata submediana; 7. maxillae primi paris; 8. maxillae secundi paris; 9. sterni decimi latera cum tergiti parte et sterno; 10. ejusdem furca; 11. feminae pars postica supina.

A = praetergitum, B = tergitum, C = praescutellum (paratergitum), D = scutellum spiraculiferum, E = postscutellum, F = furca sternalis, L = labrum, M = processus angularis genarum, N = spina infera antica sublateralis externa, P = pedis basis, R = praesternitum, S = sternum.

Pedes primi quam secundi parum minus quam dimidium breviores; pedes ambulatorii ungue terminali longo attenuato.

Segmentum ultimum pediferum sternito trapezoideo, postice setis brevissimis instructo, subcoxis poris numerosis sat magnis et aliis sparsis parvis instructis, pedibus gradatim attenuatis, quam paris precedentis parum minus quam duplo longioribus. Pori anales sat magni.

Pedum paria 49.

Long. corporis ad mm. 80, lat. segmenti primi 2.

Mas feminae similis, pedibus ultimi paris quam idem feminae parum crassioribus et parum magis setosis.

Habitat.—India: Trichinopoli (*Newton*); Rangamati, Chittagong Hill Tracts, Bengal (*R. Hodgart*).

On the nomenclature of L. punctifrons.—Newport described this species on specimens from Madras; from his time to the present day there have been referred to the same species specimens from other parts of Asia, Malaysia, New Guinea, Africa and America, but after an examination of many specimens I have been brought to consider as *L. punctifrons*, Newport, only the specimens

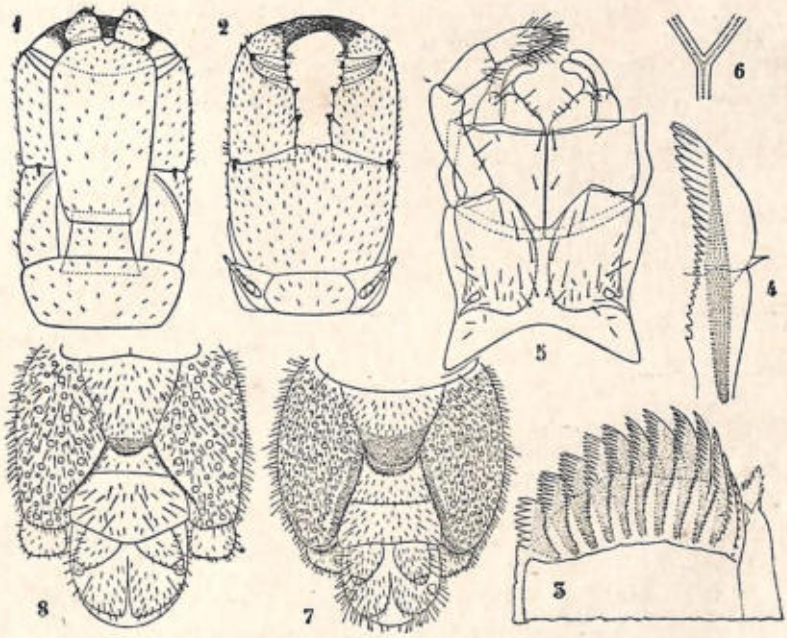

FIG. II.—*Lamnonyx punctifrons* v. *heteropus*: 1. caput et segmenta primum et secundum trunci supra inspecta; 2. pedes maxillares et segmentum primum pediferum subtus inspecta; 3. mandibulae pars distalis; 4 ejusdem lamina mediana; 5. pedes maxillares primi et secundi paris; 6. sterni decimi furca; 7.-8. feminae corporis pars postrema supina.

from Trichinopoli, a locality not far from Madras, and from a few other Indian localities.

Specimens from some parts of India and from Malaysia, Africa and New Guinea appear different from that considered by me to be *L punctifrons* and are here described as distinct varieties or species. As Gervais, Lucas, Meinert and Humbert described species of *Lamnonyx*, incorrectly retained by Pocock, Haase and others as synonyms of *L. punctifrons*, I have revived the greater number of these species, giving their names to specimens from the localities from which the types were obtained. I note that this method is not correct without the examination of the type specimens, but I

think that it is preferable, when it is impossible to obtain the types for examination, to refer to old species of the same locality the specimens which appear to agree with them in the light of the descriptions than to propose new names.

Lamnonyx punctifrons (Newp.) var. **heteropus**, Humb.

(Fig. II).

Mecistocephalus heteropus, Humbert, *Mem. Soc. Phys. Genève*, XVIII, p. 19, pl. ii, fig. 4 (1865).

Corpus ferrugineo-ochraceum dorso fusco marmorato, capite latericio.

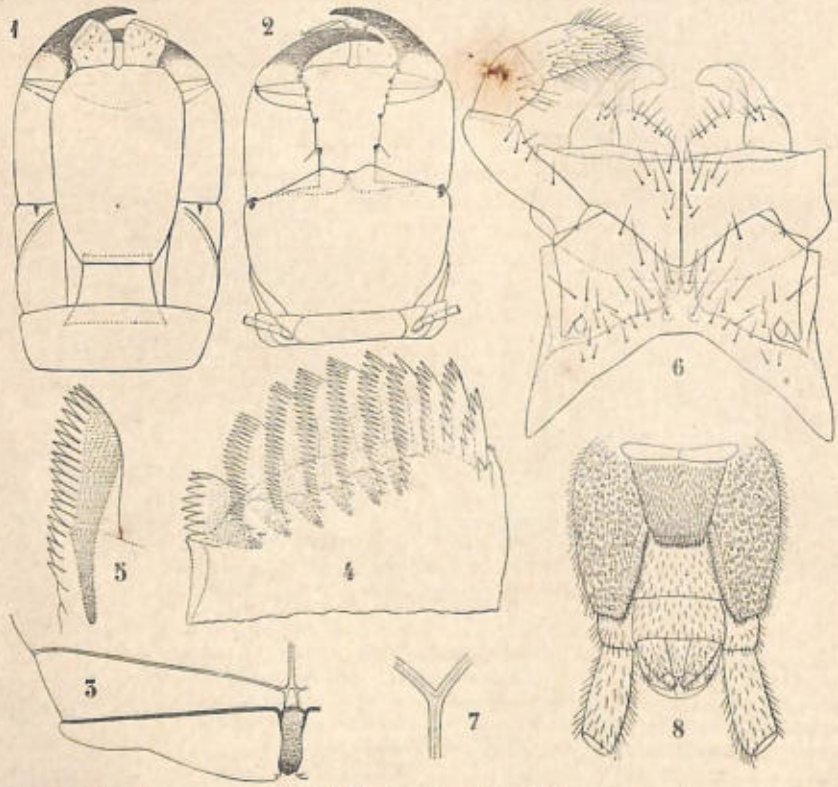

FIG. III.—*Lamnonyx punctifrons* v. *sulcicollis*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labri dimidia pars; 4 mandibula; 5. ejusdem lamina mediana; 6. maxillae primi et secundi paris; 7. sterni decimi furca; 8. maris corporis pars postrema supina.

Lamina cephalica parum minus quam duplo longior quam latior, superficie punctis parvis parum numerosis impressa.

Pedes maxillares subcoxis aliquantum antice latioribus quam longioribus, dentibus typicis bene evolutis.

Labrum unidentatum margine submediano convexo integro; mandibulae margine interno ad laminam primam serrato, laminis

pectinatis 12, quarum prima 7-dentata, ceterae dentibus proximalibus quam distales multo minoribus, medianae dentibus 25-30 instructae.

Notae ceterae ut in *L. punctifrons*, Newp.

Long. corporis ad mm. 85, lat. segmenti primi 3.

Habitat.—Ceylon: Pattipola (*Gravely*); Horton Plains, 7,000 ft. (*Kemp*).

Observatio.—Species haec a *L. punctifrons* (Newp.) mandibularum forma et a *L. cephalotes* (Mein.) sternitorum furca angulum acutum formante distincta est.

L. punctifrons (Newp.) var. sulcicollis (Tömösvary).

(Fig. III).

Mecistocephalus sulcicollis, Tömösvary, *Termèsz. Füzet.* VI, p. 162, tab. iii, fig. 3-4 (1882).

Corpore luride ochraceum capite testaceo.

Lamina cephalica et pedes maxillares parum latiora quam in forma typica ex Trichinopoli, mandibularum margo internus parum serratus, segmenti ultimi sternum lateribus parum minus convergentibus.

Long. corp. ad mm. 58, lat. 2·6.

Habitat.—Borneo: Irusau (*coll. Silvestri*).

Observatio.—Exemplum unum vidi, quod mihi aliquantum diversum ab exemplis ex Trichinopoli videtur et ut varietas considerandum.

Lamnonyx insularis (Lucas).

(Fig. IV).

Geophilus insularis, Lucas, *Myriapodes*, in Maillard, *Note sur l'ile de la Réunion*, ed 2, Paris 1863, Annex N, pl. xxi, fig. 1.

Mecistocephalus heros, Meinert, *Proc. Am. Phil. Soc.* XXIII, p. 214 (1886).

Mecistocephalus punctifrons, Porat, *Bihang Sv. Vet.-Ak.* XX, Afd. IV, No. 5, p. 20 (1894); Silvestri, *Ann. Mus. Genova* XXXV, p. 484 (1895); Broelemann, *Mem. Soc. Zool. France* VIII, p. 528 (1895); Saussure & Zehntner, *Abh. Senckenb. nat. Ges.* XXVI, p. 433 (1901); Saussure, *Myr. Madagascar*, p. 328, pl. xiv, fig. 14-14*b* (1902); Broelemann, *Boll. Soc. ent.* Ital. XXXV p. 118 (1903); Attems, ex p. *Zool. Jahrb. Syst.* XVIII, p. 211 (1903); Silvestri, *Mir.* in "*Il Ruvenzori*" *Relaz scientif.* I, p. 322 (1909); Attems, in "Voeltzkou", *Reise in Ostafrica* 1903-1905, *Wiss. Ergeb.* III, p. 80 (1910); Ribaut, *Myr.* I, *Chilopoda*, p. 117, pl. i, fig. 9-12 et pl. ii, fig. 13-15 in "*Voyage Alluaud et Jeannel en Afrique or.* (1914)".

Lamnonyx togensis, O. F. Cook, *Brandtia*, p. 39 (1896) *Pullus!*

Mecistocephalus punctifrons v. *glabridorsalis*, Attems, *Zool. Jahrb. Syst.* XIII, p. 138 (1900).

Corpus luride ochraceum vel ochraceo-testaceum, capita latericio dorso et lateribus immaculatis vel fusco plus minusve marmoratis, rare corpus totum cremeum capite fulvo-ferrugineo vel ferrugineo-latericio, antennis fulvo-ferrugineis, pedibus ochraceis vel cremeis.

Lamina cephalica parum minus quam duplo (12 : 7 vel 10 : 5·8) longior quam antice latior, lateribus postice parum convergentibus, superficie praesentim postice grosse punctata.

Antennae gradatim attenuatae, art.culorum longitudine et forma variabili, articulo sexto tam longo atque lato vel plerumque

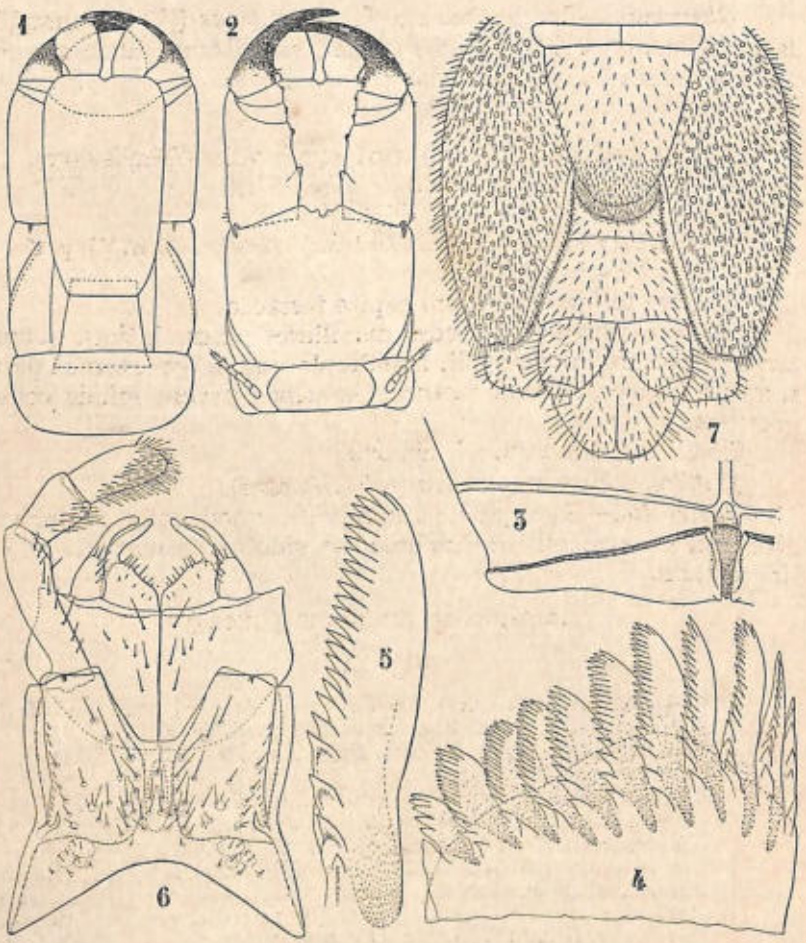

Fig. IV.—*Lamnonyx insularis*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labri dimidia pars; 4. mandibulae pars distalis; 5. ejusdem lamina mediana; 6. maxillae primi et secundi paris; 7. feminae corporis pars postrema supina (figuras omnes exempli ex Africa occidentali: ins. Annobom).

longiore (usque duplo) quam ad apicem latiore, articulo ultimo c. duplo longiore quam latiore, articulis 1-4 setis brevibus, articulis ceteris setis brevibus et setis brevioribus gradatim magis numerosis instructis.

Pedes maxillares flexi marginem frontalem spatio sat magno superantes, subcoxis coalitis parum (antice) latioribus quam longio-

ribus, dentibus typicis bene evolutis, ungue terminali attenuato, acuto, bene arcuato.

Labrum medium unidentatum margine cetero aliquantum convexo nudo; mandibulae laminis pectinatis 10 praeter laminam externam obsoletam, quarum prima 6—7-dentata, mediana, 20-dentata, maxillae primi et secundi paris vide fig. IV, 6.

Sterna furca angulum subrectum vel parum obtusum formante et setis numerosis brevissimis instructa.

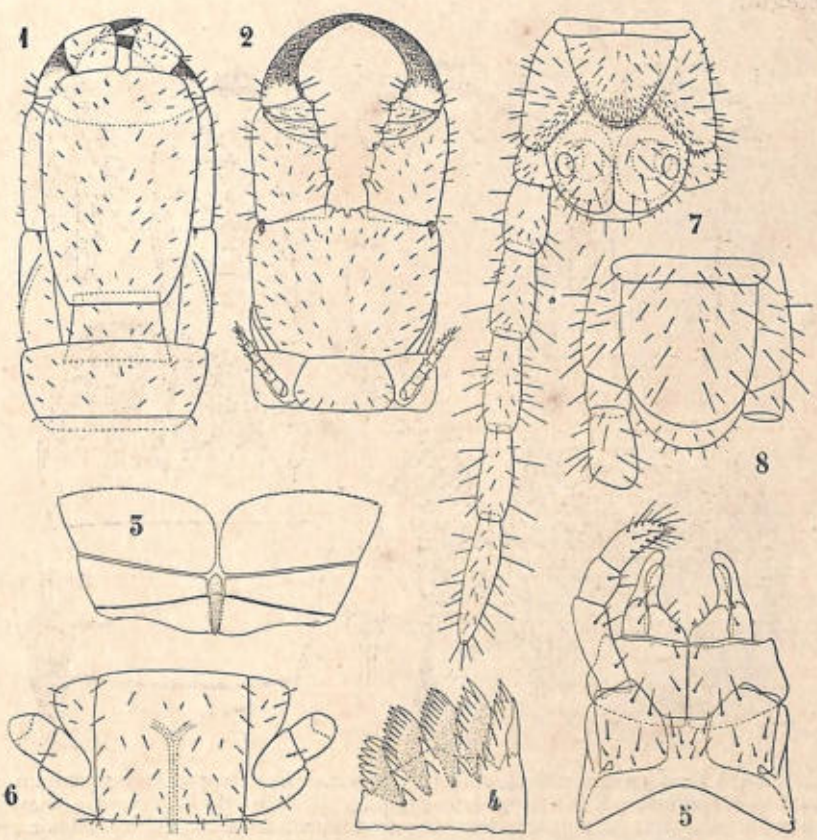

FIG. V.—*Lamonyx insularis*, pullus: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. sternum decimum; 7. corporis pars postrema supina; 8. eadem prona.

Pedes primi paris quam secundi dimidio breviores (long. maxima mm. 1·20); pedes omnes hirtelli, ungue terminali robusto.

Segmentum ultimum sternito trapezoideo postice ante apicem parum angustiore setis brevissimis praesertim postice pernumerosis instructo, subcoxis poris numerosis parvis et aliis magis numerosis perparvis instructis, pedibus parum attenuatis quam paris praecedentibus c. 1/3 longioribus brevissime setosis.

Pori anales sat magni, sub appendicibus genitalibus obtectis.

Pedum paria 49; long. corp. mm. 40-90, lat. segmenti primi ad 3·6.

Mas segmento ultimo pedifero, pedibus inclusis, quam idem feminae magis piloso.

Pullus (fig. V) iam coloratus long. corp. mm. 13, lat. segmenti primi 0·68. Corpus ochraceum capite ferrugineo. Caput forma eidem adulti simile, pedum maxillarium dentibus omnibus evolutis; segmentum ultimum pediferum subcoxis poris nullis; pori anales magni.

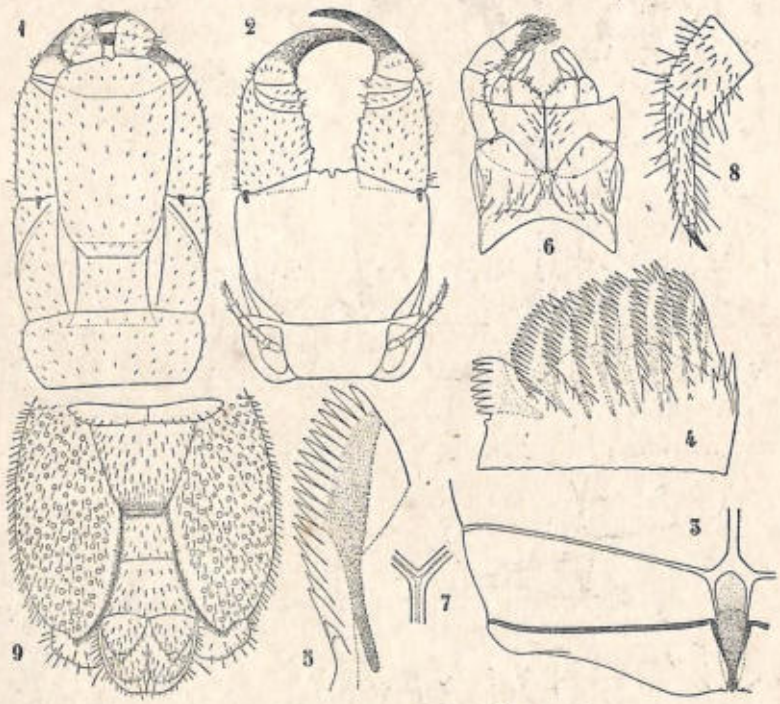

FIG. VI.—*Lamnonyx insularis* var. *orientalis*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labri dimidia pars; 4. mandibulae pars distalis; 5. ejusdem lamina pectinata submediana; 6. maxillae primi et secundi paris; 7. furca sterni decimi; 8. pedis decimi pars distalis; 9. feminae pars postrema supina (figurae exempli ex Kavalai).

Mandibulae laminis pectinatis 6, quarum prima 6-dentata, mediana 10-dentata, maxillarum setis vide fig. V, 5.

Habitat.—Africa tropicalis tota et insulae adiacentes. Exempla vidi ad Olokemeji (Nigeria), Aburi (Auris Costa), Segboroue (Dahomey), Victoria (Camerum), Quifangondo (Angola), Boma (Congo), Asmara (Erythrea), Somalia et Toro (Africa orientalis); Ins. S. Thomè; Vista Alegre, Ribeira, Palma, Ins. Fernando Poo; Ins. Annobon.

Exemplum typicum a Lucas descriptum ex ins. Réunion.

Exempla ex India: Parambiculam, Cochin State, 1700-3200 ft.

(*Gravely*); Foot of the Nellampathies, Cochin State (*G. Matthai*): cum exemplis ex Africa notis omnibus bene congruunt.

Observatio.—Species haec a *L. punctifrons* furca antica sternali angulum subrectum, vel parum obtusum (haud acutum) formante, poris subcoxarum segmenti ultimi pediferi minoribus bene distincta est.

Lamnonyx insularis (Lucas) var. **orientalis**, nov.

(Fig. VI).

Mecistocephalus punctifrons ex p. Haase, *Abh. Zool. u. Anthr. Mus. Dresden* I, N. 5, p. 104 (1887); Silvestri, *Ann. Mus. Genova* XXXIV, p. 134 et 719 (1895).

Varietas haec a forma typica differt pedibus primi paris quam idem *L. insularis* c. 1/4 longioribus (long. ad mm. 1·60), poris sub-

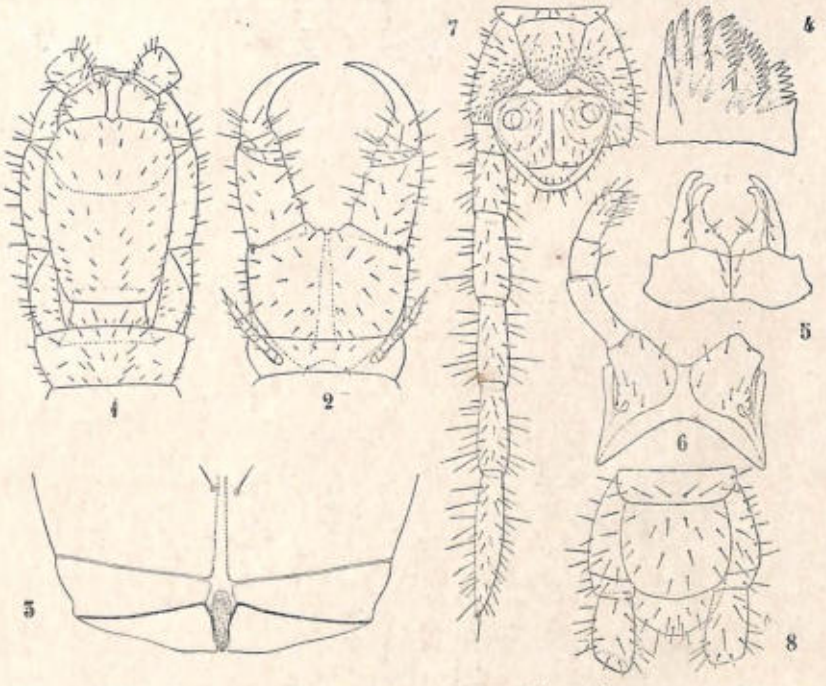

FIG. VII.—*Lamnonyx insularis* var. *orientalis*, pullus: 1. caput et segmenta primum et secundum prona; 2 eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi paris; 6. maxillae secundi paris; 7. corporis pars postrema supina; 8. eadem prona.

coxarum segmenti ultimi pedigeri parum majoribus (cfr. fig. VI, 9).

Pullus (cum matre ex Kavalai collectus) cremeus capite ochroleuco, long. corp. mm. 13, segmenti primi lat. 0·70 eodem formae typicae similis (cfr. fig. VII).

Habitat.—India: Kavalai (♀ cum pullis 15), Cochin State (*Gravely*); Kobo, 400 ft. (Abor Expedition); Ootacamund, S. India

et Anamalais (*Fletcher*); Mergui; Port Blair, Andamans; Sumatra: Si-Rambè (*Modigliani*).

Lamnonyx cephalotes (Mein.)

(Fig. VIII).

Mecistocephalus? pilosus, Wood, *J. Ac. Nat. Sci.* 1863, p. 43.
Mecistocephalus cephalotes, Meinert, *Nat. Tidsskr.* VII, p. 100 (1871).
Mecistocephalus? punctifrons, Attems, *Mitt. Naturh. Mus. Hamburgh* XXIV, p. 96 (1907).

♀ Corpus testaceo-ochraceum vel plus minusve dilute ochroleucum capite fulvo vel latericio.

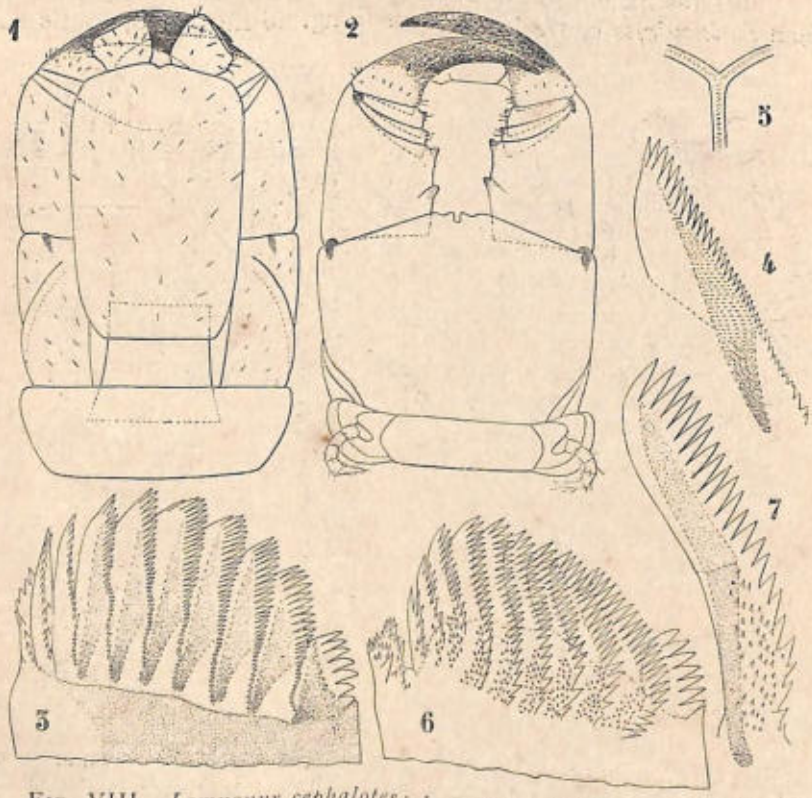

FIG. VIII.—*Lamnonyx cephalotes*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. mandibulae pars distalis; 4. ejusdem lamina mediana; 5. sterni decimi furca.
Lamnonyx cephalotes var. *multispinata*: 6. mandibulae pars distalis; 7. ejusdem lamina submediana.

Lamina cephalica c. 3/8 longior quam latior, lateribus postice parum convergentibus. Antennae gradatim attenuatae, articulo sexto c. 1/5 longiore quam ad apicem latiore, articulo ultimo c. 3/5 longiore quam latiore, articulis 1-6 setis brevibus, articulis ceteris etiam setis brevioribus gradatim magis numerosis instructis.

Pedes maxillares flexi marginem frontalem spatio sat brevi superantes subcoxis coalitis parum antice latioribus quam longioribus, dentibus typicis bene evolutis, unguo terminali bene arcuato.

Labrum medium unidentatum margine cetero convexo nudo; mandibulae laminis pectinatis 10, quarum prima 7-dentata, mediana c. 40-dentata, dentibus usque ad basim sistentibus et gradatim ab apice ad basim minoribus instructa; maxillae primi et secundi paris eisdem speciei pracedenti similes.

Sterna antica furca angulum obtusum formante.

Pedes primi paris quam secundi c. dimidio breviores; pedes omnes hirsutelli, ungue terminali longo robusto, attenuato.

Segmentum ultimum sternito trapezoidali, postice parum angustiore, brevissime persetoso, subcoxis poris sat numerosis et sat parvis, pedibus quam paris precedentis duplo vel parum magis quam duplo longioribus, postice parum attenuatis, hirtellis.

Pedum paria 49; long. corp. ad mm. 60, lat. segmenti primi 2·6.

Habitat.—Exemplum descriptum in monte Tengger, Java (*Frühstorfer*) collectum fuit. Exempla minora ex eodem loco corpore ochroleuco. Exempla alia vidi ad Gedè Java (*Frühstorfer*) collecta et ad Kalimpong, Darjiling, E. Himalaya, 600-4,500 ft (*F. H. Gravely*); ad Darjiling, 6,000-7,000 ft. (*Id.*); ad Singla, Darjiling, 1,500 ft (*Lord Carmichael*); ad Hanoi (*V. Demange*); ad Tan-Moi, Tonkin (*Frühstorfer*).

Observatio.—Species haec a *L. punctifrons* et a *L. insularis* furca sternorum anticorum angulum obtusum formante bene distincta est.

Lamnonyx cephalotes (Mein.) var. **subinsularis**, nov.

Varietas haec a forma typica mandibularum laminis pectinatis dentibus proximalibus quam distales parum minoribus differt.

Habitat.—Ceylan: Madatugama (*Madarasz*); Sumatra: M. Singalan (*Beccari*); Mergui (*Mus. Calcutta*); Tonkin: Hanoi (*Demange*).

Lamnonyx cephalotes (Mein.) var. **multispinata**, nov.

Varietas haec a forma typica mandibularum (fig. VIII, 6, 7) laminarum partis proximalis superficie spinis minimis numerosis instructa distinguenda.

Corpus ochroleucum vel ochraceum capite latericio.

Long. corp. ad mm. 52, lat. segmenti primi 2·4.

Habitat.—India: Rotung, 1,400 ft. et Upper Rotung, Abor Exped. (*Kemp*).

Lamnonyx maxillaris (Gerv.).

(Fig. IX).

Geophilus maxillaris, Gervais, *Ann. Sci. nat.* (2) VII, p. 52 (1837); *Id.*, *Atlas de zoologie* pl. 55, fig. 4 (1844); *Id.*, *Ins. apt.* IV, p. 309, pl. 39, fig. 5 (1847).

Mecistocephalus guildingii, Newport, *Tr. Linn. Soc.* XIX, p. 429 (1845); Meinert, *Nat. Tidsskr.* (3) VII, p. 97 (1871).
Mecistocephalus gulliveri, Butler, *Ann. Nat. Hist.* (4) XVII, p. 446 (1876); *Id., Phil. Trans.* CLXVIII, p. 500 (1879).
Mecistocephalus punctifrons ex p. Haase, *Abh. Mus. Dresden* I, N. 5, p. 104 (1887); ex p. Pocock, *Ann. Mus. Genova* XXX, p. 423 (1891); Latzel, *Jahrb. Hamb. Wiss. Anst.* XII, p. 5 (1895); Broelemann, *Bull. Soc. ent. France* 1897, p. 136.
Lamnonyx leonensis, O. F. Cook, *Brandtia*, p. 39 (1896).
Mecistocephalus parvus, Chamberlin, *Psyche* XXI, p. 85 (1914).

♀ Corpus pius minusve dilute ochraceum capite latericio vel rufo-ferrugineo, antennis rufo-ferrugineis, pedibus corpori concoloribus.

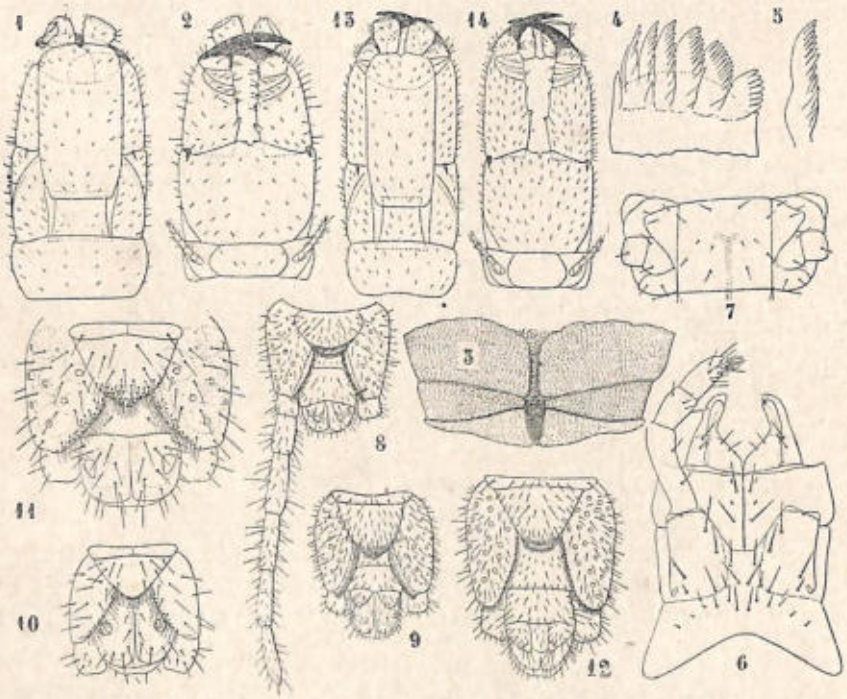

FIG. IX.—*Lamnonyx maxillaris*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. ejusdem lamina submediana; 6. maxillae primi et secundi paris; 7. sternum decimum; 8. feminae corporis pars postrema supina (fig. 1-8 exempli ex Kierpur); 9. feminae corporis pars postrema supina (exempli ex Hawaii); 10. eadem pulli et 11. eadem juvenis (exemplorum ex Hawaii); 12. maris pars postrema supina; 13. caput et segmenta primum et secundum; 14. eadem supina (figurae 12-14 exempli ex Andaman).

Lamina cephalica parum minus quam duplo longior quam latior (63 : 34), lateribus postice parum convergentibus.

Antennae gradatim attenuatae, articulo sexto c. 1/3 longiore quam ad apicem latiore, articulo ultimo fere duplo longiore quam latiore, articulis 1-6 setis brevibus, articulis ceteris etiam setis brevioribus gradatim parum magis numerosis instructis.

Pedes maxillares flexi marginem frontalem spatio brevi superantes, subcoxis coalitis parum latioribus quam longioribus, margine antico dentibus duobus sat parvis, articulo secundo dentibus duobus brevibus, articulo tertio et quarto dente perparvo, ungue terminali longo, attenuato, sat arcuato. Labrum medium incisum unidentatum utrimque integro, convexo; mandibulae laminis pectinatis 5-6, quarum prima dentibus 6, quarta dentibus 9 subaequalibus et dente parvo basali instructa, nec non appendici externa longa, plus minusve manifeste bifida, et appendici brevi apice varie partito compositae; maxillae primi et secundi paris vide fig. IX, 6.

Sterna furca ramis brevibus angulum obtusum formante et setis brevibus, praesertim postice, et setis brevioribus sat numerosis instructa. Pedes primi paris quam secundi parum magis quam dimidium minores; pedes omnes hirsutelli, ungue terminali attenuato, sat longo.

Segmentum ultimum sternito subtrapezoideo postice parum constricto setis pluribus brevissimis instructo, subcoxis poris parvis et aliis perparvis sat numerosis (subtus c. 20) instructis, pedibus gradatim parum attenuatis, quam paris praecedentis c. 1/3 longioribus, hirtellis.

Pedum paria 49. Pori anales sat magni. Long. corp. ad mm. 38, lat. segmenti primi 1·05.

Mas feminae similis.

Habitat.—Species haec in regionibus tropicalibus orbis terrarum sparsa est et etiam in Ins. Canarie et in Parisiorum et Hamburg calidariis. Exempla vidi ex India: Kierpur, Purnea distr. (femina long. mm. 28 cum pullis 18); Sadiya, N.E. Assam (*Kemp*); Samagooting, Assam; Puri, Orissa (*Kemp*); Mahè; Trichinopoli (*Newton*).

Nuova Guinea: Simbang et Sattelberg (*Birò*).

Ins. Philippine: Manila.

Samoa: Pago Pago (*Silvestri*).

Hawaii: Hilo (*Silvestri*).

S. America: Cuba, Cuyaba, Brazil (*Silvestri*).

Africa: S. Paolo de Loanda, Angola et Lagos, Nigeria (*Silvestri*); S. Nikola, Ins. Capo Verde (*Fea*).

Aberratio.—Exemplum vidi ad Andaman collectum lamina cephalica (fig. IX, 13) magis quam duplo longiore quam latiore; idem ut exemplum aberrans "dolichocephalum" considero.

Lamnonyx superior, sp. n.

(Fig. X).

♀ Corpus supra testaceum fusco dense marmoratum, subtus ochraceo-testaceum fusco parum marmoratum, capite latericio, antennis pallide latericiis pedibus testaceis, segmento ultimo pedigero testaceo.

Lamina cephalica c. 4/9 longior quam latior grosse et sparse punctata (postice praesertim). Antennae gradatim attenuatae,

articulo sexto c. 1/3 longiore quam ad apicem latiore, articulis 1-4 setis brevibus, a quinto setis etiam brevioribus gradatim magis numerosis instructis.

Pedes maxillares flexi marginem frontalem spatio sat longo superantes, subcoxis parum antice latioribus quam longioribus, dentibus typicis brevibus, ungue terminali bene arcuato. Labrum medium obtuse unidentatum, margine cetero per partem submedianam breviter setoso et angulo interno acute producto; mandibulae laminis pectinatis 14, quarum prima 11-dentata, mediana 55-dentata, dentibus basim attingentibus et ab apice gradatim

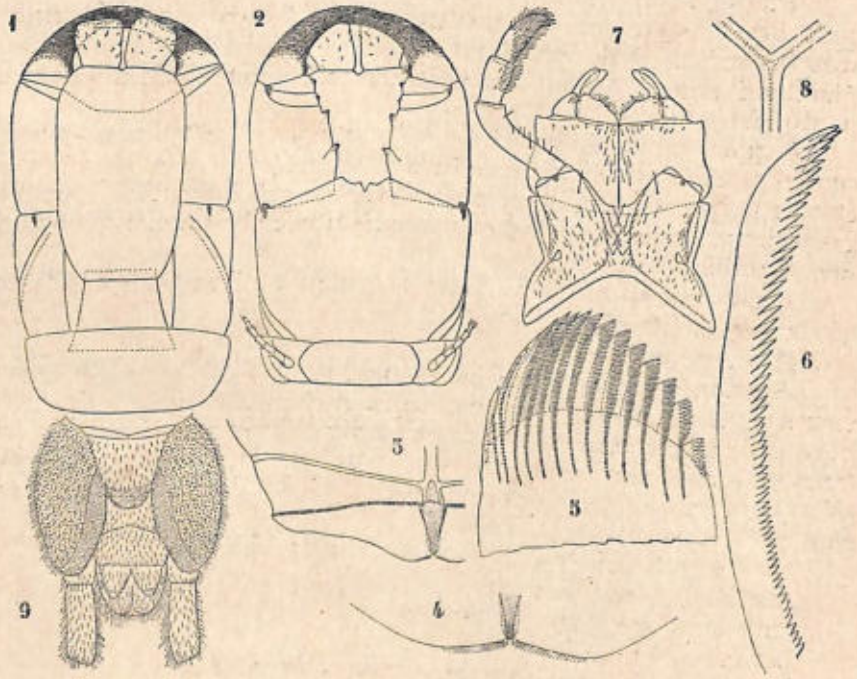

FIG. X.—*Lamnonyx superior*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. ejusdem pars mediana et submediana magis ampliatae; 5. mandibulae pars distalis; 6. ejusdem lamina pectinata submediana magis ampliata; 7. maxillae primi et secundi paris; 8. sterni decimi furca; 9. feminae corporis pars postrema supina.

minoribus, mandibulae margine interno irregulariter et parum profunde serrato, margine externo ad laminam 14 mam appendicibus duobus dentatis acuto; maxillae primi et secundi paris setis vide fig. X, 7.

Sterna antica furca angulum obtusum formante instructa.

Pedes primi paris quam secundi c. dimidio breviores; pedes ambulatorii setis numerosis brevioribus et nonnullis brevibus instructi, ungue terminali sat longo, robusto, attenuato.

Segmentum ultimum sterno trapezoideo, postice praesertim brevissime persetoso, ante apicem paullum angustiore, subcoxis

bene inflatis poris parvis et poris perparvis numerosis instructis, pedibus quam praecedentes magis quam duplo longioribus, tenuibus et attenuatis, hirtellis.

Pedum paria 49; long. ad mm. 110, lat. segmenti primi ad 4·5.

Habitat.—Nechal, W. Ghats, c. 2,000 ft.; Taloshi, Koyna Valley, c. 2,000 ft., E side of Koyna Valley et Helvak, Koyna Valley, c. 2,000 ft., Satara dist. (*F. H. Gravely*); Palgad, Ratnagiri dist.

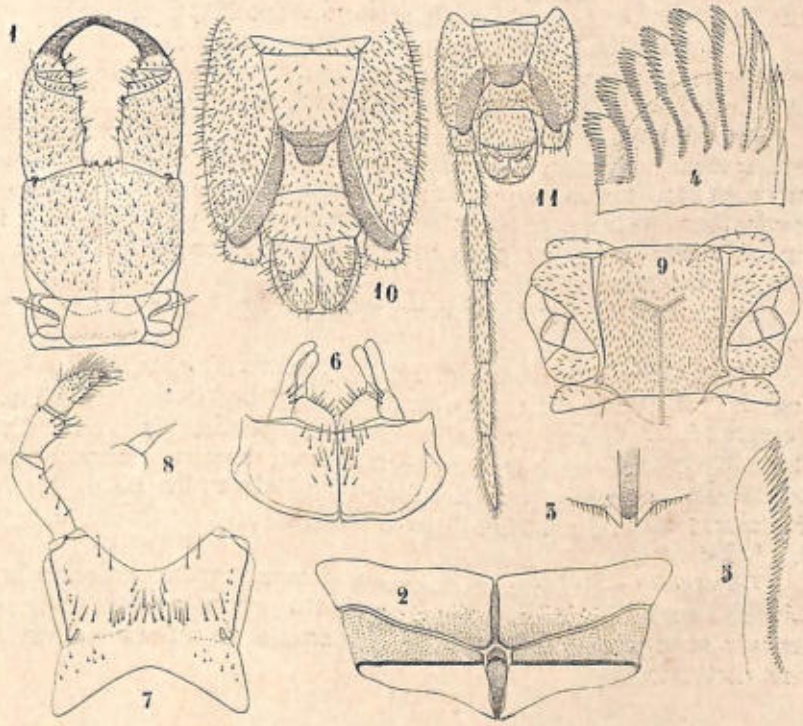

FIG. XI.—*Lamnonyx superior* subsp. *pallida*: 1. pedes maxillares et segmentum primum pediferum supina; 2. labrum; 3. ejusdem pars mediana et submediana magis ampliatae; 4. mandibulae pars distalis; 5. ejusdem lamina pectinata submediana; 6. maxillae primi paris; 7. maxillae secundi paris; 8. palpi apex; 9. sternum decimum; 10. feminae corporis pars postrema supina; 11. maris corporis pars postrema supina.

Lamnonyx superior, Silv. subsp. pallida, nov.

(Fig. XI).

Corpus pallide flavum vel ochroleucum capite latericio antennis fulvis, pedibus corpore concoloribus.

Lamina cephalica parum minus quam duplo longior quam latior, punctis grossis praesertim in fovea mediana postice impressa.

Antennae attenuatae, articulo sexto c. 1/3 longiore quam ad apicem latiore, articulis 1-6 setis brevibus, articulis ceteris setis brevioribus gradatim magis numerosis instructis.

Pedes maxillares marginem frontalem spatio sat magno superantes, subcoxis coalitis subaeque antice latis quam longis, dentibus typicis robustioribus. Labrum medium obtuse unidentatum, margine cetero per partem submedianam setis brevibus instructo et angulo interno acute bene producto; mandibulae laminis pectinatis 9, quarum prima 16-dentata, ceterae dentibus ab apice ad basim gradatim minoribus, mediana dentibus c. 37 instructa; maxillae primi et secundi paris setis vide fig. XI, 6-7.

Sterna antica furca angulum obtusum formante.

Pedes primi paris quam secundi c. dimidio breviores, pedes ambulatorii hirtelli, ungue terminali elongato, attenuato, acuto.

Segmentum ultimum pediferum sterno trapezoideo parum ante apicem angustiore, postice breviter persetoso, subcoxis poris parvis et praesertim perparvis numerosis nec non setis brevibus et brevioribus, numerosis brevioribus praesertim per marginem instructis; pedibus quam praecedentes c. duplo longioribus, aliquantum attenuatis.

Pedum paria 49; long. corp. ad mm. 45, lat. segmenti primi 1·70.

Habitat.—Parambiculam, 1,700-3,200 ft., Cochin State (*F. H. Gravely*); Base of hills, Chakardharpur, Singbhoom dist., Chota Nagpur (*F. H. Gravely*); Kalka, Simla; Purulia, Manbhum dist., Chota Nagpur (*Gravely*); Dinapore, Bihar; Medha, Yenna Valley, Satara dist., 2,500-3,500 ft. (*Gravely*); Bababudin Hills, Mysore (*Fletcher*); Khondmal Hills, Angul dist., interior of Orissa, c. 1,500 ft. (*J. Taylor*).

Observatio.—Subspecies haec a forma typica magnitudine, colore et mandibularum lamina pectinata prima longiore et magis dentata et segmenti ultimi pediferi sterno ante apicem angustiore bene distincta est.

Lamnonyx rubriceps, Wood.

(Fig. XII).

Mecistocephalus rubriceps, Wood, *J. Ac. Nat. Sci. Philad.* 1863, p. 42.
Geophilus tenuiculus, C. Koch, *Verh. zool.-bot. Ges. Wien* XXVII, p. 794 (1878).
Mecistocephalus tenuiculus, Haase, *Abh. Mus. Dresden* I, N. 5, p. 103 (1887).

Corpus ochroleucum medio dorse parum infuscato, capite fulvo-ferrugineo vel latericio.

Lamina cephalica parum minus quam duplo longiore quam latiore, superficie sparse et grosse punctata praesertim postice.

Antennae attenuatae articulis 1-6 setis brevibus nonnullis, articulis ceteris setis brevioribus gradatim magis numerosis instructis, articulo sexto c. 1/3 longiore quam latiore, articulo ultimo duplo longiore quam latiore.

Labrum medium unidentatum margine cetero integro, nudo; mandibulae laminis pectinatis 9, quarum prima 6-dentata, mediana 23-dentata dentibus ab apice ad basim gradatim parum minoribus; maxillae primi et secundi paris setis vide fig. XII, 5. Pedes maxillares flexi marginem frontalem spatio sat longo superantes, subcoxis parum antice latioribus quam longioribus margine antico parum sinuato dentibus submedianis destituto, articulis ceteris dentibus typicis sat parvis, ungue terminali longo, bene arcuato dente basali infero parvo, supero sat magno conico.

Sterna antica sulco longitudinali postico exarata, furcae brachiis brevissimis, subnullis.

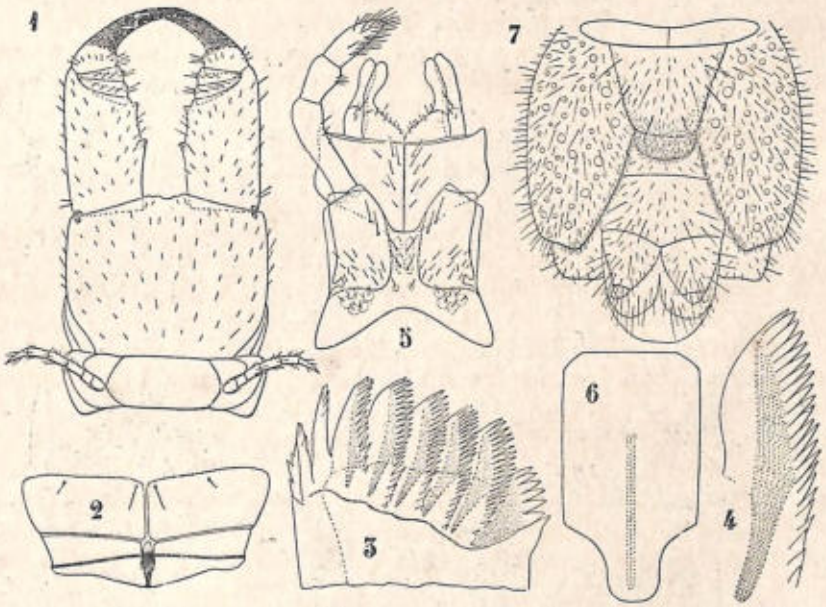

FIG. XII.—*Lamnonyx rubriceps:* 1. pedes maxillares et segmentum primum pediferum supina; 2. labrum; 3. mandibulae pars distalis, 4. ejusdem lamina submediana; 5. maxillae primi et secundi paris; 6. sternum decimum; 7. feminae corporis pars postrema supina.

Pedes primi paris quam secundi aliquantum minus quam dimidium breviores ungue terminali sat longo; pedes ceteri hirtelli ungue terminali sat longo, robusto.

Segmentum ultimum pedigerum sternito trapezoidali ante apicem parum angustiore parte postica setis brevissimis vestita, subcoxis per superficiem internam parum latam brevissime setosis, cetero poris sat magnis et poris parvis numerosis undique instructis, pedibus quam praecedentes c. duplo longioribus, hirtellis.

Mas corporis parte postrema quam eadem feminae magis setosa.

Pedum paria 49; long. corp. ad mm. 50, lat. segmenti primi

Habitat.—Japan. Ins. Bonin (*Univ. Tokio*).

Variatio.—Exempla numerosa ad Kosempo (Ins. Formosa) a Cl. H. Sauter collecta vidi, quae notis omnibus cum exemplis ex Ins. Bonin congruunt corporis colore excepto, qui melleus vel luride melleus est per dorsum fusco variegatus et per caput testaceo-latericius vel latericius.

Long. corp ad mm. 60.

Observatio.—Species haec a *L.* sectionis *L. insularis*, Lucas sternis tantum sulco postico mediano impressis facile distinguenda est.

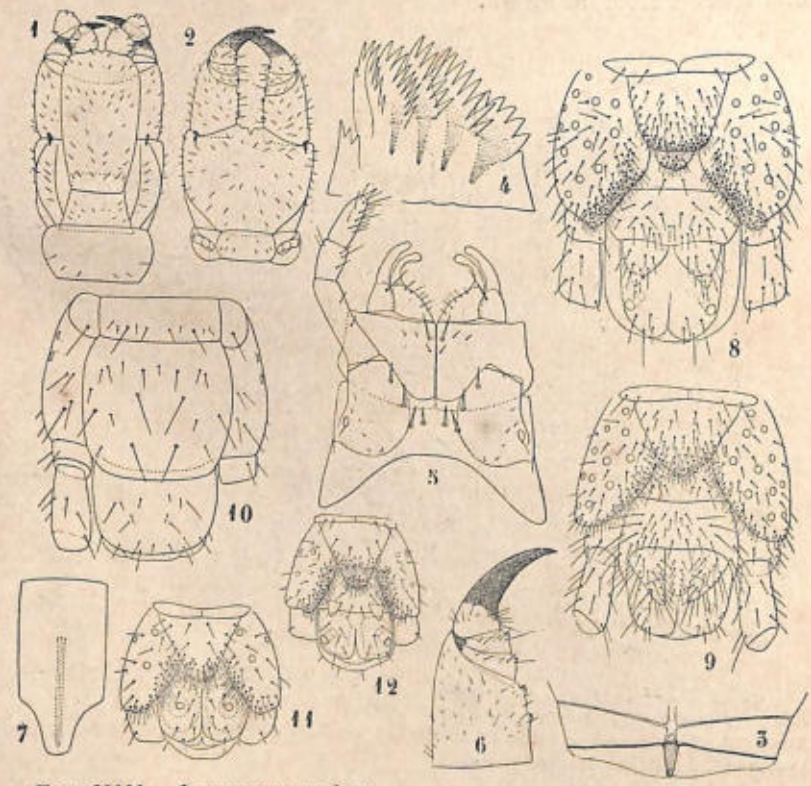

Fig. XIII.—*Lamnonyx modestus*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. pedis maxillaris articuli 2-5; 7. sternum decimum; 8. feminae corporis pars postica supina; 9. maris corporis pars postica supina; 10. eadem prona; 11. et 12. juvenium corporis pars postica supina.

Lamnonyx modestus, sp. n.

(Fig. XIII).

Corpus melleum capite fulvo-testaceo.

Lamina cephalica parum minus quam duplo (80 : 45) longior quam latior, superficie sparse et grosse punctata. Antennae aliquantum attenuatae, articulis 1-6 setis brevibus, a septimo grada-

tim setis parum magis numerosis et brevioribus instructis. Pedes maxillares flexi marginem frontalem parum superantes, subcoxis parum antice latioribus quam longioribus margine antico sinuato, dentibus submedianis parvis, articulis ceteris dentibus typicis sat parvis, ungue terminali sat arcuato, sat attenuato, acuto, haud longo.

Labrum medium unidentatum, margine cetero integro; mandibulae laminis pectinatis 5-6, lamina mediana 7-dentata, dentibus subaequalibus; maxillae primi et secundi paris vide fig. XII, 5.

Sterna antica sulco mediano postico antice haud bifurcato exarata.

Pedes primi paris quam secundi parum minus quam dimidium breviores, pedes ceteri hirtelli ungue terminali robusto, brevi.

Segmentum ultimum pediferum sternito trapezoideo postice parte mediana valde angustiore, dimidia parte postica setis brevioribus numerosis vestita, subcoxis facie interna postica spatio sat angusto setis numerosis brevioribus vestita, poris inferis et lateralibus c. 15 instructis, pedibus quam praecedentes c. 2/7 longioribus, parum attenuatis hirtellis.

Pedum paria 49; long. corp. ad mm. 20, lat. segmenti primi 1.

Habitat.—Sattelberg, Nova Guinea, exempla nonnulla Cl. L. Birò in arboribus putrescentibus et sub foliis legit.

Observatio.—Species haec ad *L. rubescens*, Wood proxima est, sed statura minore, sterniti ultimi forma et poris subcoxalibus segmenti ultimi pedigeri minus numerosis facile distinguenda est.

Lamnonyx gigas (Haase).

(Fig. XIV).

Mecistocephalus gigas, Haase, *Abh. Mus. Dresden* I, N. 5, p. 105, taf. vi, fig. iii.

Corpus melleum supra fusco variegatum capite testaceo-lateritio; superficie dorsuali brevissime setosa.

Lamina cephalica parum minus quam duplo (8 : 4·5) longior quam latior sparse et sat grosse punctata. Pedes maxillares flexi, marginem frontalem spatio longo superantes subcoxis parum antice (c. 1/8) latioribus quam longioribus, margine mediano anguste sinuato dentibus duobus parvis limitato, dentibus ceteris typicis sat parvis, ungue terminali bene arcuato attenuato acuto, tuberculo basali parvo. Labrum medium unidentatum, parte submediana aliquantum producta margine toto usque ad latera brevissime setoso. Mandibulae lamina prima pectinata parva 4-dentata, laminis aliis 26 apice dentibus 10-15 armato cetero margine setis brevissimis instructo. Maxillae primi et secundi paris setis vide fig. XIV, 6.

Sterna antica furca angulum sat acutum formante instructa.

Pedes primi paris quam secundi c. 1/3 (vel parum magis) breviores. Pedes ceteri hirtelli.

Segmentum praegenitale lamina ventrali trapezoidea ante apicem paullum angustiore, brevissime setosa, subcoxis multo in-

flatis poris parvis et perparvis obsessis, pedibus quam praecedentes duplo longioribus, attenuatis, breviter setosis, poris analibus sat magnis.

Pedum paria 51; long. corp. ad mm. 87, lat. segmenti primi 3·8.

Habitat.—Feminas duas vidi a Cl. J. Steel ad Fife Bay, Nova Guinea Britannica, collectas.

Fig. XIV.—*Lamnonyx gigas:* 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. ejusdem lamina submediana; 6. maxillae primi et secundi paris; 7. sterni decimi furca; 8. feminae corporis pars postica supina.

Lamnonyx subgigas, sp. n.

(Fig. XV).

Corpus luride testaceum dorso infuscato, capite testaceo-lateritio.

Lamina cephalica parum minus quam duplo longior quam latior (8 : 4·5), superficie sparsissime et grosse punctata, postice magis punctata. Antennae attenuatae articulis 1 6 setis brevibus, articulis ceteris setis gradatim magis numerosis et brevioribus instructis. Pedes maxillares flexi marginem frontalem spatio sat magno superantes, subcoxis parum antice latioribus quam longioribus, margine antico medio anguste sinuato, dentibus submedianis sat parvis, dentibus typicis articulorum ceterorum bene evolutis, ungue terminali attenuato, acuto, bene arcuato.

Labrum medium unidentatum margine cetero setis brevioribus toto vestito; mandibulae laminis 15-20, quarum prima 6—7-dentata, ceterae parte apicali tantum dentata, parte proximali tota setis marginalibus minimis vestita; maxillae primi et secundi paris vide fig. XV, 5.

Sterna antica furca angulum obtusum formante impressa.

Pedes primi paris quam secundi parum minus quam dimidium breviores, pedes ceteri hirtelli ungue terminali elongato, attenuato.

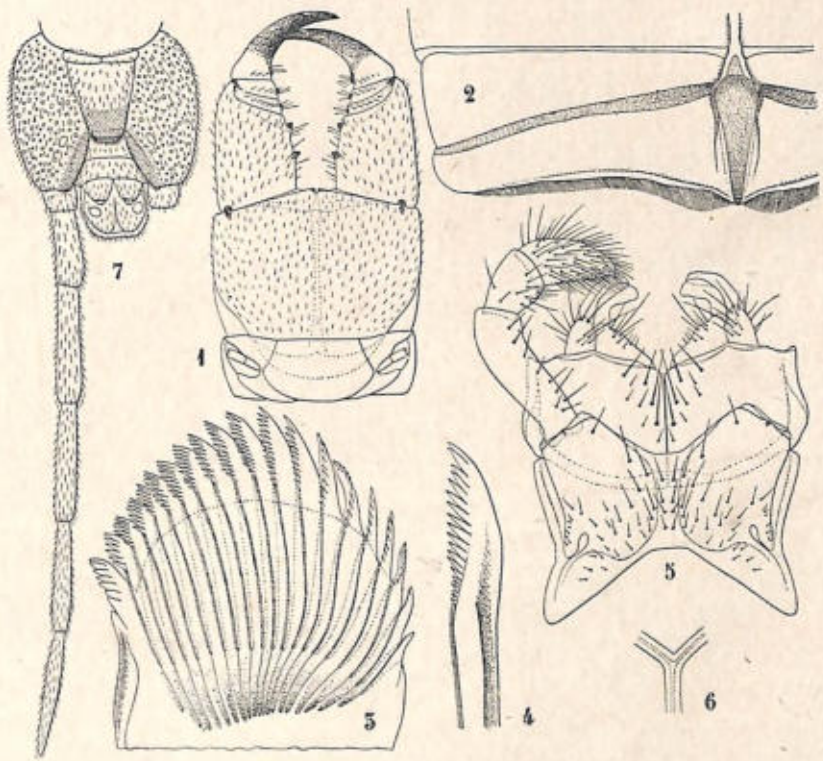

FIG. XV.—*Lamnonyx subgigas*: 1. pedes maxillares et segmentum primum pediferum supina; 2. labrum; 3. mandibulae pars distalis; 4. ejusdem laminae submedianae pars distalis; 5. maxillae primi et secundi paris; 6. sterni decimi furca; 7. feminae corporis pars postica supina.

Segmentum praegenitale sternito longo, trapezoideo, ante apicem parum angustiore, parte postica magis setosa, subcoxis poro subpostico ventrali magno, nec non poris numerosis parvis et perparvis undique instructis, pedibus quam praecedentes duplo vel parum magis quam duplo longioribus, setis brevioribus vestitis.

Pedum paria 49; long. corp. ad mm. 60, lat. segmenti primi 2·5.

Pullus (fig. XVI) long. corp. 17, lat. segmenti primi 0·90.

Corpus luride melleum capite subtestaceo. Mandibulae laminis pectinatis 13, eisdem adulti similibus sed dentibus apicalibus

minus numerosis; pedum maxillarium unguis quam idem adulti aliquantum magis arcuatus. Segmenti praegenitalis subcoxae poris nullis vel poro uno magno instructae. Pori anales magni.

Habitat.—Nova Guinea: Simbang, Sattelberg.

Observatio.—Species haec ad *L. gigas* (Haase) perproxima est, sed segmentorum numero, statura, poro magno subcoxarum posticarum, saltem ut species vel subspecies distinguenda est.

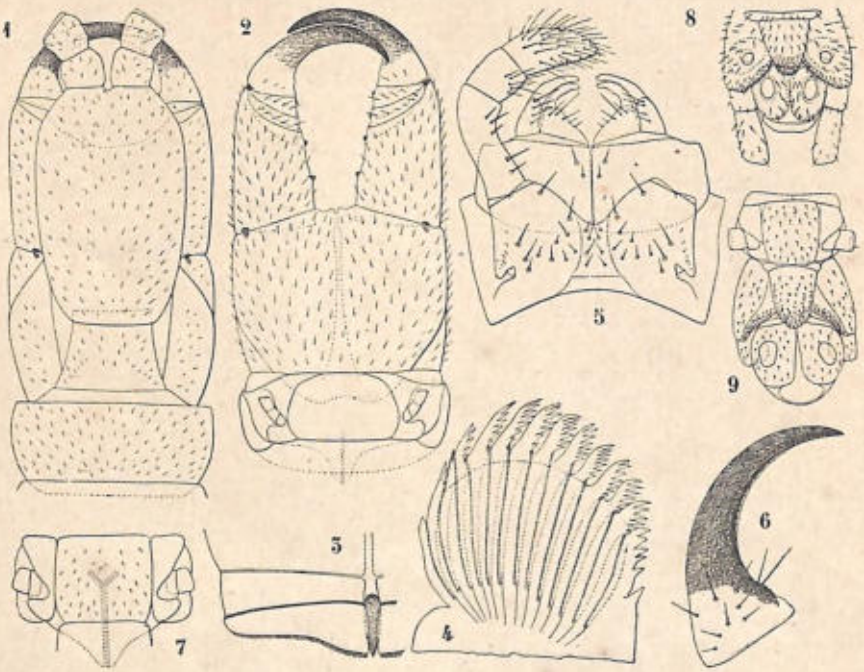

FIG. XVI.—*Lamnonyx subgigas*, pullus: 1. caput et segmenta primum et secundum prona; 2. pedes maxillares et segmentum primum pediferum supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. pedum maxillarium unguis terminalis; 7. sternum decimum cum pedum pars proximalis; 8. corporis pars postica supina; 9. exempli alii corporis pars postica supina.

Lamnonyx uncifer, sp. n.

(Fig. XVII).

Corpus melleum dorso multo infuscato, capite fulvo-ferrugineo.

Lamina cephalica parum minus quam duplo (100 : 57) longior quam latior, superficie punctis paucis impressa; lamina basalis puncto magno mediano antico impressa.

Labrum, mandibulae et maxillae eisdem speciei praecedentis similia sunt. Pedes maxillares subcoxis parum antice latioribus quam longioribus, margine antico medio anguste sed sat profunde sinuato dentibus submedianis magnis acutis, articulo secundo dentibus duobus magnis acutis uncinatis, articulo tertio dente un-

cinato parvo, articulo quarto dente uncinato sat magno armato, ungue terminali longo, attenuato, multo arcuato, acuto.

Pedes primi paris quam secundi parum minus dimidium breviores; pedes ceteri hirtelli, ungue terminali longo, robusto.

Sterna antica furca angulum subrectum vel parum obtusum formante impressa.

Segmentum praegenitale sternito longo, trapezoideo, postice vix angustiore, fere dimidia parte postica setis brevissimis vestita; subcoxis bene inflatis et poris numerosis magnis et parvis undique instructis, pedibus quam praecedentes parum magis quam duplo longioribus, parum attenuatis et breviter setosis.

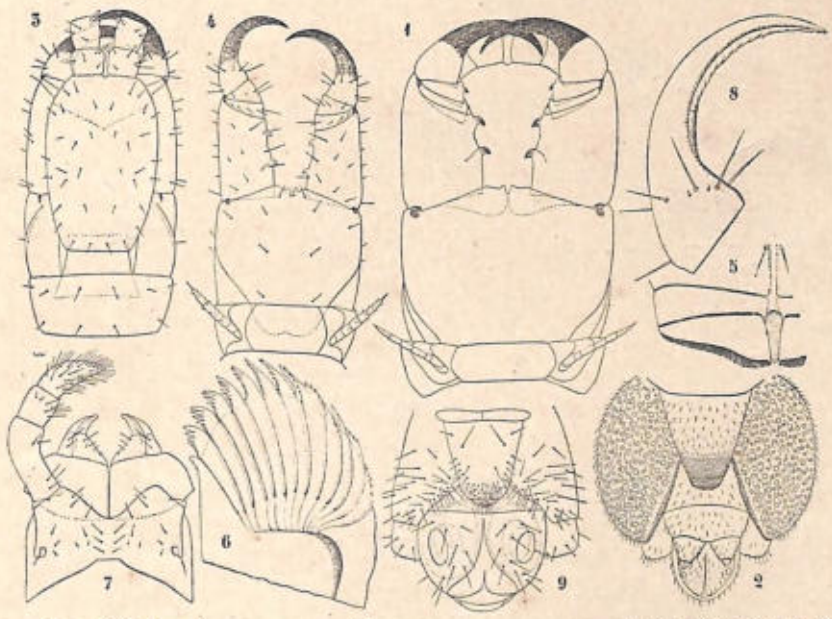

FIG. XVII.—*Lamnonyx uncifer:* 1. caput et segmentum primum pediferum supina; 2. feminae pars postica supina; 3. pulli caput et segmenta primum et secundum prona; 4. eadem supina; 5. pulli labrum; 6. pulli mandibulae pars distalis; 7. maxillae primi et secundi paris; 8. pedem maxillarium unguis terminalis; 9. corporis pars postica supina.

Pedum paria 49; long. corp. mm. 65, lat. segmenti primi 2·6.

Pullus (fig. XVII, 3-9) long. corp. mm. 18, lat. segmenti primi 0·78. Ab adulto differt mandibulis laminis pectinatis 13 instructis, pedibus maxillaribus ungue terminali magis arcuato, vix crenulato et articulis tertio et quarto dentibus destitutis, segmenti ultimi pediferi subcoxis poris destitutis, poris analibus permagnis.

Habitat.—Nova Guinea: Moroka (m. 1,300); feminam cum pullis vidi a Cl. L. Loria collectam.

Observatio.—Species haec a *L. subgigas* pedibus maxillaribus ungue magis arcuato, dentibus articulorum 2-4 uncinatis bene distincta est.

Lamnonyx tahitiensis, Haase.

(Fig. XVIII).

Mecistocephalus tahitiensis, Wood, *J. Ac. Nat. Sci. Philad.* (2) V, p. 43 (1863); Haase, *Abh. Mus. Dresden* I, N. 5, p. 101, taf. vi, fig. 108 (1887).

Lamnonyx tahitiensis, Attems, *Zool. Jahrb. Syst.* XVIII, p. 212 (1903).

Corpus luride testaceum dorso fusco parum variegato, capite badio vel corpus ochraceum capite latericio.

Lamina cephalica parum minus quam duplo (75 : 43) longior quam latior, sparse et grosse punctata praesertim postice. Antennae attenuatae articulis 1-7 setis brevibus, articulis ceteris

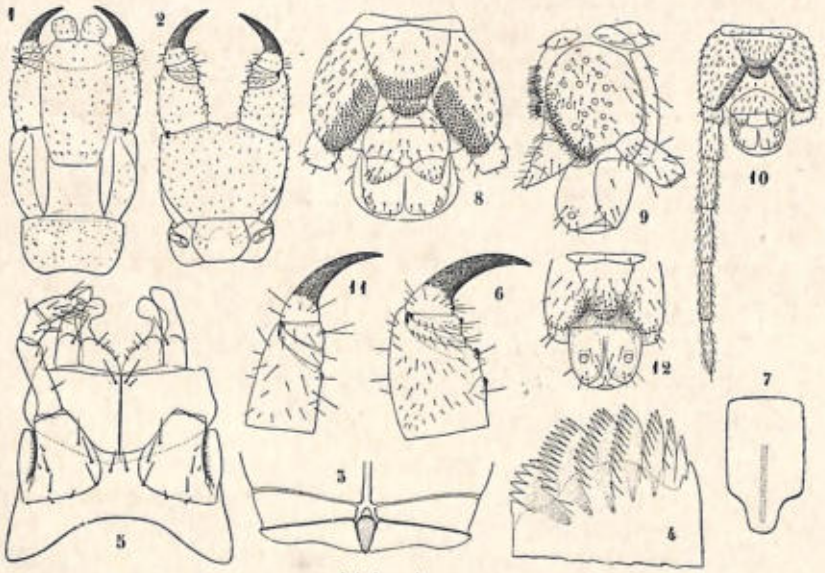

FIG. XVIII.—*Lamnonyx tahitiensis:* 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. palpi maxillares articuli 2-5; 7. sternum decimum; 8. feminae pars postica supina; 9. eadem lateraliter inspecta; 10. juvenis pars postica supina; 11. pulli pedis maxillaris articuli 2-5; 12. pulli pars postica supina.

etiam setis brevioribus numerosis instructis. Pedes maxillares flexi marginem frontalem spatio parvo superantes, subcoxis parum antice latioribus quam longioribus, margine antico medio sinuato, dentibus submedianis acutis parvis, articulis ceteris dentibus typicis bene evolutis, ungue terminali attenuato, sat arcuato, acuto.

Labrum medium unidentatum margine cetero simplici, nudo; mandibulae laminis pectinatis 7, quarum prima 5-dentata, mediana 10—12-dentata dentibus parum diversis, externa 3—4 dentata; maxillae primi et secundi paris setis vide fig. XVIII, 5.

Sterna antica sulco longitudinali mediano postico, antice haud vel vix bifurcato, instructa. Pedes primi paris quam secundi fere

dimidio breviores; pedes ceteri hirtelli ungue terminali brevi, robusto.

Segmentum praegenitale trapezoideo, postice aliquantum angustato et dimidia superficie postica setis numerosis brevibus vestita, subcoxis poris inferis et lateralibus 15-20 parvis et sat parvis, facie interna per spatium latiusculum setis brevioribus vestita, pedibus parum attenuatis quam praecedentes parum minus quam duplo longioribus.

Mas postice quam femina parum magis setosus.

Pedum paria 47; long. corp. ad mm. 30 (secundum Haase ad 50), lat segmenti primi 1·15.

Pullus (fig. XVIII, 11-12) long. mm. 7, lat. segmenti primi 0·55. Corpus pallide testaceum capite sublatericio, pedum maxillarium articulus tertius et quartus dentibus nullis; segmenti praegenitalis subcoxae poris nullis; pori anales sat magni.

Habitat.—Exempla nonnulla vidi ad Sattelberg, Nova Guinea, a L. Biró collecta (*Mus. Budapest*) et alia a me ipso ad Loftus, N. S. Wales, Australia.

Observatio.—Species haec a *L. castaineceps*, Haase saltem statura, pororum numero subcoxarum segmenti ultimi pedigeri distincta est; a *L. modestus* segmentorum numero, ungue pedum maxillarium longiore, sterniti segmenti ultimi pedigeri minus angustata bene distincta est.

Lamnonyx spissus, Wood.

(Fig. XIX).

Mecistocephalus spissus, Wood, *J. Ac. Nat. Sc. Philad.* (2) V, p. 43 (1863); Haase, *Abh. Mus. Dresden* I, N. 5, p. 101 (1887); Silvestri, *Fauna Hawaiensis* III, p. 326, pl. xi, fig. 5-7 (1904).

Corpus melleum vel umbrinum dorso medio praesertim plus minusve fusco variegato, capite fulvo-ferrugineo vel testaceo.

Lamina cephalica parum minus quam duplo (76 : 42) longior quam latior, superficie punctis numerosis impressa. Antennae attenuatae articulis 1-6 setis brevibus et brevioribus, articulis ceteris setis gradatim magis numerosis et brevioribus instructis. Labrum medium unidentatum margine cetero simplici nudo; mandibulae laminis pectinatis 8, quarum prima 7 dentata, submediana 14-dentata dentibus ab apice ad basim parum minoribus; maxillae primi et secundi paris setis vide fig. XIX, 5.

Pedes maxillares subcoxis parum, antice, latioribus quam longioribus margine antico medio parum profunde sinuato, dentibus submedianis parvis, articulo secundo dentibus duobus subaequalibus sat magnis, articulis tertio et quarto dente singulo parvo, ungue terminali longo, sat arcuato, acuto, tuberculo basali sat distincto.

Sterna sulco mediano, aliquantum longe a margine antico incipiente, exarato

Pedes primi paris quam secundi parum minus quam dimidium breviores; pedes ceteri hirtelli ungue terminali longo, acuto, parum arcuato.

Segmentum praegenitale sternito brevi latiusculo trapezoideo postice brevissime setoso, subcoxis poris parum numerosis sat magnis et parvis subtus et externe instructis, pedibus quam praecedentes c. 1/4 longioribus, hirtellis.

Mas feminae similis.

Pedum paria 45; long. corp. ad mm. 56, lat segmenti primi 2·5.

Pullus long. corp. mm. 16, lat. segmenti primi 0·84. Corpus cremeum postice stramineum capite ferrugineo. Pedes maxillares (fig. XIX, 9) articulo secundo tantum dente apicali instructo, ungue terminali vix crenulato.

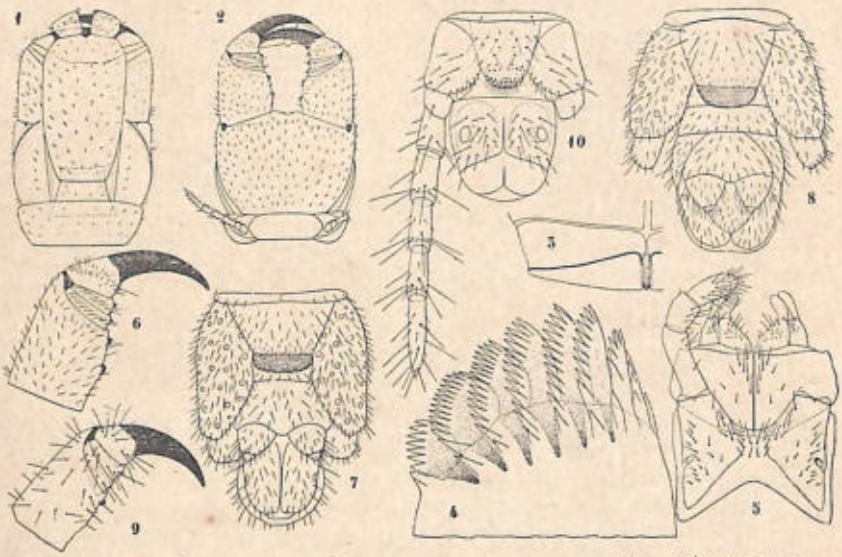

FIG. XIX.—*Lamnonyx spissus:* 1. caput et segmentum primum et secundum prona; 2. pedes maxillares et segmentum primum pediferum supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. pedis maxillaris articuli 2-5; 7. feminae pars postica supina; 8. maris pars postica supina; 9. pulli pedis maxillaris articuli 2-5; 10. pulli corporis pars postica supina.

Segmentum praegenitale (fig. XIX, 10) subcoxis poris nullis. Pori anales sat magni.

Habitat.—Is. Hawaii: Kilauea (♀, ♂ et pullum legi); Haleachala, Maui, 5,000 ft.

Lamnonyx diversidens, sp. n.

(Fig. XX).

Mecistocephalus spissus, Pocock, *Ann. Mus. Genova* XXX, p. 424 (1891); Silvestri, *Ann. Mus. Genova* XXXIV, p. 15 (1894); Attems, *Mtt. Naturh. Mus. Hamburg* XXIV, p. 95, fig. viii-ix (1907).

Corpus melleum vel isabellinum dorso fusco variegato, capite fulvo-ferrugineo vel testaceo.

Lamina cephalica c. 2/7 longior quam latior, superficie mediana praesertim sparse et grosse punctata. Antennae attenuatae, setis ab articulo sexto gradatim magis numerosis et brevioribus.

Labrum medium unidentatum margine cetero integro, nudo; mandibulae laminis pectinatis 8-10, quarum prima 6-dentata, mediana dentibus 16 ab apice ad basim gradatim parum minoribus; maxillae primi et secundi paris vide fig. XX, 5.

Pedes maxillares flexi marginem frontalem spatio sat magno superantes, subcoxis parum antice latioribus quam longioribus, articulo secundo tantum dente magno (rare dente parvo) apicali armato, articulo tertio dente nullo vel subnullo, articulo quarto

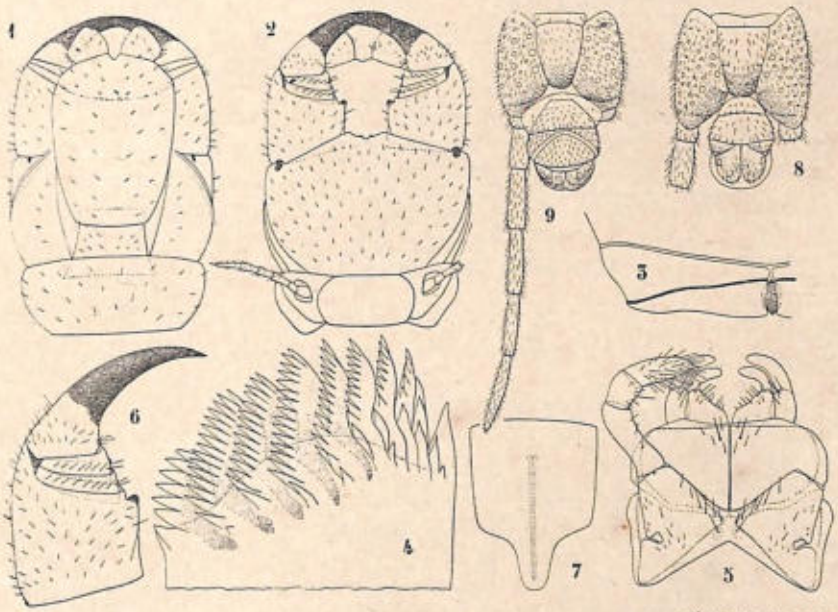

FIG. XX.—*Lamnonyx diversidens*: 1. caput et segmenta primum et secundum prona; 2. pedes maxillares et segmentum primum pediferum supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. pedis maxillaris articuli 2-5; 7. sternum decimum; 8. feminae pars postica supina; 9. maris pars postica supina.

dente parvo tubercoliformi, ungue terminali bene arcuato acuto, basi inermi.

Sterna sulco longo mediano parum longe a margine antico incipiente impressa. Pedes paris primi quam secundi fere 1/3 breviores, pedes ceteri hirtelli ungue terminali robusto.

Segmentum praegenitale sternito longo lateribus aliquantum convergentibus, ante apicem paullum angustato, parte postica setis numerosis instructa, subcoxis poris numerosis sat magnis et nonnulis parvis undique instructis et per superficiem internam posticam setis numerosis brevissimis, pedibus quam praecedentes c. 1/3 longioribus, attenuatis, breviter setosis.

Mas feminae similis.

Pedum paria 45; long. corp. ad mm. 55, lat. segmenti primi 2·8.

Habitat.—India: Bagarkote, 8,000 ft, Kumaon, W. Himalayas (*Tytler*); Darjiling distr., 7,000-8,000 ft., E. Himalayas (*Lord Carmichael*); Painsur, above Lohba, 3,000 ft., Garhwal W. Himalayas (*Tytler*); Birch Hill, Darjiling, 6,000-7,000 ft. (*Lord Carmichael*); Senchal, Darjiling distr., 8,000 ft. (*Lord Carmichael*); Darjiling, 7,000 ft, E. Himalayas (*Gravely*); by side of stream at Nagabevar, 10,000-10 500 ft., Kashmir (*H. L. Bion*); Dungagali, 8,000 ft., Hazara distr. (*Fletcher*); Assam-Bhutan Frontier, Mangaldai distr. (*S. W. Kemp*); Simla, W. Himalayas, 7,000 ft. (*N. Annandale*); Theog, Simla hills, 5,000 ft. (*N. Annandale*); Katmandu, Nepal; Kobo, 400 ft., Abor Expedition, in rotten wood (*Kemp*); Rotung, 1,400 ft., Abor Expedition (*M. de Courcy*); Renging, 2,100 ft., Abor Expedition.

Observatio.—Species haec a *L. spissus*, Wood pedum maxillarium articulo secundo dente uno (nec duobus) apicali plerumque magno armato, segmenti ultimi pediferi sternito longiore, nec non capite parum breviore et latiore facile distinguenda est.

Lamnonyx mirandus (Poc.)

(Fig. XXI).

Mecistocephalus mirandus, Pocock, *Ann. Nat. Hist.* (6) XV, p. 352 (1895).

Corpus ochraceum capite testaceo-latericio.

Lamina cephalica duplo longior quam latior, superficie punctis sparsissimis perpaucis et perparvis, postice sulcis duobus submedianis brevissimis punctatis impressa. Antennae attenuatae ab articulo quinto setis gradatim magis numerosis et brevioribus instructae.

Labrum medium dentatum margine cetero ad dentem mediano acute aliquantum producto et toto setis brevissimis sat numerosis instructo, mandibulae laminis pectinatis 15, quarum prima perparva 5-dentata, ceterae dentibus proximalibus perparvis, mediana dentibus c. 35; maxillae primi et secundi paris vide fig. XXI, 5.

Pedes maxillares flexi marginem frontalem spatio sat magno superantes, subcoxis sublaevigatis parum antice latioribus quam longioribus, margine antico medio parum sinuato, dentibus submedianis parvis, articulo secundo dentibus duobus sat magnis instructo, articulis tertio et quarto dente perparvo tuberculiformi, ungue terminali attenuato, sat arcuato acuto ad basim inermi.

Sterna antica sulco mediano postico profundo impressa.

Pedes primi paris quam secundi c. 1/3 breviores, pedes omnes hirtelli ungue terminali robusto.

Segmentum praegenitale sterno trapezoideo parum pone medium aliquantum angustiore setis numerosis brevissimis instructum, subcoxis bene inflatis undique poris crebris sat parvis instructis, pedibus quam praecedentes c. duplo longioribus, crassiusculis setis brevissimis vestitis.

Pedum paria 65; long. corp. ad mm. 82 (secund. Pocock ad 99), lat. segmenti primi 3.

Habitat.—Mares duos vidi alterum ad Kankan, Formosa, alterum ad Shushu, a Cl. H. Sauter collectos.

Exempla a Cl. Pocock descripta ad Great Loo-Choo collecta erant.

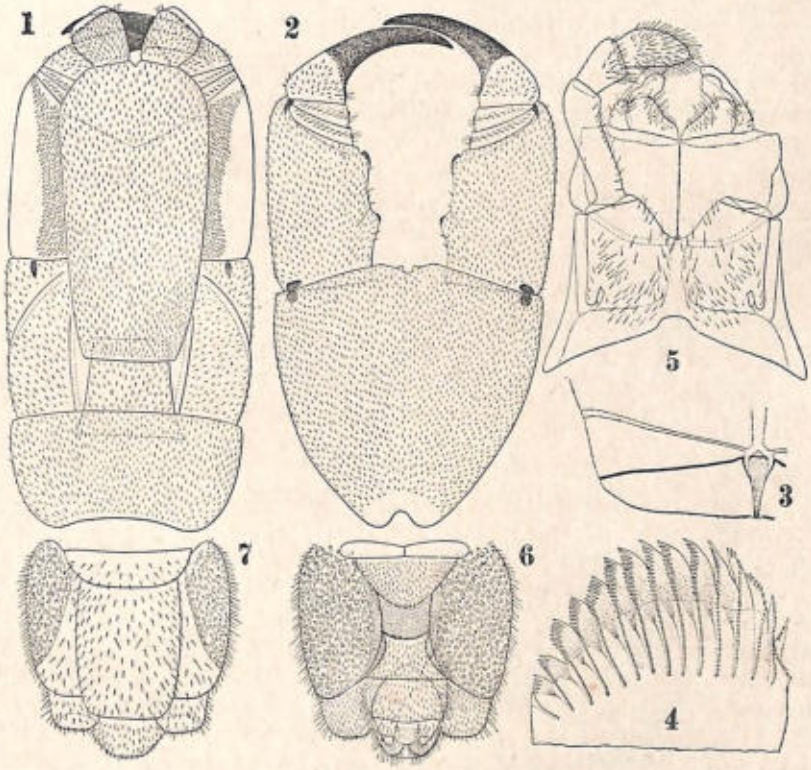

FIG. XXI.—*Lamnonyx mirandus:* 1. caput et segmenta primum et secundum prona; 2. pedes maxillares supini; 3. labrum; 4. mandibulae pars distalis 5. maxillae primi et secundi paris; 6. maris corporis pars postica supina; 7. eadem prona.

Lamnonyx smithi (Poc.)

(Fig. XXII).

Mecistocephalus smithi, Pocock, *Ann. Nat. Hist.* (6) XV, p. 351 (1895).

Corpus ochroleucum capite testaceo-latericio.

Lamina cephalica c. 1/10 longior quam latior, superficie grosse et sparse punctata postice sulcis submedianis brevioribus punctatis impressa. Antennae attenuatae ab articulo sexto setis gradatim magis numerosis et brevioribus instructae

Labrum medium uniden:atum, margine cetero subrecto, nudo ad dentem medianum acute producto, mandibulae praeter laminam obsoletam externam laminis 6, quarum prima 5-dentata,

mediana 11-dentata dentibus proximalibus parum minoribus; maxillae primi et secundi paris vide fig. XXII, 5.

Pedes maxillares flexi marginem frontalem spatio magno superantes, subcoxis parum antice latioribus quam longioribus, superficie sparse et grosse punctata, margine antico medio anguste sinuato, dentibus submedianis acutis sat parvis, articulo secundo dentibus duobus obtusis sat magnis armato, articulis tertio et quarto dente parvo tuberculiformi instructis, ungue terminali bene arcuato, attenuato, acuto, basi vix inflata.

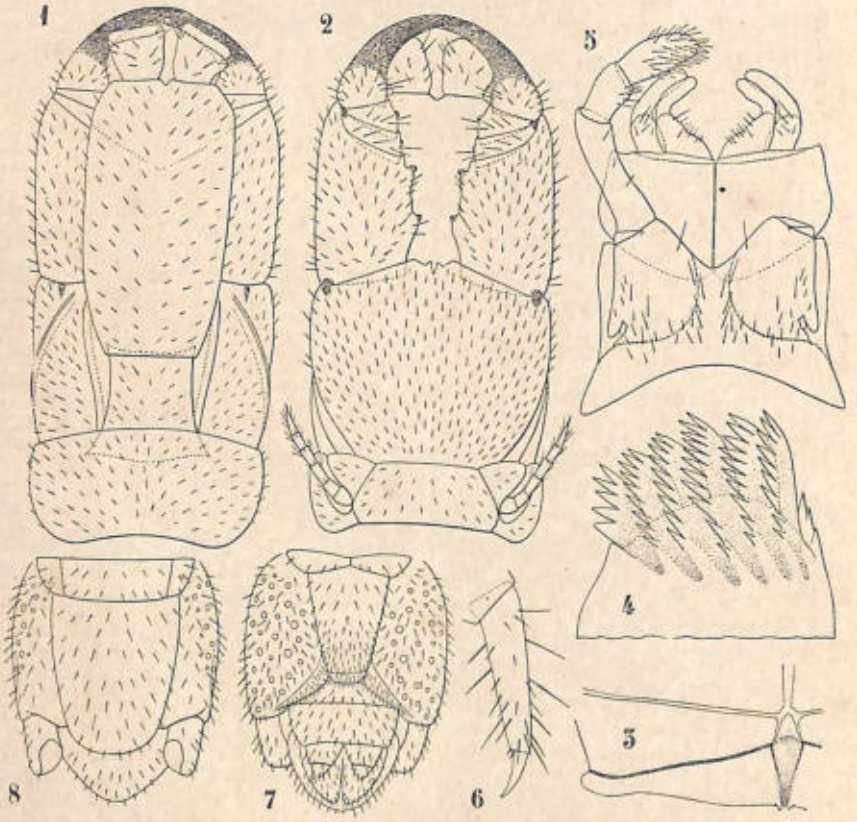

Fig. XXII.—*Lamnonyx smithi*: 1. caput et segmenta primum et secundum prona; 2. pedes maxillares et segmentum primum pediferum supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. pedis paris decimi pars distalis; 7. feminae pars postica supina; 8. eadem prona.

Sterna antica sulco profundo postico mediano impressa.

Pedes primi paris quam secundi c. 1/3 breviores, pedes omnes ungue terminali longo, attenuato, acuto.

Segmentum praegenitale sterno longo, parum lato, trapezoideo, subcoxis poris sat numerosis parvis et perparvis, lateraliter et supra antice instructis, pedibus quam praecedentes c. duplo longioribus sat gracilibus, attenuatis, setis brevioribus numerosis instructis.

Pedum paria 59; long. corp. ad mm. 32 (secund. Pocock ad mm. 80) lat. segmenti primi 1·40.

Habitat.—Formosa: Kosempo (*H. Sauter*); exempla typica ex China ad Da-laen-Saen et Wo-Lee Lake, Ningpo.

Lamnonyx diversisternus, sp. n.

(Fig. XXIII).

♂ Corpus melleum capite latericio.

Lamina cephalica parum minus quam duplo longiore quam latiore, superficie sparse et grosse punctata postice sulcis duobus submedianis punctatis impressa

Antennae attenuatae, ab articulo sexto setis gradatim magis numerosis et brevioribus.

Pedes maxillares flexi marginem frontalem spatio magno superantes, subcoxis parum antice latioribus quam longioribus superficie punctis parvis sparsis impressa, margine antico medio anguste sinuatum, dentibus submedianis parvis, articulo secundo dentibus duobus sat magnis armato, articulis tertio et quarto dente perparvo tuberculiformi instructis, ungue terminali attenuato, sat arcuato, acuto, tuberculo parvo basali acuto.

Sterna antica sulco profundo postico impressa.

Pedes primi paris quam secundi c. 1/3 breviores, pedes omnes hirtelli ungue terminali longo attenuato.

Segmentum praegenitale trapezoideo valde angustato, subcoxis bene inflatis, interne postice spatio sat lato breviter setoso, cetera superficie poris sat parvis numerosis sed haud crebris subtus et lateraliter instructa, pedibus quam praecedentes duplo longiores, attenuatis, setis brevibus numerosis instructis.

Pedum paria 57; long. corp. ad mm. 34, lat. segm. primi 1·30.

Habitat.—Japonia: Kamatura (*coll. Silvestri*).

Observatio.—Species haec a *L. smithi* segmentorum numero et segmenti ultimi pedigeri sterniti forma praesertim bene distincta est.

Gen. Dicellophilus, Q. F. Cook.

(Fig. XXIV).

Clinopodes ex p. C. Koch, *Syst. Myr.* p. 184 (1847).
Mecistocephalus ex p. Meinert, *Nat. Tidsskr.* VII, p. 92 (1870).
,, Latzel, *Die Myr. Öst.-Ung. Mon.* I, p. 160.
Dicellophilus, O. F. Cook, *Pr. U.S. Nat. Mus.* XVIII, p. 61 et 74 (1895).
Mecistocephalus, Attems, *Zool. Jahrb. Syst.* XVIII, p. 208 (1903).
,, Verhoeff, Bronn's *Klass. Philop.* p. 272 (1908).
,, Chamberlin, *Pomona J. Ent.* IV, p. 053 (1912).
? *Tygarrup*, Chamberlin, *Bull. Mus. Zool. Cambridge, Mass.* LVIII, p. 210.

Corpus postice attenuatum.

Lamina cephalica aliquantum longior quam latior, sutura

frontali discreta, genarum angulo antico interno ad labrum in processum acutum producto, superficie infera antica sublateral externa spina destituto.

Labrum tripartitum parte mediana angustiore, acuta; mandi-

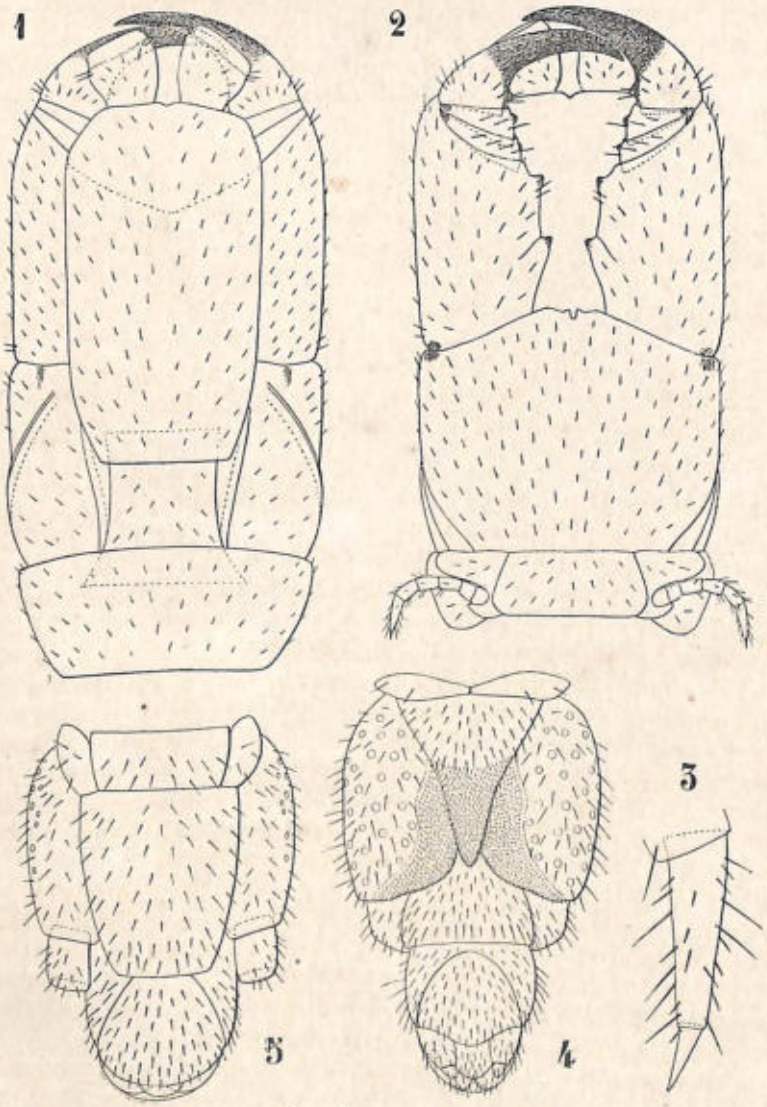

Fig. XXIII.—*Lamnonyx diversisternus*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. pedis decimi pars distalis; 4. corporis pars postica supina; 5. eadem prona.

bulae laminis pectinatis nonnullis, superficie externa laterali pilosa; maxillae primi et secundi paris ut in gen. *Lamnonyx*, palpi ungue terminali breviore.

Lamina basalis subtrapezoidea ad basim longior quam latior.

Pedes maxillares flexi marginem frontalem superantes vel fere superantes.

Tergita longitudinaliter bisulcata, praetergita magna.

Sterna antica sulco mediano abbreviato instructa, praesterna media divisa et in segmentis anticis 2-15 spatio sat lato disjuncta; praescutellum (paratergitum) quam scutellum spiraculiferum multo majus.

Segmentum ultimum pedigerum sterno bene evoluto, subcoxis poris numerosis instructis, pedibus (subcoxis exclusis) 6-articulatis, inermibus.

Pori anales duo.

Habitat.—Europa et America septentrionalis.

Species typica: *Mecistocephalus limatus*, Wood.

Observatio.—Genus hoc a gen. *Lamnonyx*, O. F. Cook lamina cephalica spina sublaterali infera antica destituta et lamina basali aliquantum latiore facile distinguendum est.

Generi huic species pertinent: *Mecistocephalus limatus*, Wood, Nord West America; *M. anomalus*, Chamberlin, Nord West America; *Clinopodes carniolensis*, C. Koch, Europa; forsan *Tygarrup intermedius*, Chamberlin, British Guiana.

Dicellophilus anomalus (Chamb.)

(Fig. XXIV).

Mecistocephalus anomalus, Chamberlin, *Pr. Ac. Nat. Sc. Philad.* 1904, p. 655; *Id.*, *Pomona Journ. Ent.* IV, p. 653 (1912).

Corpus ochroleucum capite latericio-ferrugineo.

Lamina cephalica c. 1/3 longior quam latior, lateribus postice aliquantum convergentibus, superficie punctis sparsis postice secundum lineis submedianis subseriatis impressa. Antennae longiusculae, attenuatae, articulo sexto duplo longiore quam ad apicem latiore, articulo ultimo 5/8 longiore quam latiore articulis 7º ad ultimum setis gradatim magis numerosis et brevioribus instructis.

Labrum medium unidentatum, margine cetero breviter ciliato paullum sinuato; mandibulae laminis pectinatis 5, quarum prima 5-dentata, mediana 14-dentata, dentibus subaequalibus, margine interno ad laminam primam acute producto, margine externo ad laminam quintam processibus setiformibus 3-4 apice integro vel bifurcato aucto, superficie laterali externa setibus brevioribus vestita; maxillae primi et secundi paris vide fig. XXIV, 5.

Pedes maxillares flexi marginem frontalem spatio sat magno superantes, subcoxis parum antice latioribus quam longioribus superficie punctis perparvis sparsissimis, margine antico medio sinuato et dentibus duobus submedianis parvis instructo, articulo secundo dente apicali sat magno tantum armato, articulo tertio dente tuberculiformi perparvo, articulo quarto dente tuberculiformi parvo instructo, ungue terminali bene arcuato, attenuato, acuto et dente basali sat magno instructo.

Sterna antica sulco mediano postico impressa.

Pedes primi paris quam secundi c 1/3 breviores, pedes omnes hirtelli ungue terminali longo, attenuato.

Segmentum praegenitale sterno subtriangulari postice parum lato, rotundato, dimidia parte postica setis brevissimis vestita, subcoxis interne postice spatio latiusculo setis brevissimis vestito, superficie cetera subtus et lateraliter poris numerosis parvis et perparvis nec non poro sat magno infero submediano instructis; pedibus quam praecedentes c. 3/7 longioribus, parum attenuati setis brevioribus numerosis instructis.

Mas pedibus ultimis parum crassioribus.

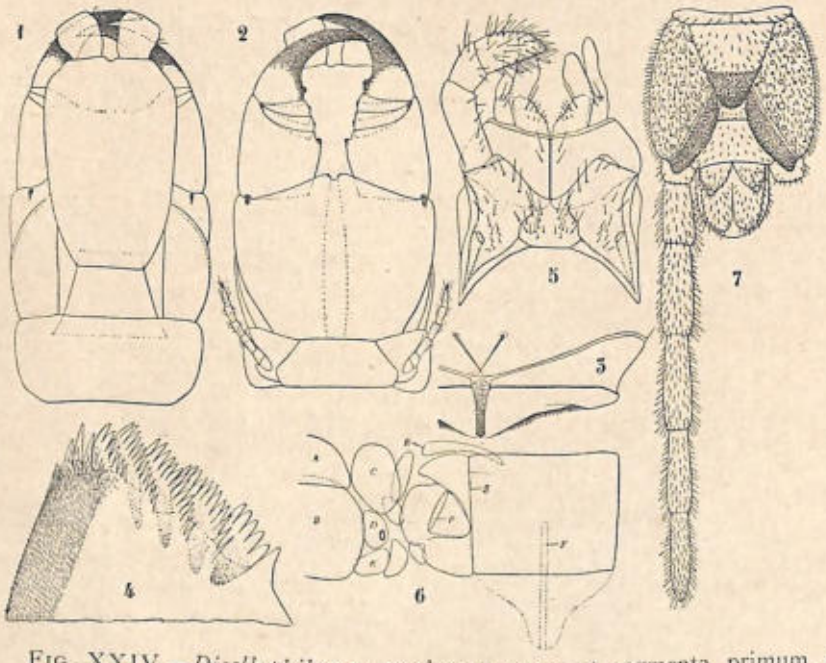

Fig. XXIV.—*Dicellophilus anomalus:* 1. caput et segmenta primum et secundum prona: 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. tergiti decimi pars cum scutellis lateralibus et sterno: A = praetergitum, B = tergitum, C = praescutellum, D = scutellum spiraculiferum, E = postscutellum, F = furca, P = pes, R = praesternum, S = sternum; 7. feminae corporis pars postica supina.

Pedum paria 43; long. corp. ad mm. 60, lat. segmenti primi 2·4.

Habitat.—Exempla descripta a me ipso ad Lebanon, Oregon U.S.A., collecta fuerunt; Cl. Chamberlin ad Monterey Bay et Oroville, California, exempla typica legit.

Gen. **Prolamnonyx**, nov.

(Fig. XXV et XXVI).

Corpus postice parum attenuatum.

Lamina cephalica aliquantum longior quam latior sutura frontali reticulo microscopico, aliquantum minus distincto quam in

genere *Lamnonyx*, O. F. Cook, indicata, genarum angulo antico interno ad labrum in processum auctum producto, superficie antica sublaterali externa spina destituto.

Labrum tripartitum, parte mediana parum latiore quam in genere *Lamnonyx*; mandibulae laminis pectinatis nonnullis instructae; maxillae primi paris coxosterno integro malis simplicibus ut in *Lamnonyx*; maxillae secundi paris subcoxosterno medio linea diviso, palpo 3-articulato ungue destituto.

Lamina basalis ad basim latior quam longior, aliquantum minus lata quam eadem generis *Lamnonyx*.

Pedes maxillares flexi marginem frontalem superantes.

Tergita longitudinaliter bisulcata, praetergita sat magna, praetergito segmenti primi pediferi excluso quod perparvum est et inter latera laminae basalis postice vix manifestum.

Sterna antica sulco profundo postico impressa, praesterna media divisa et in segmentis 2-12 aliquantum disjuncta; praescutellum (paratergitum) magnum quam scutellum spiraculiferum majus, postscutellum scutello spiraculifero subaequali, scutella cetera vide fig. XXV, 8.

Segmentum ultimum pedigerum sterno bene evoluto, subcoxis poris numerosis instructis, pedibus, subcoxis, exclusis, 6-articulatis inermibus.

Pori anales duo.

Species typica: *Geophilus* (?) *holstii*, Pocock.

Observatio.—Genus hoc ad genus *Lamnonyx* proximum est, sed lamina cephalica breviore et spina antica sublaterali destitutum, lamina basali aliquantum latiore, labri parte mediana parum latiore, palpo maxillari ungue destituto bene distinctum est; a gen. *Dicellophilus* maxillae primi paris subcoxosterno integro, maxillae secundi paris subcoxosterno diviso et palpo maxillari ungue destituto; a gen. *Arrup*, Chamberlin mandibulis laminis pectinatis numerosis et maxillis primi paris subcoxis coalitis distinctum est.

Prolamnonyx holstii (Poc).

(Fig. XXV).

Geophilus (?) *holstii*, Pocock, *Ann. Nat. Hist.* (6) XV, p. 352, pl. xi, fig. 1, 1a (1895).

Mecistocephalus indecorus, Attems, Zichy's *Dritte asiat. Forschungsreise* II, p. 287, tab. ix, fig. 8-10 (1901).

Corpus ochroleucum capite ferrugineo.

Lamina cephalica c. 3/11 longior quam latior, superficie sparse punctata et postice sulcis duobus submedianis parum profundis impressa. Antennae attenuatae ab articulo septimo setis gradatim parum magis numerosis et brevioribus instructae.

Labrum medium unidentatum margine cetero integro nudo; mandibulae laminis pectinatis 7, quarum prima 5-dentata, mediana 14-dentata, dentibus ab apice ad basim subaequalibus; maxillae primi et secundi paris setis vide fig. XXV, 5. Pedes maxillares paullum antice latioribus quam longioribus, margine medio an-

guste sinuato, dentibus submedianis bene evolutis acutis, articulo secundo c. 2/5 externe longiore quam ad basim latiore dente uno apicali magno armato, articulis tertio et quarto inermibus, ungue terminali attenuato, sat arcuato, subacuto, ad basim dente tuberculiformi aucto.

Sterna antica sulco mediano, aliquantum longe a margine antico incipiente, impressa, sparse et breviter setosa.

Pedes primi paris quam secundi c. 1/4 breviores, pedes ambulatorii omnes hirtelli ungue terminali sat longo, robusto.

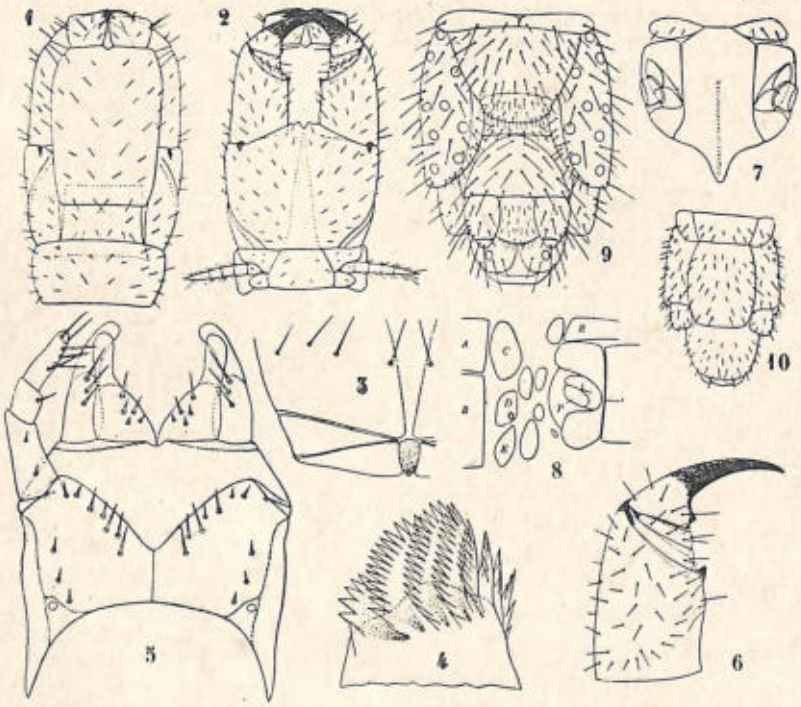

FIG. XXV.—*Prolamnonyx holstii*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. pedis maxillaris articuli 2-5; 7. sternum decimum; 8. tergiti decimi pars cum scutellis lateralibus et sterni pars: litterae ut in figura praecedente; 9. maris pars postica supina; 10. eadem prona.

Segmentum praegenitale sternito trapezoideo, postice parum magis setoso, subcoxis poris c. 20-25 subtus et per latus externum instructis, pedibus quam praecedentes c. 2/7 longioribus, crassiusculis, gradatim attenuatis.

Mas feminae similis.

Pedum paria 41; long. corp. ad mm. 19 (—33), lat. segmenti primi 0·8 (—1·5).

Habitat.—Japonia: Kamatura; exempla a me descripta haud bene adulta sunt. Exemplum typicum a Pocock descriptum ex Ashinoju, Japonia, et exemplum typicum ab Attems ut *Mecistoce-*

phalus indecorus descriptum (long. corp. mm. 32, lat. 1·5) ex Peking, China.

Prolamnonyx sauteri, sp. n.

(Fig. XXVI).

Mecistocephalus smithi, Pocock, *Ann. Nat. Hist.* (6) XV, p. 251 (1895).

Corpus (capite incluso) ochraceo-testaceum.

Lamina cephalica fere 2/7 longior quam latior, superficie sparse et sat grosse punctata, postice sulcis duobus submedianis parum profundis punctatis impressa. Antennae attenuatae ab

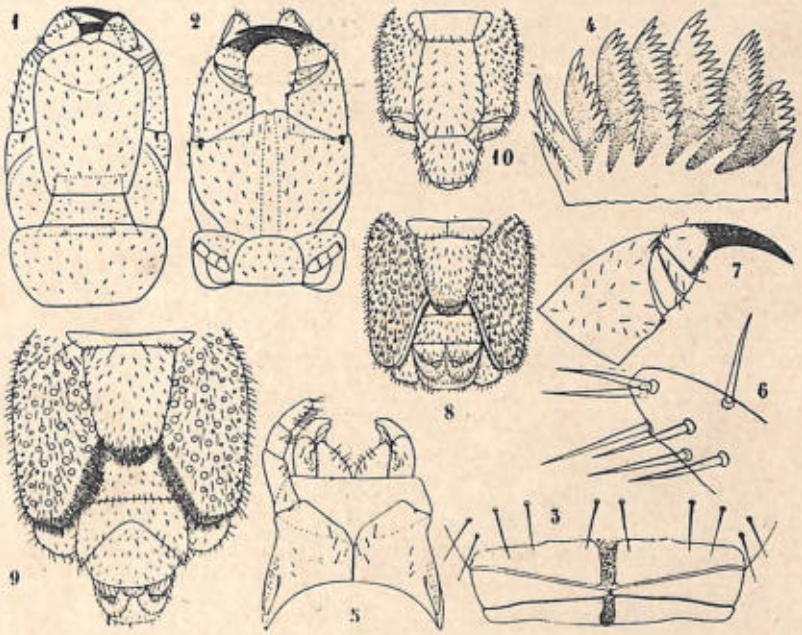

FIG. XXVI.—*Prolamnonyx sauteri*: 1. caput et segmenta primum et secundum prono; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. palpi maxillaris apex; 7. pedis maxillaris articuli 2-5? 8. feminae pars postica supina; 9. maris pars postica supina; 10. eadem prona.

articulo quarto setis gradatim magis numerosis et brevioribus instructae.

Labrum medium edentatum (an semper ?, exemplo uno observato) margine cetero subrecto, nudo; mandibulae laminis pectinatis 8, quarum prima 6-dentata, mediana 14-dentata, dentibus subaequalibus; maxillae primi et secundi paris vide fig. XXVI, 5.

Pedes maxillares flexi marginem frontalem parum superantes, subcoxis parum antice latioribus quam longioribus superficie punctis sat numerosis impressa, margine antico medio parum sinuato, dentibus submedianis perparvis, articulo secundo dente apicali

tantum armato, articulis tertio et quarto inermibus, ungue terminali sat arcuato, attenuato, acuto basi inermi.

Sterna antica sulco profundo postico instructa.

Pedes primi paris quam secundi c. 1/4 breviores, pedes omnes hirtelli ungue terminali, brevi, robusto.

Segmentum praegenitale sterno longo trapezoideo, postice rotundato et setis magis numerosis brevioribus instructo, subcoxis undique poris numerosis sat magnis et nonnullis parvis instructis, pedibus quam praecedentes fere duplo longioribus, crassiusculis gradatim attenuatis, setis brevibus numerosis instructis.

Pedum paria 41; long. corp. ad mm. 47, lat. segmenti primi 2.

Mas feminae similis, segmento ultimo pedigero subtus parum magis setoso.

Habitat.—Formosa: Kosempo (*H. Sauter*).

Observatio.—Species haec a specie praecedenti magnitudine et praesertim pedum maxillarium unguis basi inermi et segmenti ultimi pedigeri sterno longiore facile distinguenda est.

Subfam. *ORYINAE.*

Gen. **Pentorya**, O. F. Cook.

Pentorya indica, sp. n.

(Fig. XXVII).

Corpus antice et postice parum attenuatum, pallide fulvum.

Lamina cephalica subsemilliptica, aliquantum ad basim latior quam longior, minute et sparse punctata. Antennae breves, quam lamina cephalica minus quam duplo longiores, aliquantum depressae et attenuatae.

Labrum integrum margine serratim pectinato et lateraliter dentibus nonnullis magis attenuatis et inter sese aliquantum remotis instructo; mandibulae lamina dentata et laminis pectinatis 8 armatae; maxillae primi paris subcoxis externe processu palpiformi sat longo instructis, mala externa haud distincte divisa et processu palpiformi brevi instructa, mala interna quam externa parum minori; maxillae secundi paris palpo, ungue incluso, 4-articulato, ungue margine interno et margine supero interno setis pectinis instar dispositis instructo.

Lamina basalis brevis perlata, lateribus parum convergentibus; lamina praebasalis indiscreta. Pedes maxillares flexi marginem frontalem attigentes, subcoxis latis et brevioribus, lineis chitineis nullis, margine antico vix sinuato, inermi, articulis sequentibus inermibus, ungue terminali longo, attenuato, bene arcuato.

Segmenta praetergito sat parvo, tergito (posttergito) poris nonnullis submedianis et aliis sublateralibus, ut fig. XXVII, 10 demonstrat, instructis, inter praescutellum et tergitum parascutello

integro subrectangulari externo et parascutellis duobus internis, quorum anticum quam posticum minus est, instructa; praescutellum et scutellum spiraculiferum poris sat numerosis instructa; stigmata longa; sterna primo excluso, quod area parva porosa instructum est, areis quatuor anticis, quarum externae minores sunt et areis duabus posticis latis instructa; parasterna etiam antice et postice area porosa aucta; praesterna parva media valde angustata.

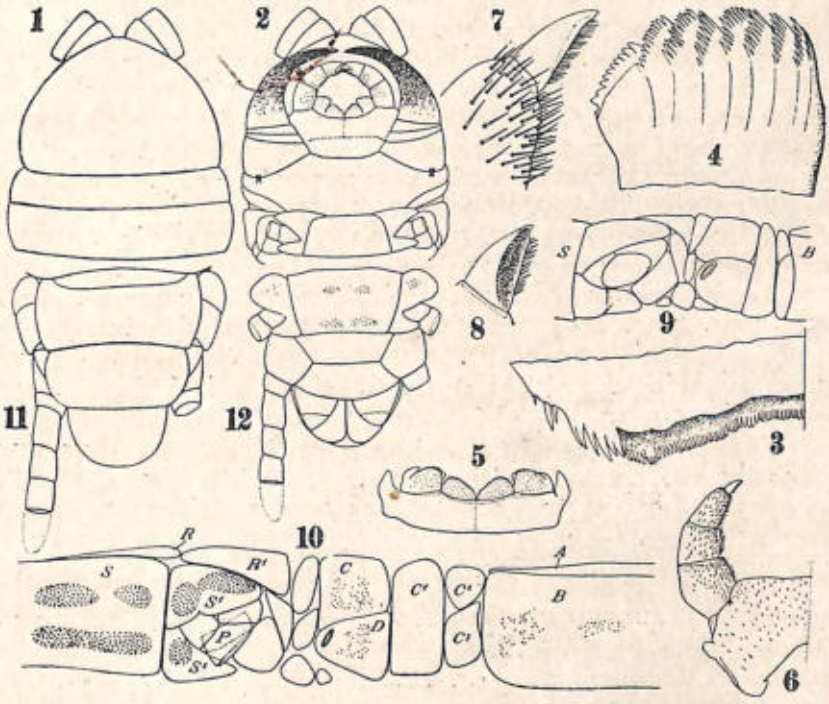

FIG. XXVII.—*Pentorya indica*: 1. caput et segmenta primum et secundum prona; 2. eadem prona; 3. labri dimidia pars; 4. mandibulae pars distalis; 5. maxillae primi paris; 6. maxillarum secundi paris dimidia pars; 7. palpi maxillaris pars apicalis subtus inspecta; 8. ejusdem unguis supra inspectus; 9. segmenti 40^{i} pars lateralis; 10. segmenti 100^{i} pars lateralis extensa cum dimidia pars tergalis et dimidia pars sternalis; 11. corporis pars postica prona; 12. eadem supina.

A = praetergitum, B = posttergitum, C = praescutellum, C^{1}-C^{3} = paratergita; D = scutellum spiraculiferum; P = pedis basis; R = praesternum; S = sternum; S^{1}-S^{2} = parasterna.

Segmentum ultimum pediferum sterno breviore, lato, lateribus convergentibus, margine postico truncato, subcoxis parvis, poris nullis, pedibus in exemplo typico haud integris, subcoxis exclusis, articulis quatuor forsan articulo ultimo tanto abrupto et a me verisimiliter 5-articulatis et inermibus consideratis, quare species haec ad genus *Pentorya*, O. F. Cook a me relata est.

Pedum paria 141; long. corp. mm 186; lat. corporis 5·5.

Habitat.—South India: Ootacamund, Nilgiri Hills (*Beddome*).

Subfam. *HIMANTARIINAE.*

Polyporogaster, Verh.

(Figs. XXVIII—XXX).

Polyporogaster, Verhoeff, *Zool. Anz.* XII, p. 364 (1899); Attems, *Zool. Jahrb.* XVIII, p. 182 (1903); Verhoeff, Bronn's *Klass. u. Ord. Chilopoda*, p. 291 (1908.)

Corpus antice et postice paullum attenuatum.

Lamina cephalica aliquantum latior quam longior sutura frontali haud distincta, pedes maxillares obtegens. Antennae plus minusve attenuatae.

Labrum integrum, sinuatum medium laeve, lateraliter parum profunde dentatum; mandibulae lamina dentata et laminis pectinatis tribus instructae; maxillae primi paris mala interna parva simplici, mala externa biarticulata processibus palpiformibus nullis: maxillae secundi paris palpo (praeter subcoxis) 4-articulato, articulo ultimo unguiformi, brevi subtus ad basim processibus duobus brevioribus setiformibus aucto.

Lamina basalis latior, perbrevis, lateribus parum convergentibus, lamina praebasalis obtecta. Pedes maxillares flexi marginem frontalem haud attingentes, subcoxis lineis chitineis manifestis antice inermibus, articulis sequentibus etiam inermibus, ungue terminali sat longo.

Tergita haud distincte sulcata praetergito sat magno, paratergito primario (praescutello) magno, secundario parvo, scutello spiraculifero quam praescutello (paratergito primario) minore, scutellis ceteris vide fig. XXVIII, 3. Sterna praeter sternum praegenitale area porosa instructa, praesterno medio plus minusve manifeste diviso.

Pedes ungue semplici, parum curvato, seta basali brevi instructo.

Segmentum praegenitale sterno sat parvo, subcoxis sat parvis, supra fovea interna, poris numerosis instructa, auctis, subtus et lateraliter poris nullis, pedibus, praeter subcoxas, 6-articulatis, ungue nullo; maris pedibus quam idem feminae crassioribus. Appendices genitales biarticulatae. Pori anales nulli.

Pedum paria ad 95.

Species typica: *P. tunetanus*, Verh. Tunisia.

Praeter speciem typicam species quatuor asiaticae mihi notae sunt, ita distinguendae:

1. Sternorum area porosa (ad medium corpus) c. 1/3 sterni latitudinem aequans vel minor.
3. Area porosa dicta c. sterni dimidium latitudinem aequans ... ... *P. geminatus*,[1] Silv.
4. Area porosa dicta c. 1/3 sterni latitudinem aequans.
5. Segmenti ultimi pediferi sternum parvum subtrapezoideum; pedum paria 69-75 ... *P. insignis* (Mein.)

[1] *Polyporogaster geminatus* = *Mesocanthus geminatus*, Silv., *Zool. Anz.* XVIII, p. 179 (1895), Transkaspien: Askabat. *Mesocanthus porosus*, Sseliw., *Turkenst. Stan. Obsch. Antrop. i Etn.* XXXVII, p. 217 (1881), Turkestan, generi *Polyporogaster* etiam pertinet.

6. Segmenti ultimi pediferi sternum sat magnum, transverse subrectangulare, postice aliquantum sinuatum; pedum paria 81-97 ... *P. sinuatus*, sp. n.

2. Sternorum area porosa (ad medium corpus) c. 3/5 sterni latitudinem aequans ... ... *P. indicus* (Mein.)

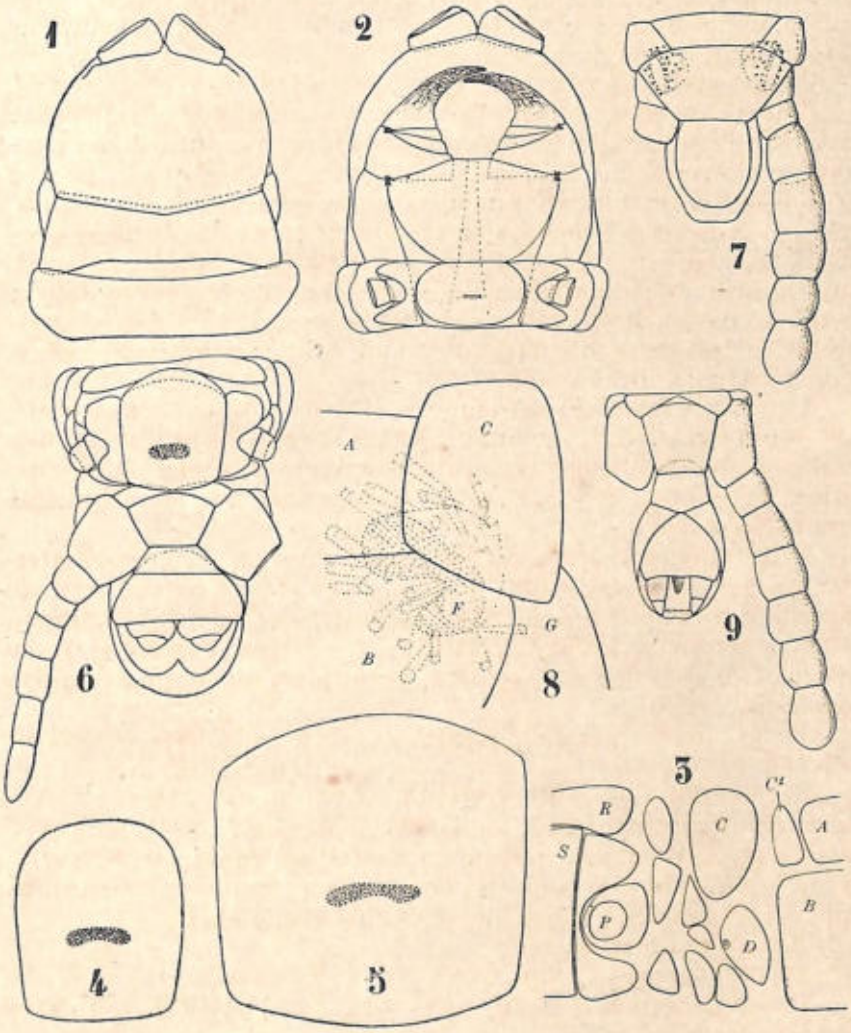

FIG. XXVIII.—*Polyporogaster insignis:* 1. caput et segmentum primum et secundum prona; 2. eadem supina; 3. segmenti 20i pars lateralis extensa (litterae ut in fig. praecedente); 4. sternum 40um; 5. sternum 40um exempli alii; 6. feminae corporis pars postica supina; 7. maris corporis pars postica prona; 8. fovea pororum segmenti ultimi pediferi multo ampliata; A = praetergitum, B = posttergitum, C = paratergitum, G = subcoxa; 9. maris pars postica supina.

Polyporogaster insignis, Mein.

(Fig. XXVIII).

Himantarium insigne, Meinert, *Pr. Am. phil. Soc.* XXXIII, p. 227 (1885).

♀ Corpus antice parum postice parum magis attenuatum, testaceo-latericium.

Lamina cephalica aliquantum latior quam longior lateribus anticis convexis. Antennae quam laminae cephalicae latitudo minus quam duplo longiores, basi contiguae, cetero gradatim attenuato, articulo sexto c. 1/3 latiore quam longiore, articulo ultimo c. 1/3 longiore quam ad basim latiore.

Pedes maxillares flexi marginem frontalem spatio magno haud attingentes, subcoxarum parte detecta c. duplo latiore quam longiore, antice vix sinuatis inermibus, articulis sequentibus omnibus inermibus; primo fere duplo ad basim latiore quam externe longiore, margine interno quam externus fere dimidio breviore, articulis 2º et 3º brevioribus, articulo 4º attenuato, sat arcuato, integro, acuto.

Sternitum primum area porosa parva, sternita cetera area porosa transversali gradatim majore, in medio corporis fere sterniti latitudinis tertiam partem aequante, antice paullum convexa, postice parum concava.

Pedes breves articulo penultimo quam praecedens paullum longiore, ungue robusto spina basali breviore.

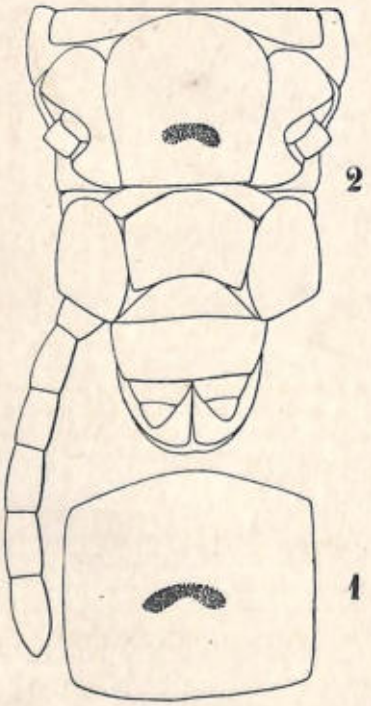

FIG. XXIX.—*Polyporogaster sinuatus:* 1. sternum 40um; 2. feminae corporis pars postica supina.

Segmentum praegenitale sternito angusto, trapezoideo, ♂ pedibus quam paris praecedentis aliquantum longioribus et multo crassioribus, subcoxis supra (subtergito) fovea magna poris glandularibus numerosis instructa auctis, articulis ceteris brevibus et latis, articulo ultimo apice convexo.

Pedum paria ♀ 69, ♂ 75; long. corp. mm. 72, lat. 2 5.

Habitat.—N.W. Kashmir; Bijnor, United Provinces. Exempla typica a Cl. Meinert descripta ad Kulu collecta erant.

Polyporogaster sinuatus, sp. n.

(Fig. XXIX).

♀ Corpus pallide ochraceum.

Sternitum primum area porosa parva (poris c. 25), sternita cetera area porosa transversali submediana, antice convexa postice concava, tertiam partem sterniti latitudinis occupante instructa.

Segmentum praegenitale, sternito brevi, lato, subrectangulari postice parum sinuatum, pedibus

quam paris praecedentis paullo crassioribus, subcoxarum poris superis numerosis.

Pedum paria 81-97; long. corp. mm. 95, lat. 2.

Habitat.—N. Baluchistan (*Maynard and MacMahon*).

Observatio.—Species haec a *Polyp. insignis* (Mein) segmentorum numero, sterni segmenti ultimi pediferi forma et sternorum area porosa magis concava distinguenda est.

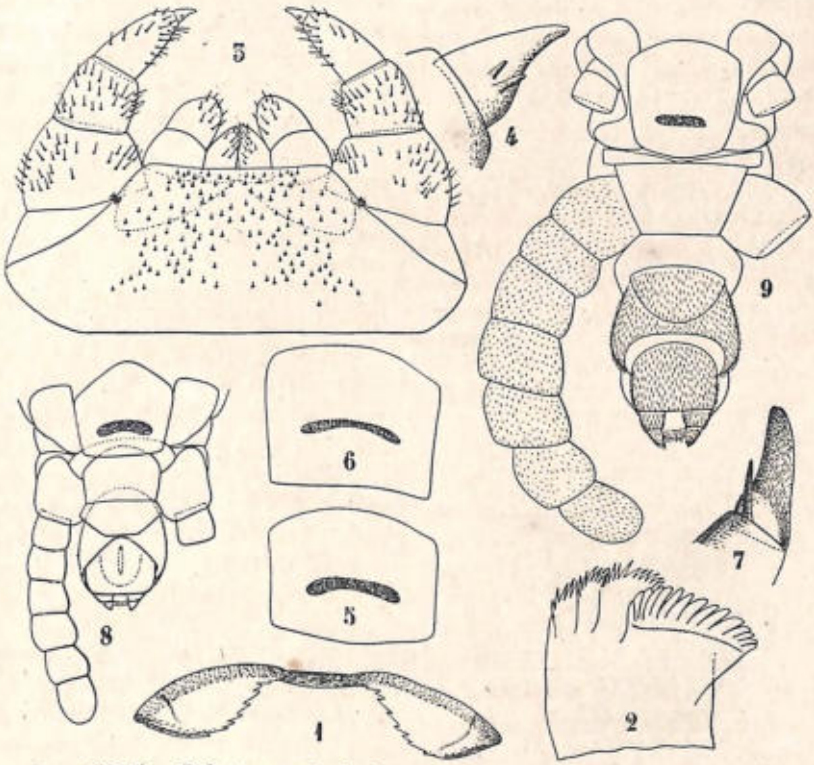

FIG. XXX.—*Polyporogaster indicus*: 1. labrum; 2. mandibulae pars distalis; 3. maxillae primi et secundi paris; 4. palpi maxillaris apex subtus inspectus; 5. sternum 40um; 6. sternum 40um exempli alii; 7. pedis apex; 8. maris corporis pars postica supina; 9. maris alii corporis pars postica supina.

Polyporogaster indicus (Mein.)

(Fig. XXX).

Himantarium indicum, Meinert, *Pr. Am. phil. Soc.* XXXIII, p. 228 (1885.)

♀ Corpus testaceo-latericium

Sternitum primum area porosa parva, sternita cetera area porosa transversali submediana gradatim majore, in medio corpore c. 3/5 sterniti latitudinem occupante antice paullum convexa, postice parum concava.

Segmentum praegenitale sterno transverse subrectangulari vel lateribus parum convergentibus, pedibus quam paris praecedentis parum crassioribus et parum longioribus.

Segmenti praegenitalis sternitum lateribus parum convergentibus, pedibus quam paris praecedentis multo crassioribus et fere duplo longioribus.

Pedum paria 69-83; long. corp. ad mm. 85, lat. 2·2.

Habitat.—India: Hurdwar, United Provinces; Theog, Simla Hills, 8,000 ft. (*Annandale*); Leh, Ladakh; Murree, W. Himalayas (*Stoliczka*); Kiari, Naini Tal distr; Karwarpani, sal forests; W. Dun; Kalka, base of Simla Hills, 2,400 ft (♂ p.p. 77); near Badrinath, British Garhwal, 10,600 ft. (*A. D Imms*, 1 ♀ 75, 1 ♂ 71, 1 juvenis 77); Bagarkote, 8,000 ft., Kumaon, W. Himalayas.

Exempla a Cl. Meinert descripta ad Kulu a Rev. Mr. Carleton collecta erant.

Gen. **Mesocanthus**, Mein.

(Figs. XXXI—XXXIV).

Mesocanthus, Meinert, *Naturh. Tids.* VII, p. 34 (1870); Attems, *Zool. Jahrb. Syst.* XVIII, p. 206; Verhoeff, Bronn's *Klass. u. Ord. Chilopoda*, p. 294 (1908).

Corpus angustum antice parum, postice parum magis attenuatum.

Lamina cephalica latior quam longior, pedes maxillares obtegens, sutura frontali indistincta. Antennae attenuatae.

Labrum sinuatum, medium laeve, lateraliter parum profunde dentatum; mandibulae lamina dentata et laminis pectinatis quatuor instructae; maxillae primi paris mala interna triangulari, mala externa integra processis palpiformibus nullis; maxillae secundi paris palpo (praeter subcoxas) 4-articulato, articulo ultimo unguiformi perparvo, nudo.

Lamina basalis perlata, brevis, transverse subrectangularis, lamina praebasalis obtecta. Pedes maxillares subcoxis lineis chitineis manifestis, margine antico et margine interno articulorum sequentium inermibus, ungue terminali sat magno et sat arcuato.

Tergita sulcis indistinctis, praetergito sat magno, paratergito secundario parvo, paratergito primario magno quam scutellum spiraculiferum multo majus, scutellis ceteris vide fig. XXXI, 7. Sterna a primo ad penultimum area porosa instructa, praesterno medio plus minusve manifeste diviso.

Pedes ungue terminali parum arcuato et utrimque seta brevi basali instructo.

Segmentum praegenitale sterno parvo medio profunde sulcato vel non, tergito lato, subcoxis poris destitutis, pedibus, praeter subcoxas, 6-articulatis ungue destitutis crassiusculis, in mare crassioribus.

Observatio.—Genus hoc a gen. *Polyporogaster*, Verh. segmenti ultimi pediferi subcoxis supra poris haud instructis distinctum est.

Appendices genitales biarticulatae.
Pori anales nulli.
Pedum paria ad 91.
Typus: *Mesocanthus albus*, Mein.

CONSPECTUS SPECIERUM.

1. Sternum primum poris destitutum, sterno segmenti ultimi pediferi medio sulcato ... ... *M. albus* v. *minuta*, Brölem.
2. Sternum primum poris instructum, sterno segmenti ultimi medio haud sulcato.
   3. Area porosa in medii corporis sternito quam eorumdem srernitorum latitudo parum minus lata; corporis pedum paria 81 ... ... *M. perporosus*, sp. n.
      4. Area porosa in medii corporis sternitis quam eorumdem sternitorum latitudo c. 2/5 minus lata.
         5. Corporis pedum paria 69-73; corpus parum angustum ... ... *M. discretus*, sp. n.
         6. Corporis pedum paria 57-59: corpus angustius ... ... *M. brevis*, sp. n.

Mesocanthus albus, Mein. var. **minuta**, Brol.

(Fig. XXXI).

Brölemann, *Boll. Soc. ent. ital.* XXXV, p. 116 (1903).

The characters of the species are comprised in that of the genus and demonstrated by the figures.

The variety is certainly distinct from the typical form, as represented by *M. albus*, Mein. from Tunis (North Africa), especially on account of the number of legs, which reach 85-73 in specimens from Erythrea and 71-79 in specimens from India, instead of 87-91 as in specimens from Tunis.

The specimens preserved in the Indian Museum and referred by me to the named form are the following: 2 ♀ near Bombay, p p. 75; 1 ♀ Nowgong, Central Provinces, p.p. 77, long. corp. 57, lat. 1·4; 1 ♀ Kach, W. India, p.p. 79; 1 ♂, Beyt, Dwarka, Kathiawar, p.p. 73; 1 ♀ near stream, Dakar Hill near Junagadh, Kathiawar, p p. 81; 1 ♀ Khas, Satara distr., c. 3,700 ft, p.p. 75; 2 ♂ Sasan, Kathiawar, p.p. 71 and 73.

Mesocanthus brevis, sp. n.

(Fig. XXXII).

Corpus luride testaceum capite parum obscuriore.

Lamina cephalica aliquantum ad basim latior quam longior. Antennae basi contiguae gradatim attenuatae quam lamina cephalica longitudo fere duplo longiores. Pedes maxillares flexi marginem frontalem spatio sat longo haud attingentes, articulis inermibus, articulo ultimo unguiformi arcuato, acuto.

Sternitum primum area submediana transversali porosa parva instructum, sternita cetera area porosa transversali submediana antice late convexa postice media plus minusve concava c. 3/5 sterniti latitudinem occupante instructa.

Pedes breves, articulo sexto quam quintus 1/3 longiore (ungue terminali robusto).

Segmentum ultimum pediferum lamina sternali brevi, trans-

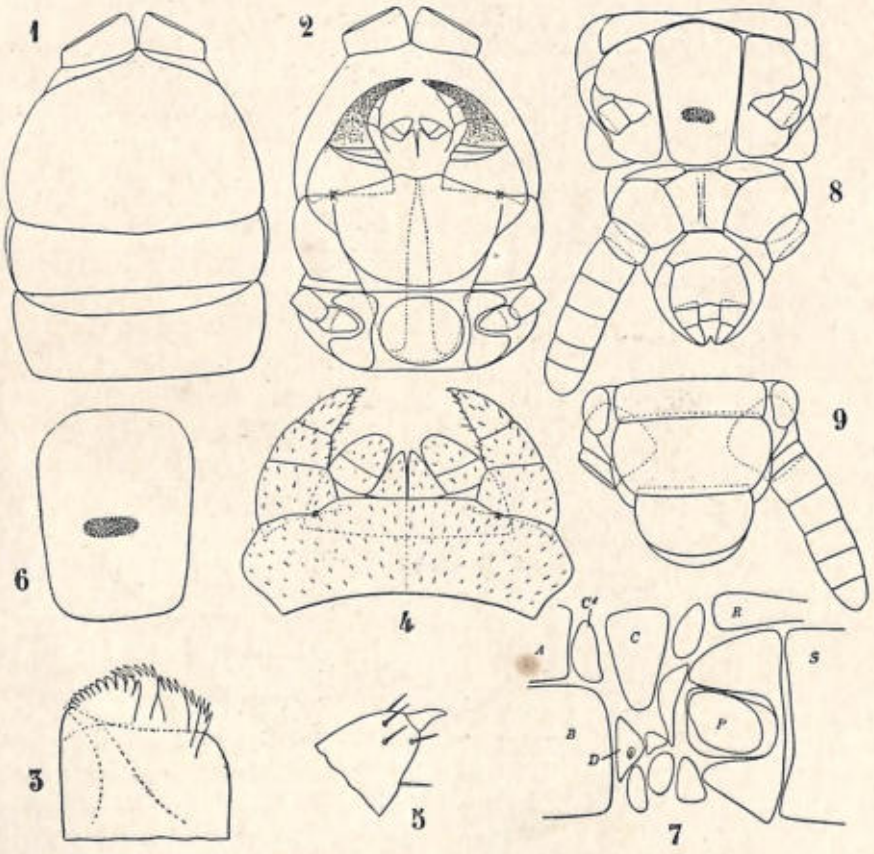

FIG. XXXI.—*Mesocanthus albus* v. *minuta*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. mandibulae pars distalis; 4. maxillae primi et secundi paris; 5. palpi maxillaris pars distalis; 6 sternum 40^{um}; 7. segmenti 40^{i} pars lateralis (litterae ut in fig. XXVII); 8. maris corporis pars postica supina; 9. eadem prona.

verse subrectangulari, ad basim fere duplo latiore quam longiore, pedibus quam paris praecedentis vix longioribus et vix crassioribus.

♂ Segmentum ultimum pediferum lamina ventrali subtrapezoidea parum ad basim latiore quam longiore, pedibus quam paris praecedentis multo crassioribus et aliquantum longioribus.

Pedes paria ♀ 57-59, ♂ 57; long. corp. mm. 35, lat. 1.

Habitat.—Tambi, Koyna Valley, Satara dist., c. 2,100 ft. (*F. H. Gravely*).

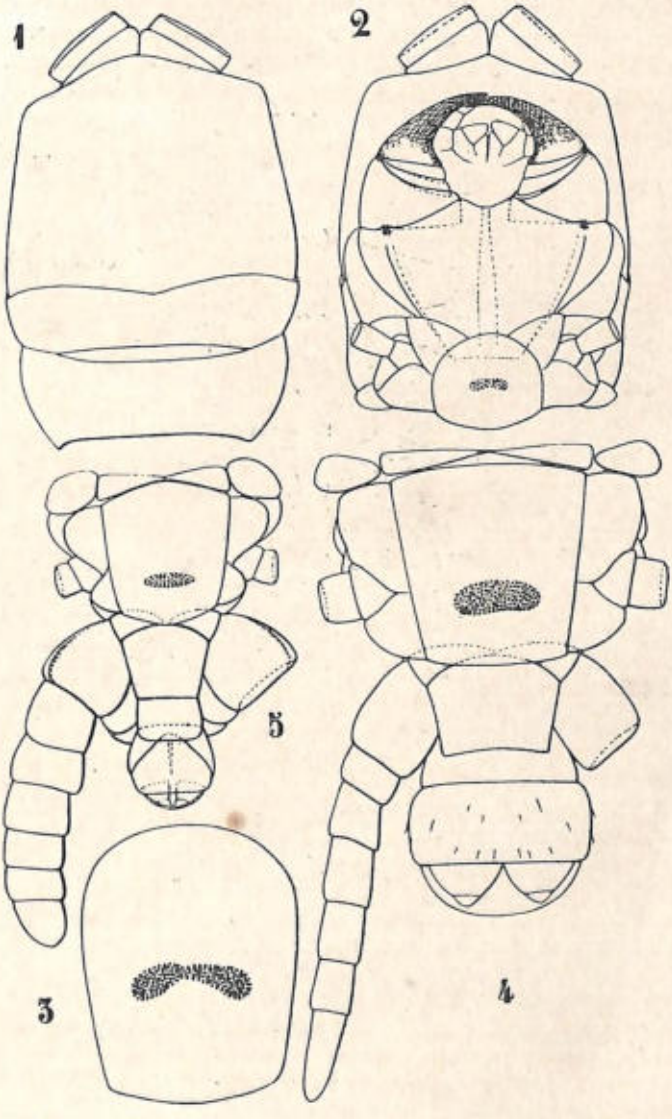

FIG. XXXII.—*Mesocanthus brevis*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. urosternum 40um; 4. feminae corporis pars postica supina; 5. maris corporis pars postica supina.

Mesocanthus perporosus, sp. n.

(Fig. XXXIII).

Corpus latericium, antice parum, postice parum magis attenuatum.

Sternitum primum area porosa trasversali parva, sternita cetera area porosa gradatim latiore, in medio corpore quam sterniti latitudo parum minus lata (= c. 11/14).

Segmentum ultimum pediferum sternito brevi, lato, transverse subrectangulari, pedibus quam paris praecedentis haud crassioribus paullum longioribus.

Pedum paria 81; long. corp. mm. 70, lat. 3·5.

Habitat.—Simla, W. Himalayas (*N. Annandale*).

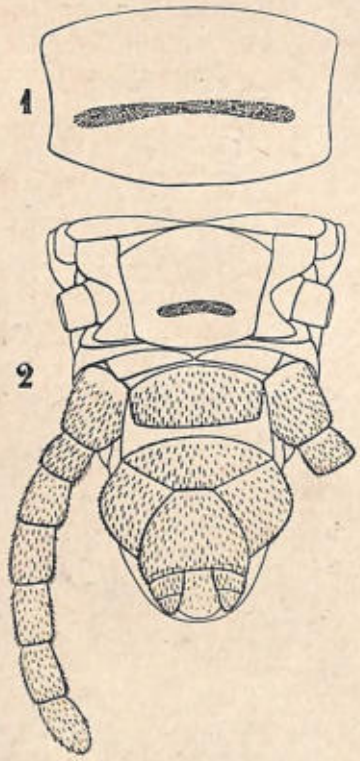

FIG. XXXIII.—*Mesocanthus perporosus*: 1. sternum 40um; 2. maris pars postica supina.

Mesocanthus discretus, sp. n.

(Fig. XXXIV).

Corpus colore et forma eidem speciei praecedenti simile.

Sternita area porosa submediana transversali c. 3/5 sterniti latitudinis occupante et postice sinuata instructa.

Segmentum ultimum pediferum sternito brevi, transverse subrectangulari, pedibus quam paris praecedentis aliquantum longioribus et parum crassioribus.

Segmenti ultimi pediferis pedes crassiores.

Pedum paria ♀ et ♂ 69-73; long. corp. ad mm. 42, lat. 1 6.

Habitat.—Almora, 5,500 ft., Kumaon (*Paiva*); Siripur.

Observatio.—Species (vel subspecies) haec a praecedente corpore minus angusto pedum paribus magis numerosis distincta est.

Subfam. *GONIBREGMATINAE.*

Gen. **Himantosoma**, Poc.

(Figs. XXXV—XXXVII).

Himantosoma, Pocock, *Ann. Mus. Genova* XXX, p. 428 (1891); Attems, *Zool. Jahrb.* XVIII, p. 286 (1903); Verhoeff, Bronn's *Klass.u. Ordn. Chilopoda*, p. 274 (1908).

Corpus paullum antice, parum postice attenuatum.

Lamina cephalica parum latior quam longior, partem lateralem posticum pedum maximallarium spatio perparvo haud obtegens, sutura frontali male distincta. Antennae haud attenuatae vix crassatae.

Labrum integrum appendice setoliformibus longis instructum; mandibulae margine distali tantum pectinato; maxillae primi paris subcoxis haud coalitis, mala interna parva, mala externa biarticulata articulo primo perbrevi et supra enterne processu palpiformi ut subcoxa instructo instructa; maxillae secundi paris subcoxis coalitis palpo, praeter subcoxam, 4-articulato, longo antrorsum ad frontis marginem directo articulo ultimo subunguiformi interne pectinato.

Lamina basalis perbrevis, lata, capitis latitudinem paullum

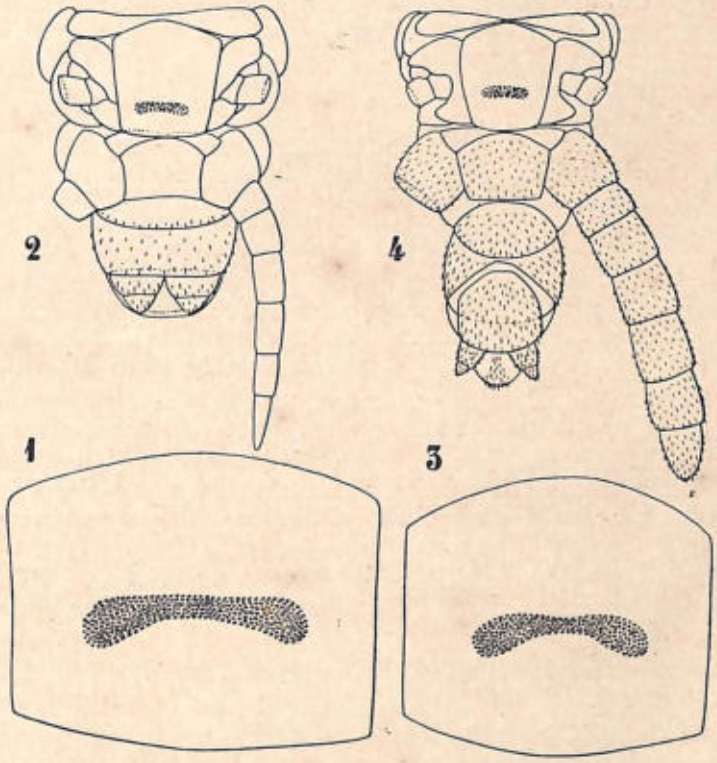

FIG. XXXIV.—*Mesocanthus discretus*: 1. feminae urosternum 40um; 2. feminae corporis pars postica supina; 3. maris sternum 40um; 4. maris pars postica supina.

superans, lamina praebasalis obtecta. Pedes maxillares flexi marginem frontalem haud superantes, lineis chitineis subevanidis margine antico et articulis ceteris inermibus, ungue terminali magni, attenuato.

Tergita haud distincte sulcata (an semper?), praetergito sat magno, praescutello magno, scutello spiraculifero sat parvo, scutellis ceteris vide fig. XXXV, 7. Sterna praesterno medio diviso; sternum primum area porosa parva postica, sternita cetera area porosa submediana parum lata et area porosa postica latiore interrupta vel non instructa.

Pedes ungue simplici, attenuato, parum arcuato et seta basali breviore instructo.

Segmentum praegenitale sterno sat parvo, subcoxis aliquantum inflatis poris praesertim per superficiem inferam et superam internam numerosis parvis et perparvis, pedibus, prater subcoxas, 7-articulatis ungue incluso.

Appendices genitales biarticulatae.

Pori anales asunt.

Typus: *Himantosoma typicum*, Poc.

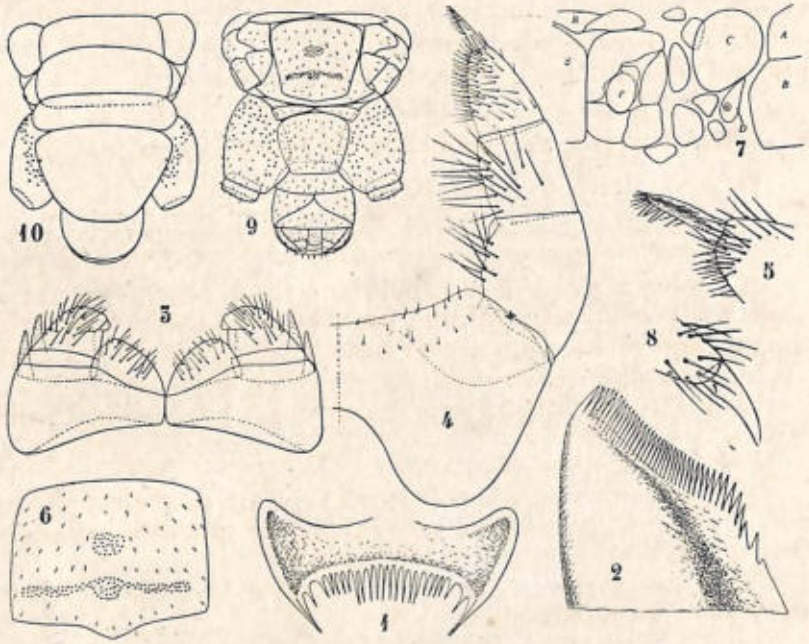

FIG. XXXV.—*Himantosoma typicum*: 1. labrum; 2. mandibulae pars distalis; 3. maxillae primi paris; 4. maxillarum secundi paris dimidia pars; 5 palpi maxillaris pars distalis; 6. sternum decimum; 7. segmenti decimi pars lateralis (litterae ut in fig. XXVII); 8. pedis decimi pars distalis; 9. maris corporis pars postica supina; 10. eadem prona.

Himantosoma typicum, Poc.

(Fig. XXXV).

Himantarium indicum, Pocock, *J. Linn. Soc.* XXI, p. 289, pl. xxiv, fig 3 (1887) nec *Himantarium indicum*, Meinert.
Himantosoma typicum, Pocock, *Ann. Mus. Genova* XXX, p. 429 (1891).

♂ Corpus luride ochraceum. Lamina cephalica fere 1/4 postice latior quam longior; antennae parum attenuatae.

Pedes maxillares flexi marginem frontalem parum superantes ungue terminali perlongo, attenuato, parum arcuato.

Sternum primum area porosa parva postica, sterna cetera area porosa antica mediana subrotunda et area postica perlata in parte submediana attenuata instructa.

Segmentum ultimum pediferum sterno subtrapezoideo, subcoxis poris parvis numerosis subtus interne et antice, supra interne instructis, pedibus quam paris praecedentis aliquantum crassioribus et paullum longioribus.

Pedes paria 63; long. corp. mm. 45, lat. segmenti primi 1·30.

Habitat.—Mergui Archipelago.

The description is based on a specimen in very poor condition preserved in the Indian Museum, originally referred by Pocock, on the suggestion of Meinert, to *Himantarium indicum* and subsequently taken by the same author as type of *Himantosoma typicum*. I have seen another specimen from Orissa and one from Sumatra: Si Rambè, which present little difference from *H. typicum*, and are considered for the present as varieties.

Himantosoma typicum, Pocock. var. tridivisa, nov.

(Fig. XXXVI).

Himantosoma porosum, Silvestri, *Ann. Mus. Genova*, XXXIV, p. 719 (1895) nec *Himantosoma porosum*, Pocock, *ibidem*, XXX, p. 31 (1891).

♀ Sterna a secundo ad penultimum area porosa transverse subovali et area porosa postica in parte submediana interrupta instructa. Superficies subcoxarum segmenti ultimi pediferi poris paucis inferis c. 18 sparsis et poris c. 8 superis instructa.

Pedum paria 59; long. corp. ad. mm. 22, lat. segmenti primi 0·75.

Habitat.—Sumatra: Si-Rambè.

Observatio.—Varietas haec a forma typica area porosa postica tridivisa et poris subcoxarum segmenti ultimi minus numerosis et etiam subtus postice sparsis distincta est.

Ab *Him. porosum*, Poc. poris subcoxarum segmenti ultimi minus numerosis saltem diversa est.

Himantosoma typicum, Poc. var. bidivisa nov.

(Fig. XXXVII).

♂ Corpus testaceo-latericium capite et segmentis duobus anticis testaceis, medio dorso fascia longitudinali angusta subtestacea, ventre umbrino, corporis parte postica subochracea.

Sterna a secundo ad penultimum area porosa antica mediana subrotunda vel subelliptica et area postica media divisa instructa.

Segmentum ultimum pediferum subcoxis poris praesertim subtus interne c. 18 et poro nonnullo sparso, nec non poris c. 25 supra interne instructis.

Pedum paria 79; long. corp. mm. 45, lat. segmenti primi 1·10.

Habitat.—Barkul, below 1,000 ft., Orissa (*Gravely*).

Observatio.—Varietas haec a forma typica sternorum area postica porosa bidivisa et segmenti ultimi pediferi subcoxis poris minus numerosis bene distincta est.

Subfam. *EUCRATONYCHINAE.*

Gen. **Eucratonyx**, Poc.

(Fig. XXXVIII).

Eucratonyx, Pocock in A. Willey, *Zoolog. Results, Loyalty Isl. etc.* p. 66, pl. vi, fig. 2-2c (1898); Attems, *Zool. Jahrb.* XVIII, p. 1917 (1903); Verhoeft, Bronn's *Klass. u. Ord. Chilopoda*, p. 288 (1908).

Corpus paullum antice et parum postice attenuatum.

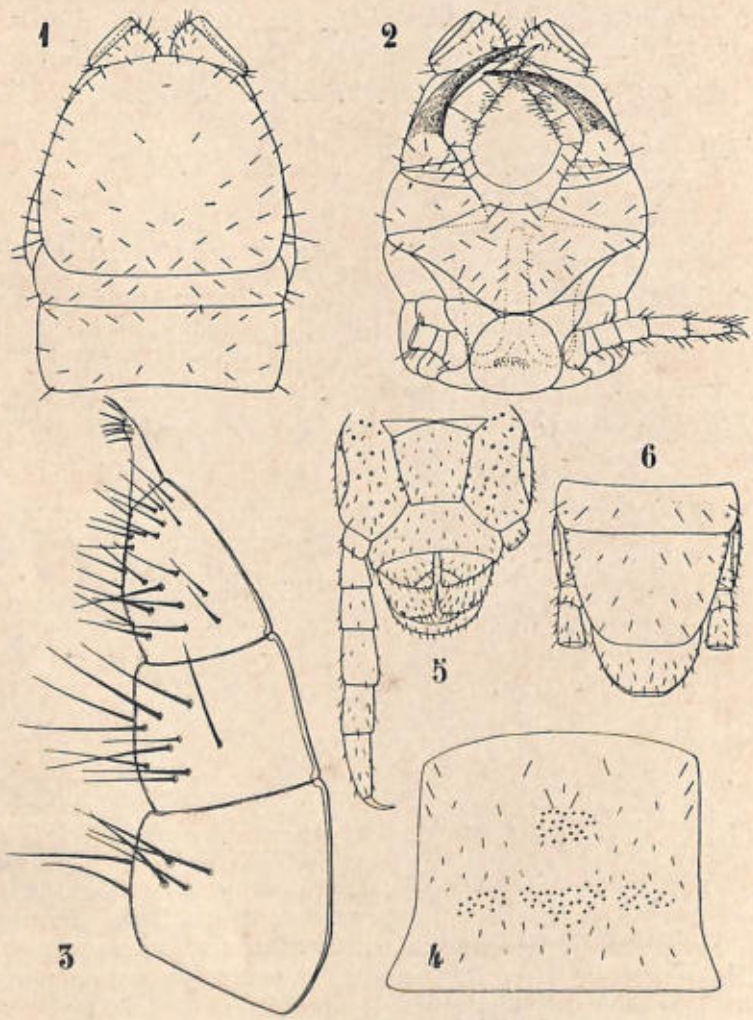

FIG. XXXVI.—*Himantosoma typicum* v. *tridivisa*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. palpus maxillaris; 4. sternum decimum; 5. feminae corporis pars postica supina; 6. eadem prona.

Lamina cephalica latior quam longior pedes maxillares obtegens, sutura frontali (saltem in *E. meinerti*) indistincta. Antennae

attenuatae. Labrum integrum processibus dentiformibus, sat longis, per marginem lateralem magis attenuatis instructum: mandibulae margine ipso per partem brevem internam dentato, per partem ceteram majorem pectinato sed haud lamella dentata et lamella pectinata distinctis instructo; maxillae primi paris mala externa biarticulata articulo primo supra externe processu palpiformi instructo, subcoxis etiam externe processu palpiformi instructis; maxillae secundi paris subcoxis coalitis, palpo (subcoxis exclusis) 4-articulato, articulo ultimo longo unguiformi setis marginalibus et setis inferis pectinis instar seriatis instructo.

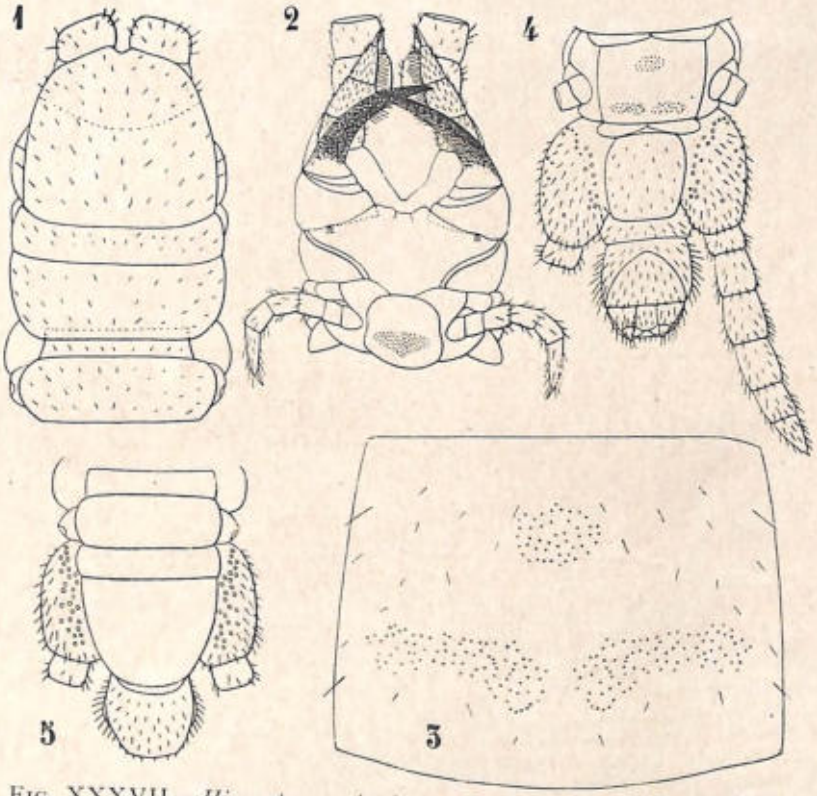

FIG. XXXVII.—*Himantosona typicum* v. *bidivisa*: 1. caput et segmenta 1-3 prona; 2. caput et segmenta primum et secundum supina; 3. sternum decimum; 4. maris corporis pars postica supina; 5. eadem prona.

Lamina basalis postice laminae cephalicae latitudinem subaequans, brevissima lateribus parum convergentibus, lamina praebasalis plus minusve manifesta. Pedes maxillares flexi marginem frontalem spatio sat parvo haud attingentes, subcoxis aliquantum antice latioribus quam longioribus antice inermibus, lineis chitineis distinctis, articulis 2-4 brevibus, ungue terminali longo.

Tergita praetergito sat magno, paratergito (praescutello) quam scutellum spiraculiferum majus scutellis ceteris vide fig. XXXVIII, 8.

Sterna a primo ad penultimum area porosa lata postica et a secundo (saltem in *E. meinerti*) in corporis parte anteriore areis parvis subanticis lateralibus et areis parvis (antica et postica) per parasterna instructa, in corporis parte posteriore etiam poris medianis sparsis. Praesterna parva parte mediana subnulla lineari.

Pedes corporis partis anticae unguis seta basali longa, plus minusve latiuscula et ungue ipso parum vel multo curvato.

Segmentum praegenitale subcoxis plus minusve inflatis poris numerosis parvis praesertim subtus et supra interne distributis instructis, pedibus praeter subcoxis 6-articulatis, ungue nullo.

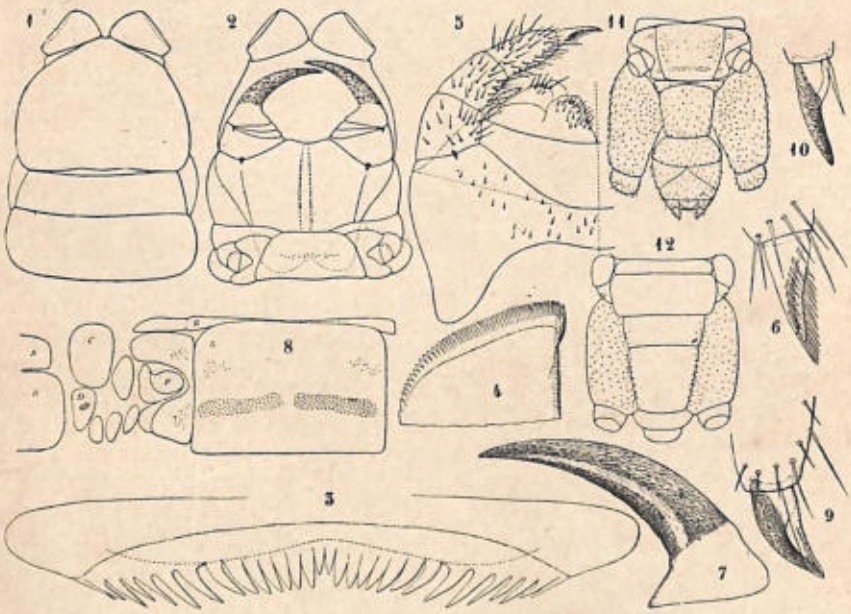

FIG. XXXVIII.—*Eucratonyx meinerti*: 1. caput et segmenta primum et secundum prona; 2. eadem supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillarum primi et secundi paris dimidia pars; 6. palpi maxillaris pars apicalis; 7. pedum maxillarium unguis; 8. segmenti decimi latera et sternum totum (litterae ut in fig. XXVII); 9. pes paris decimi; 10. pes paris 50i; 11. maris corporis pars postica supina; 12. eadem prona.

Appendices genitales biarticulatae.
Pori anales nulli.
Pedum paria ad 123.
Typus: *Eucratonyx meinerti* (Poc.).

Eucratonyx meinerti (Poc.).

(Fig. XXXVIII.)

Himantarium meinerti, Pocock, *J. Linn. Soc.* XXI, p. 289, pl. xxiv, fig. 1; *Id., Ann. Mus. Genova* XXX, p. 426 (1891).
Eucratonyx meinerti, Pocock, in A. Willey, *Zool. Results, Loyalty Isl. etc.*, p. 66 (1898).

Corpus ochroleucum capite parum obscuriore.

Lamina cephalica fere 1/4 latior quam longior. Pedes maxillares ungue longo bene arcuato et macroscopice crenulato. Labrum, mandibulae et maxillae vide fig. XXXVIII.

Sternum primum area porosa parva transversali submediana, sterna sequentia corporis partis anterioris area porosa lata subpostica et poris nonnullis subanticis sublateralibus, sterna corporis partis posterioris etiam poris nonnullis medianis sublateralibus sparsis instructa; parasterna antice et postice area porosa parva etiam instructa.

Pedes corporis partis anterioris ungue terminali parum ante mediam longitudinem infra exciso et ab excisione ad apicem gradatim attenuato parum arcuato, seta unguis basali quam unguis parum longiore lata, apice latiore, spatuliformi unguis apicem complectente; pedes ceteri ungue ad basim parum lato et gradatim attenuato paullum arcuato, seta basali attenuata quam unguis breviore.

Segmentum praegenitale sterno vix trapezoideo subaeque longo atque ad basim lato, subcoxis sat inflatis parum ante praetergitum pertinentibus, poris parvis numerosis praesertim supra et subtus per partem anticam internam, cetera superfie poris parvis sparsis, pedibus quam praecedentes circa duplo longioribus haud attenuatis setis brevioribus vestitis.

Pedum paria ♂ 103-109, ♀ 111-128; long. ad mm. 130, lat. segmenti primi 1·90.

Habitat.—Exempla vidi (♀ p.p. 111, ♂ 109) ex Little Coco Island, Andamans. Species iam nota erat ex Mergui Archipelago (Sullivan Island), Great Coco Island, Reef Island (Tavoy), Moulmein et Palon, Burma.

Subfam. *GEOPHILINAE.*

Gen. **Geoporophilus**, nov.

(Fig. XXXIX.)

Corpus angustum antice haud, postice parum angustius.

Lamina cephalica subquadrata, pedes maxillares obtegens, sutura frontali indiscreta. Antennae attenuatae; labrum tripartitum, parte mediana quam laterales minore profunde, pectinis instar, dentata, partibus lateralibus dentibus paucis longis, angustis, acutis gradatim minoribus armatis; mandibulae margine pectinato simplici; maxillae primi paris mala externa biarticulata articulo primo supra externe processu palpiformi sat longo, ut subcoxae angulus externus, instructo, mala interna sat magna, simplici; maxillae secundi paris palpo, praeter subcoxam et ungue incluso, 4-articulato, ungue terminali subtus interne aliquantum excavato et per margines internos (superum et inferum) pectinato.

Lamina basalis fere duplo postice latior quam longior trapezoidea, pedum maxillarium latera haud obtegens, lamina praebasalis obtecta. Pedes maxillares flexi marginem frontalem haud

attingentes, subcoxis antice dentibus duobus armatis, articulis ceteris inermibus, ungue terminali attenuato margine interno maxima pro parte minute crenulato.

Tergita bisulcata praetergito magno, paratergito (praescutello) magno: quam scutellum spiraculiferum majore scutellis ceteris vide fig. XXXIX, 8, praesterna antica media subdivisa, cetera integra, sterna a secundo ad 45^{um} areis parvis duabus lateralibus inter sese poris nonnullis conjunctis vel non et areis duabus parvis (altera antica, altera postica) super parasternum instructa, a segmento 45° ad 88^{um} poris lateralibus anticis gradatim minus numerosis vel nullis et poris anticis parasterni aliquantum magis

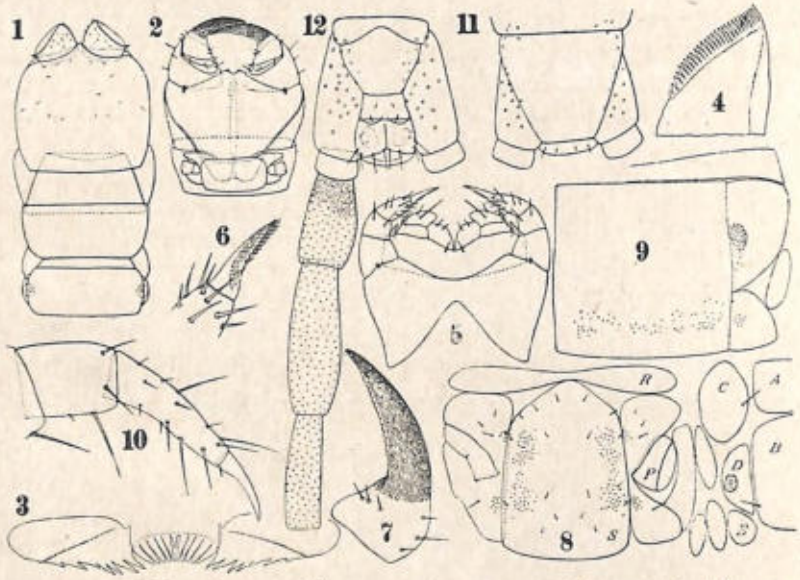

FIG. XXXIX.—*Geoporophilus angustus*: 1. caput et segmenta tria prona, 2. pedes maxillares et segmentum primum supina; 3. labrum; 4. mandibulae pars distalis; 5. maxillae primi et secundi paris; 6. palpi maxillaris pars distalis; 7. pedum maxillarium unguis; 8. segmenti 40^{i} sternum latera et tergiti pars (litterae ut in fig. XXVII); 9. sternum 90^{um}; 10. pedis 50^{i} pars distalis; 11. corporis pars postica prona, 12. corporis pars postica supina.

numerosis, sterna postica area porosa lata postica et parasterna area porosa sat magna parum convexa antica et area porosa parva postica instructa.

Pedes ungue terminali longo seta basali antica minima et seta basali infera breviore instructo.

Segmentum ultimum pediferum subcoxis subtus et supra antice et interne poris glandularibus sat numerosis instructis, lateraliter et postice poris destitutis (saltem in specie typica), pedibus in exemplo typico haud integris, forsan 6-articulatis et forsan ungue destitutis, articulis sistentibus (praeter subcoxam) quatuor quorum secundus, tertius et quartus elongati poris minimis glandularibus per superficiem inferam totam distributis instructo.

Pori anales adsunt.
Pedum paria ad 107.
Species typica: *Geoporophilus angustus*, sp. n.
Observatio.—Genus hoc ad gen. *Pleurogeophilus*, Verh. aliquantum proximum est, sed palpi maxillaris ungue pectinato pedum maxillarium lineis chitineis nullis et pororum ventralium distributione saltem distinctum.

Geoporophilus angustus, sp. n.

Corpus ochroleucum totum. Pedum paria 107; long. corp. mm. 55, lat. segmenti primi 0·80.
Characteres ceteri vide generis descriptionem et figuras.
Habitat.—Sumatra: Indragiri (*Burchard*).

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VI. THE FAUNA OF CERTAIN SMALL STREAMS IN THE BOMBAY PRESIDENCY.

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

(With Plates I—VII.)

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INTRODUCTION.

The notes embodied in this paper are based primarily on collections made in the course of a tour in the Satara and Poona districts in February and March, 1918. The chief localities at which these collections were made were Medha in the Satara district (alt. *ca.* 2,000 feet) and Khandalla in the Poona district (alt. *ca.* 2,500 feet). The former place is situated on the river Yenna or Vena, a tributary of the Kistna or Krishna, in a valley among the easternmost spurs of the Western Ghats; the latter on the hillside about a mile and a half east of the well-known pass Bhor Ghat. From Medha the Zoological Survey of India already possessed large collections of aquatic invertebrates made by Dr. F. H. Gravely and Mr. S. P. Agharkar.

My main object in visiting Medha was to obtain further information about the freshwater medusa *Limnocnida indica*, which was originally discovered there by Mr. Agharkar; while Khandalla was selected as a suitable spot at which to study the fauna of the small mountain torrents of the Bombay Ghats. It is a locality well known to conchologists as the home of the interesting genera *Lithotis* (Succineidae) and *Cremnoconchus* (Littorinidae).

So far as *Limnocnida* was concerned the results of my tour were purely negative, but even so they are not devoid of interest, for they prove beyond doubt that the medusa must have a fixed

or resting stage in its life-history, perhaps with the structure of a minute hydroid, or more probably encysted in a form that would not be recognizable with our present knowledge.

The most interesting results obtained in the streamlets at Khandalla were those bearing on adaptation to environment in fish and molluscs.

Notes resulting from a tour of the kind cannot be exhaustive, but our knowledge of the bionomics and environment of the aquatic fauna of India is still in its preliminary stage, in which it is, in my opinion at any rate, worth while to publish notes of the kind, even at the risk of being superficial.

I must be held wholly responsible for all statements made in those sections of the paper in the superscription of which no author's name is given.

I. THE LIMNOCNIDA POOL IN THE YENNA RIVER AT MEDHA.

The Yenna or Vena is a stream of a type very common in hilly districts in Peninsular India. In the wet season it may be described as a small river in which deep pools alternate with rapids obstructed by rocks of irregular shape. In dry weather, however, the pools shrink considerably, while the rapids are reduced to a mere trickle of water or even disappear altogether, leaving the pools completely isolated. The bed of the stream is for the most part rocky, with gravelly reaches, but in the pools it is covered with a layer of mud and vegetable debris. As in all the smaller tributaries near the source of the Kistna, the water contains an abundance of very finely divided silt never completely deposited, and is, therefore, opaque and brownish. After heavy rain it is further contaminated with red mud, from the Mahableshwar plateau, that seems to be particularly inimical to animal life. The pools are practically devoid of aquatic vegetation. The temperature of the water of the pools must rise to a considerable height in the hot season; at other times of year it is strictly temperate.

The pool in which *Limnocnida indica* was originally found is, including the gorge at its upper end, about 50 yards long and a stone's throw across; its width must vary slightly with the seasons. A photograph of it is published by Gravely and Agharkar in *Rec. Ind. Mus.* VII. In March the water is 7 to 12 metres deep, but must be considerably deeper in the "rains." In March there is very little current, as the rapid above the pool is then small and feeble. A tall man could stride across the outlet. The rocky bottom is very irregular; in the lower part of the pool it is covered with a fairly deep layer of gravel mixed with mud, but in the upper part, which is the deepest, there is only a sparse coating of small pebbles and vegetable debris. A large irregular rock rises far above the surface in the lower part and a foot-bridge spans the upper part at a considerable height above the water. It is impossible, owing to the opacity of the water, to see the

bottom of the pool. Except algae, which are scantily represented, there is no living vegetation.

The fauna of this pool is chiefly a bottom fauna. The bare rock of the sides is covered for considerable areas by the hard black encrusting sponge *Corvospongilla ultima* var. *spinosa* and by the much softer and rather thinner green species *Spongilla perviridis* and *S. sumatrensis* var. *rivularis*. The Polyzoa *Plumatella javanica* and *P. emarginata* occur sparingly on the cleaner parts of the rocky basin and also on the lower surface of loose stones. In the mud and dead vegetable matter a small white dipterous larva of the family Chironomidae is abundant, while in the more gravelly spots thick-shelled Unionids (*Parreyssia corrugata* and *P. cylindrica*, sp. nov.) are not uncommon. For some inches above the bottom Entomostraca, chiefly Copepods and Daphnids, are abundant and with them occur the larvae and pupae of the Corethrine Culicid *Chaoborus manillensis*.[1] None of these arthropods commonly rise to the surface, on which the only zooplancton taken in my nets consisted of the statoblasts of *Plumatella*. Surface-haunting fish such as *Barilius bendelesis* are scarce in the pool, but bottom-haunting forms, notably *Discognathus lamta* and *Gobius bombayensis*, are numerous; a large proportion of the fish bore the glochidia of Unionidae on their fins at the time of my visit. Small prawns of the genera *Caridina* and *Palaemon* are not uncommon, and the crab *Paratelphusa* (*Barytelphusa*) *jacquemonti* burrows in the mud at shallow points near the shore.[2]

The facts known about the life-history of *Limnocnida* are as follows:—they are taken mainly from the papers referred to in a footnote below.[3]

L. indica has been found only in the smaller streams of the upper Kistna river-system, and only in pools situated as described above. It has been observed only in the months of April and May; in places where it is abundant in these months it has been proved to be completely absent in February, March and October,

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[1] Both larva and pupa of this fly are modified in correlation with life near the bottom instead of at the surface, the larva in its very small air-sacs, the pupa in several structures, particularly in its balloon-like breathing trumpets, which are sufficiently bouyant to keep it in an upright position but not to raise it to the surface. See Baini Prashad, *Rec. Ind. Mus.*, XV, pp. 154–156 (1918).

[2] I may refer briefly to two small but remarkable Orthopterous insects common at the edge of the pool, *viz. Scelimena harpago* (Serv.) and *Paranemobius pictus*, Sauss. The former is an Acridiid grasshopper of the subfamily Acrydiinae (or Tettiginae) and is amphibious in habits, flying, diving and swimming with equal ease. I hope on some future occasion to discuss the peculiar modification of its hind legs by means of which it can cling to rocks under water. The *Paranemobius* is a brachypterous, long-legged cricket which runs, as often sideways as forwards, with great agility on the shady sides of dry rocks at the edge of water. It is widely distributed in India (Kashmir to South India) and is always found in this position. I have to thank M. L. Chopard for this identification.

[3] See Annandale, "A Preliminary Description of a Freshwater Medusa from the Bombay Presidency," *Rec. Ind. Mus.*, VII, p. 253 (1912): Gravely & Agharkar, "Notes on the Habits and Distribution of *Limnocnida indica*," *Rec. Ind. Mus.*, VII, p. 399 (1912): Agharkar, "Further Notes on the Habits and Distribution of *Limnocnida indica*," *Rec. Ind. Mus.*, IX, p. 247.

and is stated by natives of these places (who are well acquainted with it under the names "water-wheels" or "water-flowers") to be absent at all other times of the year. In the pools it feeds on minute crustacea, which are probably always to be found in abundance at the bottom, near which the medusa spends most of its time. All attempts either to breed the animal in captivity or to discover what becomes of the species when the medusa is not present have hitherto failed. Investigation of the latter point is rendered difficult at Medha by the inequalities of the rocky basin of the pool. I found that a heavy dredge invariably caught in projections of the rock, but succeeded by careful manipulation in dragging a D-net over the bottom and in bringing up pebbles and vegetable debris from it. I could detect no organism of a coelenterate nature in this matter; nor could I find any trace of a parasitic or quasiparasitic stage on or in any of the fish, molluscs or crustaceans of the pool. The structure of the stream and of the surrounding country renders it almost impossible that the medusa could be introduced periodically; at other localities it appears in bodies of water completely isolated at the time of its appearance. We know that it is killed off annually by the red mud brought down from higher up stream in the first summer freshets. We know also that sexual reproduction is active immediately before this occurs, and evidence that asexual budding ever occurs is altogether lacking. I am sure no ordinary hydroid, if at all abundant, could have escaped my notice in the investigations I undertook at Medha, while Mr. Agharkar's experiments at the same place had equally negative results. The most probable explanation seems to me to be that the hydrozoon remains for the greater part of the year in an encysted condition and that the medusa becomes fully developed in favourable conditions of temperature, as soon as the hot season is fully established. The union of ova and spermatozoa probably gives rise to planulae of the type usual in hydroids. Probably those planulae which are produced in the earlier part of the brief season of activity develop directly into medusae, but there may be a short-lived hydroid generation. Those planulae, however, which have not undergone further development at the time when the water is rendered unfit for the activities of the medusa by the freshets, perhaps become encysted and lie on the bottom until conditions favourable for active life return. Their cysts may be very minute and have no definite characters by which they could be recognized. I know of no case[1] in the Hydrozoa precisely parallel, but that of the encysted embryo of *Hydra* is similar and encystment is a phenomenon of such common occurrence in many diverse groups of freshwater invertebrates that it would not be at all surprising to find it in *Limnocnida*.

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[1] In *Annulella*, an anomalous hydroid from the brackish water of the Gangetic delta, an encysted resting stage has been described.. See Ritchie, *Rec. Ind. Mus.*, XI, p. 552, pl. xxxa, fig. 9 (1915).

II. THE FAUNA OF MOUNTAIN STREAMLETS AT KHANDALLA.

The hills at Khandalla are fairly steep and almost bare or at any rate devoid of heavy jungle. Numerous small streams rush down them, falling over many cliffs and rocks and thus forming cascades and waterfalls, some of which are of a considerable, even a great height. The streams are for the most part very small indeed, nowhere more than a yard or two across and in the deepest pools not more than a foot or two deep. This description applies to their conditions in the dry season; in the rainy season they must be small but raging torrents, the biological investigation of which would be difficult. In the following notes I discuss the true aquatic fauna of these streamlets; the fauna of damp rocks at the edge of the waterfalls will be considered separately.

It is impossible at present to give anything like a full account of the fauna of any body of water in India, because it inevitably includes among its members a large proportion of insect larvae even the adults of which are imperfectly known, if known at all. This is particularly unfortunate in the case of small torrents, the insect larvae of which are almost without exception highly modified and adapted forms. In present circumstances, however, it is perhaps best to ignore the curious flattened Ephemerid and other larvae that play an important part in the natural history of the streamlets at Khandalla, and also the aquatic and semi-aquatic beetles which, though never of large size, are by no means uncommon in the water or at the edge. Mr. Paiva's co-operation has made more satisfactory reference to the Rhynchota possible. I shall do no more than mention here that Anopheline larvae are abundant in small pools and that the adults rest in large numbers on damp rocks shaded from the sun and standing in the water. It will be remembered that my observations were made in March, when there was very little water in the streamlets.

Batrachia.—The only frogs observed at the edge of the streamlets were *Rana limnocharis syhadrensis* and *Ixalus bombayensis*, both of which were fairly common under stones. The *Ixalus* was also found in the cracks between the narrow strata of the rocks over which little cascades fall in the streamlets. These cracks often make it possible to strip off slabs of stone by the exercise of a little force, and when this is done the frogs appear flattened against the parent rock, with their pupils strongly contracted. With them there is abundant food, particularly in the form of earwigs (*Forcipula*), which greatly favour such situations. When the streamlets become broader owing to natural or artificial obstructions in comparatively level areas *Rana cyanophlyctis* is abundant round the margin. I found no tadpoles of any species.

Fish.—Three species of fish, all very small, make their way into the smallest pools in the streamlets. They are *Nemachilus evezardi*, *Discognathus nasutus* and *Psilorhynchus tentaculatus*. All of these, and especially the two last, are modified forms.

The loach resembles other small species of its genus in general structure but has the processes between the two nostrils on each side of the head prolonged into regular barbels. This feature does not occur in any other Indian species of *Nemachilus* but is present in the closely allied genus *Aborichthys*, which is found in hill streams in Assam and north-eastern Burma.

The modifications exhibited by the *Discognathus* and the *Psilorhynchus* are of a more extreme and more clearly adaptive nature. Many species of *Nemachilus*, with their ventral mouth, swollen suctorial lips, glandular skin, flat ventral surface and small size are well fitted to live in rapid-running water among rocks, to which they are able to adhere and over which they can crawl even when the surface is not entirely submerged ; but other species of similar structure live in ordinary rivers. The two species of *Psilorhynchus* are inhabitants only of streams in or near Indian mountains, and are modified accordingly. The Bombay species does not differ from its Himalayan congeners to any important degree in this respect. It has been generally assumed that the genus

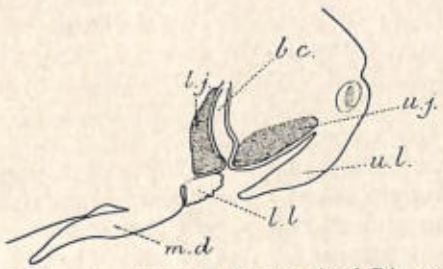

FIG. 1.—Vertical section through the mouth of *Discognathus lamta*.
b.c. = buccal cavity. *l.j.* = lower jaw. *l.l.* = anterior free portion of lower lip. *m.d.* = mental disk. *u.j.* = upper jaw. *u.l.* = upper lip.

Discognathus has had a similar history, but though *Psilorhynchus* may be a more primitive form of *Discognathus*, there is something to be said for another view.

The main if not the only generic peculiarities of *Discognathus* lie in the structure of its mouth and lips (fig. 1). The jaws are of semicircular shape, firm and bony, with blunt edges and covered with soft integument; they are directed downwards and can be tightly closed together with their margins in contact. The upper lip is a deep but delicate fold covered with minute papillae, mobile and probably sensitive. It entirely conceals the upper jaw, to which it is not attached. The lower lip bears much the same relation to the lower jaw so far as its anterior part is concerned, but the free portion is shorter; posteriorly it is much enlarged and flattened and bears in its centre a relatively large transversely oval or nearly circular pad, which can be elevated by muscular action and so produce a partial vacuum, thus forming an organ of adhesion. The mouth of *Psilorhynchus* is essentially similar, except that the pad is entirely absent or represented, as in *P. ten-*

taculatus, by a slight swelling. From the more normal species of *Discognathus* the genus is further separated by the structure of the pectoral fins, which are greatly expanded, entirely horizontal in position and with their rays broad, flat and sparingly branched. The chest is also flat, devoid of scales, highly muscular and, with the pectoral fins, capable of adhering tightly to flat or uneven surfaces. The other generic differences are trivial or inconstant: *Discognathus* may have two or four barbels or none, *Psilorhynchus* two or none; the two lips are joined together by a fold in *Discognathus*, separated by a groove in *Psilorhynchus*. In the Indian species there is no difficulty in separating the genera, but both in India and Africa forms occur that are intermediate in one way or another. Boulenger[1] in describing the Nilotic species of *Discognathus* says:

> "Aberrant Cyprininae adapted for living in torrents and mountain rivers. The mental disk by which they are enabled to fasten themselves to stones varies greatly in its degree of development, and is so reduced in some specimens of the species described below as *D. quadrimaculatus* as to be almost indistinguishable. Such specimens might be referred to the genus *Crossochilus*, Van Hasselt, were it not for the more reduced gill-openings, which do not extend to the lower surface of the head, the isthmus being much broader than in the related genera."

The resemblance between *D. quadrimaculatus* and *Psilorhynchus* seems to me to be very close indeed, both in the structure of the mouth and as regards general facies. There is no resemblance, however, in the structure of the pectoral fins, and the lips are continuous in the African fish.

If we have in this African species a close approximation to *Psilorhynchus*, we have among Indian forms a still closer resemblance in the modification of the pectoral fins and chest in one or possibly two species of *Discognathus*. This is the case in *D. nasutus*. Here again, however, we have a difference as well as a resemblance, for the pectoral fins in *D. nasutus* differ from those of all species of *Psilorhynchus* in that all the rays except the outermost ones are branched, though sparingly so, whereas in *Psilorhynchus* several of the outer rays are simple or nearly so.

Resemblances between the mouth-parts in these fish are perhaps more important genetically than those between the fins, both because they are more exact and because we find similar modifications in the fins of other unrelated genera (such as *Homaloptera* and even some Siluridae) that also live in mountain streams. The latter resemblances are, therefore, without doubt convergent. It will be as well, however, to inquire a little further, before coming to any conclusion, what are the normal modifications in the

[1] *The Fishes of the Nile*, p. 180 (1907). See also the same author's *Fresh-Water Fishes of Africa*, I, p. 343 (1909).

clearly specialized genus *Discognathus* and in what way these modifications are actually utilized.

With the structure of the mouth in *Discognathus* I have dealt to some extent. The Western Asiatic forms (*D. variabilis* and *D. lamta* var. *rufus*) closely resemble the Indian forms in this respect, and so does the one species (*D. borneensis*) known from the Malay Archipelago. I have been able myself to observe both the typical *D. lamta* and its Syrian race under natural conditions in exceptionally favourable circumstances. Neither of these forms lives habitually in mountain streams; both affect the pools of streams and rivers and even isolated masses of still water; they are what we may call normal forms of the genus with well-developed mental suckers and with the pectoral fins and chest comparatively little modified. My observations on the Syrian fish were made in a walled fountain at the Lake of Tiberias, those on the Indian form in the Inlé Lake in the Southern Shan States. Moreover, in the literature on other species of the genus I can find no statement that would justify, so far as most species are concerned, the belief that the genus is like *Psilorhynchus*, essentially a mountain one. Blanford[1] took the types of *D. blanfordii* in a stream which he describes as a torrent, and Max Weber[2] states that *D. borneensis* lives in mountain streams. All the other species are recorded from rivers or lakes. *Discognathus lamta*, in both its races, feeds on small organisms that are tightly fixed to rocks or other hard objects. Its manner of feeding is this. Having fastened itself, usually in a more or less vertical position with the head uppermost, to a rock or post by means of its mental disk, it selects suitable food with its lips, bites it off with its jaws and sucks it into its almost horizontal buccal cavity. When the food in its reach is exhausted, it relaxes its adhesive organ and by means of an almost imperceptible movement of its tail, thrusts itself slightly upwards. The disk then takes hold again. In Palestine I experienced this process by bodily sensation on placing my bare feet in the water of the fountain. The fish invariably attached themselves and it was possible to feel the action of the disk fixing itself, the movements of the lips and the nibblings of the jaws, which were not sharp enough to pierce the human skin. *Psilorhynchus* apparently feeds in the same way but clings rather by means of its pectoral fins and flattened, highly muscular chest, which can probably be rendered concave by muscular action. *Discognathus nasutus* has both means of attachment strongly developed.

It is noteworthy that in *D. blanfordii*, so far as can be seen from Boulenger's figures, the fins and chest have a considerable resemblance to those of *D. nasutus*, while those of the other African species, which apparently live in comparatively still water, resemble those of *D. lamta*. The Bornean species also

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[1] *Discognathus lamta*, Blanford, *Geol. Zool. Abyssinia*, pp. 460-461 (1870).

[2] *Indo-Australian Fish*, III, p. 228 (1916); see also Vaillant, *Notes Leyden Mus.*, XXIV, p. 9, figs. 25, 26 (1902).

resembles *D. nasutus* in this respect, so far as can be judged from published figures.

Taking all these facts into consideration and further remembering that the peculiar structure of the pectoral fins found in *Psilorhynchus* is also found in *Homaloptera* and to a still greater degree of specialization in the Bornean genus *Gastromyzon*,[1] I am of the opinion that the resemblance between *Psilorhynchus* and *Discognathus* is to a large extent due to parallel evolution. In the species of the latter genus that live in comparatively still water (*i.e.* in the majority of species) it is superficial, while in those species that live in hill torrents convergence has certainly taken place. I am inclined to think, therefore, that both *Psilorhynchus* and *Discognathus* have been derived from a genus like *Crossochilus* or probably *Labeo*, but that their evolution took place independently, and that whereas the chief factor in the case of *Psilorhynchus* was rapid-running water in a rocky stream-bed, in *Discognathus* the primary factor was a peculiar mode of feeding. The close resemblance between such forms as *P. tentaculatus* and *D. nasutus* is due, if this be so, to secondary convergence. The resemblance between *D. quadrimaculatus* and *Crossochilus* may or may not be due to a real genetic relationship, while that between the former and *Psilorhynchus*, close though it seems at first sight, cannot be closer at most than that between distant cousins, so far as descent is concerned.

Molluscs.—The only mollusc found in the upper parts of the streams at Khandalla was *Ampullaria nux*. As we have pointed out in our systematic notes on the Mollusca collected on my tour, this species is modified for its peculiar habitat in respect to two characters: (1) its small size and (2) the curious development of the inner lip of the aperture of the shell. It is the only species of *Ampullaria* that I have seen in anything but still or at most very sluggish water. The columellar callus of the shell is a flattened ridge nearly two millemetres broad, and this ridge forms with the outer lip a continuous margin of attachment, enabling the shell to come into much closer contact with the rocks to which the animal attaches itself than is the case with the shells of more normal species that crawl on water-weeds. Only one living individual was seen, though broken shells were not uncommon in the streamlets and it is probable that *A. nux*, like many other species of its genus, conceals itself in the dry season. The one individual was attached to the rocky margin of a small pool densly shaded at all times of day and supplied by a small but perennial waterfall.

Paludomus obesa was found in some abundance in the same streams, but in a small plain where it was not shaded and had lost for a short distance its peculiar character as a mountain streamlet. It was feeding on algae covering stones.

Insects.—As I have already stated I can deal only with the Rhynchota of the streamlets. These fall from a bionomical point

[1] See Weber, *Indo-Australian Fishes*, III, p. 3, fig 1 (1916).

of view into three categories: (1) surface forms, (2) mid-water forms confined to still pools, and (3) bottom forms that can live in rapid running water. The list of species collected in the streamlets at Khandalla is as follows; I have distinguished the names of those that belong to the first category with an *, those of the species of the second category with a † and those of the species of the third category with a §.

*Rhagovelia nigricans.**	*Heleocoris elongatus.*§
*Ptilomera laticaudata.**	*Naucoris sordidus.*§
*Metrocoris ståli.**	*Erithares templetoni.*†

Even in dealing with the Rhynchota I think it will be better to defer a detailed discussion until it has been possible to investigate the structure of Indian aquatic insects more completely. I shall merely point out that the Hydrometridae of running water, in India at any rate, usually differ from those that live on the surface of pools and have either extremely long legs and bodies, as in *Cylindrostethus*, or else have the body short and rounded like that of the marine species, as in *Metrocoris*; while the species of *Heleocoris* are flattened and smooth and are thus well adapted to cling tightly to stones or to make their way beneath and between them. Such small, short-legged surface forms as *Rhagovelia* live at the edge of the stiller parts of the streamlets and are not perceptibly modified.

III. The Fauna of Damp Rocks at the Edge of Waterfalls at Khandalla.

Where the small streamlets near Khandalla are precipitated over the sheer basaltic cliffs that abound in the neighbourhood waterfalls of different heights are formed. The larger of these, where the water drops for some hundreds of feet, are practically inaccessible, but many smaller ones can be readily investigated in which hundreds of feet are represented by tens and the amount of water is by no means great.

The fauna of these waterfalls is of considerable bionomic interest, but what I have said in reference to insects of small streams has even greater force here. The fauna of the actual falls is perhaps exclusively entomological, its most conspicuous members being certain moth-larvae that spin their flattened cocoons on the rocks and certain caddis-worms that make bag-shaped reticulate snares of such strength that the water pours right through without breaking them. At the edge of the falls, however, at any rate in the dry season, a much larger and more varied fauna has established itself where the rock is kept wet with spray and the growth of algae is thus encouraged.

Here again insects predominate, but other animals also occur.

Batrachia.—Ixalus bombayensis is not uncommon in cracks in the damp rock, and *Rana limnocharis syhadrensis* may be found under stones at the bottom of the falls.

Molluscs.—Two species of molluscs, both belonging to highly peculiar genera probably of very limited range, have been described from the edge of the waterfalls at Khandalla. These are *Cremnoconchus* of the almost exclusively marine family Littorinidae and *Lithotis* of the semi-terrestrial pulmonate family Succineidae. Our knowledge of both these interesting genera is due primarily to the work of the late Dr W. T. Blanford.[1] In March *Lithotis* was entirely absent from the cliffs from which it was described. Its absence in the dry season is additional evidence for the belief that, like other members of its family, it is an air-breathing mollusc that can only exist in damp surroundings. In dry weather it probably conceals itself and aestivates. *Cremnoconchus syhadrensis*, on the other hand, was found in great abundance, but only at places where the cliff was shaded from the midday sun and supported a growth of the peculiar dull green filamentous alga on which it feeds. Some individuals were in an active condition, crawling and feeding in the spray of the falls; others, in drier places, were apparently quite torpid and had their opercula tightly closed. A number of individuals in both states were placed in jars of water. Some were prevented from reaching the surface. These were drowned in 24 hours, dying partially expanded. Others, placed in a jar with flat sides and only half full of water, crawled out after a short time. Their movements could be observed with great nicety through the glass. They moved upwards slowly. When out of the water the shell was closely applied to the glass except where the tentacles protruded in front, the ventral surface of the body-whorl being in contact with it as well as the rim of the aperture. The opening of the branchial cavity was patent, but was relatively small and had a somewhat lunate form. It could be easily seen that this cavity was full of water, and the animal took with it a film of water that surrounded the shell on the glass. After it had been moving about for some hours this film grew smaller and finally disappeared. The orifice of the branchial cavity was then shut, the foot retracted and the operculum closed. The mollusc remained for days in this condition, absolutely immobile, and probably would have so remained until it had been soaked with water. Although the glass on which it crawled was quite clean, it opened its mouth and thrust out its radula from time to time, as though trying to scrape off its food, so long as it remained active. Fig. 3, pl. IV, which shows the film of water, the open branchial orifice, etc., was drawn from a specimen brought alive but torpid to Calcutta and revivified by being placed in water.

Cremnoconchus seems, therefore, to be in a sense a water-breather, incapable of obtaining its oxygen direct from the air, but also incapable of obtaining it from water in the manner usual

[1] Blanford, *Ann. Mag. Nat. Hist.*, (3) XII, p. 184 (1863), and (4) III, p. 343 (1869). For *Lithotis* see also Gude, *Faun. Brit. Ind. Moll.*, II, p. 457 (1914); for *Cremnoconchus*, Stoliczka, *Proc. As. Soc. Bengal*, 1871, p. 108.

in aquatic Prosobranchiate molluscs. It possesses both a gill and a branchial chamber with a small orifice that can be completely closed. The branchial chamber, however, is not transformed into a lung and is apparently never filled with air; breathing is effected by the absorbtion of atmospheric oxygen through a thin film of water. *Cremnoconchus* belongs to a family (the Littorinidae) of which other forms are maritime, rupicolous or even arboricolous and more or less amphibious. According to Pilseneer,[1] the branchial cavity of some species of *Littorina*, though not transformed into a lung like that of Pulmonates and though containing a gill, is filled with air when the animals are out of the water, and with water when they are submerged; while other species of the same genus "ménent ordinairement une véritable existence de Pulmoné." The physical modifications of the breathing apparatus found in *Cremnoconchus* are not very greatly different from those found in *Littorina*, but they *are* different and have a different function. In the former genus the branchial cavity is more of a closed chamber; the structure of the gill,[2] though essentially similar, is somewhat more simplified, its vascular outgrowths are less developed and the osphradium is still more reduced, having become papilliform instead of ridge-like. The small size of the branchial orifice and the completeness with which it can be closed are adaptations correlated with life in circumstances in which prolonged periods of desiccation occur. In these periods the animal is in a state of coma and probably requires little fresh oxygen, but the gill must be kept wet.

Insects.—The insect fauna of damp rocks at Khandalla is a rich one. In little ledges in which masses of damp algae grow or dead leaves accumulate numerous dipterous larvae of the families Tipulidae,[3] Chironomidae and Stratiomyidae occur, with small beetles belonging to the Staphylinidae, the Clavicornia and other groups. In cracks in the rocks the earwig *Forcipula quadrispinosa* and the Reduviid bug *Pirates arcuatus* are not uncommon, while Tettigine grasshoppers frequently alight on the algae coating smooth surfaces. I shall, however, say nothing of these, but merely draw attention to the great abundance of two species of water-bugs, *Hebrus bombayensis* and *Onychotrechus rhexenor*. The former runs about on the damp alga and takes readily to flight. It was also found on the surface of water at Medha, and exhibits no particular modification for life on rocks. *Onychotrechus* is a genus which, so far as my experience goes, is always found either on damp rocks or on the surface of small rocky streams.[4] It differs from its nearest ally *Gerris*, which always

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[1] Pelseneer, *Arch. de Biol.*, XIV, p. 356 (1895).

[2] Stoliczka, *Proc. As. Soc. Bengal*, 1871, p. 108, fig. 1.

[3] An adult fly of this family found beneath a stone on a ledge in one of the waterfalls has been identified by Mr. Brunetti as a new species of *Antocha*.

[4] Mr. Green's remarks on *O. vadda*, Dist. (quoted by Distant on p. 147 of Vol. V of the "Fauna" volumes on the Rhynchota) would apply equally well to *O. rhexenor* at Khandalla.

lives on the surface of water, and as a rule, though not invariably, of still water, in the structure of its feet, more particularly of those of the two hinder pairs of legs. On these feet there is in *Gerris* a pair of slender, almost bristle-like claws, which are situated at the tip of the limb; some distance in front of them, on the lower surface, there is a large bristle, but there is no definite empodium and the whole structure is degenerate. In *Onychotrechus* the claws are real claws, of a horny consistency, curved towards the tips, sharply pointed and flattened from side to side; they are separated from the extremity of the limb by several strong bristles and small processes perhaps of a sensory nature; similar processes also occur just behind the claws, and between them protrudes a coiled band-like empodium. These structures deserve a more detailed examination. I refer to them here merely to indicate that the foot is modified in this genus to enable it to cling to slippery surfaces, while in *Gerris*,[1] which apparently does not use the claws of its hinder legs at all, they are degenerate. There is less difference between the anterior feet of the two genera, both of which probably use them for grasping prey, but even in these feet the claws of *Onychotrechus* are much stronger and larger than those of *Gerris*. These facts are illustrated in figures 8 and 9 on plate III, drawn on the same scale from insects of approximately the same size.

Oligochaeta.—Small white worms of the family Naiadae are abundant in damp algae on the cliffs.

The fauna of these cliffs, where they are wet with the spray of waterfalls, includes, therefore, highly modified forms among both the Mollusca and the insects. The latter are still imperfectly known, but there is every reason to think that a proper entomological investigation of the waterfalls would have great biological interest.

IV. Some Frogs from Streams in the Bombay Presidency.

Only three species of frogs were found at the edge of the streams investigated at Medha and Khandalla. They are *Rana cyanophlyctis*, an undescribed race of *R. limnocharis* for which I propose the subspecific name *syhadrensis*, and an undescribed species of *Ixalus*, which I have called *I. bombayensis*. Both new race and new species are abundant in the Bombay Ghats. The *Ixalus* has been found in the North Canara, Satara and Poona districts, the race of *R. limnocharis* in the two latter and also in the Nasik district; neither form is known to occur at altitudes below 2,000 or above 4,000 feet.

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[1] I have seen a species of *Gerris* clinging to rocks at the edge of the Bhavani river by means of its anterior claws. It could not, however, run about on the slippery surface.

Rana cyanophlyctis, Schneider.

This frog, one of the commonest species in the plains of India, is found only in the immediate neighbourhood of water. It is equally at home in puddles of rain-water, ponds and streams, but does not frequent the smaller mountain streamlets. So far as my own observations go, it is the only species that skips over the surface of the water as *R. limnocharis* is sometimes stated, I believed incorrectly, to do. The habit was first noted in literature by the Emperor Bābur[1] in the year 1525-1526. *R. hexadactyla* may have the same habit when young, but when full grown is probably, as Dr. Henderson points out in a letter, too heavy an animal.[2] *R. cyanophlyctis* is frequently seen in wells and in pools with a steep margin. In such conditions it floats on the surface of the water, but when a resting place is available it usually sits at the edge. When disturbed it gives a short leap, horizontally

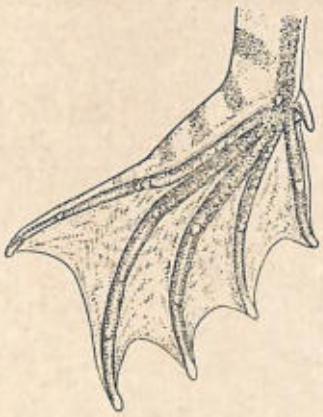

FIG. 2.—Hind foot of *R. cyanophlyctis* (enlarged).

rather than upwards, and strikes the surface of the water with its short, broad, slightly cup-shaped and stoutly webbed hind feet (fig 2) at such an angle that it is again propelled forwards through the air for some inches; it then again strikes the water in the same way, and the manoeuvre may be repeated as many as seven times. When the impetus is exhausted, as it usually is after a couple of yards or at most 10 feet—the Emperor's observation was not strictly accurate—the frog dives obliquely forwards to the

[1] He says in his "Memoirs," "The frogs of Hindustan, though otherwise like those others (Tramontane) run 6 or 7 yards on the face of the water." See *The Memoirs of Emperor Bābur*, translated by Annette S. Beveridge, fasc. III, p. 503 (1918).

[2] Since this was written I have been able to observe *R. hexadactyla* in Madras. The adult usually sits among weeds in the water, where its bright green colour conceals it to some extent. When disturbed it dives through the weeds but if they are too thick it skips feebly two or three times.

bottom. If this be soft it burrows into it with its fore feet, impelling itself forwards at the same time by vigorous kicks of its hind legs. It makes its way more or less completely into the mud or sand but does not attempt to go downwards. After remaining buried or half buried for a few minutes, it backs from its temporary burrow and rises cautiously to the surface. If no danger threatens it then swims ashore. I have often seen a frog dive direct into the water from a stone or rock and then leap out and skip two or three times. When living at the edge of a stream it dives against the current, and often has difficulty in reaching the bottom. Its swimming stroke is, however, very powerful; it is the only frog with the habits of which I am acquainted that habitually swims upstream.

R. cyanophlyctis is abundant at the edge of the Yenna at Medha and also at that of ponds and of the larger streams, where they traverse fairly level ground, at Khandalla. It evidently prefers pools or streams of which the bottom is soft. It appears rapidly in isolated temporary pools and must make its way overland by night; I have never seen it except at the edge of water by day.

Rana limnocharis, subsp. **syhadrensis,** nov.

This is a dwarfed race akin to the subsp. *niligiraca* but of much smaller stature and with the hind limbs as a rule shorter. The first finger hardly extends beyond the second; the hind feet are as in the typical form except that the webbing is slightly less extensive and the tibio tarsal articulation reaches the anterior border of the eye or a point between it and the tip of the snout. The dorsal surface is grey with black spots sometimes with a reddish suffusion; a narrow pale mid-dorsal line is often present; the ventral surface is white; with the whole of the throat black in the adult male. The length does not exceed 3·5 cm.

Measurements in millemetres.

	(type) ♂	♀
Snout to vent	27	31·5
Length of head	11	12·5
Width of head	9·5	11
Snout	4·5	6
Eye	3·4	3·4
Interorbital breadth ..	2·8	3
Tympanum	1·7	2
Fore limb	13·2	16
1st finger . ..	4	5
2nd finger	3·8	4·5
Hind limb	42·7	45·8
Inner metatarsal tubercle ..	2	2·3
Middle toe	11	12

Type-specimen.—Rept. No. 19764, Z.S.I. (*Ind. Mus.*).

Geographical Range.—This little frog is abundant in the hills and elevated valleys of the middle region of the Bombay Presidency. I have examined specimens from several places in the Satara district at altitudes between 2,000 and 4,000 feet; also from Khandalla (2-3,000 feet) in the Poona district and from Igatpuri (2,000 feet) in the Nasik district. Apparently the typical *R. limnocharis* is absent from these localities.

Ixalus bombayensis, sp. nov.

(Plate I, fig. 1).

Tongue with a free pointed papilla, often inconspicuous, in the anterior part of the median line. Snout rounded, as long as or a little longer than the orbital diameter; canthus rostralis distinct; loreal region concave; nostril much nearer the tip of the snout than the eye; eye very large and prominent; *interorbital space broader than the upper eyelid*; tympanum small, hidden. Fingers free; *toes not more than one third webbed*; disks and subarticular tubercles moderate; a fairly large but by no means prominent oval inner metatarsal tubercle; outer toes slightly fringed. The hind limb being carried forward along the body, the tibio-tarsal articulation reaches the eye. *Skin more or less distinctly rugose*[1] *above, bearing small, scattered pointed warts or tubercles*; *upper eyelid tubercular*; throat and chest smooth; belly coarsely granular; a fold from the eye to the shoulder; a low ridge, sometimes broken up into a series of tubercles, on the middorsal line of the head. The adult male with a very large gular pouch.

Colouration variable; dorsal surface dark brown or grey speckled with black, sometimes almost entirely occupied by a large dicebox-shaped mark of pinkish buff edged and speckled with black; a dark pale-edged cross-bar often present between eyes; sides dark, spotted and blotched with dull yellow; a large black and lemon-yellow mark in front of the groin in adults; limbs pale grey more or less irregularly cross-barred with black; hind part of thighs mottled with black and dull yellow; ventral surface greenish-yellow suffused with black.

Length not exceeding 3 cm.

Type-specimen.—Rept. No. 18782, Zool. Survey of India (*Ind. Mus.*), from Castle Rock.

Geographical Range.—Hills of the Bombay Presidency from N. Canara (Castle Rock) to the Satara (Khas) and Poona (Khandalla) districts at altitudes between 2,500 and 4,000 feet.

The species is closely allied to *I. flaviventris*, Boulenger,

[1] In the specimen figured on pl. I it is smoother than usual. This specimen is the only fully developed adult male in the series examined.

whose description of that species I have followed closely, italicizing the more important differences. I have examined a large series of specimens.

I. bombayensis is common at Khas (where it occurs with *I. glandulosus*) and Khandalla; Mr. Kemp found a single specimen at Castle Rock. It is evidently nocturnal in habits and in the daytime its pupil is often reduced to a very narrow transverse slit. It hides under stones in damp places at the edge of small streams and in cracks in rocks kept wet by the spray of waterfalls.

V. NOTES ON FRESHWATER FISH MOSTLY FROM THE SATARA AND POONA DISTRICTS.

Fish of the following species were collected in the Yenna at Medha in February and March:—

Euglyptosternum saisii (Jenkins).
Lepidocephalus thermalis (C. & V.)
Nemachilus botia (Ham. Buch.).
Nemachilus savona (Ham. Buch.).
Nemachilus anguilla, sp. nov.
Psilorhynchus tentaculatus, sp. nov.
Discognathus lamta (Ham. Buch.), Day.
Cirrhina reba (Ham. Buch.).
Barbus malabaricus, Jerdon.
Barbus kolus, Sykes.
Barbus ticto, Day.
Rasbora daniconius (Ham. Buch.).
Barilius bendelisis (Ham. Buch.).
Danio aequipinnatus (McCl.).
Chela boopis, Day.
Mastacembelus armatus (Lacép.).
Ophiocephalus gachua, Ham. Buch.
Gobius bombayensis, sp. nov.

About several of these fish, having put on record their occurrence in the head waters of the Kistna, I have nothing further to say.

In small hill streamlets at Khandalla I obtained three species of fish:—*Nemachilus evezardi*, Day; *Psilorhynchus tentaculatus*, sp. nov. and *Discognathus nasutus* (McCl.). These I have already discussed at some length (pp. 113–117).

In addition to my own collection I have before me some interesting specimens of *Barbus* from the Satara district, sent me by Mr. C. D. McIver of the Public Works Department, a very keen student of the local fish-fauna. To these I shall refer, and with them to an interesting specimen of the same genus recently sent to the Indian Museum from Gauhati on the Brahmaputra by Mr. T. R. Phookun on behalf of the late Chief Commissioner of Assam.

I shall also discuss the Indian species of the genus *Discognathus*, so far as the material at my disposal permits me to do so.

Family SILURIDAE.

Euglyptosternum saisii (Jenkins).

1910. *Glyptosternum saisii*, Jenkins, *Rec. Ind. Mus.* V, p. 128, pl. vi, fig. 6.

A specimen from the Yenna (Vena) River at Medha in the Satara district agrees well with the type-specimens from Paresnath in Bihar except in being much larger; its total length is 121 mm.

In general facies the species resemble *Euglyptosternum* rather than *Glyptosternum* and I find that both in Dr. Jenkin's specimens and in my own microscopic horny teeth are scattered on the palate. They are, however, attached to skin and not to the bone and are not arranged in any definite manner. The tooth-band on the upper jaw is narrow as in *Glyptosternum*. I have examined the palate of *E. lineatum* and of several species of *Glyptosternum* and cannot discover any trace of scattered teeth.

Family CYPRINIDAE.

Lepidocephalus thermalis (C. and V.).

1889. *Lepidocephalicththys thermalis*, Day, *Faun. Brit. Ind., Fishes*, I, p. 221.

Weber[1] has shown that the clumsy generic name by which this fish and its congeners were known to Day may be abbreviated to *Lepidocephalus*.

L. thermalis is characteristic of Peninsular India and Ceylon as distinct from the Indo-Gangetic river-systems. It is not uncommon in the Yenna River

Nemachilus evezardi, Day.

(Plate I, figs. 2, 2*a*).

1878. *Nemachilus evezardi*, Day; *Fishes of India*, II, p. 613, pl. cliii, fig. 11.
1889. *Nemachilus evezardi*, Day, *op. cit.*, p. 226.

Hitherto known from a single specimen (now in the Indian Museum) from a stream near Poona, this little loach is actually one of the commonest species in small streamlets in the Bombay Ghats. I obtained numerous specimens at Khandalla in the Poona district and my assistant Mr. J. W. Caunter collected others at Khas in the Satara district, while Mr. E. A. D'Abreu of the Nagpur Museum has recently sent me one from Pachmhari in the Central Provinces. All these places lie between 2,000 and 4,500 feet above sea level.

The species is stated by Day to differ from all other Indian species of its genus in possessing a pair of nasal barbels. These

[1] *Indo-Australian Fishes*, III, p. 27 (1916).

are merely prolongations of the processes that always occur between the two nostrils on either side of the head. The colouration of the fish varies considerably in different parts of the same streamlet. When the bottom is sandy the dark bars or spots on the sides are much less strongly marked than where it is of a dark colour.

At Khandalla I found *N. evezardi* with *Discognathus nasutus* and a new species of *Psilorhynchus* in hill streamlets nowhere more than a few feet in breadth. It frequented small pools, taking the place occupied by *N. montanus* in similar streamlets in the Eastern Himalayas.

Nemachilus savona (Ham. Buch.).

This loach is common in many of the smaller rivers of Peninsular India and the Indo-Gangetic plain. I obtained several specimens from the Yenna River at Medha.

In fresh specimens the head and forequarters are of a rather bright olivaceous green, obscurely mottled; the posterior part of the body is of the same colour but with a variable number of pale vertical bars, which vary greatly in breadth but are always narrower than the green interspaces. A purplish black band embraces the posterior extremity of the caudal peduncle and there is a black spot at the root of the dorsal fin in front. This fin is opaque white with seven longitudinal rows of small black spots, while the caudal has similar rows of black spots arranged vertically.

Nemachilus botia (Ham. Buch.).

1878. *Nemachilus botia*, Day, *op. cit.*, p. 614, pl. clvi, fig. 5.
1889. *Nemachilus botius*, Day, *op. cit.*, p. 227.

This fish is perhaps the most widely distributed of the Indian species of the genus. It occurs in small streams all over northern and central India and also on the Shan Plateau, and is not absent from the Kistna as Day thought.

Specimens from Medha agree with Day's var. *aureus* in that the lateral line disappears behind the dorsal fin, but the number of rays in that fin seems to be variable.

Nemachilus anguilla, sp. nov.

(Plate I, fig. 3; plate III, fig. 1).

D. 10 (2/8). P. 13. V. 8. A 6 (2/4).

Habit elongate, shallow and somewhat compressed; total length $5\frac{1}{3}$ to $5\frac{1}{2}$ times that of head, $4\frac{3}{4}$ that of caudal fin, about 9 times the greatest depth of the body. Head narrow, conical; snout bluntly pointed, with 6 slender and rather short barbels, the rostral pair of which extend backwards almost as far as the anterior border of the eyes, while the outer maxillary pair almost

reach their posterior border. Lips greatly swollen, corrugated; the upper lip with two short, stout digitiform processes in front; the lower lip interrupted in the middle line, with two or three longitudinal ridges on either side; mouth entirely ventral. Eye large and prominent, situated dorsally near the middle of the length of the head.

Pectoral fins long and narrow, extending backwards about $\frac{3}{4}$ the distance between their own roots and those of the ventrals; ventrals narrow, extending backwards about the same distance towards the anal; anal very short, a little deeper than the body; dorsal short, a little higher than the body, with its upper margin nearly straight but sloping rapidly downwards and backwards; caudal very long, deeply emarginate, with the two halves pointed. Scales small, absent from the head, hardly distinguishable on the ventral surface of the body. Lateral line complete or nearly so.

Natural colouration.—Head and body dull golden yellow; tip of snout scarlet; numerous transverse bars of dark olive green, usually broader than the interspaces, across the back; a row of large blackish spots or blotches running along the mid-lateral line and sometimes coalescing, extended on to the caudal fin. Fins yellowish; dorsal with an anterior scarlet border and caudal broadly edged both above and below with the same colour. Red markings evanescent.

I have examined three specimens, the largest of which is 57 mm. long.

Type-specimen.—F $\frac{2\,2\,2\,2}{1}$, *Zool. Survey of India* (*Ind. Mus.*).

Locality.—Yenna River at Medha, Satara district, Bombay Presidency.

Psilorhynchus tentaculatus, sp. nov.

(Plate I, figs. 4, 4*a*; plate III, fig. 2).

D. 9-10 (3/6-7). P. 15. V. 9. A. 6 (2/4). L. l. 37. L. t. 6/3½.

A very distinct species, distinguished from *Ps. balitora* by the possession of a pair of rostral barbels, by the fact that the dorsal fin commences immediately above the ventrals, etc.

Size small; back moderately elevated; ventral surface flat. Total length 5 to 5½ times length of head, about 5 times length of caudal fin and 4½ to 5 times greatest depth of body. Eye 2¾ to 3½ times in length of head. A pair of short barbels on the snout. Upper lip long, fringed, plicate; lower lip bilobed, covered with minute tubercles. Five outer pectoral rays undivided, flattened; pectoral not nearly reaching root of ventral when adpressed; ventral a little longer than in *P. balitora*, with a small fleshy appendage at its root in the male; anterior border of dorsal immediately above that of ventral; the last undivided dorsal ray considerably shorter than the first branched ray; caudal bilobed, the lobes rounded. Lateral line complete, running along caudal peduncle. The pharyngeal bones very slender; their teeth long,

narrow and pointed, 11 in number, arranged in three rows, 2 in the outer row, 5 in the middle row and 4 in the inner row, grouped close together on a very distinct outward protuberance of the bone; the two outer teeth less sharply pointed than the others. The air-bladder well developed and distinctly divided into two parts.

Head and body dark purplish-grey or black, paler immediately above and below mid-lateral region; ventral surface white; operculum strongly iridescent, edged with white behind; a black horizontal bar or spot on the caudal peduncle edged with white posteriorly; fins whitish; dorsal more or less infuscated and with a black spot on each branched ray, caudal with its central part infuscated and with a vertically oval black spot at its base.

My largest specimen is less than 45 mm. long.

Type-specimen —F. 9695/1, *Zool. Survey of India* (*Ind. Mus.*).

Distribution.—Abundant in small hill-streamlets at Khandalla in the Poona district (2-3,000 feet), less common in the Yenna River at Medha in the Satara district (2,000 feet).

Genus **Discognathus**, Heckel.

(Plate II, figs. 1-3).

1868. *Discognathus*, Günther, *Cat. Fishes Brit. Mus.* VII, p. 68.

Both the name and the species of this genus have been subjected to many vicissitudes and the Indian forms are still imperfectly known The earlier writers on Indian ichthyology, notably Buchanan and McClelland, described a considerable number of so-called species that would now be placed in the genus, but they paid little attention to sexual differences or individual variation and their descriptions were too brief to be definitive. Day in his *Fishes of India* (1878) and his volume in the *Fauna of British India* (1889) recognized three species, *D. lamta* (Ham. Buch.), *D. jerdoni* and *D. modestus*. Günther, however, in his British Museum Catalogue (1868), though he also recognized three Indian species, gave them different names and different definitions: he called them *D. lamta*, *D. macrochir* and *D. nasutus*. Jenkins (*Rec. Ind. Mus.* III, p. 291: 1909), with Day's specimens before him, was of the opinion that they represented a single species, possibly with local varieties, while I pointed out in 1913 (*Journ. As. Soc. Bengal*, n. s. IX, p. 36) that a considerable number of forms occurred in different parts of the Indian Empire that were at least worthy of racial distinction. In the meanwhile Vinciguerra [1] had not only discussed the form he believed to be Buchanan's *Cyprinus lamta* but had also described a very distinct Burmese species under the name *D. imberbis*. Finally, in the early part of the present year, I was able to provide evidence that two distinct species occurred in the Southern Shan States and that one of them was the *D. lamta* of Day (*Rec. Ind. Mus.* XIV, p. 45).

[1] *Ann. Mus. Stor. Nat. Genova* (2) IX (XXIX), pp. 275-280, figs. (1889).

Since I discussed the collection from the Inlé Lake I have had an opportunity of examining a large series of fresh and well preserved specimens of the two commonest Indian forms from the Deccan and elsewhere. The names most convenient for these two forms are *D. lamta*, Day and *D. nasutus* (McClelland). I give Day and not Buchanan as the author of the former, because it is impossible to be sure as to the species to which Buchanan first applied the name *Cyprinus lamta*; his original figures in the library of the Asiatic Society of Bengal cast no light on the subject.

A great deal of the uncertainty about the Indian species of the genus has arisen from the fact that the marked and constant structural characters which separate these two forms are to some extent concealed by bad preservation of specimens. The essential differences between *D. lamta* and *D. nasutus* (= *D. modestus*, Day) are correlated with the fact that whereas the former lives in the pools of larger streams in or near the plains or even in upland lakes, the latter is an inhabitant of mountain torrents. In *D. lamta*, although the fish can cling to vertical surfaces by means of its mental disk, the abdomen is not flattened, the pectoral fins are set obliquely on the sides of the body and the rays are not greatly flattened or expanded. In *D. nasutus* on the other hand the fins and chest are modified to form an organ of adhesion, as is well shown in fig. 2*a*, pl. II. Unless great care is exercised in preserving specimens of *D. lamta*, however, the ventral surface collapses and though the structure of the pectoral fins remains of course unchanged, their relations to the chest and to one another are distorted. The form I describe here as *D. gravelyi* is allied to *D. lamta*, from which it differs in outline, in the shape of the head and in the form of the mental disk.

The form Day called *D. jerdoni* seems to me to be distinguished from *D. lamta* by characters which are quite apparent when adult specimens are compared.[1] They lie mainly in the shape and proportions of the body and the relative size of the head and eye.

D. macrochir (McCl.) from Assam is evidently allied to *D. nasutus*, but may be distinct.

Two forms of the genus occur in Syria and Mesopotamia. One of these (*D. rufus*, Heckel) I regard as a variety of *D. lamta*, while the other (*D. variabilis*,[2] Heckel) differs from all the Indian forms in having only one pair of barbels. A form has been described from Southern Arabia and the Punjab Salt Range the male of which bears a forwardly directed tubercular appendage on the

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[1] Since this paper was written I have examined a good series of fresh specimens from the Bhavani River at the base of the Nilghiris. They fall definitely into three species, two of which are distinguished from all those included in my key by the possession by the adult male of a conical tuberculate process between the nostril. I hope to discuss this new material shortly.

[2] This species also occurs in the Helmand basin, possibly within the limits of the Indian Empire. See Tate Regan, *Journ. As. Soc. Bengal*, (n.s.) II, p. 8 (1906).

head, but no specimens of this form are at present in Calcutta. The only species known from the Malay Archipelago is *D. borneensis*, Vaillant, which has larger scales than any Indian species.

Key to the Asiatic forms of Discognathus *at present described.*

I. No barbels. L.L. 44 ... ... *D. imberbis.*
II. Two barbels. L.L. 38-40 ... ... *D. variabilis.*
III. Four barbels. L.L. 28 ... ... *D. borneensis.*
IV. Four barbels. L.L. 32-36.
A. Pectoral fins entirely horizontal, with their rays broad and flat; chest flat, without scales.
1. Pectoral fins longer than head, their tips extending nearly to base of ventrals ... *D. macrochir.*
2. Pectorals hardly longer than head, their tips not approaching the base of the ventrals ... ... *D. nasutus.*
B. Pectoral fins set obliquely on the sides of the body; chest convex, with scales.
1. Pectoral fins longer than head, their tips approaching the base of the ventrals; eye much nearer margin of opercle than tip of snout; 2nd dorsal fin-ray slender ... *D. gravelyi.*
2. Pectoral no longer than head, not approaching base of ventrals; eye near middle of head; 2nd dorsal fin-ray stout.
a. Posterior barbels longer than anterior; pectorals directed backwards and upwards, arising some distance from ventral surface .. ... *D. lamta* var. *rufus.*
b. Barbels subequal, anterior pair usually a little longer; pectorals directed backwards and a little downwards, arising immediately above ventral surface.
i. Length of head 5 to 5½ times in total length; dorsal profile convex in adult male ... *D. lamta (s.s.)*
ii. Length of head 6 to 6½ times in total length; dorsal profile nearly straight in adult male ... ... *D. jerdoni.*

Discognathus lamta (Ham. Buch.), Day.

(Plate II, figs. 1, 1*a*).

1841. *Chondrostoma mullya*, Sykes, *Trans. Zool. Soc. London*, II, p. 359.
1889. *Discognathus lamta*, Day, *Faun. Brit. Ind. Fish.*, I, p. 246, fig. 87.
1909. *Discognathus lamta*, Jenkins, *Rec. Ind. Mus.*, III, p. 291 (in part).
1913. *Discognathus lamta*, Annandale, *Journ. As. Soc. Bengal*, (n.s.) IX, p. 36, fig. 1.
1918. *Discognathus lamta*, *id.*, *Rec. Ind. Mus.*, XIV, p. 45.

The form to which I give this name is certainly the *D. lamta* of Day, but there is some doubt as to whether Buchanan's *Cyprinus lamta* was not rather the form called *D. modestus* by Day and *Platycara nasuta* by McClelland. In any case, as the point cannot be settled satisfactorily, it is best to accept Day's nomenclature so far as *D. lamta* is concerned.

In this species the abdomen is naturally convex (it is apt to collapse in preserved specimens) and the pectoral fins are set on the sides of the body a short distance above the ventral surface and somewhat obliquely. These fins, though sometimes as long as the head, are usually a little shorter; the distance between their tips and the base of the ventrals is about ½ their own length; they are not greatly expanded and only the outermost ray is simple and flattened. The eye is variable in size even in specimens from precisely the same locality, but its length is usually contained at least very nearly 5 times in the length of the head: its upper border is situated considerably below the upper profile of the head. The upper profile of the body is arched. A broad but shallow depression runs across the snout of the adult male a little in front of the eyes and the region immediately in front of and behind it is covered with prominent tubercles.

D. lamta is common in the river at Medha, where it is captured in considerable numbers for food by fishermen using cast-nets. Specimens are very similar to those recently obtained in the Shan States (*op. cit.*, 1918), but perhaps a little darker in colour. The largest collected is 152 mm. long. The sides and back of the head and body are dark olivaceous green. Traces of a darker mid-lateral stripe extending on to the caudal fin can be detected, and of a small dark spot just behind the upper angle of the opercle. The free border of the opercle is paler and the ventral surface yellowish. The fins are pale olivaceous.

Discognathus jerdoni, Day.

1889. *Discognathus jerdoni*, Day, *op. cit.*, p. 247.

This species is distinguished from the former by the following characters:—

(*a*) The head is relatively smaller.
(*b*) The eye is as a rule larger in proportion to the head.
(*c*) The pectoral fin is much shorter than the head and its tip is further removed from the root of the ventral fin.
(*d*) The body is less elevated, the dorsal and ventral profiles being nearly parallel in the adult male.

I can detect no real difference in the scales and fin-rays.

Discognathus nasutus (McClelland).

(Plate II, figs. 2. 2*a*).

1839. *Platycara nasuta*, McClelland, *As. Res.* IX(2) (*Ind. Cypr.*), p. 300, pl. lvii, fig. 2.
1871. *Mayoa modesta*, Day, *Journ. As. Soc. Bengal* (2)XL., p. 108, pl. ix, fig. 2.
1889. *Discognathus modestus*, Day, *op. cit.*, p. 247.
1890. *Discognathus lamta*, Vinciguerra, *Ann. Mus. St. Nat. Genova* (2)IX, p. 270, fig.

McClelland's figure is a somewhat exaggerated presentiment of an adult male of this form, which must be accepted as specifically distinct in that it exhibits quite definite and constant structural modifications. It differs from *D. lamta* in the following characters :—

(*a*) The head is flattened and depressed in such a way that the upper border of the eye is practically co-terminous with the upper profile. The whole of the upper profile is straight and horizontal.

(*b*) The abdomen is flat, and the chest is both flattened and expanded.

(*c*) The adhesive organ on the lower lip is much larger.

(*d*) The pectoral fins are enlarged and expanded, being always longer than the head and separated when adpressed from the ventrals by a distance less than half their own length. They are set on the body horizontally at the junction of the ventral and lateral surfaces and form with the chest an organ of adhesion.

(*e*) Several of the outer pectoral rays are simple and flattened.

(*f*) The whole of the dorsal and lateral surfaces is nearly black, the ventral surface dead white.

(*g*) The length rarely if ever exceeds 110 mm.

This species is found only in small hill streamlets. It occurs in the Himalayas, the hills of Assam, the Western Ghats, the hills of the Central Provinces and probably those of Burma. Vinciguerra's figure cited above seems to represent this species rather than *D. lamta*, but probably he had examined specimens of both.

Discognathus gravelyi, sp. nov.

(Plate II, figs. 3, 3*a*).

Having now been able to compare good series of well-preserved specimens of *D. lamta* from districts so far apart as the Shan States and the Deccan, and having found certain differential characters quite constant, I no longer hesitate to describe the new species referred to in my recent account of the fish of the Inlé Lake (*Rec. Ind. Mus.* XIV, p. 45 : 1918). It is distinguished from *D. lamta* by the different shape and the larger size of its mental disk, by the different shape of the head, by its larger scales and apparently also by difference in the formulae of the fin-rays.

D. 10(2/8). P. 14. V. 8. A 7(2/5). L. tr. $3\frac{1}{2}/3$.

The total length is $5\frac{3}{5}$ times the greatest depth of the body and a little more than 5 times the length of the head. The length of the eye, which is large and prominent, is contained a little more than $4\frac{1}{2}$ times in that of the head. The snout is somewhat produced and in the adult male there is a deep but narrow

transverse groove just behind the tip. The dorsal profile slopes abruptly from a point a little in front of the dorsal fin to the tip of the snout and, although the head is not flattened, the upper border of the orbit is practically co-terminous with its upper surface; behind the dorsal fin the profile is highly convex. The upper lip is very broad, the lower lip greatly enlarged, the mental disk large and subcircular; the fringe of the lower lip broad, with the margin semieircular. In the adult male there is a semicircle of glandular openings beneath and behind the eye. There are four short barbels, those at the angle of the mouth being particularly small. The ventral surface is convex and the scales extend all over the chest. The pectoral fins are longer than the head and broad in proportion, but they are lateral and oblique. They extend backwards almost as far as the base of the ventrals, but their rays are not flattened and expanded The ventrals are also large and almost reach the anal when adpressed. The caudal is deeply forked and the upper lobe is a little smaller than the lower. The dorsal is short; its unbranched rays are slender and not at all ossified, but the second is longer than the head.

Colouration.—Head and body purplish-brown, with a darker mid-lateral streak and a dark horizontal lunate mark on the caudal peduncle; ventral surface slightly paler; pectoral fins infuscated, with pale edges; other fins pale yellowish clouded towards the base with a dusky brown.

The only specimen I have seen, an adult male, is 112 mm. long.

Type-specimen.—F 9694/1, *Zool. Survey of India* (*Ind. Mus.*).

Locality.—Stream at He-Ho, Yawnghwe State, Southern Shan States, Burma: alt. 3,800 feet.

The type-specimen was taken with typical specimens of *D. lamta*.

Genus Barbus, Cuvier.

There are few genera among the freshwater fish that have received greater difference of treatment from different ichthyologists than this. Day in his works on Indian ichthyology recognizes three subgenera or groups of species, while Boulenger in his "Fishes of the Nile" and in his recent monograph of the freshwater fishes of Africa divides the genus into a number of sections for which he does not provide names. Weber, on the other hand, in the third volume of his "Indo-Australian Fishes" recognizes a number of distinct genera among the species placed in *Barbus* by other authors, but denies the occurrence of *Barbus* s.s. in the Malay Archipelago. So far as specific limits and definitions are concerned there is still much confusion among the Indian species, and this is the case not only with rare and inconpicuous forms but even with some of the largest and most conpicuous. Indeed, there is no group in which confusion is greater than that of the Mahseer so familiar to Indian sportsmen.

I have not the material to attempt a revision of the Mahseer group, specimens of which are difficult to preserve in large series on account of their size, but two species have recently come to my notice which it seems justifiable to rescue from the oblivion of synonymy as they possess differential characters of a marked nature and likely to be constant. These species are *Barbus putitora* (Ham. Buch.) and *Barbus mussullah*, Sykes. That Hamilton's *mossul* and Jerdon's *hamiltonii* differ in some respects from the *forma typica* of *Barbus tor* the collection in the Indian Museum provides abundant evidence, while specimens from the upper Kistna seem to differ from any of these; but the question whether the differences should be considered specific or merely racial must be left to be answered with more extensive experience.

Another group of species in which confusion exists so far as the Indian forms are concerned is that popularly called Carnatic Carp. It is, indeed, doubtful how far this designation has any scientific basis, for certain species so called have no more than a distant resemblance to *Barbus carnaticus* (Jerdon).

I have nothing particular to say about the species of *Barbus* (*B. malabaricus*, *B. kolus* and *B. ticto*) that I obtained at Medha myself, but Mr. McIver has sent me specimens of three species from the Kistna near Satara that are of considerable interest. Two of these may be called Mahseer, while the third is known locally as the Carnatic Carp.

Barbus tor (Ham. Buch.)

(Plate III, figs. 3, 3*a*).

It is not yet possible to discuss the races or species of the Mahseer, of which six or seven probably exist in different parts of the Indian Empire, in a satisfactory manner. Specimens sent me from the Kistna River near Satara by Mr. McIver certainly differ both from the north Indian and the south Indian forms and probably represent an undescribed race, which has only 3 rows of scales above the lateral line and 12(3/9) dorsal fin-rays. Mr. McIver informs me that it grows to a large size.

Barbus mussullah, Sykes.

(Plate III, figs. 4, 4*a*).

1841. *Barbus mussullah*, Sykes, *Trans. Zool. Soc., London* II, p. 356, pl. lxi, fig. 4.

Sykes's description of this fish is inadequate and his figure inaccurate, but he refers to and illustrates one trivial but apparently constant character that gives me confidence in identifying specimens sent by Mr. McIver. This character is the presence under the eye of a group of small tubercles not confined to one sex and visible with the aid of a lens in quite young fish.

A more important differential character, not recognized by Sykes but shown in his figure, is, however, to be found in the

structure of the mouth, the opening of which is much more oblique than in any race of *Barbus tor*. The extremity of the maxillary lies directly under the middle part of the eye. This feature is well shown on plate III. There are 13 (3/10) dorsal and 8 (3/5) anal fin-rays; 25-26 scales in the lateral line, 4 rows of scales above it and 3 below.

B. mussullah is common in the upper Kistna, where it occurs with the local race of *B. tor*. The Maharatta fishermen of Satara never fail to distinguish the two species. *B. tor* they call *Kudis*; *B. mussullah*, *Masundi*. Mr. McIver, to whom I am indebted for this information, has caught a specimen of the *Masundi* 21 lbs. in weight.

Barbus putitora (Ham Buch.).

(Plate III, fig. 5).

1822. *Cyprinus putitora*, Hamilton, *Fishes of the Ganges*, p. 303.

Having received some time ago a large *Barbus* from Gauhati in Assam that was evidently related to but distinct from any of the races or species at present included under the name *Barbus tor*, I have made a careful examination of it and have compared it with the specimens labelled by that name in the collection of the Indian Museum. From these specimens it differs not only in shape and proportions but also in having only two undivided rays in the dorsal fin and only 15 rays in the pectoral fins. As these characters are given by Hamilton among those proper to his *Cyprinus putitora*, I have little doubt that our specimen is identical with that form and must be called *Barbus putitora*. It may be redescribed as follows:—

D 10-11 (2/8-9). P. 15. V. 9. A 7 (2/5). L. l 27. L. tr. $3\frac{1}{2}/2\frac{1}{2}$.

The habit is stout and though the body is somewhat compressed it may almost be described as subcylindrical; its depth is contained only a little more than 4 times in the total length. The length of the head is contained between $4\frac{1}{2}$ and $4\frac{3}{4}$ times in the total length and is thus distinctly less than the greatest depth of the body. The snout is blunt and very little declivous; the length of the part of the head in front of the eye is about $\frac{2}{3}$ of that of the part behind the eye. The upper profile of the head and body is feebly arched, the curve of the lower profile a little more marked. The mouth is protrusible and nearly horizontal; the posterior end of the maxilla is in front of the eye; the lower jaw is shorter than the upper. The lips are thick and fleshy but not produced forwards; the lower lip is slightly retroverted in the middle line. There are 4 barbels; the anterior pair is much shorter than the posterior; the latter extend backwards to a point under the middle of the eyes. The nostrils are a little nearer the eyes than the tip of the snout. The eyes are rather small, their diameter being contained about $7\frac{3}{4}$ in the length of the head. The cheeks are quite smooth. All the fins are relatively small. The dorsal is short and about $\frac{2}{3}$ as deep as the

body. The first dorsal ray is stout and bony but short, the second, which is also bony, tapers to a fine point and is about $\frac{2}{3}$ as long as the head; it is quite smooth. The anterior root of this fin lies immediately above that of the ventrals. The pectorals are particularly small, their length is between $\frac{2}{3}$ and $\frac{3}{4}$ that of the head. The ventrals, from which they are widely separated, are considerably shorter; their tips do not quite reach the vent. The anal is distinctly pedunculate. The caudal peduncle is well differentiated but less than twice as long as deep; it is strongly compressed. The caudal fin is short; its upper lobe is distinctly sharper and more produced than the lower lobe. The scales are very large; sometimes notched in front. Their exposed parts are marked with delicate longitudinal striae. The lateral line is rather obscure.

The only specimen of this fish that I have seen was sent from Gauhati on the Brahmaputra by Mr. T. R. Phookun. It is 115 cm. long and is preserved stuffed, its number in our register being F 9654/1.

Barbus jerdoni, Day.

(Plate II, fig. 4, var. *maciveri*, nov.).

1889. *Barbus jerdoni*, Day, *op. cit.*, p. 312.
1889. *Barbus dobsoni*, *id.*, *ibid.*

As Day himself suggests in his *Fishes of India* (p. 568), the two forms included in the above synonymy are merely varieties or local races of the same species. The only constant difference that I can find between the specimens in his own collection are that the body is considerably deeper in *B. dobsoni* than in *B. jerdoni* and that there are more scales below the lateral line in the former. Mr. McIver has sent me specimens from the Kistna River near Satara that represent a third variety, which has the following differential characters:—

D. 13 (4/9). A. 8 (3/5). L. l. 31-33. L. tr. $5\frac{1}{2}/3\frac{1}{2}$.

Depth of body $3\frac{2}{3}$ to 4 times in total length; length of head about $5\frac{2}{3}$ times in total length; diameter of eyes $3\frac{1}{2}$ times in length of head. The body is brownish above and the caudal, dorsal and anal fins are tipped with black. The specimens I have examined are small (not more than 151 mm. long), but Mr. McIver tells me that the form attains a weight of 20 to 25 lbs. I propose for it the name var. *maciveri*. The Maharatta name at Satara is *purgi*; Mr. McIver refers to the fish as the "Carnatic Carp of the Krishna."

Type-specimen of variety.—F 9576/1, *Zool. Survey of India* (*Ind. Mus*).

Family OPHIOCEPHALIDAE.

Ophicephalus gachua, Ham. Buch.

This widely distributed species, of which specimens were taken in the river at Medha and in artificial ponds at Khandalla,

is much more variable in the number of its dorsal and anal fin-rays than published descriptions indicate. The Assamese form *O. stewarti*, Playfair, and my own recently described *O. harcourt-butleri* from the Southern Shan States may ultimately prove to be no more than local races. In both of these the number of vertical fin-rays is variable. In *O. harcourt-butleri*[1] there are from 28 to 38 in the dorsal fin and from 16 to 25 in the anal. Dr. Chaudhuri tells me that in a series of *O. stewarti* from Shillong he finds the corresponding numbers to be 34 to 39 and 22-27. In the typical *O. gachua* the variation is at least as great as in the latter, but it will be better to defer a more precise statement until good series are examined from numerous localities.

Family GOBIIDAE.

Gobius bombayensis, sp. nov.

(Plate I, fig. 5).

A small species resembling *G. viridipunctatus*, Day, but with fewer vertical fin-rays and without enlarged canine teeth; allied to *G. chilkensis*, Jenkins,[2] but with a much longer snout and smaller caudal fin.

D. 6-1/7-8. P. 17-18. A. 1/7. L.e. 28-29. L. tr. 7.

Size small; habit slender, slightly compressed. Total length about 4¼ the length of the head and about 5¼ the greatest depth of the body. Dorsal profile slightly arched. Caudal peduncle distinct, rather more than twice as long as deep. Head coarse; snout blunt, rather short, less than ½ as long as the part of the head behind the eye, nearly twice as long as the eye. Mouth large, slightly oblique; the posterior extremity of the maxilla situated below the middle of the eye; lower jaw very slightly longer than the upper; teeth small; tongue notched in front, without teeth. Eye large and prominent, its length contained 5 times in the length of the head. Dorsal fin low, with none of the rays elongate.

Colouration.—Pale yellowish, irregularly blotched with black. Anterior dorsal fin infuscated, with a rather deep whitish border; posterior dorsal with three longitudinal rows of small dark spots; other fins irregularly infuscated, the caudal with obscure and irregular vertical dark bars.

The largest specimen examined is 42 mm. long.

Type-specimen.—F 9698/1, *Zool. Survey of India* (*Ind. Mus.*).

Locality.—The species is not uncommon in the Medha river at Satara.

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[1] *Rec. Ind. Mus.*, XIV, p. 54, fig. 2, pl. ii, fig. 7, pl. iv, figs. 16, 17 (1918).
[2] *Rec. Ind. Mus.*, V, p. 137, pl. vi, fig. 2.

VI. SOME FRESHWATER MOLLUSCS FROM THE BOMBAY PRESIDENCY.

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The molluscs discussed in these notes are for the most part common species of wide geographical range. This makes it the more necessary that their differential characters should be understood, exact localities put on record and the precise environment which each affects described. Unfortunately nothing was known as to the anatomy of the commonest Indian freshwater molluscs when Preston's volume in the official *Fauna of British India* was written, and very little attention was paid by him even to published records of locality. Two of the species we have to consider are of particular interest on account of their habitat. They are *Cremnoconchus syhadrensis*, a Littorinid which lives on inland cliffs at the edge of waterfalls, and *Ampullaria nux*, which, unlike other Indian species of its genus, frequents small hill-streams.

The following species were taken in the river at Medha:—*Melania tuberculata*, *M. scabra*, *Parreyssia cylindrica*, *P. corrugata* and *Lamellidens marginalis*. *Ampullaria nux* and *Cremnoconchus syhadrensis* were found on the hill-side at Khandalla.

We also discuss specimens from ponds at Khandalla, and from reservoirs in the Satara fort, at Karla in the Poona district and at Igatpuri in the Nasik district.

We may note here, though the fact is perhaps of archaeological rather than malacological interest, that single valves of *Arca granosa* are occasionally found in the Yenna. They are invariably pierced in the umbonal region and probably served as ornaments for some jungle tribe which has now disappeared or become civilized and ceased to affect such primitive decorations.

Family LIMNAEIDAE.

Genus **Limnaea**, Lamarck.

Preston, in his volume in the official *Fauna of British India*, gives descriptions of twenty-eight Indian species and varieties of this genus, but (although he describes *L. bowelli*, a Tibetan mollusc not found within the limits of the Indian Empire), he makes no reference to the peculiar forms of *L. lagotis*[1] long known to occur in Kashmir, the Kangra Valley and Baluchistan, or to *L. andersoniana*,[2] which Nevill reported from the Shan States of Burma as well as from Western China. One of us has recently added two

[1] See Nevill's *Hand List*, pt. I, pp. 234, 237, 239 (1889); also Hanley and Theobald's *Conch. Ind.*, pl. lviii, fig. 7 (1876).

[2] Nevill, *Journ. As. Soc. Bengal*, (ii) XLVI, p. 26 (1877), and I., p. 142, pl. v, fig. 9.

further species[1] from the Shan States to the Indian fauna, namely *L. shanensis*, of which several extinct phases as well as the living form have been described; and the highly peculiar *L. mimetica*.

The shell is extraordinarily plastic in *Limnaea* and it is of great importance that the genitalia, the radula and the structure of the upper jaw should, whenever possible, be examined in the identification of the species. In the genitalia we find the most constant differences in the relative lengths of the different parts of the main ducts, in the form of the penis-sheath and in the presence or absence of the spermathecal duct.

Limnaea acuminata, Lamarck.

(Plate V, fig. 1).

1890. *Limnaea acuminata* varr. *patula* and *rufescens*, Von Martens, *Conch. Mitth.* I, pp. 75, 76, pl. xiv, figs. 1-3.

We confine this name to the forms in which the outer margin of the aperture of the shell is regularly curved, thus excluding both *L. chlamys*, Benson and *L. amygdalum*, Troschel.

The radula (fig. 1) is rather broad. The lateral teeth have three distinct cusps; there are about nine rows of lateral teeth on each side of the central tooth, but there is no very abrupt difference between the lateral and the marginal teeth, of which there are at least twenty rows on each side. The central tooth is practically unicuspid, and the single cusp is narrowly produced. The lateral teeth are very broad, their central cusp is not much larger than the two lateral ones, which are subequal; the outer lateral cusp is considerably nearer the base of the projecting part of the tooth than the inner one. The marginal teeth have from three to six rather short and blunt cusps, the outermost of which is situated near the base of the projecting part.

The central piece of the horny upper jaw is broad and strongly convex, but hardly beak-like; it is of a dark brown colour.

The genitalia are of normal type. The duct of the hermaphrodite gland is short and coarse, never much longer than the gland itself, it does not appear to be swollen at the point at which the male and female ducts diverge. In the male duct the part between the prostate and this point of divergence is slightly longer than that between the prostate and the proximal end of the penis-sheath, which is of considerable length, sausage-shaped and rather narrow. The albumen and accessory glands are rather large in the specimens examined; they arise close together and are situated much nearer to the uterus than to the hermaphrodite gland. The oviduct is very short; the uterus is elongate and narrow; and the spermatheca, which is pear-shaped when fully mature, is almost sessile.

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[1] Annandale, *Rec. Ind. Mus.*, XIV, pp. 107-109, pl. x, figs. 5, 8, 9, pl. xi, figs. 2, 3, 4 (1918).

This species was found in considerable abundance at Khandalla in pools containing an abundant aquatic vegetation but largely of artificial origin and formed by the damming of small hill-streams.

The shells bear a close general resemblance to Von Marten's figure of the var. *patula*, but vary considerably in the breadth of the body-whorl. Most of the adult specimens are not more than about 19 mm. long and about 10 mm. broad. Occasionally, however, very much larger and broader individuals occur in the ponds. The shells of such individuals are always eroded on the surface and have the apex more or less eaten away; if complete they would be about 30 mm. long and 18 mm. broad. The aperture of the shell is relatively large (about 21 mm. by 11 mm.). Such shells are evidently those of aged individuals which have survived the vicissitudes to which most of their contemporaries have succumbed.

The Oligochaete worm *Chaetogaster* was frequently observed on this mollusc at Khandalla.

The species is one of the commonest of the Indian *Limnaeae*, and has been found in many parts of Peninsular India and the Indo-Gangetic Plain.

Limnaea acuminata var. **nana**, nov.

(Plate IV, fig. i; pl. V, fig. 2).

The shell of this form (pl. IV, fig. 1) is very small, rather thick, of a blackish colour and with the longitudinal striae very strongly developed. In outline it somewhat resembles the var. *rufescens*, Gray, as figured by Von Martens in the paper cited above, but the spire is relatively longer, the body-whorl more swollen, the columellar callus coarser and the aperture narrower and somewhat curved inwards posteriorly.

Measurements of type-specimen.

Length	9·3 mm.
Breadth	5·6 mm.
Length of aperture	6 mm.
Breadth of aperture	3 mm.

Shells of this size are sexually mature. The radula (fig. 2, pl. V) differs from that of the typical form mainly in the greater irregularity of the shape of the teeth. Even in parts which are quite unworn the cusp of the central tooth is irregular and often asymmetrical. The cusps of the lateral teeth are shorter and the inner cusp is relatively smaller. In the marginal teeth the second and the innermost cusps are considerably enlarged.

The central piece of the horny upper jaw is narrower, paler in colour and apparently less convex than in the *forma typica*.

The genitalia (text-fig. 3) agree precisely with those of the typical form.

Type-specimen.—No. M 11397/2 in the register of the Zoological Survey of India (*Indian Museum*).

Locality.—Khandalla, Poona district, Bombay Presidency; altitude 2,500 ft., March, 1918.

We have thought it convenient to give this form a varietal name as the characters are constant in the series we have examined. We believe, however, that its peculiarities are due to the unfavourable conditions in which the individuals were living. They were found at the side of the railway line in a small ditch not more than a couple of feet wide and three or four inches deep. The bottom was muddy and there was a considerable but ephemeral vegetation of semi-aquatic plants. Some of the shells possess a kind of varix (pl. iv, fig. 1) across the middle of the body-whorl; this we believe to be probably due to a temporary cessation in shell-production at a time when the water in the ditch had completely

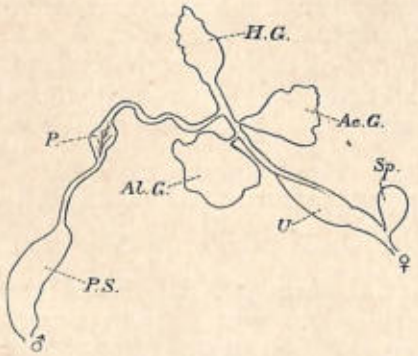

FIG. 3.—Genitalia of *Limnaea acuminata* var. *nana*.

Ac. G.=accessory gland. Al. G.=albumen gland. H. G.=hermaphrodite gland. P.=prostate. P. S.=penis-sheath. Sp.=spermatheca. U.=uterus.

dried up, and the animal had buried itself deeply in the mud, as molluscs of this genus do in periods of drought. The ditch was situated within a few hundred yards of the ponds in which the typical form of the species was found.

Limnaea chlamys, Benson.

(Plate V, fig. 3).

1836. *Limnaea chlamys*, Benson, *Journ. As. Soc. Bengal*, V, p. 744.
1876. *Limnaea chlamys*. Hanley and Theobald. *Conch. Ind.*, pl. lxix, figs. 5, 6.

The radula and genitalia of this form seem to us sufficiently different from those of *L. acuminata* to justify specific separation. The shell may be distinguished by the obliquity of the body-whorl and by the peculiar curvature of the outer margin of the aperture.

The measurements of a specimen are as follows:—

Length	..	..	15 mm.
Breadth	..	..	9 mm.
Length of aperture	..	..	9 mm.
Breadth of aperture	..	..	6 mm.

The radula (pl. V, fig. 3) is very similar to that of *L. acuminata*, except that the central cusp of the lateral teeth is considerably longer, all the cusps of these teeth sharper, and in there being a second internal cusp resulting in four cusps in all; the fourth cusp is situated at a lower level than the others. The cusps of the marginal teeth are more regular and have a distinctly pectinate appearance. The central tooth is trilobed and distinctly asymmetrical.

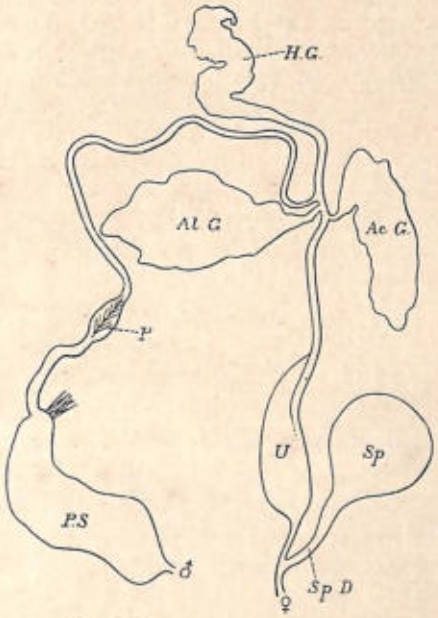

FIG. 4.—Genitalia of *Limnaea chlamys*, Benson.
Lettering as in fig. 3, p. 142. Sp. D.=spermathecal duct.

The central part of the horny upper jaw is broad, but the outer margin is less convex than in *L. acuminata*; its colour is paler than in that species.

The genitalia (text-fig. 4) of this species differ from those of *L. acuminata* mainly in the much greater length of the proximal part of the male duct and the hermaphrodite duct; in the position of the accessory and the albumen glands, which are situated close to the junction of the male and female systems rather nearer the hermaphrodite gland than the uterus, and in the considerable length of the spermathecal duct, which is as long or nearly as long as the spermatheca. The penis-sheath is also thicker.

A large series of specimens was obtained in one of the artificial ponds in the old fort on the hill-top immediately above the town of Satara. The bottom of this pond, which is shallow, is rocky but covered with a growth of minute green algae on which the molluscs were apparently feeding. The shells are all small and fragile, of a pale but bright yellowish colour, and with the microscopic sculpture less marked than is usually the case. The Oligochaete worm *Chaetogaster* was abundant on these molluscs also.

Limnaea pinguis, Dorhn.

(Plate V, fig. 4).

1876. *Limnaea pinguis*, Hanley and Theobald, *Conch. Ind.*, pl. lxx, figs. 7, 8, 10.

Two individuals of this form were found among a large series of *L. acuminata* from the ponds at Khandalla. The shells of

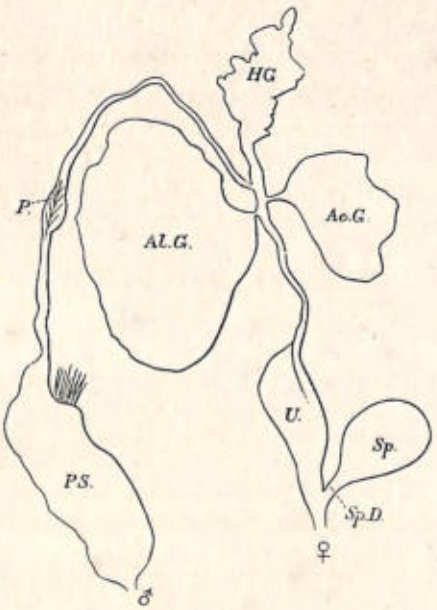

FIG. 5.—Genitalia of *Limnaea pinguis*, Dorhn.
Lettering as in figs. 3, 4, pp. 142, 143.

these two specimens are rather narrow and of small size; the longitudinal striae are very well developed and the shell is very pale in colour. *L. pinguis* may prove synonymous with *L. succinea*, Desh.

The measurements of one of the specimens are as follows :—

Length	21 mm.
Breadth	11 mm.
Length of aperture	12·5 mm.
Breadth of aperture	6·5 mm.

The radular teeth (fig. 4, pl. V) are coarser in this species than in the other two we have discussed. The central tooth is small, often distinctly asymmetrical and with either two or three lobes. The lateral teeth have three distinct cusps, but the innermost is strongly curved and bends outwards towards or even beneath the median cusp[1] in a very characteristic fashion; the central cusp is much larger than the outer one. There are only about six rows of lateral teeth. The marginal teeth have a considerable number of cusps the outermost of which is much coarser and nearer to the base than the others, especially towards the edge of the radula.

The middle piece of the horny upper jaw is broad and coarse and of a dark brown colour; the cutting edge is nearly straight.

In this species the genitalia (fig. 5) closely resemble those of *L. chlamys*, but all the ducts are shorter and the distal part of the male duct is hardly longer than the proximal part. The spermathecal duct, although distinctly present, is much shorter than the spermatheca.

Genus **Planorbis**, Geoffroy.

The Indian species of this genus are still very imperfectly known. The large collection of shells belonging to the Indian Museum has recently been examined by M. L. Germain of the Paris Museum but the transmission of the manuscript of his report upon it has been delayed by the war.

Planorbis exustus, Desh.

1918. *Planorbis exustus*, Annandale, *Rec. Ind. Mus.* XIV, p. 111, pl. xi, figs. 1, 1*a*.

This is certainly the most abundant species as well as the largest commonly found in the plains of India. It is, however, scarcer as a rule in hilly country. A young specimen was obtained in the ponds at Khandalla.

Planorbis labiatus, Benson.

1915. *Planorbis* (*Gyraulus*) *labiatus*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 119, fig. 5.

A specimen from the ponds at Khandalla agrees well with Preston's figures of the type-specimen.

Family MELANIIDAE.

Genus **Melania**, Lamarck.

Two species of this genus were found in abundance at the edge of the Yenna River at Medha, and at other places in the

[1] The innermost cusp is much larger and more distinct from the median cusp in a specimen from Madras (presented by the late Prof. Gwatkin) than in the one we have figured. Its outward curvature is, however, just as strongly marked and characteristic.

Satara and Poona districts. They are *M. tuberculata* and *M. scabra*, perhaps the two commonest and the most widely distributed of the Indian species.

Melania tuberculata (Müller).

(Plate V, fig. 5).

1918. *Melania tuberculata*, Annandale, *Rec. Ind. Mus.* XIV, pp. 114, 115, pl. xii, figs. 1, 2.

In the paper cited one of us has recently discussed the variation and plasticity of the species. Shells from the Yenna River are of the typical form but pale in colour, with the reddish markings very conspicuous. Specimens from the Igatpuri Lake, an artificial reservoir situated at about the same altitude in the Nasik district, are a little stouter and have the sculpture deeper; they are as a rule still paler and have the reddish marks even more conspicuous, but there is a tendency for the older whorls to be blackened. Several individuals of a dwarfed type were found living in a small ditch at Khandalla with *L. acuminata* var *nana*, they resemble the form from the pools of brackish water at Port Canning figured (fig. 6*f*) in the paper cited above. They are darker in colour than others from the same district, but this appears to be due largely to a deposit formed on their surface. Most of the Medha shells are not more than 25 mm. long, but occasionally larger individuals of a somewhat more elongate type occur.

We give measurements of the largest shells from each of the three localities; none of them are much eroded.

	Length.	Breadth.	Length of aperture.	Breadth of aperture.
Medha ..	25 mm.	8·7 mm.	8·8 mm.	4·3 mm.
	31·4 mm.	10·3 mm.	9 mm.	5 mm.
Igatpuri ..	22 mm.	8 mm.	7·8 mm.	4·2 mm.
Khandalla ..	16 mm.	5·4 mm.	5·2 mm.	3 mm.

We figure the radular teeth (fig. 5, pl. v) of a specimen from Igatpuri. They are of the type normal in the genus, and differ (according to Heude's figure) from those of *M. jacquetiana*, Heude,[1] a closely allied species if not a mere variety from China, in having more numerous denticulations on the central tooth. They also show minor differences from Jickeli's figure of a North African specimen.[2]

The species was found with *M. scabra* in the Yenna River on mud in still pools. It was particularly abundant on shelves of rock covered with mud.

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[1] Heude; *Mem. Hist. Nat. Chinois, I. Moll. D'Eau Douce*, p. 163, pl. xliii, fig. 5*r* (1890).

[2] Jickeli, *N. A. K. Leop-Carol. Ak. Naturf.* XXXVII (1), pl. iii, fig. 7 (1874).

Melania scabra (Müller).

(Plate V, fig. 6).

1874. *Melania scabra*, Brot, *Melaniaceen* in Martini und Chemitz, *Conch.-Cab.* (*Ed. Kuster*), p. 266, figs. 14, 15.

Brot places this species in the group or subgenus *Plotia*, in the definition of which he writes "Anfractibus superne angulatis et spinulosis." This applies exactly enough to most young shells, but, as Brot's own figures show, the spines and even the angulation of the whorls disappear with age, and are not equally developed even in all young specimens. In our series from the Medha River all intermediate stages are represented. In this locality the shells reach a large size, but at Karla in the Poona district a series of dwarfed shells was collected at the edge of a small partially artificial reservoir situated at the base of the hill in which is the well-known Buddhist cave monastery. Shells from the two localities do not differ in shape or sculpture.

We give measurements of two fully developed specimens from each locality. In all cases the apices are somewhat eroded.

	Length.	Breadth.	Length of aperture.	Breadth of aperture.
Medha ..	29·3 mm.	13·2 mm.	12·6 mm.	8·2 mm.
	28·2 mm.	12·1 mm.	11 mm.	7 mm.
Karla ..	17 mm.	8·6 mm.	8·3 mm.	5·4 mm.
	16·6 mm.	8·5 mm.	8·1 mm.	5·3 mm.

The radula (fig. 6, pl. v) differs little from that of *M. tuberculata*.

Though rarely as abundant as *M. tuberculata* and *M. variabilis*, this species has a wide range in the Indian Empire and as far east as New Guinea. There are specimens of the typical form in the collection of the Zoological Survey of India from Calcutta; Chaibassa, Chota Nagpur; the foot of the Garo Hills, Assam; Madras (many localities in the eastern districts), Bangalore (3,000 feet); Nemunangad, Travancore; Simla; Matelle, Ceylon; Kawkareik, Amherst District, Tenasserim, etc.

Genus **Paludomus**, Swainson.

The distribution of the genus in Peninsular India is somewhat peculiar. Numerous species have been described from the hill-streams of South India, and also from those of Ceylon on the one hand, and of Assam and Burma on the other. From the central and northern part of the Peninsula, however, only one species (*P. obesa*) is known, though many apparently suitable streams are to be found.

Paludomus obesa (Phillipi).

(Plate V, fig. 7).

This mollusc was found in considerable abundance on stones covered with algae in a small stream at Khandalla. The stream

was one of those which rushes down the hill-side, but the mollusc only occurred where it broadened out and its currents became less strong as it crossed a small plain. We figure (fig. 7, pl. v) the radular teeth of a specimen from Khandalla.

P. obesa seems to be the most widely distributed of the Indian species. It was described from the Bombay Deccan, but one of us collected a large series some years ago at Courtallum in South India. These specimens were examined by Mr. Preston, who, however, with his habitual indifference to geography, makes no reference to them. It was noted at the time that they replaced *P. annandalei*, Preston, an abundant species on the ledges above waterfalls on the western side of the Western Ghats at Tenmalai, where the railway crosses that range, as soon as the eastern watershed was reached. The range of *P. obesa* may, therefore, be described as consisting of the western part of the Indian Peninsular area, properly so called, as distinct from the Malabar Zone to the west and the Indo-Gangetic Plain to the north. Khandalla, however, lies technically within the limits of the Malabar Zone. We regard this species provisionally as distinct from *P. tanjoriensis*, etc., see Blanford, *Trans. Linn. Soc.*, XXIV, p. 173 (1863).

Family Littorinidae.

Genus **Cremnoconchus** (Blanford).

1863. *Cremnobates*, Blanford, *Ann. Mag. Nat. Hist.* (3) XII, p. 184, pl. iv.
1869. *Cremnoconchus*, Blanford, *Ann. Mag. Nat. Hist.* (4) III, p. 343.
1871. *Cremnoconchus*, Stoliczka, *Proc. Asiat. Soc. Bengal*, p. 108, figs. 1-4.
1878. *Cremnoconchus*, Blanford, *Journ. As. Soc. Bengal*, XXXIX (ii), p. 10.
1887. *Cremnoconchus*, Fischer, *Conchyliologie*, pp. 708-709

We have no doubt that Blanford and Stoliczka were right in referring this genus to the family Littorinidae. Blanford says (*loc. cit.* 1863): "Every character of shell, operculum and animal with the one exception of the pulmoniferous sac admits of the position I have assigned to it amongst the Littorinidae." As Stoliczka has shown, the gill is present, and the branchial chamber is less like that of the Pulmonata than Blanford imagined. The osphradium is present, but much reduced and almost papilliform (pl. iv, fig. 3). As to the origin of the genus, which lives on inland cliffs kept moist by the spray from waterfalls, we can add nothing to Blanford's statement. "No question can exist as to the Western Ghats having been formed from a marine cliff in comparatively recent geological times. Whether *Cremnobates* be a lineal descendant of the Littorinas or Fossars then inhabiting the coast may perhaps not be an unfair subject for speculation."

A species has since been described from French Indo-China,[1] but the shell differs considerably from that of the Western Indian forms, and nothing is known of the soft parts.

[1] Bavay et Dautzenberg, *Journ. de Conchyliologie*, XLVIII, pp. 116, 449, pl. x, fig. 10 (1900).

Cremnoconchus syhadrensis (Blanford).

(Plate IV, figs. 2-4).

Two types of shells occur in a large series from the cliffs at Khandalla. The commoner of these agrees well with Blanford's figure (*op. cit.*, 1863, pl. iv), but in a few specimens the upper surface of the body-whorl is flattened and grooved much as in the same author's var. *canaliculatus* of *C. conicus*.

We have nothing to add to Blanford's description of the external characters, but his account of the branchial chamber is incorrect. As shown in fig. 3, a well developed gill is present. The orifice of the chamber bears a certain resemblance to that of the Pulmonates and can be completely closed. It appears, however, that the cavity is always filled with water and not air (see p. 119), and the roof is not highly vascular.

The radula (fig. 4, pl. iv) is that of a typical Littorinid. It is very long and narrow, but the tooth-formula is in our opinion 1. 2. 1. 2. 1. All the denticulations are very broad and rather blunt.

Khandalla appears to be the original locality of this species, and Blanford states that it is only found in the Western Ghats, in the neighbourhood of Bombay.

Family AMPULLARIDAE.

Genus **Ampullaria**, Lamarck.

Only a single species is represented in the collection.

Ampullaria nux, Reeve.

(Plate V, fig. 8).

1856. *Ampullaria nux*, Reeve, *Con. Icon.*, X, *Ampullaria*, pl. xxviii, figs. 132*a*, *b*.

Reeve in describing this species noted the peculiar development of the columellar callus, which forms a flat ridge nearly 2 mm. in diameter. This and the small size of the shell are probably correlated with the unusual habitat, for *A. nux*, unlike any other species of the genus with which we are acquainted, inhabits small mountain streamlets, in which it is important for it to be able to cling as tightly as possible to smooth rocks in rapid-running water. A single living specimen was obtained on the hill above Khandalla; it was clinging to the rocky margin of a small pool immediately below a waterfall. Numerous more or less broken shells were observed in the same streamlets. We figure the radular teeth of this specimen (fig. 8).

The operculum is long, rather narrow (13·3 mm. long by 8·5 mm. in a shell with the apex eroded 21 mm. long), thin and slightly transluscent. The inner margin is practically straight, the outer margin strongly convex; its horny epidermis is thin and of a

brownish colour; the nacre outside the muscular scar is tinged with lilac. The sculpture of the scar somewhat resembles that on the operculum of *A. winkleyi* (Pilsbry),[1] being concentrically striate on the columellar side.

Hanley and Theobald record this species from Bhor Ghat, which is within two miles of Khandalla; we have seen a series of dead shells from a small stream at Igatpuri in the Nasik district.

Family UNIONIDAE.

A large number of fish, belonging to several distinct species, from the *Limnocnida* pool at Medha were found to have glochidia of this family embedded in their fins. Unfortunately in the present state of our knowledge it is not possible, except in a few cases recently dealt with by one of the present authors, to identify larval Indian Unionidae.

Genus **Parreyssia**, Simpson.

This genus is represented in our collection by two species from Medha, one of them a common form, the other apparently new.

Parreyssia cylindrica, sp. nov.

(Plate IV, figs. 6, 7).

A small species closely allied to *P. favidens* (Benson), but with a much broader and lower shell than any of the varieties of the latter.

Shell moderately small and thick, transverse-ovate, sub-cylindrical, with the umbo rounded and by no means prominent in unworn shells; dorsal margin nearly straight, anterior margin broadly rounded. Umbonal region sculptured with numerous low corrugated ridges which tend to run together to form V-shaped prominences; towards the posterior margin of the shell these ridges are transverse and curved; they extend downwards in a more or less distinct fashion, and even in old shells can be traced almost to the lower margin. Periostracum coarse, irregularly striate transversely, of a brownish colour, darker in older shells than in young ones, not at all polished. Nacre with a strong rosy-pink tinge. Hinges much as in *P. favidens* but less strongly developed. Pseudocardinal teeth prominent, strongly ridged, divided on both valves by a deep groove which slopes forwards and downwards. Lateral teeth slender but prominent, of considerable length, oblique, slightly arched; two on each valve, a vestigial tooth present in the form of a low ridge below the anterior part of the main lateral tooth on the right valve. Muscular impressions strongly developed, oval or sub-circular.

[1] *Proc. Acad. Nat. Sci. Philadelphia*, LIII, p. 189, pl. v, figs. 2, 3 (1901).

The measurements of four specimens are as follows :—

	Length.	Height.	Thickness.
1 ..	44 mm.	25·5 mm.	18·4 mm.
2 ..	35·1 mm	21 mm.	13·2 mm.
3 ..	22·5 mm.	13·6 mm.	9·4 mm.
4 ..	17·2 mm.	10 mm.	6·9 mm.

Type-specimen.—No. M 11398/2 in the register of the Zoological Survey of India (*Indian Museum*).

Locality.—Yenna River, Upper Kistna watershed, at Medha; common, with *P. corrugata*, in the pool in which *Limnocnida indica* occurs.

Parreyssia corrugata (Müller).

This species is even commoner in the Yenna River at Medha than the former one. The shells, which are much eroded, vary greatly in shape, some being much broader and less tumid than others. The external sculpture is always strongly but irregularly developed. The colour of the periostracum is dull brownish or greenish, and the nacre has a strong salmon-pink tinge.

The measurements of three specimens from Medha are as follows :—

	Length.	Height.	Thickness.
1 ..	43·2 mm.	19·1 mm.	29·5 mm.
2 ..	37 mm.	17·4 mm.	28·4 mm.
3 ..	30 mm.	14·6 mm.	23·1 mm.

Genus **Lamellidens**, Simpson.

This genus is represented in the collection by two varieties of the commonest Indian species, *L. marginalis*.

Lamellidens marginalis (Lamarck)

There is a single small valve of this species, in rather bad condition, from the Medha River.

Lamellidens marginalis var. **cylindrica** (H. and T.).

(Plate IV, fig. 5).

1876. (*Unio marginalis* var. *cylindrica*, Hanley and Theobald, *Conch. Ind.*, p. 20, pl. xliv, fig. 1.

We assign to this variety with some doubt a series of shells from the Igatpuri reservoir in the Nasik district (alt. 2,000 feet). On the whole they resemble the figure in the *Conch. Ind.*, but are considerably smaller and have the anterior margin less broadly rounded and the posterior dorsal margin a little more elevated. The shell-substance has a distinct salmon-pink tinge and the epidermal membrane is translucent olivaceous with obsolescent dark radiating lines. The outline is very like that of *L. mainwaringii*, Preston, but the valves are much more inflated, there are differ-

ences in the dentition and the colour of the nacre is totally different. The outline is broader than that of *L. consobrina* (Lea), the shell much thinner, the epidermis paler, the pseudo-cardinal teeth smaller and less prominent and the laterals straighter.

The measurements of four shells are as follows:—

	Length.	Height.	Thickness.
1 ..	56·5 mm.	30 mm.	18·7 mm.
2 ..	53·4 mm.	28·6 mm.	18 mm.
3 ..	52 mm.	27·6 mm.	18 mm.
4 ..	51·8 mm.	27·5 mm.	17·8 mm.

"Not uncommon in shallow muddy bays, many specimens found in damp mud (after a night's light rain) in a drying creek. Some of these were a considerable distance from water, but they were in an active condition. These individuals were observed lying horizontally dorsal side uppermost in shallow and narrow grooves in the mud some four or five inches long and not quite deep enough to contain their shells. Probably they had been buried deeper in the mud and had come to the surface owing to the rain. When placed in a jar of mud they sank to the bottom and there lay horizontally" (*field notes*).

VII. AQUATIC AND SEMI-AQUATIC RHYNCHOTA FROM THE SATARA AND POONA DISTRICTS.

By C. A. PAIVA, *Assistant, Zoological Survey of India.*

Specimens of the following species were collected by Dr. N. Annandale in the course of his tour:—

FAM. HEBRIDAE.

Hebrus bombayensis, sp. nov.

FAM. HYDROMETRIDAE.

Hydrometra vittata, Stål
Rhagovelia nigricans (Burm.).
Onychotrechus rhexenor, Kirk.
Ptilomera laticaudata (Hardw.).
Metrocoris stali (Dohrn.).

FAM. REDUVIIDAE.

Pirates arcuatus (Stål).

FAM. PELOGONIDAE.

Pelogonus marginatus (Latr.).

FAM. NEPIDAE.

Laccotrephes ruber (Linn.).
Laccotrephes griseus, Guer.

FAM. NAUCORIDAE.

Heleocoris elongatus, Montand.
Heleocoris obliquatus (Spin.).
Naucoris sordidus, Dist.

FAM. NOTONECTIDAE.

Enithares templetoni (Kirby).
Enithares lactea, sp. nov.

FAM. CORIXIDAE.

Corixa hieroglyphica, Duf

Family HEBRIDAE.

Hebrus bombayensis, sp. nov.

(Plate III, fig. 6).

One specimen from surface of a small pool at the edge of the river at Medha, *ca.* 2,200 feet, Yenna Valley, Satara district, 27-ii-4-iii-1918 and five specimens found running and flying on vertical

rocks covered with damp algae at the edge of a waterfall at Khandalla, *ca.* 2,500 feet, Poona district, 6-10-iii-1918.

The description is taken from two carded specimens from the latter locality.

Black with greyish-white and golden pubescence; apical margin of head, a spot before each eye and the basal margin more or less greyishly pubescent; antennae ochraceous, apically darker, first joint stout, longest, shorter than any two joints together, second joint shortest, widened at apex and tapering towards base, third and fifth joints subequal, longer than fourth, the three apical joints slender; head slightly tumid above, gently sloping towards the apex; lateral projections at bases of antennae pointed; disk of vertex with two shallow longitudinal grooves united posteriorly and extended as one to basal margin of head; pronotum with two shallow depressions on each anterior lateral area, and a central longitudinal depression on disk; a line of deep punctures on each side of the central depression and also on the basal margin of the pronotum; the depressed portions of the pronotum in fresh specimens are greyishly pubescent; scutellum with its basal area gibbous, beyond which it is foveate as far as apex; a short central longitudinal carina on depressed portion; clavus and corium covered with short golden pubescence; a large subtriangular patch at base of clavus and three spots on membrane arranged in a triangle, white or greyish-white; the outer spot on the membrane transverse, widening inwardly, the other two near the inner margin are rounded; legs ochraceous.

Length 1·75—2 mm.

Type. No. 8048/H.I. in the collection of the Zoological Survey of India.

Family HYDROMETRIDAE.

Hydrometra vittata, Stål.

One specimen from a small pool at the edge of the river at Medha and another from the edge of a waterfall at Khandalla.

A very common species and probably found all over India.

Rhagovelia nigricans (Burm.).

Two apterous specimens from under a rock at the edge of a stream at Khandalla.

As far as the Indian fauna is concerned this species has been recorded from Travancore and Ceylon and it is represented in our collection from Pinjore, Patiala State, base of Simla Hills, W. Himalayas; Tura and Ganool River, Damalgiri, Garo Hills, Assam; Sanjai River, Chakradharpur, Chota Nagpur, 8-10-ii-18, "In large numbers under the shelter of a rock in the stream. N. A." We have also specimens from the mouth of the Jordan, Tiberias, and the plains of Gennesaret, Palestine, collected by Dr. Annandale. It appears to be very widely distributed.

Onychotrechus rhexenor, Kirk.

(Plate III, figs. 8, 8*a*)

A number of specimens were found running and leaping on vertical rocks covered with damp algae at the edge of a waterfall, and two specimens were taken from a rocky stream at Khandalla.

This species has hitherto been recorded only from S. India; Kanara (*colln.* Distant).

Ptilomera laticaudata (Hardw.).

Three specimens from the surface of small streams at Khandalla.

Metrocoris stali (Dohrn).

A number of specimens from the surface of small pools at the edge of the river at Medha and two from small rocky streams at Khandalla.

This and the preceding species are widely distributed.

Family REDUVIIDAE.

Pirates arcuatus (Stål).

Three specimens from under stones at the edge of a stream, Khandalla.

Not an uncommon species.

Family PELOGONIDAE.

Pelogonus marginatus (Latr.).

One specimen from the edge of a stream at Khandalla. Within our limits the distribution of this species extends from Nepal to Ceylon and from Bombay to Burma.

Family NEPIDAE.

Laccotrephes ruber (Linn.).

One specimen from a small pool at the edge of the river at Medha.

Laccotrephes griseus (Guer.).

One specimen from same position and locality as the last. Both these species have a very wide distribution.

Family NAUCORIDAE.

Heleocoris elongatus, Montand.

A number of specimens from small rocky streams at Khandalla. "Very abundant, running about on and under stones below water and swimming when disturbed. N. A."

Recorded from Paresnath, 2,500 feet, iv-09, Bihar; Matheran, Bombay and "Indes Orientales." Also obtained by Dr. Gravely from the following localities in the Bombay Presidency:—Pophli, Vashishti Valley, Ratnagiri district, c. 400 ft., 1-2-v-1912; Tambi, Koyna Valley, Satara district, c. 2,100 ft., 24-26-iv-1912; and Nechal, W. Ghats, Satara district, c. 2,000 ft., 30-iv-1912.

Heleocoris obliquatus, Montand.

A number of specimens in various stages of development from small pools at the edge of the river at Medha. Also found clinging to the lower surface of stones in stream, Sanjai River Chakradharpur, Chota Nagpur. Previously recorded from Bombay and Lower Burma. This species was also obtained by Dr. Gravely at Medha in April, 1912.

Naucoris sordidus, Dist.

A single specimen from a small rocky stream at Khandalla. This species has been recorded from the Calcutta tanks, and from Kerumaadi, S. end of Vembanaad Lake, Travancore, 6-xi-08 (N. A.).

Family NOTONECTIDAE.

Enithares lactea, sp. nov.

(Plate III, fig. 7.)

Described from a single specimen from a small pool at the edge of the river at Medha, Satara district.

Head, pronotum, scutellum and hemelytra milky white; vertex of head tinged with pale orange yellow, a somewhat large orange yellow spot just below apical margin of vertex; a faint, shallow, longitudinal groove within the margin of each eye, not extending beyond the middle of the vertex; eyes greyish, with light purplish reflections, converging towards their bases; length of vertex about equal to its greatest breadth at apex, shorter than the pronotum, which is shining almost smooth and with a few, very minute, scattered punctures; foveately excavate anterior pronotal angles more or less fuscous; length of pronotum at centre less than half its greatest breadth; scutellum much broader at base than long, with a distinct transversely impressed line near basal margin; corium nearly as long as head, pronotum and scutellum together; embolium tinged with very pale yellow, a dull fuscous spot at its basal angle; body beneath dull white; two small contiguous spots on centre of face, lateral margins of face below eyes, margins of clypeus, linear markings on trochanters and on the hind femora beneath, and segmental spots on underside of connexivum dark castaneous; ventral longitudinal carina of abdomen fringed with long black hairs, a fringe of paler hairs on lateral margin of abdomen; intermediate femora with a

strong tooth near apex, hind tibiae about twice the length of the hind tarsi, deeply grooved beneath with a fringe of fine black hairs inside groove; hind tarsi also fringed with black hairs beneath.

Type. No. 8064/H.I. in the collection of the Zoological Survey of India.

This species is very closely related to *E. indica* and *E. paivana* from which it differs chiefly in the total absence of any black markings on its upperside; the transversely impressed line near the base of the scutellum is sufficient to differentiate it structurally from any allied form.

Enithares templetoni (Kirby).

Three specimens from small pools at the edge of the river at Medha, and three from small rocky streams at Khandalla. "Dives under water and clings to stones some inches below the surface. N. A." Evidently a very widely distributed species. Represented in the collection of the Zoological Survey of India from various localities in the Western Himalayas, Bombay Presidency, Ceylon and Southern Shan States.

Family CORIXIDAE.

Corixa hieroglyphica, Duf.

A number of specimens from small pools at the edge of the river at Medha.

VIII. SPONGES FROM THE SATARA AND POONA DISTRICTS AND FROM CHOTA (CHUTIA) NAGPUR.

I have already discussed Spongillidae from the Satara district in my paper on the sponges of the Malabar Zone (*Rec. Ind. Mus.* VII, pp. 383-397: 1912) and have referred to specimens from the Poona district in an earlier paper (*ibid*, VI, pp. 225, 226: 1911); but when I wrote these papers I had not visited the districts myself, and observation of sponges in the natural surroundings is always important. The species that inhabit the beds of rocky streams are of particular interest, and I am now able to compare those that do so at Medha with those found in a very similar stream at Chakradharpur in Chota Nagpur near the centre of Peninsular India. I have not yet found any sponge in a small mountain torrent such as those at Khandalla, in which food is probably deficient; but when these streams are dammed to form ponds in which aquatic vegetation grows up, sponges soon make their appearance.

So far as my experience goes, Spongillidae that grow on the rocks of Indian streams are always encrusting forms. Massive sponges would be in danger of destruction in floods, and although

the lax branches of *Spongilla lacustris* may be observed hanging in the water of placid streams such as the Isis at Oxford, the only branched form from running water that I can call to mind in the tropics is the South American *Uruguaya*, in which the skeleton is of coralline hardness. In the creeks of the Gangetic delta *Spongilla alba* may seem to be a branched form even when the water is moved by sluggish currents. It is not really so, but an encrusting sponge covering the roots or stems of grasses.

The sponges of Indian streams vary considerably both in external appearance and in internal structure. As a rule they are either of a vivid leaf-green colour or of a dense purplish-brown or black. They may be either soft or extremely hard; they usually spread over considerable areas, but are sometimes confined to pockets in the rock. Their colour, whether black or green, is due to the presence of large numbers of minute organized bodies in their cells. These bodies probably represent in all cases a stage in the life history of a microscopic alga, but whether the green corpuscles are all specifically identical we do not know, and no investigation has been made of the purple corpuscles which cause the darker colour. Black or brown sponges occur together with green ones and though their colour has no generic significance, it appears to be, in spite of its quasi-parasitic origin, of specific importance.

All the green sponges from rocky streams with which I am acquainted have a peculiar type of circulatory system that is often to be found in thin encrusting sponges, not only among the Spongillidae but also in several marine Tetraxonid families. In this type the pores, which are usually of relatively large size, are arranged in more or less circular groups immediately over the mouths of relatively wide inhalent canals, which run vertically downwards to near the base of the sponge, giving off lateral channels which convey the incoming water to the ciliated chambers. The exhausted water returns through other channels of similar calibre to the surface of the parenchyma, where it enters relatively wide horizontal canals that ramify immediately below the dermal membrane, which forms their roof. Each system has an osculum situated near the centre of these ramifying channels. It is never of large size and is always protected by a conical dermal collar, which is highly contractile and disappears in preserved specimens. This type of circulatory system is found among marine sponges that encrust rocks in shallow water and is by no means peculiar to green species; among the Spongillidae it is also found in almost colourless lacustrine species that grow near the edge of lakes on the lower surface of stones. Its development has no taxonomic significance but appears to be correlated with growth in the form of a thin layer on smooth surfaces in situations in which there is considerable movement in the water and danger from the accumulation of silt.

I collected specimens of the following species in the Satara and Poona districts and in Chota Nagpur:—

Spongilla lacustris var. *proliferens*, Annand. ..	Artificial pond at Khandalla
S. cinerea, Carter	Streams near Chakradharpur
S. perviridis, sp. nov.	Stream at Medha; rocky artificial pools in Satara fort and at Karla in the Poona district.
S. crateriformis, Potts	Artificial pond at Khandalla.
S. sumatrana, Weber	Well at Medha.
S. sumatrana var. *rivularis*, nov.	Stream at Medha.
S. sumatrana var. *centralis*, nov.	Stream at Chakradharpur.
S. carteri, Carter	Reservoir in the Satara fort.
Corvospongilla ultima var. *spinosa*, Annand. ..	Stream at Medha.

Of these species I need only discuss *S. cinerea*, *S. perviridis*, and *S. sumatrana* with its varieties.

Spongilla (Euspongilla) cinerea, Carter.

(Plate VI, figs. 1, 1*a*, 1*b*).

1911. *Spongilla cinerea*, Annandale, *Faun. Brit. Ind., Freshw. Sponges*, etc., p. 79, fig. 10.

This sponge, which appears to be very rare, has been known to me until recently merely from Carter's description, from a dried schizotype of the original specimen from a tank at Bombay and from some very imperfect material from Nasik. Living specimens were, however, obtained by Dr. Gravely and myself in Chota Nagpur some months ago and I am now able to differentiate from Carter's species a closely allied form (here described under the name *S. perviridis*) that I formerly believed to be a mountain phase of it.

S. cinerea may be distinguished from all other species of the subgenus *Euspongilla* yet known by three characters:—

(1) Its dense purplish-brown or black colour.
(2) Its very finely spinose or subspinose skeleton-spicules.
(3) The great regularity of its skeletal structure.

To take these characters in order. The colour is due to the presence in the cells of both the parenchyma and the dermal membrane[1] of minute organized bodies resembling the green

[1] This is also the case in *Corvospongilla ultima* var. *spinosa*.

corpuscles of many freshwater sponges in structure but of a deep purple colour, which is not soluble in spirit.

The spinosity of the megascleres is so faint that it is apt to escape notice altogether unless they are examined under a very high power of the microscope. The tips are smooth.

The regularity of the skeleton is due mainly to the compact formation and large number of the primary radiating or vertical spicule-fibres, which run upwards through the sponge for considerable distances without branching and are joined together by much less regular cross-fibres or by groups of spicules. The vertical fibres contain a considerable amount of binding substance.

The gemmules are small and very numerous in all the specimens I have examined. They have a thick pneumatic layer in which the air-spaces are very minute, and a slender, straight, projecting foraminal tubule.

In February, 1918 Dr. Gravely and I found specimens at two localities in the Singbhum district of Chota Nagpur, in a rocky stream close to Chakradharpur and in a pool of muddy water, evidently part of a sluggish stream in the rains, on the road between that place and Chaibassa.

At Chakradharpur the sponge was growing on the rocky bed of the stream in clear running water. It was essentially of encrusting habit but in little pockets in the rock showed a tendency to adopt a cushion-like form and was then a centimetre or more thick. The oscula were small on the flat rock but in the pockets become larger (about 5 mm. in diameter). In all cases they opened into wide vertical exhalent canals and horizontal subdermal exhalent canals were absent. The sponge was very soft and of a deep purple-brown colour. Our specimens from a pool on the Chaibassa road were attached to the lower surface of bricks at the base of the piers of a bridge. They had a cushion-like form and were harder and blacker than those from the stream. Their oscula were small and branching horizontal exhalent channels were conspicuous on the surface of the parenchyma.

Spongilla (Euspongilla) perviridis, sp. nov.

(Plate VI, figs. 2, 2*a*, 2*b*).

1912. *Spongilla cinerea*, Annandale (*nec* Carter), *Rec. Ind. Mus.* VII, pp. 137, 387.

This sponge, though closely related to *S. cinerea*, can always be distinguished by the following characters:—

(1) Purple corpuscles are absent from both parenchyma and dermal membrane and are replaced in the former only by green corpuscles.

(2) The skeleton-spicules are more distinctly spiny, but also have smooth extremities.

(3) The skeleton is much less regular.

(4) The oscula are always small and surrounded by radiating exhalent channels.

Type-specimen.—P 59/1 *Zoological Survey of India* (*Ind. Mus.*).

Distribution.—I have examined specimens from the Kumaon lakes in the Western Himalayas as well as from the Koyna and Yenna rivers in the Satara district and from artificial reservoirs in the Satara fort and at Karla in the Poona district. At the last-named place I found the surface of the water densly covered with gemmules from dried sponges exposed on rocks.

Spongilla (Stratospongilla) sumatrana, Weber.

1890. *Spongilla sumatrana*, Weber, *Zool. Ergebn. Niederl. Ost.-Ind.*, 1, p. 38, pl. iv, figs. 6-10.

S. sumatrana has not hitherto been recognized as occurring in British India, though reported from both Sumatra and the Nile. In describing *S. indica* and *S. gravelyi* I pointed out their close relationship to this species, but in the absence of linking forms was obliged to regard them as specifically distinct. Linking forms have, however, now been found and specimens of the *forma typica* discovered in Indian territory. The species seems to be an extremely plastic one and at least five varieties may be recognized. The species as a species must, therefore, be defined in somewhat general terms. I believe that the following description should be adequate.

Sponge thin and encrusting, of a bright green colour except when in deep shade or very muddy water, with small oscula and horizontal ramifying subdermal exhalent channels, with a hard but very friable skeleton formed of large numbers of macroscleres without well-defined spicule-fibres, with short slender macroscleres the majority of which are spiny, with slender amphioxous or amphistrongylous free microscleres that are always densely covered with short spines and are usually abundant in the dermal membrane, with short, compact amphistrongylous gemmule-spicules also covered with short spines; gemmules small, spherical, covered with a single layer of microscleres arranged mosaic wise in a single layer in an outer horny membrane, with a short, nearly straight foraminal tubule.

forma typica.

In this form the skeleton-spicules are sharply pointed and irregularly spiny; there are two kinds of free microscleres, one larger and more sharply pointed than the other; the gemmule-spicules are very short and stout, uniformly spiny and either straight or slightly curved. The gemmules are free. The skeleton is very compact.

The form was described from Lake Singkarah in Sumatra. I found small patches of dried sponge on the walls of a well at Medha that agree with a co-type sent me by Prof. Max Weber. The nilotic variety described by Weltner [1] seems to differ from the

1 "Die Coelenteraten und Schwämme des Süssen Wassers Ost-Afrikas" in Mobius' *Ost.-Afrika*, IV (1908).

forma typica merely in slight differences in the measurements of the spicules.

var. **rivularis,** nov.

(Plate VII, fig. 2).

The skeleton-spicules are stouter and as a rule less sharply pointed than in the *forma typica*; the gemmule-spicules are relatively longer, more variable and often more irregular in outline; the skeleton is less compact; the gemmules are either free or fixed by means of their outer spiculiferous coat at the base of the sponge.

Type-specimen.—P 66/1 *Zool. Survey of India* (*Ind. Mus.*).

Locality.—Rocks in the river Yenna at Medha.

I could not distinguish living specimens from *S. perviridis,* side by side with which they were growing.

var. **centralis,** nov.

(Plate VI, fig. 3; plate VII, fig. 1).

The skeleton-spicules, though remaining long and relatively slender, are for the most part distinctly blunt at the tips. Otherwise the form resembles the var. *rivularis*.

Type-specimen.—P 71/1, *Zool. Survey of India* (*Ind. Mus.*).

Locality.—Rocky bed of a stream at Chakradharpur, Chota Nagpur.

var. **indica,** Annandale.

(Plate VII, fig. 3).

1908. *Spongilla indica,* Annandale, *Rec. Ind. Mus.*, II, p. 25, figs. 1, 2.
1911. *Spongilla indica, id., Faun. Brit Ind., tom. cit.*, p. 100, fig. 17.

Most of the skeleton-spicules are blunter and shorter than in the last variety; the gemmule-spicules are on an average much smaller and more slender; the skeleton is more compact and the gemmules are as a rule fixed at the base of the sponge.

Localities.—Nasik and Igatpuri in the Nasik district, Bombay.

var. **gravelyi,** Annandale.

1912. *Spongilla gravelyi,* Annandale, *Rec. Ind. Mus.*, VII, p. 385, fig. 1.

The skeleton-spicules are relatively long, slender, sharply pointed and sparsely spined; the gemmule-spicules have a peculiar curvature and are often knobbed at the end; the gemmules are free.

Locality.—Koyna river at Taloshi, Satara district, Bombay.

In distinguishing these varieties reference should be made to the figures here reproduced or cited. I have avoided giving detailed descriptions as it is possible that intermediate forms exist and it seems best in dealing with the varieties of a plastic species not to be too exact.

EXPLANATION OF PLATE I.

Frog and Fish from Bombay Streams.

Ixalus bombayensis, sp. nov.

FIG. 1.—Type-specimen (adult male) from N. Kanara, × 2.

Nemachilus evezardi, Day.

FIG. 2.—Adult specimen from hill streamlet at Khandalla (nat. size).

,, 2*a*.—Ventral surface of head and chest of same specimen (enlarged).

Nemachilus anguilla, sp. nov.

FIG. 3.—Type-specimen (adult male) from the R. Yenna at Medha, × 2.

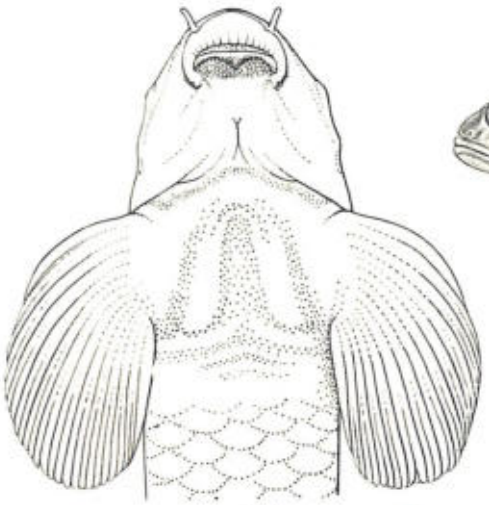
Psilorhynchus tentaculatus, sp. nov.

FIG. 4.—Type-specimen from hill streamlet at Khandalla, × 2.

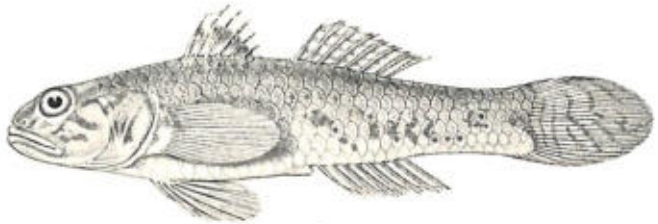
,, 4*a*.—Ventral surface of head and chest of same specimen (further enlarged).

Gobius bombayensis, sp. nov.

FIG. 5.—Type-specimen from Medha (enlarged).

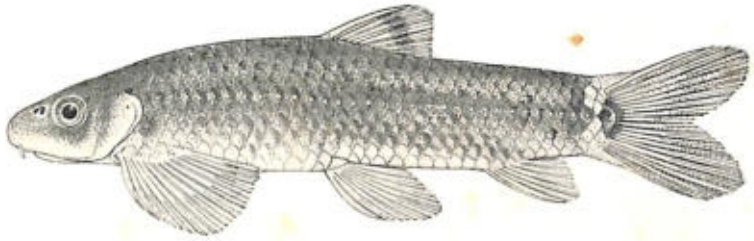


4*a*



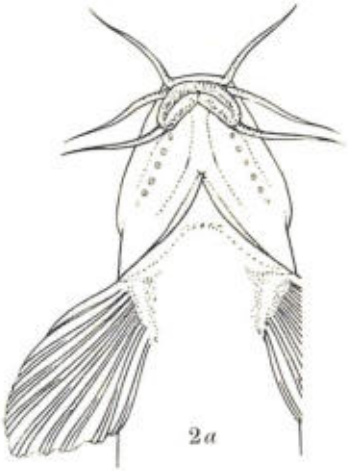
5

2



4

1



2*a*

3

A. C. Chowdhury, *del*

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1918.

FRESHWATER FISH AND FROG FROM BOMBAY STREAMS.

EXPLANATION OF PLATE II.

Indian species of *Discognathus*, etc.

Discognathus lamta, Day.

FIG. 1.—Adult male from the R. Yenna at Medha (slightly reduced).

,, 1*a*.—Ventral surface of head and chest of same specimen (slightly enlarged).

Discognathus nasutus (McClell.).

FIG. 2.—Adult male from Pachmarhi, Central Provinces (same scale as fig. 1).

,, 2*a*.—Ventral surface of head and chest of same specimen (enlarged).

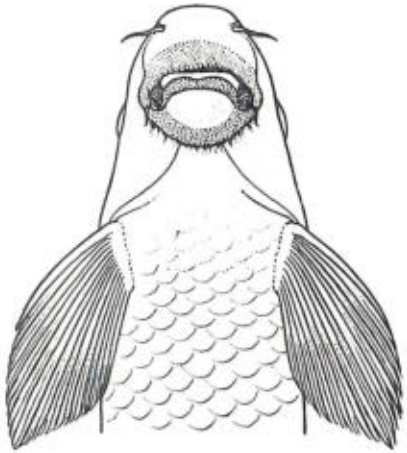
Discognathus gravelyi, sp. nov.

FIG. 3.—Type-specimen (adult male) from He-Ho, S. Shan States (same scale as fig. 1).

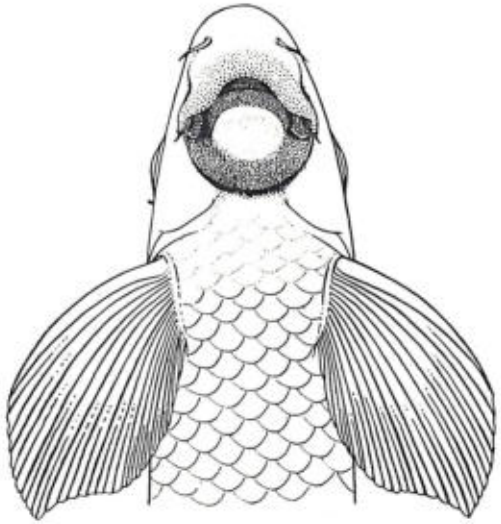
,, 3*a*.—Ventral surface of head and chest of same specimen (enlarged).

Barbus jerdoni var. **maciveri**, nov.

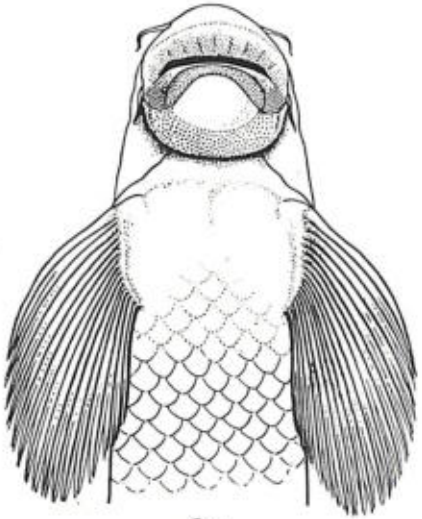
FIG. 4.—Type-specimen of variety (young) from R. Kistna near Satara (reduced).



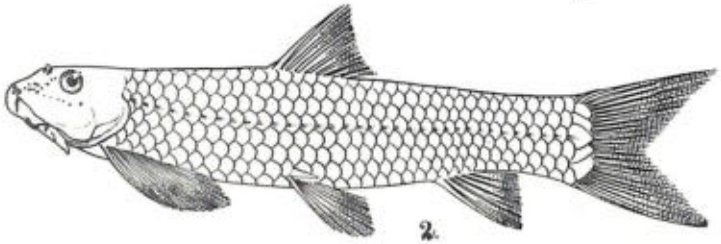
1a.



3a.



2a.



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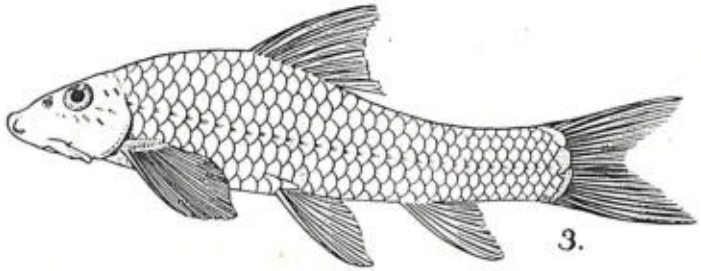

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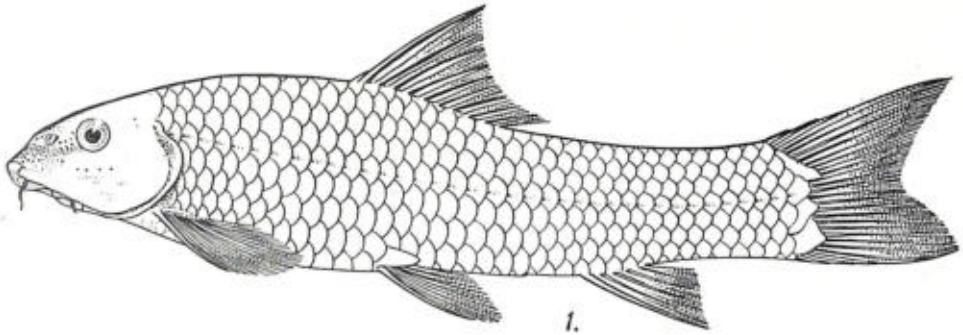

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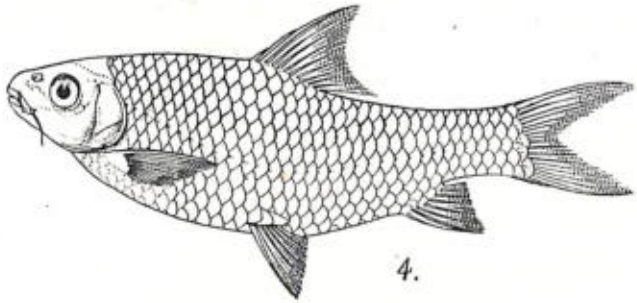

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A. Chowdhary del.

INDIAN SPECIES OF *DISCOGNATHUS*, ETC.

EXPLANATION OF PLATE III.

Fish and Aquatic Rhynchota, mostly from Bombay Streams.

Nemachilus anguilla, sp. nov.

FIG. 1.—Ventral surface of head and chest (enlarged).

Psilorhynchus tentaculatus, sp nov.

FIG 2.—Pharyngeal teeth (highly magnified).

Barbus tor (Ham. Buch.).

FIGS. 3, 3*a*.—Head of young specimen from the R. Kistna near Satara (about nat. size).

Barbus mussullah, Sykes.

FIGS. 4, 4*a*.—Head of young specimen from the R. Kistna near Satara (about nat. size).

Barbus putitora (Ham. Buch.).

FIG. 5.—Adult specimen from Gauhati, Assam (much reduced).

Hebrus bombayensis, Paiva, sp. nov.

FIG. 6.—Enlarged dorsal view of type-specimen from Khandalla.

Enithares lactea, Paiva, sp. nov.

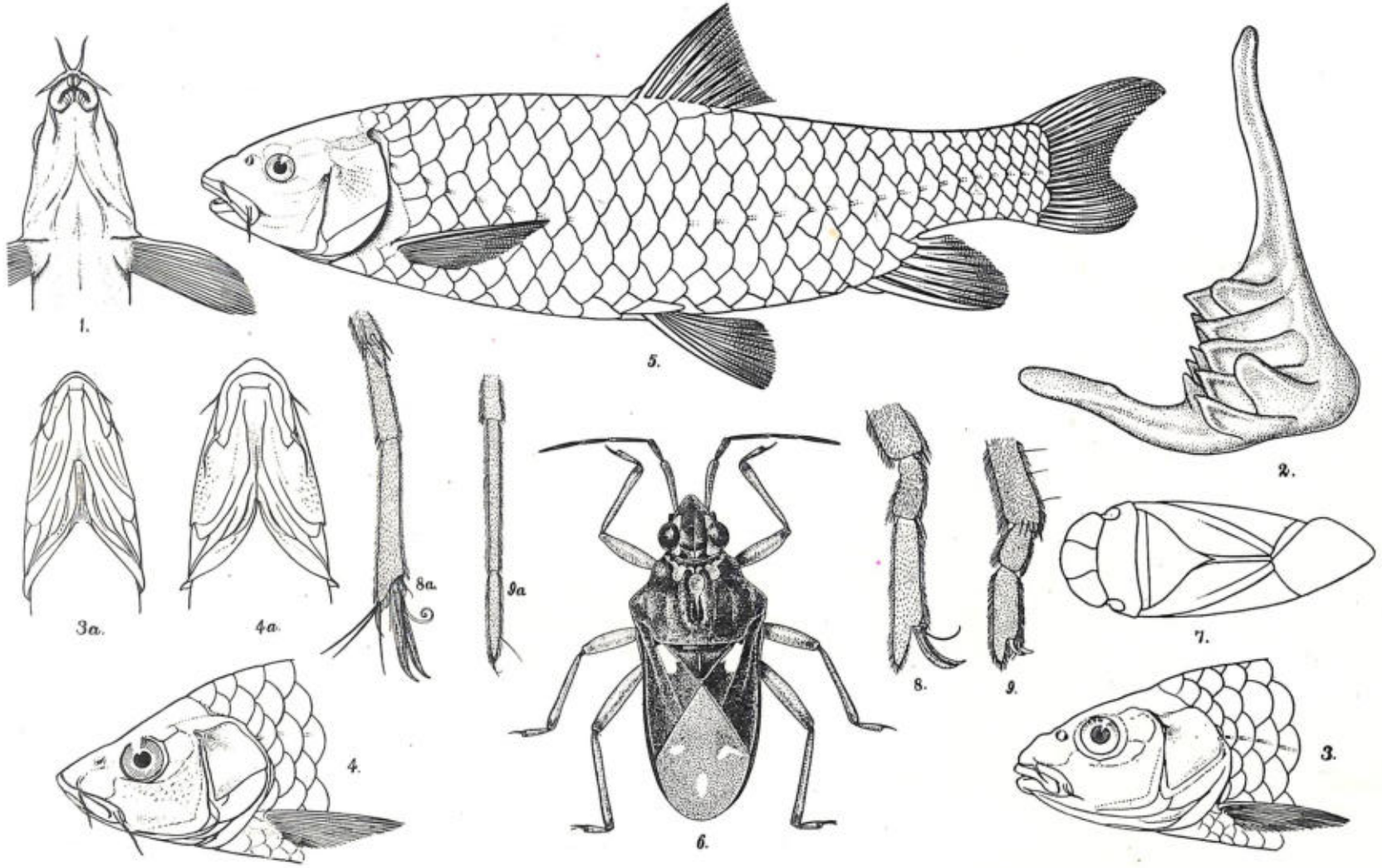
FIG. 7.—Outline of dorsal surface (enlarged).

Onychotrechus rhexenor, Kirk.

FIGS. 8, 8*a*.—Front and hind feet (enlarged).

Gerris tristan, Kirk.

FIGS. 9, 9*a*.—Front and hind feet (on same scale as figs. 8, 8*a*).



A. Chowdhury & D. Bagchi del.

FRESHWATER FISH AND WATER-BUGS MOSTLY FROM BOMBAY.

EXPLANATION OF PLATE IV.

Freshwater Molluscs from Bombay.

Limnaea acuminata var. **nana**, nov.

FIG. 1.—Photograph of type-specimens from Khandalla, × 4

Cremnoconchus syhadrensis (Blanford).

FIG. 2.—Living mollusc crawling on side of glass jar above water showing film of water it carries with it, opening of branchial chamber, etc.: enlarged.

,, 3.—Animal (♀) removed from shell and with the branchial chamber slit open to show gill (*a*) and osphradium (*b*): enlarged.

,, 4.—Radular teeth (highly magnified).

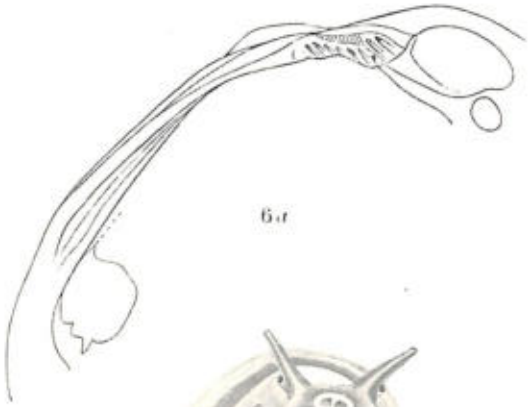
Lamellidens marginalis var. **cylindrica**, H. and T.

FIG. 5.—Shell from reservoir at Igatpuri provisionally assigned to this variety (nat. size).

Parreyssia cylindrica, sp. nov.

FIG. 6.—Type-series of shells from the R. Yenna at Medha (nat. size).

FIGS. 7, 7*a*.—Enlarged view of hinge, etc. in the two valves of an adult shell.



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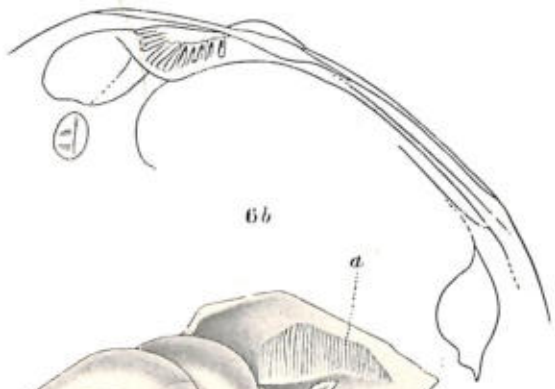

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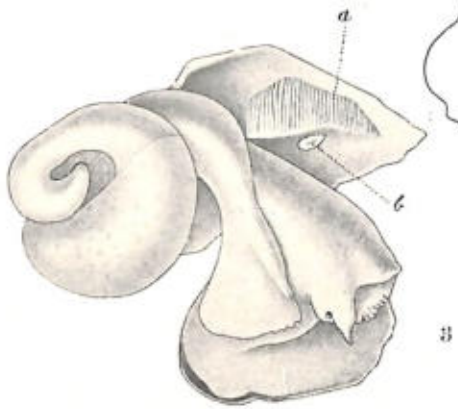

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S. C. Mondul, photo.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1918.

FRESHWATER MOLLUSCS FROM BOMBAY.

EXPLANATION OF PLATE V.

Radular teeth of freshwater molluscs from Bombay.

The teeth of the different forms of *Limnaea* proceed in each figure from the centre outwards in the natural order. Most of the lateral teeth are omitted, only the innermost one on each side being shown. Only a few of the marginal teeth on one side are figured. *a* = central tooth with innermost lateral tooth on either side. *b* = marginal teeth.

Limnaea acuminata, Lamarck.

FIG. 1.—Teeth of the *forma typica*, × 500. Specimen from Khandalla.

,, 2.—Teeth of the var. *nana*, × 500. Specimen from Khandalla.

Limnaea chlamys, Benson.

FIG. 3.—Teeth, × 500. Specimen from Satara fort.

Limnaea pinguis, Dorhn.

FIG. 4.—Teeth, × 500. Specimen from Khandalla.

Melania tuberculata (Müller).

FIG. 5.—Teeth, × 250. Specimen from Igatpuri, Nasik district.

Melania scabra (Müller).

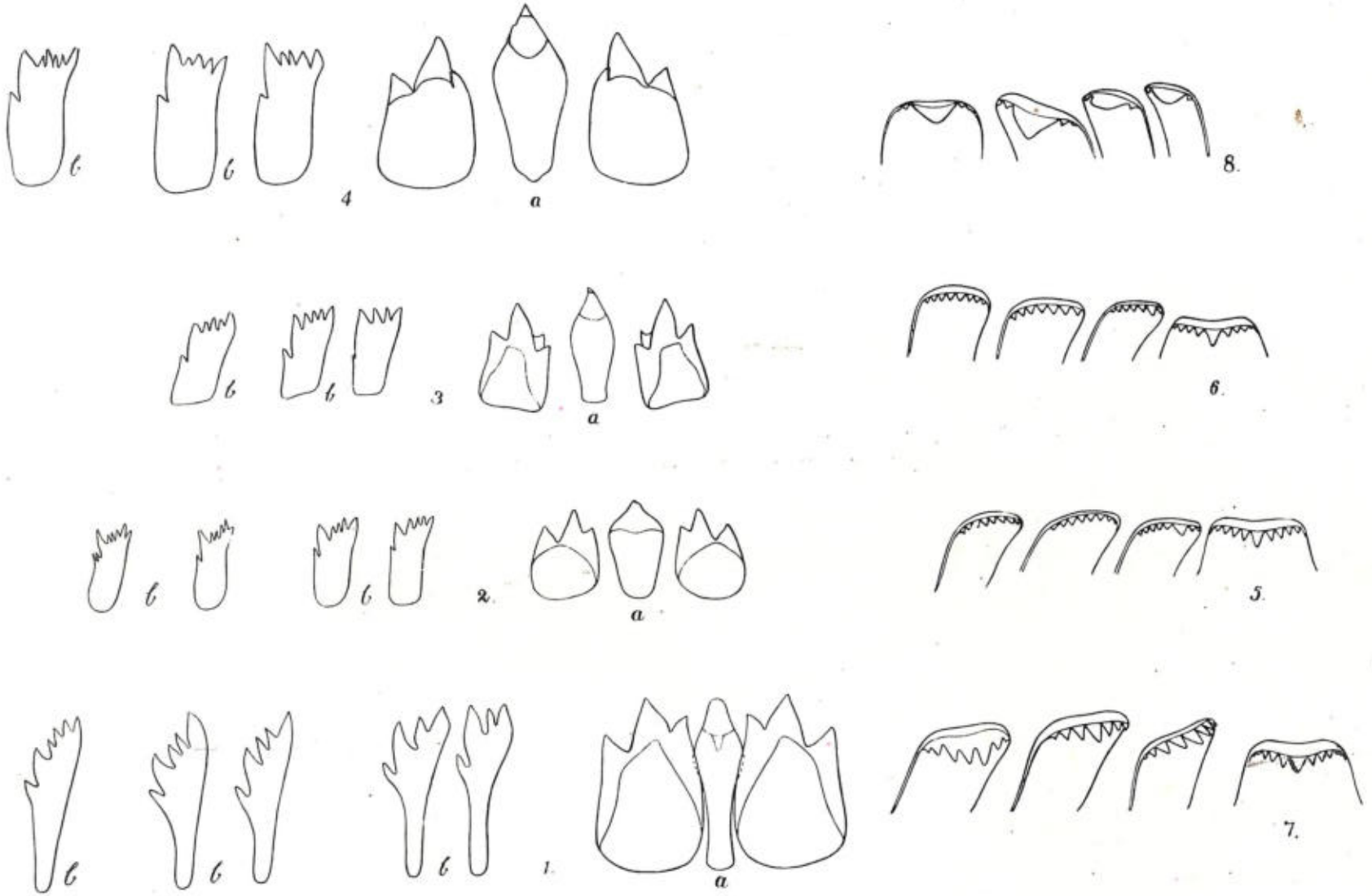
FIG. 6.—Teeth, × 250. Specimen from the Yenna R. at Medha.

Paludomus obesa (Philippi).

FIG. 7.—Teeth, × 250 Specimen from Khandalla.

Ampullaria nux, Reeve.

FIG. 8.—Teeth, × 75. Specimen from Khandalla.



D. Bagchi del.

RADULAR TEETH OF FRESHWATER MOLLUSCS.

EXPLANATION OF PLATE VI.

Freshwater sponges from Bombay and Chota Nagpur.

Spongilla cinerea, Carter.

FIG 1.—Vertical section through middle region of skeleton with gemmules *in situ*, × 30. Schizotype from Bombay I.

,, 1*a*.—Typical skeleton-spicule, × 250.

,, 1*b*.—Part of same spicule, × 750.

Spongilla perviridis, sp. nov.

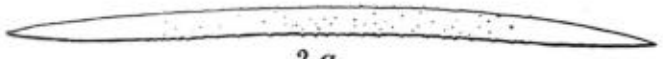
FIG. 2.—Vertical section through middle region of skeleton, × 30. Specimen from Yenna R.

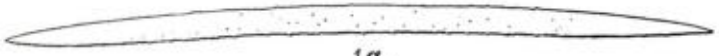
,, 2*a*.—Typical skeleton-spicule, × 250.

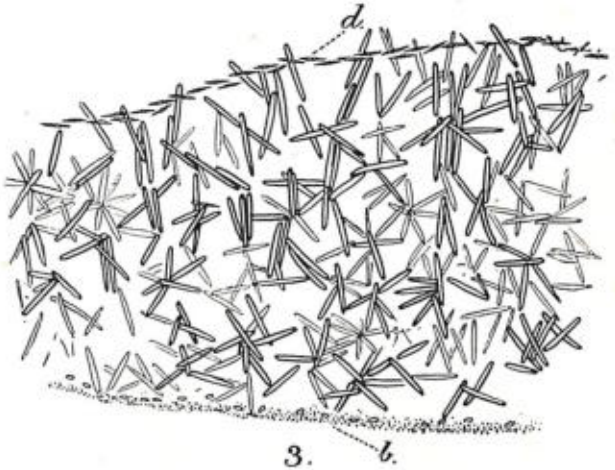
,, 2*b*.—Part of same spicule, × 750.

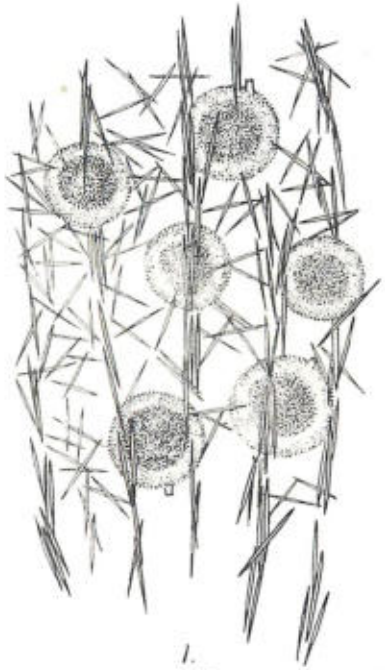
Spongilla sumatrana var. **centralis**, nov.

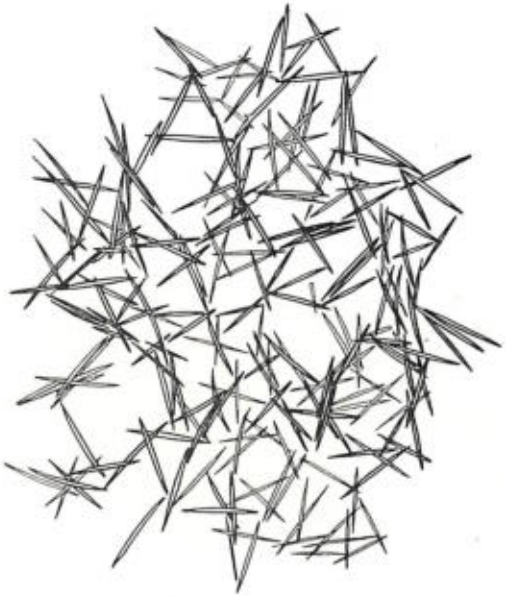
FIG. 3.—Vertical section through skeleton, × 30. *b* = basal membrane with microscopic algae. *d* = dermal membrane with free microscleres. Specimen from Chakradharpur.

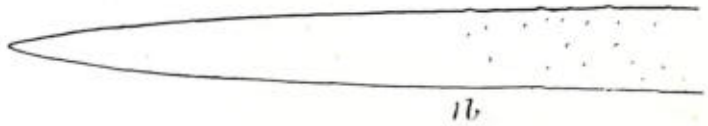












A. C. Chowdhary del.

FRESHWATER SPONGES FROM BOMBAY, ETC.

EXPLANATION OF PLATE VII.

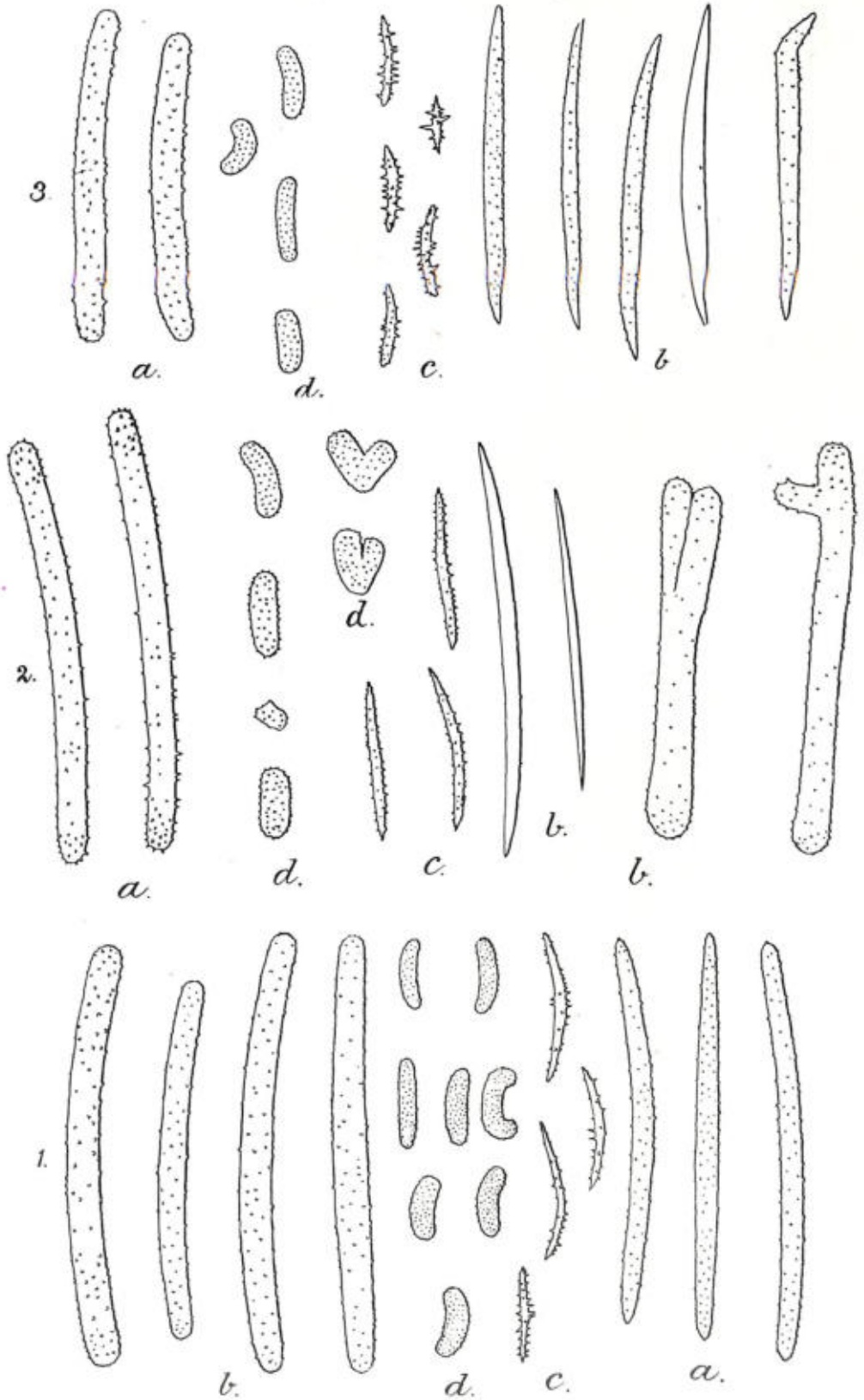
Spicules of Indian varieties of *Spongilla sumatrana*, Weber

a = typical macroscleres. *b* = other macroscleres. *c* = free microscleres. *d* = gemmule-spicules.

FIG. 1.—**Spongilla sumatrana** var. **centralis**, nov., × 250.

,, 2.—**Spongilla sumatrana** var. **rivularis**, nov., × 250.

,, 3.—**Spongilla sumatrana** var. **indica**, Annand., × 250.



FRESHWATER SPONGES FROM BOMBAY, ETC.

A. C. Chowdhary del.

EXPLANATION OF PLATE VII.

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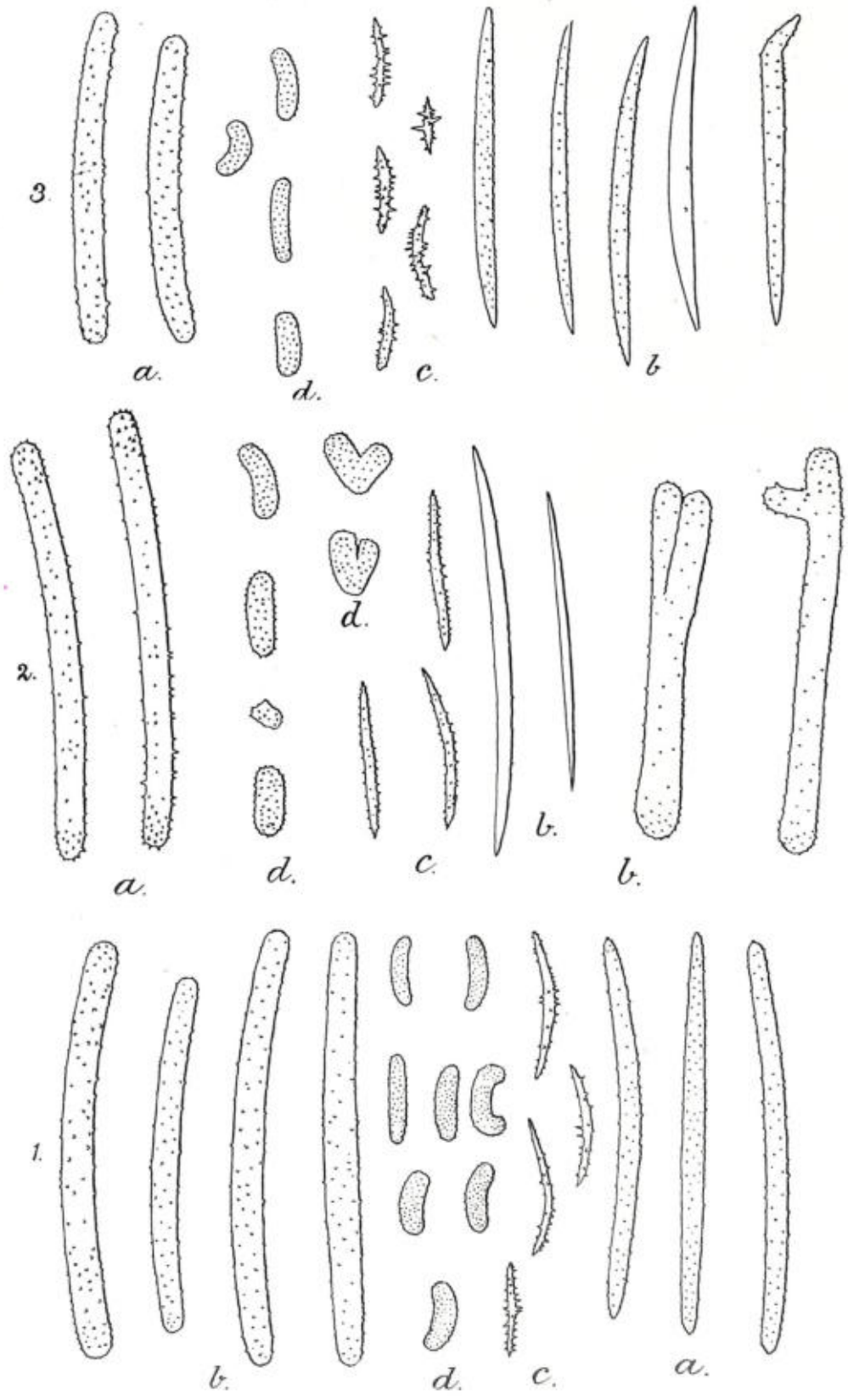
,, 3.—**Spongilla sumatrana** var. **indica**, Annand., × 250.



FRESHWATER SPONGES FROM BOMBAY, ETC.

A. C. Chowdhary del.

VII. ON A NEW SPECIES OF *DISCOGNATHUS* FROM THE KANGRA VALLEY.

By B. PRASHAD, *D.Sc., Superintendent of Fisheries, Bengal Fisheries Laboratory, Indian Museum, Calcutta.*

(*Published by permission of the Director of Fisheries, Bengal*).

(With two text-figures).

The identification of the various Indian species of the genus *Discognathus* has always been a matter of great difficulty. The task has, however, been made much easier by the admirable treatment of the subject by Dr. Annandale. This paper, of which I had the privilege of consulting the manuscript and the original drawings, is published in the present volume of the "*Records*" immediately previous to this note (pp. 125-138). I am also deeply indebted to Dr. Annandale for his valuable advice regarding this species of fish and for going through the manuscript. The specimens of this fish were sent to me by L. Devi Ditta Mal of the Punjab Fisheries Department and to him also my best thanks are due.

Discognathus kangrae, sp. nov.

This species differs from the other Indian species of the genus in the proportions of the different parts of the body, in the shape and size of the mental disc, the situation of the eye, the shape of the tail and the dorsal fin.

D. 11 (2/9). P. 16. V. 9. A. 7 (2/5). L.l. 34. L.t. 4/5.

The total length is about 4¼ times the greatest depth of the body and less than 4 times the length of the head. The diameter of the eye, which is situated nearer the operculum than the snout, is contained a little less than 8 times in the length of the head. The interorbital space is slightly convex, about 3½ times the diameter of the eye. The snout has in the adult male a large number of tubercles, some with small conical spines, arranged in two to three rows on the lateral sides of the head. There is a fairly deep groove of a semicircular outline on the dorsal surface of the head, extending along the sides up to the nostrils, but there is no projection. The nostrils are large and prominent. The dorsal profile from the anterior edge of the dorsal fin is nearly straight up to the eyes, whence it suddenly slopes forwards; behind the dorsal fin the profile is slightly concave. The upper lip is fairly broad and the lower lip is very much enlarged with an ovoid mental disc. There are four barbels, the posterior pair at the margins of the mouth being much smaller than the anterior ones.

The ventral surface is convex with scales extending forward on the chest in the form of a triangle. The pectoral fins are much shorter than the head and do not extend nearly to the ventrals; they are set obliquely on the sides of the body but much nearer the ventral surface than in some other species. The caudal fin is deeply forked; the two lobes are nearly of the same size. The dorsal fin originates further forwards than the ventrals and is

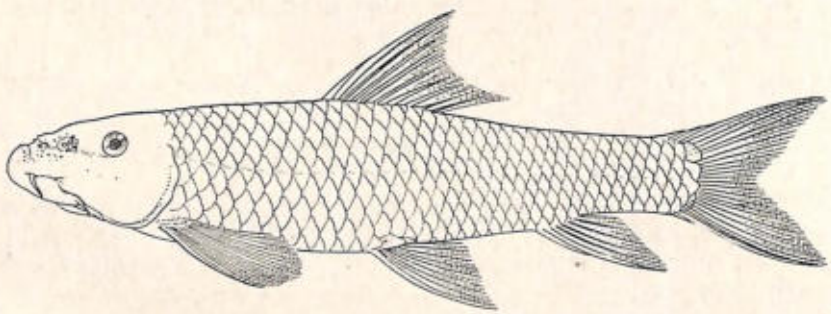


FIG. 1.—*Discognathus kangrae*, sp. nov.
Type specimen (adult male) from the Kangra Valley (slightly reduced).

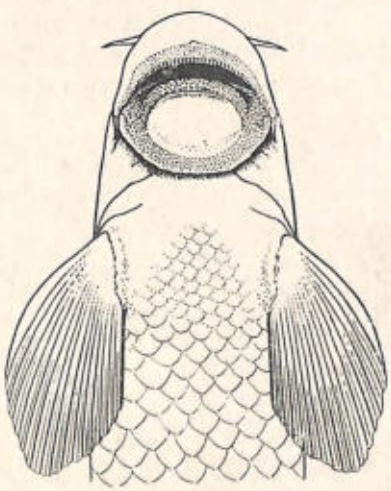


FIG. 1a.—*Discognathus kangrae*, sp. nov.
Ventral surface of head and chest of same specimen.

much shorter than the maximum depth of the body; the first unbranched ray is well developed but not ossified; the second is fairly thick, much larger than the first but like it not ossified; it is shorter than the head. The specimens are of a uniformly bluish-grey colour, the ventral surface being yellowish.

The largest specimen measures 14 cm. in length.

Type-specimen.—F. $\frac{8.8.9.9}{1}$ *Zoological Survey of India* (*Ind. Mus.*).

Locality.—In a hill-stream at Jaugal-khad, Kangra district, Punjab. Four specimens.

The present species comes near *D. lamta*, but the shape of the snout, the body as a whole and the tail fin, the position and insertion of the pectoral fins and the structure of the mental disc are sufficient to mark it off as a distinct species.

In Dr. Annandale's key (*loc. cit.*) the species would be distinguished from the typical *D. lamta* and *D. jerdoni* by the length of the head being not more than one fourth of the total length.

MISCELLANEA.

BIRDS.

Two interesting Albinos.

Through the courtesy of the authorities of the Indian Museum two very interesting albino specimens of birds have been sent home to me for examination.

The first of these is a very curious semi albino Red-vented Bulbul (*Molpastes haemorrhous bengalensis*). The whole head, fore-neck and nape are white, a few of the anterior feathers edged black and others next to them again pale brown or greyish-brown. The bill is quite black, and the feet, though now discoloured, appear also to have been black in life.

I should presume this to be a case of partial temporary albinoism, possibly started by the bird, a captive one, rubbing its head and neck against the bars of its cage in attempting to escape when first confined. The feathers of the forehead are edged with orange pink, this colour extending to some of the lateral crest feathers and the tiny orbital plumes and this is really the most remarkable feature about the bird, for this is red naturally in this Bulbul in these parts. I have examined the pigment very closely under a powerful glass but have no reason to imagine it to be artificial.

The specimen No. 25456 was presented to the Indian Museum by Baboo Madhusudan Mullick.

The second bird is a specimen of the common Indian Myna, *Acridotheres tristis*, presented to the Museum by A. C. Tunstall, Esqr., from Tocklai, Assam. This is an example of *constitutional albinoism* as compared with *accidental albinoism* in the Bulbul. The whole bird is white with the exception of the lores and feathers round the eye which are black as in a normal bird. Below the whole plumage is suffused with rufous buff and the chin, earcoverts and throat are dark and almost normal in tint; above the feathers of the head are tipped dull fulvous brown and those of the back, rump and upper tail coverts with the same but paler. The wing-quills are white-shafted but the rectrices have them dark. The bill and feet are yellow but appear in life to have been paler and more lemon yellow than in a normal bird. It is not ea y to say whether this specimen is losing or acquiring pigment; I incline to the former opinion as the wings which are newly moulted are all pure white.

E. C. Stuart Baker, *F.L.S., F.Z.S., M.B.O.U.*

Upper Norwood,
15-viii-18.

VIII. A LIST OF THE DRAGONFLIES RECORDED FROM THE INDIAN EMPIRE WITH SPECIAL REFERENCE TO THE COLLECTION OF THE INDIAN MUSEUM.

Part II. (*Contd*). The Family Agrionidae.

B. The Legions Argia and Agrion.

By F. F. Laidlaw, *M.A., M.R.C.S., L.R.C.P., Lt., R.A.M.C. (temp.).*

(With text-figures 1-4.)

Introduction.

The first of these Legions is represented by a single species of the genus *Onychargia*, the only oriental genus which approximates closely to the great American genus *Argia*, so prominent in almost every part of the new world.

The Legion *Agrion* includes genera which are commonly held to be the most advanced of the Zygoptera. River species retain few or no archaic characters; are mostly of small or moderate size; are often very numerous in individuals, and of wide distribution. The Legion is in fact one of the dominant groups of existing Odonata, and its genera present a general similarity of structure, and especially of venation, which makes it a matter of difficulty to arrive at a satisfactory natural classification; exactly as the same difficulty arises in the case of other highly specialized dominant groups, for example the Passeres amongst birds. The table given below is an attempt to arrange these genera in such a manner as to indicate their salient characters and as far as possible to show relationships. It is a modification of the arrangement suggested by Selys, his scheme being open to the objection that it relies mainly on a sexual character. Tillyard's classification depending as it does on a venational and purely adaptive character has also grave disadvantages.

Any clear-cut grouping is rendered all the more difficult by the fact that one finds exceptional characters in certain species.

In discussing venation I employ in this and other parts of this list the modification of the Comstock-Needham nomenclature given by Tillyard, to be found in his book *The Biology of Dragonflies*.

TABLE ILLUSTRATING THE SALIENT CHARACTERS AND RELATIONSHIPS OF THE GENERA OF THE LEGION *AGRION*.

Venation.	♀ with spine at apex of abdominal segment 8 ventrally.	♀ without spine at apex of abdominal segment 8 ventrally.
Ab. commences before the level of Ac.	Apex of segment 10 of male raised to form a distinct prominence. Post-ocular spots present. ♂ pterostigmata heterochromatic. ♀ dimorphic. *Ischnura.* *Rhodischnura.*	Arculus distal to second antenodal nerve. Post-ocular spots absent. ♂ pterostigmata heterochromatic (in some species). ♀ dimorphic. *Agriocnemis.* *Argiocnemis.*
	Apex of segment 10 of male not raised to form a distinct prominence. Post-ocular spots present. *Enallagma.* *Aciagrion.*	Arculus at level of second antenodal nerve. Post-ocular spots absent. Transverse ridge on frons. *Ceriagrion*, spp. *Ceriagrion*, spp.
Ab. commences at the level of Ac.	Post-ocular spots absent. [*Xiphiagrion.*]	Post-ocular spots absent. No ridge on frons. ♀ with posterior prothoracic border provided with a pair of short projections, directed forwards and resting on the middle lobe. *Pseudagrion.*
Ab. commences beyond Ac.		*Archibasis.*

The economic importance of the insects dealt with here is probably considerable. In both larval and adult stages they prey largely on Diptera and must destroy great quantities of obnoxious forms.

Geographically the Legion *Agrion* is perhaps less interesting than other divisions of the family Agrionidae. It is necessary again to call attention to the existence of wide gaps in our knowledge.

[It is obvious that these notes are incomplete. The exigencies of military service have made it impossible for me to devote sufficient time to a difficult group, and have prevented access to literature and material.

I prefer for several reasons that they should go to press in their present condition rather than to wait publication indefinitely, chiefly because the list does not aim at the fullness of a monograph. I hope rather that it may serve to stimulate those who have the opportunity of dealing with these delightful and beautiful creatures in the field, and be of use to them. It is clear that great opportunities await the field naturalist who will devote special attention to this group in India. If these notes prove of use to such I shall have every reason to be gratified.]

The following is a list of species recorded from within the boundaries of the Empire. Those marked by an asterisk are in the collection of the Indian Museum.

	GENUS.	SPECIES.	RANGE.
	Onychargia		Indomalaya.
1		* *atrocyana*, Selys.	(*that of genus*).
	Ischnura		Cosmopolitan (except Pacific Islands.)
2		*elegans* (Van der L.)	Palaearctic, Kashmir.
3		* *senegalensis* (Ramb.)	Old-world tropics, except Australia.
4		*forcipata*, Morton.	Ganges Valley.
5		* *inarmata*, Calvert.	Kashmir.
6		* *aurora*, Brauer.	Oriental Region, Australia.
7		* *rufostigma*, Selys.	Bengal, Assam.
8		* *annandalei*, n. sp.	Shan States.
	Rhodischnura		Central Peninsular India.
9		* *nursei* (Morton).	(*that of genus*).
	Agriocnemis		Old-world tropics.
10		* *pygmaea* (Ramb.)	(*that of genus*).
11		* *incisa*, Selys.	Oriental Region.
12		* *lacteola*, Selys.	Bengal, Assam.
13		* *pieris*, n. sp.	Peninsular India.
14		* *nana*, Laidlaw.	Assam.
15		* *splendidissima*, n. sp.	Peninsular India.
	Argiocnemis		Oriental Region.
16		* *aborense*, Laidlaw.	Assam.
17		*rubescens*, Selys	? India to Australia.
	Enallagma		Cosmopolitan, except Australia.
18		* *cyathigerum* (Charp.)	Palaearctic, Kashmir.
19		* *malayanum*, Selys.	Oriental.
20		*maldivense*?, Laidlaw.	Maldive Archipelago.
21		?* *parvum*, Selys.	N. India.
	Aciagrion		Oriental, Australia.
22		* *olympicum*, n. sp.	Darjiling District.

	Genus.	Species.	Range.
23		* *pallidum*, Selys.	India, Assam, Burma.
24		* *tillyardi*, n. sp.	Assam.
25		* *hisopa*, Selys.	India, Assam, Burma.
26		*approximans*, Selys.	Assam.
	Ceriagrion		
27		* *coeruleum*, n. sp.	Darjiling District.
28		* *olivaceum*, Laidlaw.	Assam.
29		* *rubiae*, Laidlaw.	Peninsular India.
30		* *coromandelianum* (Fabr.)	Oriental.
31		* *cermorubellum* (Brauer).	Oriental.
32		*fallax*, Ris.	Burma.
33		* *melanurum*, Selys.	Sumatra to Japan.
	Pseudagrion		Old-world tropics.
34		* *microcephalum* (Ramb.)	Oriental, Australia.
35		* *bengalense*, n. n.	Bengal.
36		* *decorum* (Ramb.)	India.
37		* *hypermelas*, Selys.	India.
38		*bidentatum*, Morton.	N. India.
39		* *rubriceps*, Selys.	India.
40		*azureum*, Selys.	Burma.

Species whose occurrence, position or characterization is doubtful.

Ceriagrion		
	erubescens, Selys.	May occur in Burma.
Argiocnemis		
	* *lunulata*, Laidlaw.	Doubtfully distinct from *A. rubescens*.
	obscura, Laidlaw.	Assam.
Archibasis		
	ceylonica, Kirby.	A *Pseudagrion*.
41	* *oscillans* (Selys).	Position doubtful.

Legion Argia.

Genus **Onychargia**.

Onychargia atrocyana, Selys.

Onychargia atrocyana, Kirby, *Cat. Odonata*, p. 139 (1890); Kirby, *Journ. Linn. Soc. London, Zool.*, XXIV, p. 563 (1893).

1 ♂ 1 ♀ (imperfect). Sibsagar, Assam (♂ 320/20; ♀ 6314/1).

Labelled *Onychargia vittigera* in Selys' own writing (see *Synopsis*, p. 417).

Legion Agrion.

Genus **Ischnura**.

I have thought it advisable to make a new genus to contain the aberrant *I. nursei* of Morton.

The genus *Ischnura* is particularly interesting because of the existence in some species at least of two distinct colour forms of the female (dimorphism), and because of the colouring of the pterostigmata of the fore-wing in the males which are heterochromatic, *i. e.* differ in colour from those of the hinder-wings. Both these features occur also in *Agriocnemis*.

Rhodischnura differs strikingly in appearance from the true *Ischnuras* and the male of the single known species has no post-ocular spots; but in other respects it is closely allied to *Ischnura* and probably directly derived from that genus.

TABLE OF SPECIES OF *ISCHNURA* AND *RHODISCHNURA* (MALES ONLY).

I. Post-ocular spots present. Well-marked bifid dorsal tubercle at apex of last abdominal segment.

A. Abdomen entirely black and blue (or black and green).

1. Segments 8-10 dark-blue above, 10 with black, subquadrate, dorsal patch. Pterostigma of fore-wing with costal margin shorter than anal, and inner margin more oblique than the outer ... ... *I. forcipata*, Morton. (N. W. India).

2. Segments 8-10 blue, 9-10 marked with black dorsally. Pterostigma of fore-wing with inner and outer margins parallel, costal and anal margins sub-equal.

a. Segment 2 of abdomen steely metallic black ... *I. senegalensis* (Ramb.). (Tropical old-world, except Australia).

b. Segment 2 of abdomen black not metallic ... ... *I. elegans* (Van der L.). (Palaearctic).

B. Abdomen with orange colouring. Segments 8-9 blue, 10 black above.

1. Dorsum of segment 2 black. Larger species (abd. *ca.* 23 mm.). Costal and anal margins of pterostigma of fore-wing sub-equal ... ... *I. inarmata*, Calvert. (Kashmir).

2. Dorsum of segment 2 largely orange. Smaller species (abd. *ca.* 16-20 mm.). Costal margin of pterostigma of fore-wing distinctly longer than anal margin. Thorax with a pair of minute cylindrical horns anteriorly ... *I. aurora*, Brauer. (India to Australia).

C. Abdomen orange-red and black only.

1. Segments 7-10 black ... ... *I. annandalei*, sp. n. (S. Shan States).

2. Segments 9-10 and distal half of 8 black ... ... *I. rufostigma*, Selys. (Bengal, Assam).

II. No post-ocular spots. Apex of last abdominal segment widely excavated.

D. Abdominal segments 1-4 red, 5-6 lemon yellow, 7-10 metallic black ... ... *Rhodischnura nursei* (Morton). (N. Central India).

The females of any one species of *Ischnura* fall into one or more of three categories. *In the first place* all the species

	GENUS.	SPECIES.	RANGE.
23		* *pallidum*, Selys.	India, Assam, Burma.
24		* *tillyardi*, n. sp.	Assam.
25		* *hisopa*, Selys.	India, Assam, Burma.
26		*approximans*, Selys.	Assam.
	Ceriagrion		
27		* *coeruleum*, n. sp.	Darjiling District.
28		* *olivaceum*, Laidlaw.	Assam.
29		* *rubiae*, Laidlaw.	Peninsular India.
30		* *coromandelianum* (Fabr.)	Oriental.
31		* *cerinorubellum* (Brauer).	Oriental.
32		*fallax*, Ris.	Burma.
33		* *melanurum*, Selys.	Sumatra to Japan.
	Pseudagrion		Old-world tropics.
34		* *microcephalum* (Ramb.)	Oriental, Australia.
35		* *bengalense*, n. n.	Bengal.
36		* *decorum* (Ramb.)	India.
37		* *hypermelas*, Selys.	India.
38		*bidentatum*, Morton.	N. India.
39		* *rubriceps*, Selys.	India.
40		*azureum*, Selys.	Burma.

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TABLE OF SPECIES OF *ISCHNURA* AND *RHODISCHNURA* (MALES ONLY).

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1. Segments 8-10 dark-blue above, 10 with black, subquadrate, dorsal patch. Pterostigma of fore-wing with costal margin shorter than anal, and inner margin more oblique than the outer	*I. forcipata*, Morton. (N. W. India).
2. Segments 8-10 blue, 9-10 marked with black dorsally. Pterostigma of fore-wing with inner and outer margins parallel, costal and anal margins sub-equal.	
a. Segment 2 of abdomen steely metallic black ...	*I. senegalensis* (Ramb.). (Tropical old-world, except Australia).
b. Segment 2 of abdomen black not metallic	*I. elegans* (Van der L.). (Palaearctic).
B. Abdomen with orange colouring. Segments 8-9 blue, 10 black above.	
1. Dorsum of segment 2 black. Larger species (abd. *ca.* 23 mm.). Costal and anal margins of pterostigma of fore-wing sub-equal	*I. inarmata*, Calvert. (Kashmir).
2. Dorsum of segment 2 largely orange. Smaller species (abd. *ca.* 16-20 mm.). Costal margin of pterostigma of fore-wing distinctly longer than anal margin. Thorax with a pair of minute cylindrical horns anteriorly ...	*I. aurora*, Brauer. (India to Australia).
C. Abdomen orange-red and black only.	
1. Segments 7-10 black	*I. annandalei*, sp. n. (S. Shan States).
2. Segments 9-10 and distal half of 8 black	*I. rufostigma*, Selys. (Bengal, Assam).
II. No post-ocular spots. Apex of last abdominal segment widely excavated.	
D. Abdominal segments 1-4 red, 5-6 lemon yellow, 7-10 metallic black	*Rhodischnura nursei* (Morton). (N. Central India).

The females of any one species of *Ischnura* fall into one or more of three categories. *In the first place* all the species

(omitting *I. forcipata*, Morton, of which the female remains unknown) have females in which the colouring of the head and thorax resembles that of the males, to some extent at least; whilst the abdomen has its segments all marked with a longitudinal, dark, metallic band of considerable breadth on the dorsum; the ground colour being greenish-yellow or sometimes orange. It should be noted that in some species the antehumeral bands of the thorax are not enclosed on their outer side by black markings, but are only defined by a deepening of the ground-colour of the sides of the thorax. In the accompanying table these species are noted as having the antehumeral bands '*not enclosed.*' Females belonging to this first type of colouring are called '*normal*' in the table. It is worth remark that the abdominal pattern found in this type seems to be primitive; it is repeated in the case of the females of many other genera

Secondly certain species have a female form in which not only the head and thorax are coloured as in the male, but in which the abdominal markings are identical with those of the male. The females are noted in the table as '*andromorphs.*'

Lastly one species (*I. inarmata*, Calvert) has in addition to the '*normal*' female another form in which the thorax is uniformly bright orange and without colour pattern. This form I call a '*heteromorph.*' [1]

Forms enclosed within square brackets are the rarer of the two. For notes on Indian species see also Laidlaw, *Rec. Ind. Mus.*, XII, pp. 129-132 (1914).

	Andromorph.	Normal.	Heteromorph.
I. senegalensis (Ramb.)	[+]	+ antehumeral bands not enclosed.	
I. elegans (Van der L.)	[+]	+ antehumeral bands not enclosed.	
I. forcipata, Morton.	(*female not known.*)		
I. inarmata, Calvert.		+ antehumeral bands enclosed.	+
I. aurora, Brauer.	[+]	+ antehumeral bands not enclosed.	
I. rufostigma, Selys.		+ antehumeral bands enclosed.	
I. annandalei, n. sp.		+ antehumeral bands not enclosed.	
R. nursei, Morton.		+ antehumeral bands enclosed.	

[1] A very similar heteromorph occurs in the case of the Australian species *I. pruinosa.*

Ischnura aurora (Brauer).

Micronympha aurora, Kirby, *Cat. Odonata*, p. 143 (1890); *Journ. Linn. Soc. London, Zool.*, XXIV, p. 564 (1893).
Ischnura aurora, Ris in *Nova Caledonia, Zool.*, II, 4, p. 67 (1915).

5 ♂♂, 1 ♀, Nagpur, C.P., 1,000 ft., 15-xii-1915 (*E. D'Abreu*). 2890/H.1.
7 ♂♂, 2 ♀♀, Castle Rock, N. Kanara District, Oct. 1916 (*S. Kemp*). 4377/H.1.

In these spirit specimens the brilliant colouring is well preserved.

To Selys' account of the male it may be added that the anterior margin of the prothorax is blue, as are also the sides of segment 10 of the abdomen. In all the males segment 8 of the abdomen is entirely blue, save for the black basal mark.

Ris (*loc. cit.*) has recorded the species from New Caledonia.

Ischnura inarmata, Calvert.

Ischnura inarmata, Calvert, *Proc. Acad. Nat. Sci. Philadelphia*, 1898, pp. 147, 148, text-figs. 1–2; Laidlaw, *Rec. Ind. Mus.*, XII, pp. 131-132, 1916.

8 ♂♂, 6 ♀♀ *normal*; 8 ♀♀ *heteromorphic*. Jhelum Valley, Kashmir, c. 5,000 ft. (*H. T. Pease*).

This very handsome insect is common in Kashmir in the Jhelum Valley at an elevation of about 5,000 ft. above sea-level. I have no doubt but that the orange-coloured females first noted by Morton belong to it (*Trans. Ent. Soc. Lond.*, 1907, p. 307).

Ischnura elegans has been recorded from Kashmir by Morton (*loc. cit.*). It is of course a common Palaearctic species.

Ischnura rufostigma, Selys.

Micronympha rufostigma, Kirby, *Cat. Odonata*, p. 143 (1890).
Ischnura rufostigma, Laidlaw, *Rec. Ind. Mus.*, VIII, p. 314, pl. xvi, fig. 5 (1914), and XII, p. 130 (1916).

In addition to the Abor Expedition specimens I have examined one female from Bengal.

The males differ from that described by de Selys in having the whole of the dorsum of segment 8 black, not merely the distal half. They differ from the closely allied species described below (*I. annandalei*) in having segments 2 and 7 entirely orange.

Ischnura annandalei, sp. nov.

7 ♂♂, 4 ♀♀, Inlé Lake, Shan States (*N. Annandale*).

ADULT MALE.

Head.—Upper lip yellow with black lines at base. Anteclypeus yellow. Post clypeus black. Genae and frons as far as base of antennae yellow, including the basal joint of the antennae. The rest of the dorsal surface of the head black, with a very small pair of greenish-blue post-ocular spots.

Prothorax.—Dorsal surface black, with a narrow yellow collar anteriorly; ventral and lateral surfaces yellow.

Thorax.—Dorsally black, with narrow green-blue antehumeral bands. Sides green-blue with a small black mark at the upper end of the second lateral suture.

Abdomen.—Segments 1–2 pale blue green, but 2 changing to orange at its apex. On the dorsum of 1 is a square bronze-black mark; on the dorsum of 2 is a bronze-black mark shaped in most of the specimens like a wine-glass with a stout short stem, the "foot" of the glass resting on the apex of the segment, the "brim" on the base. In two of the males however the "bowl" of the glass is larger and the "stem" practically absent.

Segments 3–6 are bright orange, each with a fine black terminal ring; 7–10 are jet-black. Apical tubercle of 10 well marked, ending in a pair of small pointed processes directed backwards, and a little downwards.

Anal appendages yellowish-brown; the upper pair very short, directed downwards and each ending in two minute digitations of which the inner is the larger. Lower pair longer, tipped with black at their apices, stout at the base, each rapidly tapering to a fine point which is incurved, so that together they resemble the horns of a bullock.

The appendages bear a very close similarity to those of *L. rufostigma*, Selys. They differ chiefly in that in the latter species the upper pair are relatively a little larger, the digitations more equal and a little more divaricate, whilst the lower pair are not so sharply incurved.

Legs yellowish-white, distal ends of femora marked with black; spines and tarsal claws black.

FEMALE.

Head much as in the male, but ground colour duller; the post-ocular spots obsolete, at least in the adult; the occiput, over which in the male the black of the vertex extends, is in the female yellowish-brown.

Prothorax as in the male.

Thorax, ground colour yellowish-brown; dorsum with a broad bronze-black, medium band, succeeded by pale whitish-yellow antehumeral bands. These are not enclosed by lateral black bands, as in the male, but lie in contact with an ill-defined red-brown humeral area which fades gradually into the paler brownish-yellow lateral colouring. The humeral suture itself is marked with a very fine black line.

Abdomen orange-brown; each segment with a broad, dorsal band of bronze-black running longitudinally.

Legs as in the male.

It is perhaps more correct to say that the post-ocular spots in the female are not enclosed behind by black colour than to speak of them as obsolete.

I. rufostigma and *I. annandalei* are obviously very closely allied to each other, and form a small section of the genus characterized by the orange abdomen of the males and the complete absence of any blue marking.

Types, ♂ ♀, will be returned to the Indian Museum.

Genus **Rhodischnura**, nov.

Venation that characteristic of *Ischnura*. Abdomen of male shorter and stouter relative to the size of the insect than that of a typical *Ischnura*. Adult male without post-ocular spots; apex of tenth abdominal segment of male widely excavated dorsally, the excavation bounded on either side by a small tubercle. Type,—*Rhodischnura nursei*, Morton.

The single species contained in this new genus is so distinct from other *Ischnuras* that, admitting the disadvantages of defining a genus on sex characters, I feel justified in emphasizing this distinctness by the erection of a new genus for the species.

The male must be a strikingly beautiful insect, with its abdomen coloured rich red, lemon yellow and violet black.

The specimens I have seen were taken by Dr. Hankin at Agra.

Rhodischnura nursei (Morton).

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

FEMALE.

Head.—Upper lip white, as is the ante-clypeus. Post-clypeus bronze black. Frons white, with a slight reddish tinge, to beyond the level of the base of the antennae; the three basal joints of these marked with brownish-white in front. A pair of small blue post-ocular spots project into the black transverse band running across the vertex, but are not enclosed posteriorly by it. Occiput brownish white.

Prothorax bronze black, anterior lobe and sides of middle lobe white; posterior prothoracic margin simple.

Thorax.—Dorsum shining black, with broad yellowish-white antehumeral bands; sides and under surface greenish-white.

Abdomen, ground-colour reddish-white, with a broad metallic black band on the dorsum of each segment. Segments 3–7 with a very narrow basal ring of white, 8 with an apical ring but no basal ring. In 10 the black colour does not reach the apex of the segment.

Legs white, with a black mark on the dorsal surface of each femur.

Venation, pterostigmata of fore-wings appreciably longer than those of the hind-wings. Veins reddish in colour.

I have been puzzled by a female specimen from Madras taken by Dr. Annandale on the Cooum River. The specimen is identical in every respect with that described above save that the arculus

lies distinctly beyond the level of the second antenodal nerve, the pterostigmata are a trifle more oblique and the ground-colour has rather a bluish tinge. Were it not for the position of the arculus I would not hesitate to regard the specimen as an example of *R. nursei*. Some weight, however, must be allowed to the position of the arculus and for the moment the position of the specimen must remain doubtful.

Genus Agriocnemis.

No fewer than six species of this genus occur within the limits of the Indian Empire, and four of them have not been recognized outside its boundaries; the other two species are widely spread.

Members of the genus are the smallest of existing dragonflies, rivalled in India in this respect by *Enallagma* (?) *parvum*, Selys, only. As in the case of *Ischnura* some species have dimorphic females. The genus is divisible into groups most easily characterized, unfortunately, by sexual characters of the males.

A. Upper lip metallic in colour; females dimorphic, upper pair of anal appendages of male longer than lower pair	*A. pygmaea* (Ramb.).
Upper pair of anal appendages of male shorter than lower pair	*A. incisa*, Selys.
B. Upper lip not metallic.	
1. Upper anal appendages of male provided with a downwardly directed spur.[1]	
Females not dimorphic?	
Legs white, segments 8–10 of abdomen white	*A. lacteola*, Selys.
Legs marked with black, segments 8–10 pale blue	*A. pieris*, sp. nov.
(Formosan species)	(*A. selenion*, Ris.)
Females unknown	*A. nana*, Laidlaw.
2. Upper anal appendage of male not provided with spur	*A. splendidissima*, sp. nov.

As in *Ischnura* the pterostigmata of the fore-wing of the male differ in colour from those of the hind-wing; but in this case they are similar in shape.

Agriocnemis lacteola, Selys.

A. lacteola, Kirby, *Cat. Odonata*, p. 158 (1890); Laidlaw, *Rec. Ind. Mus.*, VIII, pp. 347, 348, (1914).

2 ♂♂, Kierpur, Purneah district, Bihar, 7-ix-15 (*C. Paiva*). 860/H.1.

These two specimens are not quite identical with the type as described by de Selys.

In the first place the post-ocular spots are distinctly joined to the transverse lines on the occiput. Secondly there is no white spot on the prothorax; and lastly the femora are entirely without black bands (see fig.).

[1] See figure of *A. nana*, *Rec. Ind. Mus.*, VIII, pl. xvi, fig. 10.

The general agreement is, however, so close that I have little hesitation in referring them to the Selysian species.

Like the species described next below, *A. lacteola* has the upper anal appendages, which are each provided with a strongly developed ventral spur, directed downwards, and having an acute apex.

The ground colour of the body and abdomen is bluish-white, there is no differentiation of the ground colour of the terminal segments of the abdomen such as characterizes *A. pieris.*

The specimens are identical specifically with those taken on the Abor Expedition. The type of *A. lacteola*, Selys, is from Bengal. I have no doubt but that the present specimens are conspecific with Selys' type.

Agriocnemis pieris, sp. nov.

5 ♂♂, 2 ♀♀, Talewadi, Castle Rock, N. Kanara District, Bombay, Oct. 1916 (*S. Kemp*). 4387/H.1.

MALE.

Head.—Lower lip white; upper lip, ante- and post-clypeus, genae and frons pale blue, with a fine black line at the base of the post-clypeus.

Vertex and occiput velvety black, with pale blue post-ocular marks, linear in shape; connected by a narrow creamy-white line across the occiput.

Eyes.—Upper third black; lower two-thirds white. Antennae, basal joint pale blue; the rest black.

Prothorax, anterior lobe white, middle and posterior lobes black; a small white spot on either side of the middle lobe in one specimen; the posterior lobe with a median, rectangular, slightly bifid projection, much as in *A. lacteola*, Selys, edged with white. Under surface white.

Thorax, dorsum velvety black as far as first lateral suture, with narrow pale yellow antehumeral bands; sides and under surfaces white, with a fine black line at the upper end of the second lateral suture.

Abdomen.—Segments 1–7 white, marked with black as follows:—

(1) With mark covering the whole dorsum of the segment.

(2) With longitudinal black band expanding basally and apically to form terminal black rings, and widened in rectangular fashion just behind the middle of the segment.

(3–6) With black basal and apical rings, and with an arrow-like longitudinal mark, the head of the arrow directed forwards. On segment 5 the "shaft" of the arrow is much reduced.

(7) Is without the apical ring and the head of the arrow mark is reduced whilst the distal half of the segment has a bluish tinge.

Segments 8–10 are pale blue.

Anal appendages.—Upper pair pale blue, as long as segment 10, somewhat finger-shaped a little incurved. Each carries a downwardly directed projection, not visible when seen in profile in the natural position. The projection ends in a sharp point. Lower pair minute, conical, not visible in profile.

Legs white, posterior surfaces of femora with longitudinal black bands.

Pterostigmata, fore-wings gray white, hinder wings darker. Post-nodal costal cross veins 5 or 6.

FEMALE.

Head, prothorax and *thorax* much as in the male, but the ground colour is distinctly greenish-white.

Abdomen pale blue, with a broad longitudinal black band on the dorsum of each segment, widening a little before the apex of the segment, then narrowing again to meet a black apical ring on each of segments 3–7. Segments 8–10 black above. The blue of the abdomen is of a deeper shade than in the male.

Legs as in the male but the black on the femora is darker.

Anal appendages blue.

The males show a certain amount of variation in the extent of the black markings on segments 6 and 7 of the abdomen. They are readily distinguished from the males of the species I have identified as *lacteola*, Selys, by the white abdomen tipped with pale blue on segments 8 and 10, and by the extensive black marks on the legs.

Ris has lately described a species *A. selenion* from Formosa. Unfortunately his account published in Berlin (*Supplementa Entomologica*, Berlin, No. 5) is not available to me. I have been able to see a copy in the Natural History Museum for a short time. To judge from the figure of the anal appendages it must be allied to *A. lacteola*.

Lastly, *A. nana*, Laidlaw, from the Kachin Hills has again very similar appendages although the colouring is different and segments 8 and 10 are black.

It should be noted that the upper anal appendages of this group are extremely like those found in the genus *Argiocnemis*. *A. lacteola* may be taken as the type of a group within the genus which includes *A. pieris*, and perhaps *A. nana* and *A. selenion* as well. This group may ultimately prove worth generic separation from such species as *A. pygmaea* and *A. incisa*.

A. pieris seems to be a western species and *A. lacteola* an eastern, so far as India is concerned.

Agriocnemis splendidissima, sp. nov.

2 ♂♂, Chalakudi, Cochin State, 14-30-ix-14 (*F. H. Gravely*). 8250/20.
2 ♀♀, 2 ♂♂, Talewadi, nr. Castle Rock, N. Kanara dist., Bombay (*S. Kemp*). 4378/H.1. (*Male and female types*).

Length of abdomen, ♂ 17 mm., ♀ 16 mm.; of hinder wing ♂ 9 mm., ♀ 9 mm.

MALE.

Head.—Lower lip white, upper lip pale blue; rest of head black, including the antennae, but a pair of circular post-ocular spots are blue, and inside these on either side a small cuneiform mark.

Prothorax black, the posterior lobe with a rectangular projection somewhat similar to that found in *A. lacteola.*

Thorax.—Dorsum black to level of first lateral suture, with a very narrow pair of blue ante-humeral bands. Sides rich blue with a broad black band somewhat irregular in outline on the second lateral suture. Under surface black.

Abdomen.—Segments 1, 2 black marked with blue laterally. Segments 3–7 blue marked with black. Segments 8–10 black; 3–7 have each a black dorsal band occupying the whole length of the segment; this band is pointed apically. In each of these segments, moreover, the distal third of the band is expanded over the sides of the segment and encloses a lateral blue mark.

Anal appendages.—Upper pair black, margined with white, rather longer than segment 10, curved inwards to meet at their free extremities, somewhat hollowed out internally and hooked downwards at the lip.

Legs black, posterior surfaces of tibiae with white.

FEMALE.

The specimens that I take to be the female of this species have the upper lip, the post- and ante-clypeus of an olive-brown colour, the frons and occiput black except for a comma-shaped blue post-ocular spot and a fine transverse creamy white line across the occiput, uniting the spots.

Prothorax black above, yellowish-white below.

Dorsum of *thorax* black, with a pair of fine yellow ante-humeral bands. Sides greenish-white, with a black line along the second lateral suture.

Abdomen, ground colour bluish-white. Each of the segments has a longitudinal black mark covering the dorsum of the segment. On each of segments 2–7 this mark is narrowed basally and widened apically, narrowing again immediately before the apex when it joins a narrow black apical ring. Segments 2, 6 have a transverse gray-black mark extending downwards and forwards from the widest point of the expansion of the dorsal black band antero laterally.

Legs black, femora with a yellowish-white anterior band, tibiae with posterior band of the same colour.

The second male from Talewadi is immature and imperfect. The ground colour is a dull greenish-white.

The males from Chalakudi are evidently recently emerged. The anal appendages are exactly similar to those of the adult male. The general colour is a buff white, no pattern developed. At first sight they are very similar to young examples of *A. lacteola*, with which I originally confused them.

This very striking new species seems at present to stand rather remote from its congeners.

It differs from the members of the *lacteola* group in the characters of the anal appendages, the upper pair being without a ventral spur so far as I can determine, whilst it resembles them in having a non-metallic upper lip.

For the present it may well be allowed to stand as the sole representative of a distinct group within the genus.

Types ♂ ♀ of *A. pieris* and of *A. splendidissima*, n. spp., will be returned to the Indian Museum.

Lastly one may remark that whilst *A. pygmaea* (Ramb.) is well represented in the Museum collection by specimens from Northern and Peninsular India, *A. incisa*, Selys, is not included from any locality west of Assam; the collection has in addition to a specimen taken on the Abor Expedition, one from Rangoon and one from the Inle Lake, S. Shan States (7215/H.1). All three are males. For synonymy of *A. pygmaea* see Ris' paper referred to in the *Supplementa Entomologica*, No. V.

Genus **Argiocnemis**.

See Ris, *Abhand. Senckenb. Naturf. Gesellsch.*, Bd. XXXIV, p. 517 (1913).

The upper anal appendages of the male, at least in the case of *Argiocnemis rubescens*, Selys, bears a very strong resemblance to that of *A. lacteola*, Selys, and its immediate allies, as do the appendages of the form I have called *A. obscura* from Upper Assam. The spur is not visible without a partial removal of the appendages. I have not been able to re-examine the type of *A. aborense*, Mihi, to determine whether the spur is present in it also.

Ris (*loc. cit.*) has come to the conclusion, suggested by Selys, that the following names are all synonyms of *A. rubescens*, Selys, *A. rubiola*, Selys and var. *intermedea*, Selys, race *sumatrana*, Krüger, *A. lunulata*, Selys, *A. nigricans*, Selys.

The position of *A. obscura*, Laidlaw (*Rec. Ind. Mus.*, VIII, p. 346, 1914) is uncertain. *A. aborense*, Laidlaw (*loc. cit.*, p. 347) is certainly distinct.

I have not seen any specimens belonging to the genus from Peninsular India, and have not enough material to determine satisfactorily the status of specimens that I have for examination. But I am inclined to believe that one or more of these specimens from the Malay Peninsula are specifically distinct from *A. rubescens*, Selys.

A minor character which I have noticed in all specimens of *Argiocnemis* that I have examined is perhaps worth note. It is that the dorsum of the thorax is almost entirely devoid of the hairs which are so numerous in some genera.

Genus **Enallagma.**

Enallagma cyathigerum, Charp.

Enallagma cyathigerum, Kirby, *Cat. Odonata*, p. 145 (1890); Morton, *Trans. Ent. Soc. London*, 1907, p. 307.

Many specimens ♂ and ♀ from the Jhelum Valley, Kashmir, 5,000 ft.

Also recorded by Morton (*loc. cit.*) from Kashmir.

This species and *Ischnura elegans*, Van der Linden, are the only British Agrionids known to occur within the limits of the Indian Empire.

Of the other Indian species, *E. malayanum*, Selys, belongs to a section of the genus represented in Tropical Africa by some five or six allied species; *E. maldivense*, Laidlaw, belongs to the same group. The last species *Enallagma? parvum*, Selys, is an isolated species with no near relative.

Enallagma malayanum, Selys.

Enallagma? malayanum, Kirby, *Cat. Odonata*, p. 147 (1890).
Enallagma malayanum, Ris in Schultze's *Forschungsreise im west u. zentral Südafrika* 1903–1905: *Denkschr. der medizin.-naturwiss. Gesellsch.*, Bd. XII, 1908, pp. 310–313.

2 ♂♂, 1 ♀, Nagpur, C.P., 1,000 ft., Sept. 1916 (*E. D'Abreu*).

The female of this species has not yet been described. The single specimens of this sex taken by Mr. D'Abreu has a large, ventral, apical, spine on segment 8 of the abdomen. The colour pattern of the head, prothorax and thorax is as in the male, but the ground colour is yellowish-green instead of blue. The abdomen also is yellowish-green with a broad black, dorsal band on segments 1–9.

Enallagma maldivense (?), Laidlaw.

Enallagma? maldivense, Laidlaw, in "*The Fauna and Geography of the Maldive and Laccadive Archipelagoes*," vol. 1, pt 2, p. 221.

I had an opportunity some time ago of re-examining the five specimens of this form. Unfortunately all are so dilapidated that they are useless for critical purposes. I can say, however, that they are true *Enallagmas*, considerably larger than *E. malayanum*, Selys, in size agreeing with *E. glaucum*, Burm., an African form, widely spread and found in Réunion. The measurements are:—

E. maldivense ♂, abdomen 24 mm., hind wing 18 mm.
E. glaucum ♂, abdomen 22 mm., hind-wing 17 mm. (Cape specimens, vide Dr. Ris.)

The Maldive Islands' specimens do not agree precisely in colouring with *E. glaucum*, Burm. More material is required to settle the position of the insect. (See Ris in Schultze's *Forschungsreise im west u. zentral Südafrika*, 1903-1905: *Denkschr. der medizin.-naturwiss. Gesellsch.*, Bd. XIII, 1908, fig. 310–314.)

Enallagma ? parvum, Selys.

Enallagma ? parvum, Kirby, *Cat. Odonata*, p. 147 (1890); Morton, *Trans. Ent. Soc. London*, 1907, p. 307, pl. xxiv, figs. 13, 14.
Ischnura immsi, Laidlaw, *Entomologist*, 1913, pp. 236–237, text-fig.

1 ♂, Darjiling, alt. *ca.* 7,000 ft., vi-vii-16 (*E. Brunetti*).

Recorded by Morton from Deesa, Gujerat; and by Selys from 'India.' The type specimen of *Ischnura immsi*, from Sonder Bhandara in the Central Provinces, is in the British Museum.

In size this tiny species equals the small forms of *Agriocnemis*. It is probably deserving of generic separation from the true *Enallagmas*. The female has not been described and I have not seen an example.

Genus **Aciagrion** (Selys).

A character which is constant for all the species of the genus that I have been able to examine but one which I have not seen noted, is that the pterostigma of the fore-wing is slightly though distinctly larger than that of the hinder-wing, in both sexes, its outer margin being at the same time rather more oblique.

Aciagrion is, I think, very closely related to *Enallagma* and may be regarded as a specialized off-shoot from that genus, to some extent replacing it in the Oriental region. It is not, so far as I can judge, allied to the *Amphicnemis-Teinobasis* series even nearly so.

Aciagrion olympicum, sp. nov.

(Text-fig. 1.)

4 ♂♂, 2 ♀♀, Sureil, Mangpu, Darjiling district, 5,000 ft., iv-v-17 (*S. W. Kemp*).

Length of abdomen, ♂ 34 mm., ♀ 32 mm.: of hind-wing, ♂ 22 mm., ♀ 22 mm.

13 post-nodal nerves on fore-wing, pterostigma whitish-brown, darker in the centre.

This fine new species is, so far as I know, the largest of the genus. It has a very remarkable colouration, a soft brown-grey ground with brown black markings. It thus resembles rather *A. pallidum*, Selys, than *A. hisopa*, Selys, in the latter species the abdomen being conspicuously marked with blue.

Male.

Head.—Upper lip pale brown, with a fine black line at its base. Ante-clypeus brownish-white with a black line running transversely across its summit. Post-clypeus and frons brownish-white to a level just beyond the base of the antennae. Vertex and occiput rich brownish-black; with a pair of large oval post-ocular spots of whitish-brown, united across the occiput by a narrow band of the same colour. Posterior surface of head brownish-white.

Eyes.—Upper pole gray-brown, separated by a darker belt

from a brownish-white zone. This again is separated by a dark belt from a gray-brown equatorial zone, the lower part of the eye being brownish-white deepening in hue towards the ventral pole.

Prothorax.—Dorsal surface rich brown-black, margined in front and at the sides with gray-brown; under surface brownish-white.

Thorax.—Dorsally brown-black with broad gray antehumeral bands, sides gray, with a small black mark at the top of the second lateral suture. The mid-dorsal carina is also lined with gray-brown, ventral surfaces grayish-white.

Abdomen.—Segments 1–2 gray above, brownish-white below. The second segment has a very fine longitudinal line mid-dorsally, which is black; on the apical half of the segment the line widens suddenly to form a small, rather pentagonal mark of the same colour, which does not touch the apex of the segment. The

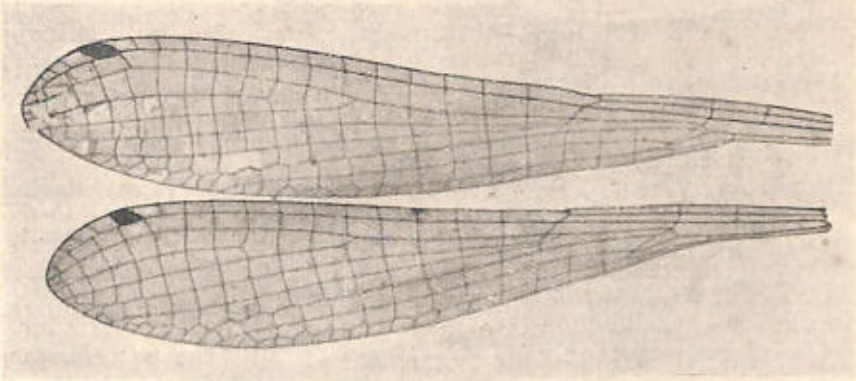


FIG. 1.—*Aciagrion olympicum*, sp. nov.

black line and mark are outlined by a very fine margin of whitish-brown colour. Segments 3–7 are brownish-white below, marked above with a broad, brownish-black band longitudinally. This band widens considerably at the apical end of each segment so as to form a dark ring round the apex of the segment, just incomplete mid-ventrally. The extreme base of each of the segments is surrounded by a very narrow white ring. Segments 8–10 blue-grey above, pale beneath. The apex of segment 10 dorsally is deeply emarginate.

Legs.—Pale brown, the posterior surfaces of the femora and anterior pair of tibiae black, as are also basal and apical marks on the posterior tibiae, the tarsal segment and the cilia.

Anal appendages.—Gray-brown tipped with black. Seen in profile the upper part is about two-thirds the length of the tenth segment, nearly square, the distal side emarginate. Lower pair shorter, conical, tapering rapidly, and directed upwards at the apex.

The appendages in general bear a close resemblance to those of *A. pallidum* (Selys). (See *Rec. Ind. Mus.*, VIII, pl. xvi, fig. 4.)

FEMALE.

Colouring as in the male, except for the following:—

Dorsum of segment 1 of abdomen black.

Segment 2 has a broad black dorsal band running longitudinally the whole length of the segment widening a short distance before the apex of the segment, and narrowing to a point at the apex.

Segment 8 has a black dorsal mark shaped like the head of a spear, the point directed forwards, not touching either extremity of the segment which, like 9–10, is otherwise gray.

Segment 9 has a basal black mark, bifid posteriorly on the dorsum, occupying nearly half the length of the segment.

Types ♂ ♀ will be returned to the Indian Museum.

Aciagrion pallidum (Selys).

Aciagrion pallidum, Selys, *Ann. Mus. Civ. Genova*, X (xxx), 1891, pp. 80 and 81; Laidlaw, *Rec. Ind. Mus.*, VIII, p. 334, pl. xvi, fig. 4.

15 ♂♂, 10 ♀♀, Nurbong, Darjiling dist., bottom of Mahanaddi Valley, March 1914 (*H. Stevens*).
2 ♀♀, Nagpur, C.P., 1,000 ft., Dec. 1915 (*E. D'Abreu*). 2801/H.1.
1 ♀, Mormugao, Portuguese India, Sept. 1916 (*S. Kemp*). 4369/H.1.
3 ♂♂, 2 ♀♀, Talewadi, Castle Rock, N. Kanara District, Oct. 1916 (*S. Kemp*). 4378/H.1.

To Selys' account it may be added that in the adult female specimens the abdomen is of a dull orange brown colour above; black marks occur only on segments 1–2 and the extreme base of 3, whilst segments 1–6 have a very fine black terminal ring and 7–10 are browner and darker than their predecessors.

Aciagrion hisopa (Selys) ? race occidentalis, nov.

Pseudagrion? hisopa, Kirby, *Cat. Odonata*, p. 153 (1890).
Aciagrion hisopa, Selys, *Ann. Mus. Civ. Genova*, X. (xxx), 1891, p. 82.

1 ♂, Castle Rock, N. Kanara Dist., Bombay, Oct. 1916 (*S. W. Kemp*).
2 ♀♀, Parambikulam, Cochin State, S. India (*F. H. Gravely*).
1 ♂, 1 ♀, Trichur, Cochin State (*F. H. Gravely*).

These specimens cannot I think be separated specifically from examples of *A hisopa* from Burma, as described by de Selys.

The two males that I have seen are, however, characterized by having a black triangle on the dorsum of the eighth abdominal segment, with its apex directed towards the hinder end of the segment, and extending for nearly the full length of the segment. This mark does not occur so far as I know on Burmese specimens and if constant is of enough importance to separate two races.

Aciagrion tillyardi, sp. nov.

3 ♂♂, 1 ♀, Cheerapunji, Assam.

Length of hind-wing ♂ 17·5 mm., ♀ 17·5 mm.; of abdomen, ♂ 24·5 mm., ♀ 22·5 mm.

MALE.

Head.—Lower surfaces yellowish-white. Upper lip dark brown, fading to black at the base. Ante- and post-clypeus black. Frons gray-blue to a point just above the base of antennae. First joint of antennae gray-blue, the rest black. The remainder of the anterior and upper surface of the head black, with a linear gray-blue post-ocular mark on either side, joined by a fine, transverse line of the same colour across the occiput. Posterior surface black. Upper pole of eyes black, the remainder olive-gray, with indications of a narrow, dark zone a little distance below the black pole.

Prothorax.—Metallic black above, under surfaces yellowish-white.

Thorax.—Dorsal surface metallic black, with a pair of narrow gray-blue ante-humeral bands; sides gray-olive, paler beneath.

Abdomen.—Metallic black above, greenish-white below; a very fine apical ring of greenish-white, incomplete in the mid-dorsal line, on segments 4–6. Segments 9–10 gray-blue, 10 metallic black; its dorsal posterior border emarginate.

Anal appendages.—Black; upper pair about one half the length of the 10th segment, their upper and lower margins parallel and equal in length, the posterior margin slightly concave; lower pair much shorter, conical and directed upwards.

Legs.—Grayish-white. The posterior surfaces of the femora, the articulations and spines black.

Venation.—Pterostigmata brownish-black; on the fore-wing covering one cell, on the hinder wing about half a cell. Twelve antenodal costal nerves.

FEMALE.

There is a distinct enlargement of the abdomen from segments 7–10. Colouring as in the male with the following exceptions:—(i) the upper lip is of a paler brown and (ii) segments 8 and 9, like the rest of the abdominal segments, are black above.

The posterior margin of the prothorax is in both sexes regularly convex.

Types ♂ and ♀ will be returned to the Indian Museum.

Genus **Ceriagrion**, Selys.

Until about five years ago only a small number of species were recognized as belonging to this genus. Within that period, however, a considerable number of new species have been dis-

covered or discriminated. The males of the genus, so far as Indian species are concerned, are better known and more easily characterized than females.

In addition to slight venational differences, which are noted below, the males have as distinguishing characters colour and the structure of the anal appendages. By the employment of these characters it is possible to subdivide the genus with groups which appear fairly natural.

In the following table I have given a list of the males of all species that I know of as occurring within the limits of the Indian Empire:—

A. Ab rises at level of Ac.

I. Colouring more or less uniform, without any marked pattern on thorax and abdomen. Lower anal appendages projecting backward about as far as upper pair and in general directed upwards.

a. Upper pair cylindrical or digitiform, in some species a little decumbent at the apex. Excision of posterior dorsal margin of segment 10 of abdomen moderately wide, about as wide as distance between upper appendages.

1. Large species, or length of abdomen in ♂ 38 mm; colour of abdomen rich blue, wings slightly tinged with yellow ... ... *C. coeruleum*, sp. nov.

2. Large species, length of abdomen in ♂ about 38 mm; colour of abdomen olive-brown, wings not tinged with colour. Upper appendages nearly as long as segment 10, with an inferior hook-like tooth at the extremity. Lower appendages not so long as but well separated from upper appendages, directed as much backwards as upwards ... *C. olivaceum*, Laidlaw.

3. Thorax olive-brown, abdomen scarlet-red; lower appendages longer than upper pair, incurved at the apex; abdomen about 32 mm. in length ... *C. erubescens*, Selys.

4. Small species, length of abdomen 26-28 mm.; colour of abdomen orange-yellow. Lower anal appendages larger than upper, directed upwards and tapering to their apices; excision of segment 10 small and shallow *C. rubiae*, Laidlaw.

b. Upper anal appendages, seen from above, inflated, nearly touching each other, with small internal tooth; excision of segment 10 very wide, Colour of abdomen lemon-yellow ... ... *C. coromandelianum* (Fabr.).

II. ♂ abdomen with strongly contrasted colour pattern. Lower anal appendages at least half as long again as upper pair; abdomen bright red, segments 4–7 black ... ... *C. cermorubellum* (Brauer).

B. Ab rises before level of Ac. (See note under *C. melanurum*.) ♂ abdomen white, segments 7–10 marked with black.

I. Upper anal appendages nearly quadrate, not half as long as segment 10. Lower pair stout, directed upwards ... ... *C. melanurum*, Selys.

II. Upper anal appendages elongate, more than half as long as segment 10; lower pair tapering, directed backwards ... ... *C. fallax*, Ris.

(See also *Rec. Ind. Mus.*, XII, pp. 132–135, 1916).

Ceriagrion coeruleum, sp. nov.

1 ♂, Pashok, Darjiling distr., E. Himalayas, 2,000 ft., May–June, 1916 (*F. H. Gravely*). 1414/H.1.

Length of hind-wing 27 mm., of abdomen 38 mm.

Ab rising from Ac. Pterostigmata dull brown, extreme base of wings tinged with saffron, 12 antenodals on the forewing.

The colour may be described as uniformly delicate blue on the dorsal surfaces, fading to a yellowish-white ventrally.

Segments 9 and 10 of the abdomen are marked with brownish-black; 9 has a rather nebulous cruciform mark of that colour and the whole of the dorsum of 10 is so coloured.

The legs are yellowish-white with black spines.

The superior anal appendages are brownish-black, the lower pair yellowish-white, with black extremities.

The apical margin of the tergum of the tenth abdominal segment has an angular excision, about one-third of the length of the segment in depth.

The anal appendages are very similar to those of *C. olivaceum*, the upper pair are about two-thirds as long as segment 10, directed horizontally backwards, truncate, with a downwardly projecting point at the apex. The lower pair are a little longer; relatively slightly stouter than in *C. olivaceum*.

♀ unknown.

This fine species is chiefly remarkable for its colouring, which is strikingly different from that of other unicolorous members of the genus. It is, I think, undoubtedly related to *C. olivaceum* more closely than to other species.

C. coeruleum is further of interest as it is, so far as I know, the only Asiatic species in which the wings are tinged with colour; in addition to the basal saffron the whole wing has a faint yellow hue.

Mr. H. Campion has very kindly examined the unique example of this species and has given me his opinion on it.

He suggests that the transverse ridge across the frons is not so well defined as in typical *Ceriagrion*, and thinks that this and the colouring are to be regarded as reasons for not referring this species to *Ceriagrion*.

He suggests a possible relationship to an African genus *Thermagrion* of Förster, but adds that as the female of the present

species is unknown and as *Thermagrion* is known only from a female specimen, more information is necessary.

He admits the close similarity between the anal appendages of *C. coeruleum* and *C. olivaceum*.

Personally, I think that the frontal ridge of *C. coeruleum* is at any rate sufficiently marked to suggest that we have to deal with a true *Ceriagrion*. As to the colour it seems to me that the difference between *C. coeruleum* and *C. olivaceum* is less than that between the latter and a crimson-bodied species, such as for example *C. rubescens*, Selys.

The specimen will be returned to the Indian Museum.

Ceriagrion coromandelianum (Fabr.).

(Text-fig. 2.)

Ceriagrion coromandelianum, Kirby, *Cat. Odonata*, p. 134 (1890); Laidlaw, *Rec. Ind. Mus.*, XII, pp. 132-135, 1916 (larva). See also Ris, *Abh. Senckenb. Ges.* XXXIV, p. 520 (1913).

Spirit specimens, showing the colouring to all appearances as brilliantly as in the living insect, enable me to give the following account of the male.

Head.—Upper lip, post- and ante-clypeus lemon-yellow, frons gray-yellow up to level of anterior ocellus, and extending obliquely upwards and inwards from the eyes to enclose the posterior ocelli. Vertex and occiput bright golden-brown. This colour is delimited from the eyes and from the gray-yellow of the frons by exceedingly fine black lines. The eyes are uniformly pale olive-green.

FIG. 2.—*Ceriagrion coromandelianum* (Fabr.). Apex of abdomen from above.

The *thorax* and *prothorax* are uniformly olive-green of a less intense tone than the eyes. On the dorsum it takes on a slightly brown tinge; below it fades to greenish-white.

Abdomen uniformly lemon-yellow, as are the legs; the latter have black spines.

Anal appendages lemon-yellow, darker towards their apices and tipped with black.

Ceriagrion rubiae, Laidlaw.

(Text-fig. 3.)

Ceriagrion rubiae, Laidlaw, *Rec. Ind. Mus.*, XII, pp. 132-133 (1916).

1 ♂, Castle Rock, Talewadi, N. Kanara District, Bombay (*S. Kemp*). 4379/H.1.

The type specimen was taken at Chalakudi in Cochin State. I have deposited a paratype in the British Museum, which possesses a splendid set of this genus.

In my account of the type I stated that the apices of the lower pair of anal appendages lie internally to the upper pair. In the present specimen they lie immediately below them.

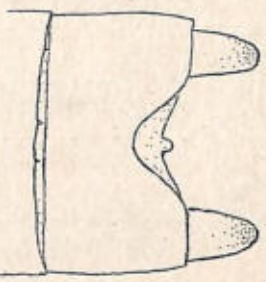


FIG. 3.—*Ceriagrion rubiae*, Laidlaw. Apex of abdomen.

This species, the smallest Indian representative of the genus, is probably a local development of the stock from which *C. erubescens*, Selys, is derived. I have seen no Indian examples of the latter, but Selys (*Odonates de Birmanie*, p. 517, 1891) has recorded the occurrence of a red-bodied form from Burma, which he regards as a race of *C. coromandelianum*, under the name *C. erubescens*, Selys, now regarded as a distinct species. (See Ris, *Abh. Senckenb. Ges.*, XXXIV, pp. 520–522, pl. xxiii, figs. 13–14; 1913).

Ceriagrion fallax, Ris.

Ceriagrion fallax, Ris, *Entomol. Mitteil.*, III, 2, pp. 47–48, fig. 2.
Ceriagrion melanurum, Selys, *Ann. Mus. Civ. Genova*, X (xxx), p. 520 (1891); Ris, *Abh. Senckenb. Ges.*, XXXIV, p. 520.

Until distinguished by Dr. Ris this species was confused with the following (*C. melanurum*, Selys).

Selys' record of *C. melanurum* from Burma (*loc. cit.*) appears, from his note on the anal appendages, to refer to this species.

Ceriagrion melanurum, Selys (*pars*).

Ceriagrion melanurum, Kirby, *Cat. Odonata*, p. 154, 1890; Ris, *Entomol. Mitteil.*, Bd III, 2, p. 44-47, fig. 1 (1914); Maclachlan, *Ann. Mag. Nat. Hist.* (6), XVII, p. 374 (1896); Kruger, *Stettin. Entom. Zeit.*, 1898, p. 120.

2 ♂♂, 2 ♀♀, Foot of Elephant Hill, near Yawngwhe, S. Shan States, 6-iii-17 (*F. H. Gravely*). 7166/H.1.

These four specimens are all very immature, and of uniform pale gray-brown colour. For some time I was unable to determine their proper position in the genus. Mr. H. Campion has very kindly examined them for me, and suggests that they are referable to this species They are, however, scarcely typical. The point of origin of Ab is scarcely different from that occurring in *C. coromandelianum* (Fabr.) for example, it is perhaps just perceptible before Ac. The appendages of the male agree with Ris' figure.

The species occurs in Moupin, Shanghai, Sumatra, Japan.

Genus Pseudagrion.

In at least three, possibly four, of the Indian species the males have 'recognition-marks,' probably of sexual importance, at the tip of the abdomen.

In *P. rubriceps*, Selys, and to a lesser extent in *P. bengalense*, nom. nov., in which the upper anal appendages are black, the large excavation at the apex of segment 10 is bright blue. In *P. hypermelas*, Selys, and in *P. microcephalum* (Ramb.) the 'recognition-mark' consists of an area of blue colour on the shelf-like projection found on the inner side of the upper anal appendages. In old males of *P. hypermelas* this mark tends to become obscured.

One other Indian Agrionine possesses a similar colour on the upper anal appendages of the male, viz. *Ischnura forcipata* (Laidlaw).

For notes on Indian species of this genus see *Rec. Ind. Mus.*, XII, pp. 21–25 (1916).

Pseudagrion bengalense, nom. nov.

(Text-fig 4.)

Pseudagrion australasiae, Selys MSS.; Laidlaw, *Rec. Ind. Mus.*, XII, p. 23 (1916).

The two specimens of this species which I have seen are both males from Calcutta.

According to a recent paper by Dr. Ris (*Supplementa Entomologica*, No. 5, Berlin) the true *Race? Pseudagrion australasiae* of the *synopsis* is a local race of *P. microcephalum* found in Australia and parts of the Malay Archipelago. This race probably does not occur in India, and the two specimens examined (one of them labelled by Selys himself as *P. australasiae*) are quite different from the Indian examples of *P. microcephalum* taken with one of them.

FIG. 4.—*Pseudagrion bengalense*, nom. nov. Apex of abdomen.

In general appearance it must be admitted that the two species, *P. microcephalum*, Selys and *P. bengalense*, are very much alike.

The differences may best be shown in tabular form:—

	P. bengalense ♂.	*P. microcephalum* ♂.
Size.	Abd. 30 mm.; hind-wing 20·5 mm. (and in general a more robust species).	Abd. 27·5 mm.; hind-wing 18 mm.
Head.	A broad black band transversely across the frons from level of base of antennae to level of posterior ocellus. Dorsum of head mainly black.	Narrow transverse band of black at level of posterior ocelli, black mark on either side of anterior ocellus. Dorsum of head mainly blue.

	P. bengalense ♂.	*P. microcephalum* ♂.
Prothorax.	Blue markings very small.	Blue markings large.
Thorax.	Mid-dorsal and antehumeral bands broad.	Mid-dorsal and antehumeral bands narrow.
Abdomen.	Segment 8 with apical spines only black. Segment 10 with dorsum entirely black.	Segment 8 with well marked terminal black ring. Segment 10 blue with large black mark not covering dorsum entirely.
Anal appendages.	Upper pair about half length of segment 10. No inner shelf. Lower pair marked with black.	About equal in length to segment 10. Well marked shelf on either of the upper appendages, on their inner side coloured white. Lower pair whitish.
Venation.	Antenodals 11 (forewing). Ab rises at Ac. Costal margin of quadrangle of fore-wing two-fifths length of anal margin.	Antenodals 10 (forewing). Ab rises distinctly before Ac. Costal margin of quadrangle of forewing rather less than one-third length of anal margin.
	Pterostigma brownish-black.	Pterostigma yellow-brown.

The fact that these two forms live side by side, as well as the striking differences in the anal appendages of the male, strengthens the view that they are distinct species in spite of their very close general similarity.

The type of *P. bengalense* will be returned to the Indian Museum.

Pseudagrion rubriceps, Selys.

Pseudagrion rubriceps, Kirby, *Cat. Odonata*, p. 153 (1890); Laidlaw, *Rec. Ind. Mus.*, XII, pp. 24–25, fig. 2 (1916).

3 ♂♂, Nagpur, C.P., 1,000 ft., 8-12-1915 (*E. D'Abreu*).

In these males the ground colour of the dorsum of the thorax is an olive-brown. On either side of the black mid-dorsal carina is a fine stripe of olive-brown enclosed within the black colouring of the mid-dorsal band.

Segments 8, 9, 10 are bright blue, but 8 has a broad black dorsal band, wider posteriorly. The excavated part of segment 10 is likewise bright blue, making the "end-on" appearance of the segment very striking, and serving perhaps as a recognition mark.

The upper anal appendages are black, and the lower pair greenish-white.

The upper pair have each a strong internal tooth directed upwards lying at about the middle. The lower pair when viewed

directly from behind show a deep cleft running from above downwards near the inner margin. The inner tooth of the upper appendage is not visible when the appendage is viewed from the side and is not shown in my figure of the anal appendages of the species (*loc. cit.*, p. 24, fig. 2).

Pseudagrion hypermelas, Selys.

Pseudagrion hypermĕlas, Kirby, *Cat. Odonata*, p. 153 (1890); Morton, *Trans. Ent. Soc. Lond.*, 1907, p. 307, pl. xxiv, fig. 9; see also *Rec. Ind. Mus.*, XII, p. 21 (1916).

The young males have segments 8–10 of the abdomen pale gray-blue *not* black, in the case of specimens from Kierpur, whence I have examined three males. Segment 8 has a black basal patch dorsally, about one-quarter the length of the segment. The pale colour is apparently replaced by black in mature specimens. The anal appendages are identical with those figured by Morton for his specimens.

Archibasis ceylonica, Kirby.

Archibasis ceylonica, Kirby, *P.Z.S.* 1891, pp. 205,206, pl. xx, fig. 4.

In reading Kirby's account of the type specimen I felt some doubt as to its generic position. Accordingly I wrote to Mr. H. Campion of the Imperial Bureau of Entomology, sending him specimens of *Pseudagrion rubriceps*, Selys, with a request for comparison and information. I am indebted to him for the following remarks :—

"The type (female) has two forwardly directed spines on the prothorax, I cannot see whether the upper anal appendages of the male, caked with mud, are simple or bifid. I do not know the genotype of *Pseudagrion* or of *Archibasis*, but see no particular objection, on venational grounds, to regard Kirby's specimen as a *Pseudagrion*. I have compared your specimens from Nagpur with the ♂ and ♀ from Ceylon which Kirby called *Archibasis ceylonica*. Upon structural grounds I am unable to separate the two series at all, and the colour differences which I have noted are probably not of more than sub-specific value."

It is reasonable to conclude that *Archibasis ceylonica*, Kirby, is really a *Pseudagrion* and that it is at any rate allied to *P. rubriceps*, Selys.

Archibasis oscillans (Selys) ?

Archibasis oscillans, Laidlaw, *Rec. Ind. Mus.*, VIII, pp. 343–344, pl. xvi, fig. 3 (1914).

I have re-examined an imperfect male of the above series and am still doubtful of the identification, though the species may be an *Archibasis*. In many respects it approximates to *Pseudagrion*; from a typical member of that genus it differs as follows :—

Venation.—The wings show rather more petiolation. Ab rises distinctly beyond Ac, whilst Ac lies nearer to Aa_2 than to An_1. The pterostigma is short and more rectangular than in *Pseudagrion*. Presence or absence of post-ocular spots is doubtful.

Tarsal claws.—The lower tooth is much reduced.

On the other hand the anal appendages of the male show a general similarity to those of a typical *Pseudagrion*.

The species appears at any rate to belong to a genus allied to *Pseudagrion*, but more specialized.

ADDENDA ET CORRIGENDA.

Part I (*Rec. Ind. Mus.*, XIII, pp. 23–40 : 1917).

Since the part was completed I have seen specimens (♂ ♀) of *Pseudophaea dispar* (Ramb.) collected by Mr. S. Kemp at Talewadi, N. Kanara District, in 1916. Also a number of males of *Rhinocypha iridea*, Selys, from the S. Shan States, collected by Dr. Annandale.

A larva of a species of *Rhinocypha* is of interest as helping to strengthen the opinion that the Libellaginae should stand as a distinct sub-family. It has no ventral abdominal gills, the mask is similar to that of the Epallaginae, but the antennae have a long pedicel recalling that of the Calopteryginae. The caudal gills are unfortunately missing.

p. 28. For "*Echo maxmia*, Martin" read "*Echo maxima*, Martin."

p. 33. Above Genus *Rhinocypha*, Ramb., insert "Sub-family Libellaginae."

p. 37. Above *Rhinocypha iridea*, Selys insert "Group *Fenestrata*."

Part II (*Rec. Ind. Mus.*, XIII, pp. 321–348 : 1917).

In the title of the paper for "The Family Agrioninae" read "The Family Agrionidae," for "Sections" read "Legions" and for "Podolestes" read "Megapodagrion."

p. 322. For "Legion Podolestes" read "Legion Megapodagrion."

p. 323. For "Legion I. Podagrion, Selys" read "Legion I. Megapodagrion."

p. 330, line 28. After the words "three species" insert "*e.s. C. eximia, miniata* and *pulverulans*."

p. 332, line 4. For RS read MS. I have hesitated whether to adopt Tillyard's nomenclature MS for this vein or whether to adhere to RS. I have now made up my mind to adopt Tillyard's nomenclature and views.

p. 339. After line 11 insert "*Platycnemis latipes*, Ramb., race *dealbata*, Selys, is recorded from Quetta by Morton (*Trans. Ent. Soc. London*, 1907, p. 306). It is a Palaearctic species."

p. 339. To the characters of *Protosticta* add "In some species at any rate *MS* distal to subnodus.

p. 343. In the characters of the genus *Chloroneura* for "(length to breadth 4 : 1)" read "(length to breadth 9 : 2)."

p. 344. In the characters of the genus *Disparoneura* for "(length to breadth 9 : 2)" read "(length to breadth 5 : 1 or 11 : 2)."

p. 347. For "Genus *Indoneura*, Kirby" read "Genus *Indoneura*, nov."

p. 348, line 12. For "gomphonic-like" read "gomphine-like."

IX. THE LARVA OF *MICROMERUS LINEATUS*, BURM.

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

(With Plate XXIII).

Head: the central part of eyes projecting slightly, this part alone being facetted and therefore probably the only functional part during the larval stage; the antennae with a very long pedicel, as long as 2/5ths the whole length of antennae, the base and tip of the pedicel pigmented; a strong, robust, backwardly directed horn behind each eye; ocelli distinct in the final instar.

Mask long and narrow; median lobe deeply hollowed out and moderately deeply cleft, the two corners of the cleft rounded and overlapping; the free border of the lobe with blunt, tooth-like crenations; lateral lobes bifid, each bifurcation bearing a strong claw, the inner with a long moveable hook which overlaps its fellow at the middle line.

Prothorax with two forwardly directed, robust horns at the anterior and outer part.

Legs long and slender, practically free from hairs, the femora adorned with four pigmented annuli.

Abdomen twice the length of the wing-cases, moderately stout, covered sparsely with short hairs and pigmented with a definite pattern; each somite bearing a row of closely-set, short spines along the apical border.

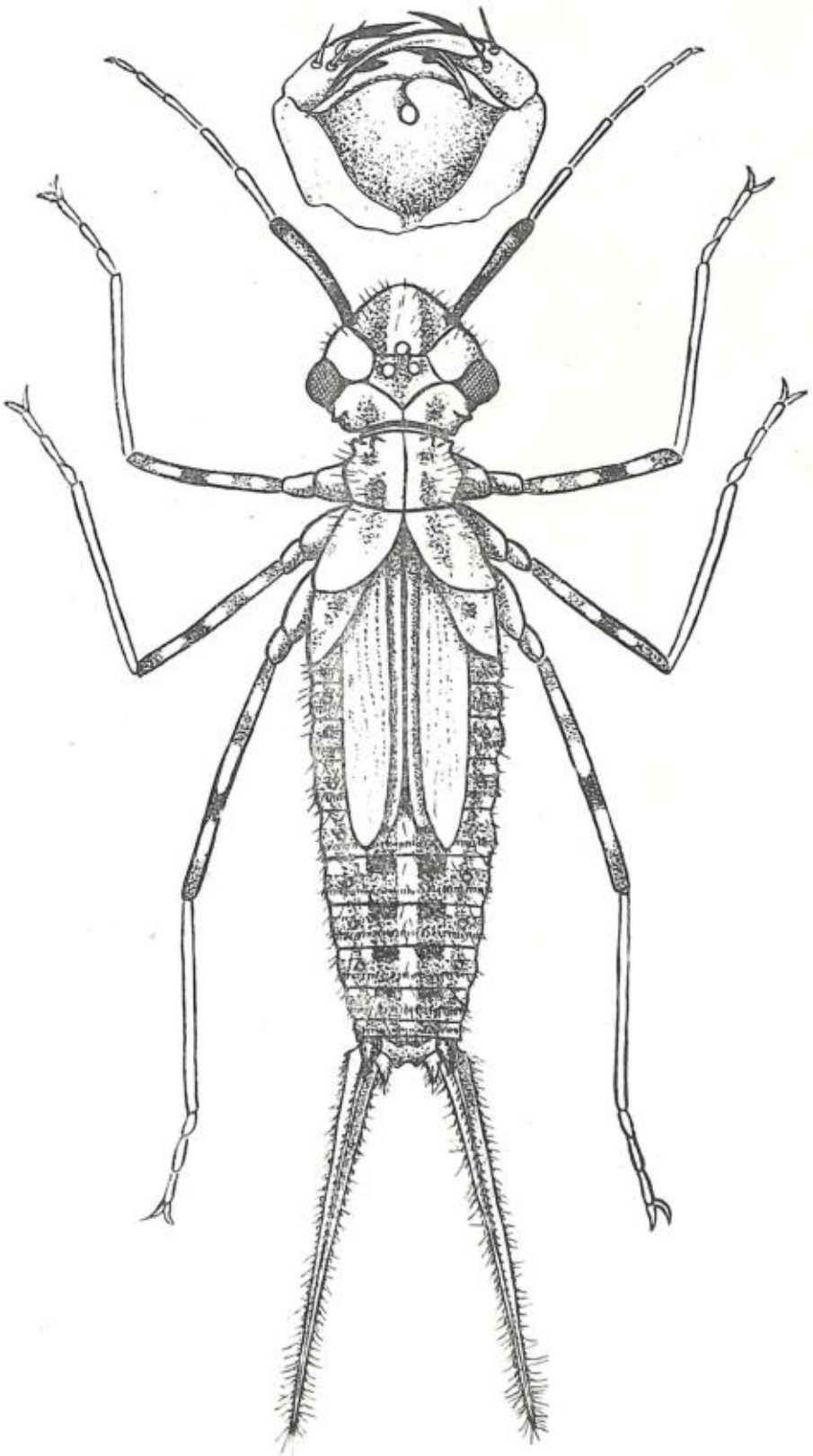
Caudal appendages only two in number, easily fractured off, not functionating as gills, covered with short stiff hairs, triquetral in section, all the three surfaces being flat and the broadest below. The two lateral surfaces meeting above to form a crest which is furnished with two rows of short, stout, strongly imbricated spines. Similar spines along the inner and outer borders.

Habits: Always in fast running water, clinging to roots, submerged twigs and other debris, rarely to the stems of weeds or reeds.

The exuviae of these insects are extremely common, being found usually on the trunks of trees adjacent to streams, sometimes as high as seven feet above water-level, although generally at not more than two. The living larvae are obtained with great difficulty owing to their clinging so tightly with their long legs to the objects mentioned above and at a comparatively great depth. In Poona I have generally managed to obtain them by pulling out submerged branches of trees and date-palm leaves which had fallen into the water, but even here they were difficult to find on account

of their habit of accumulating debris on the short hairs which cover the abdomen and caudal appendages so that it needs the closest scrutiny to detect them. Quite occasionally protozoa such as *Vorticella* are found adhering to their bodies. They are pure rectal breathers, and if the larvae be viewed in muddy water, strong currents of particles are seen issuing to and from the rectum.

It is reasonable to assume by analogy that the larvae of *Micromerus* and the associated genus *Rhinocypha* are closely similar in their morphology and if so, the above description will confirm the opinion expressed by Dr. Laidlaw, that the two should be placed together and raised to the rank of a subfamily. It will be seen that no true, and certainly not functional, caudal gills are present, these being replaced by caudal appendages which seem only to serve for purposes of defence. The autotomy associated with these appendages also points to their function as one of defence only, as if the insect be seized by any other, it merely parts company with the appendage and makes its escape. A similar habit probably exists in Rhinocyphine larvae and may account for the absence of the caudal appendages in an incomplete specimen described in a note by Dr. Laidlaw.



LARVA OF *Micromerus lineatus.*
The "Mask" is shown above.

X. ON THE GENERIC POSITION OF *HELIX DISTINCTA*, PFR., OF SIAM.

By Lt.-Colonel H. H. GODWIN-AUSTEN, *F.R.S.*

I have to thank Dr. N. Annandale for sending me a small but interesting collection of land mollusca from Siam, a donation to the Indian Museum, Calcutta, got together by Mr. C. Boden Kloss (5-v-17). One interesting species, which I now describe, he obtained at Lat Bua Kao, 30 miles west of Korat—a locality described by Mr. Kloss in "*The Ibis*" 1918, p. 78, as "just within the eastern foot of the hills which separate the slightly elevated, shallow basin of eastern Siam from the central Siam plain and the Menam river-system." There are six or more fine specimens preserved in spirit, the largest measuring 68 mm. in major diameter. It affords me the opportunity of comparing the animal with other large species from that part of the world, such as *Hemiplecta humphreysiana* and *floweri*, with which I have dealt. The latter is fully described and figured in *Proceedings Malacological Society*, Vol. IV, March, 1900. Comparison with this Siam shell should therefore be of much interest. In this paper I also described *Hemiplecta neptuna*, Pfr., received from my old friend and fellow-worker the late Dr. W. T. Blanford, also from Siam and sent to him by Mr. Daly. I alluded also to *Helix distincta*, Pfr., and pointed out there was much to be cleared up.

Helix distincta, described by Pfeiffer in 1850, is recorded in 1853 by him in *Mon. Helic. Vivent.* Vol. III, p. 81, as from the Moluccas. We next have it recorded from Siam by Von Martens in his *Preus. Exped. n. Ost-Asien*, 1867, p. 69, and placed in *Nanina* of Gray. The external characters of the animal are only referred to, and there is not a doubt he had before him this fine large Siam species which is the subject of this paper. The drawing of the animal (plate 6, fig. 8) shows clearly it has right and left dorsal lobes but *no shell lobes*, and the same is seen in the drawing of *N. siamensis*, Pfr., fig. 6.

Later in 1900, quoting from my paper on the anatomy of *Hemiplecta floweri*, E. A. Smith, I wrote "Professor Semper in his *Reisen im Archipel der Philippinen* Bd. III, p. 62, pl. vi, fig. 27, under *Xesta distincta*, mentions having obtained two shells from Zamboanga, in Mindanao. He, however, described the animal, and figured the jaw and radula of a young specimen from Saigon, Cochin China, which is over 500 miles from Siam. The jaw has no central projection; the central tooth and admedians are tricuspid, the laterals bicuspid, with 160 to 180 teeth on each

side of the radula. This description does not answer for the jaw, the form of the teeth, or the dental formula of the Siam species, which I identify as *Hemiplecta neptuna*." Semper alludes to the presence of shell lobes, an important point, the left as being moderately developed, the right well seen: this would place it in *Hemiplecta*. He put it in *Xesta* of which *citrina* is the type, a very different shell and with the generative organs differing, *vide* plate iii, fig. 13.

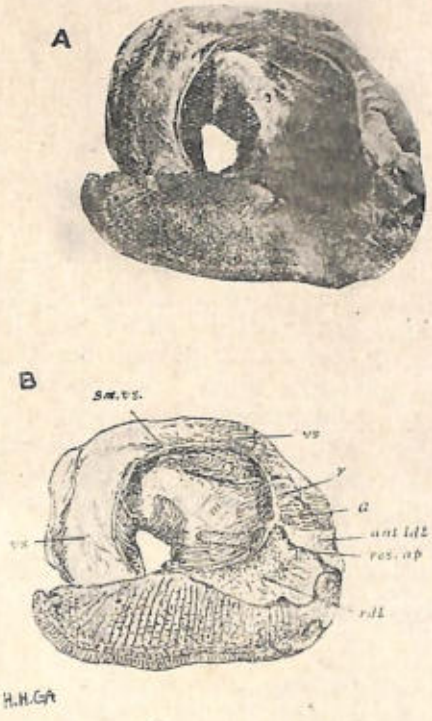


FIG. 1.—*Koratia distincta* (Pfr.).

A. Animal, view of right side, about natural size.
B. ,, ,, ,, To show different parts, and the position (*a*) of the right shell lobe (dotted line) had one been present.

ant. ldl. anterior left dorsal lobe; *r.* rectum; *rdl* right dorsal lobe; *res. ap.* respiratory aperture; *vs.* visceral sac; *sm. vs.* sutural margin of visceral sac.

The animal (text-fig. 1 A) of this species from Siam has no colour markings, the whole of the foot is ochraceous in spirit and the length of the specimen dissected, not the largest, is 45 mm. in its very contracted state. It is evident they were put direct into the spirit, they are so shrunken and hardened.

The sole of the foot is wrinkled in the central area and divided, the peripodial margin is moderately broad and closely segmented or fringed, bounded by a single straight groove above and another irregular zig-zag one above it; from this close-set

parallel grooves extend upwards towards the upper surface of the foot, the side of which is very smooth. The mucous gland is not large, not by any means so largely developed and conspicuous as in *Hemiplecta flowerí*, E. A. Smith (plate iv, fig. 1). There is not a vestige of either a right or left shell lobe as in *Ariophanta* (*Nilghiria*) *ligulata*, Fer., pl. xcviii, fig. 16, *Moll. India*. In text-fig. 1B the position is indicated where they would be at (*a*). The mantle margin is simple, straight and continuous from the rectum round to the posterior margin above the keel of the foot like a narrow hem following the peristome.

The right dorsal lobe (*rdl.*) is large and triangular in shape, the left is in two very distinctly separated portions, very irregular in breadth, the anterior about 15 mm. long by 4 mm. broad.

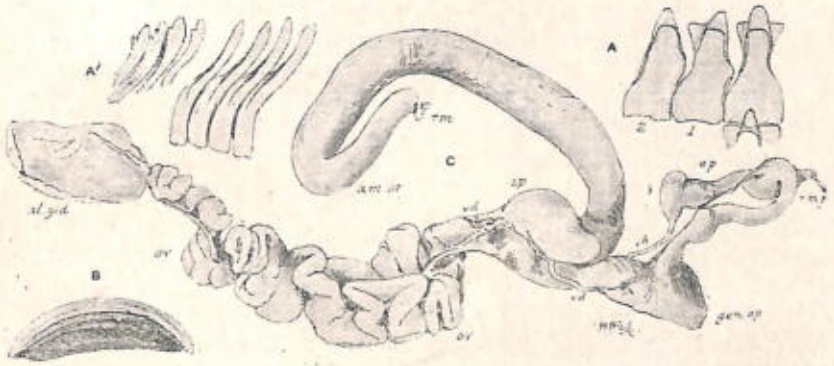


FIG. 2.—*Koratia distincta* (Pfr.)

A. Centre tooth and adjacent admedians, × 170.
A′. Inners and outside marginal teeth, × 170.
B. Jaw, × 58.
C. Genitalia, × 2.

al. gld., albumen gland; *am. or.*, amatorial organ; *ep.*, epiphallus; *gen. ap.*, generative aperture; *ov.*, oviduct; *f.*, flagellum; *rm.*, retractor muscle; *rmp.*, retractor muscle penis; *vd.*, vas deferens; *sp.*, spermatheca.

The branchial sac is very ample, the renal organ very long, narrow and white in colour.

Genitalia (text-fig. 2 C).—The amatorial organ (*am. or.*), comparatively speaking, is of great length, quite 40 mm., evenly cylindrical, having a retractor muscle (*rm.*) at its somewhat blunt end. The penis in comparison to this last organ is short; a straight tube leads from the generative aperture to the retractor muscle (*rmp.*), where it bends sharply and enlarges into a rounded mass, a sort of kink in the tube contracting again at the short epiphallus (*ep.*) leading on to the junction of the vas deferens (*vd.*), and here a short oval mass represents the usual kalk-sac or flagellum (*f.*).

The spermatheca (*sp.*) is globose, short and sessile, thus corresponding to the smallness of the kalk-sac and to the probable small size of the spermatophore. The vas deferens is long, the

ovotestis (*ov.*) largely developed, its convolutions being very large and ample, diminishing in size as they approach the albumen gland (*al. gld.*). The male organ is not unlike that of *Hemiplecta floweri* (plate iv, fig. 6a).

Radula (text-fig. 2 A, A').—No marked differences in the form or size separates the central and marginal teeth, they merge gradually one into the other. The centre tooth and about 12 on either side are on broader plates. They are succeeded by an enormus number of narrow, curved, aculeate, closely-packed teeth, and nearing the margin a few become evenly and minutely bicuspid, the outermost marginals are very minute. The first radula extracted was not complete enough to count the teeth in the row, but there are at least 250 on each side.

This does not agree with the radula of the species I dissected and described in the *Proceedings of the Malacological Society*, p. 35, of a specimen from *Saïgon* given me by Dr. Hungerford, who retained the shell. Dr. Hungerford's collection was dispersed after its sale to Messrs. Sowerby and Fulton, so there is no fear of ever tracing and seeing what that shell was like.

Jaw very dark brown, perfectly straight on the cutting edge and slightly arched above (text-fig. 2 B). It may be noticed particularly that in the genitalia the male organ of this Siam species is not at all like that of the South Indian genus *Ariophanta* with dextral shells, with which they have been placed by some conchologists.

Among the large Molluscs of the Malayan Region, this species does not find a place in either of the genera *Hemiplecta*, *Xesta*, or *Rhysota*. Thus it seems necessary to constitute one, which I name after the Siam district in which it is found.

Koratia, gen. nov.

Shell very large and solid, animal with no shell lobes, mucous gland small. Jaw straight on cutting edge. Radula, teeth numerous in row, with closely-packed, aculeate marginals.

If we consider one character, a marked external one, that of shell lobes, it is of interest to note that *Hemiplecta humphreysiana* bears the same resemblance to *Koratia distincta* as *Macrochlamys indica* and allied species do to *Bensonia monticola*.

XI. DESCRIPTION OF A NEW SPECIES OF *MARGARITANOPSIS* (UNIONIDAE) FROM THE SOUTHERN SHAN STATES, WITH NOTES ON *SOLENAIA SOLENIFORMIS*.

By Lt.-Col. H. H. Godwin-Austen, *F.R.S.*

(With Plate XV.)

Feddon and Theobald were the first to visit and collect mollusca in the Shan country in 1864, but they did not penetrate to the neighbourhood of the Inlé Lake which is not, as far as I can remember, mentioned in their Geological Reports. It was not until Colonel R. Woodthorpe, R.E., visited Fort Stedman in 1894 on his way to survey the Siam frontier that he obtained any shells from this piece of water or its neighbourhood. Among them is the remarkable large bivalve, which I have named after him, but never as yet had an opportunity of publishing. The animal has not yet been seen nor has that been described of its possible ally *Solenaia soleniformis*, Bs. of Cachar.[1]

I append the description of *Unio laosensis*, to which the Shan species comes nearest.

Genus **Margaritanopsis**, Haas, 1912.

Haas in Martini u. Chemnitz, *Syst. Conch. Cabinet*, Bd. IX (ii) 2, pp. 121-122, pl. xii, figs. 1-2 (1912). Laos Mountains, Cambodia, Siam. Mons. Mouhot. Diam. 0·9, length 1·2, breadth 3 inches.
C. Torrey Simpson, *Des. Cat. Naiades*, p. 520 (1914).
Sowerby, *Conch. Icon.*, XVI, pl. xlvii, f. 256 (1866).

Type, *Unio laosensis*, Lea.

It is thus described. "Shell elongated, arcuate, rather solid, not inflated, inequilateral; beaks slightly elevated, not full, thin sculpture consisting of ridges that nearly follow the growth lines, posterior ridge high. Very wide and rounded, anterior end of the shell rounded, posterior end a little wider, rounded or feebly pointed, surface with rude, concentric growth lines, epidermis brownish-green, or greenish-brown and subshining in young shells, brown or blackish and dull in old ones; left valve with two small stumpy pseudocardinals, the anterior one often almost obsolete, and two remote small laterals; right-valve with two peseudocardinals, the

[1] Since this was written a description of the animal of *S. soleniformis* has been published by Dr. Ekendranath Ghosh in *Rec. Ind. Mus.* XV, pp. 109-122, pl. xvi (1918).—*N. A.*

hinder rudimentary and one lateral; laterals granular and showing traces of vertical striation, muscle scars well impressed, the anterior ones rough, the posterior elliptical; nacre whitish or purplish; thickened in front, generally showing small pits.

Laos Mountains, Cambodia: Siam: Burma."

Margaritanopsis woodthorpi, n. sp.

(Plate xv.)

Locality.—Fort Stedman, Shan States (*Woodthorpe*). Two specimens received.

Shell very elongate or broad, somewhat flattened, solid, umbones high, nearly level, inequilateral, posterior ridge straight, long. Anterior end of shell rounded, posterior end also, ventral margin pinched in or compressed with considerable convexity. Surface eroded on umbones, then smooth followed by strong lines of growth next and up to the margin, epidermis greyish-black (pl. xv, fig. 1). Left valve (pl. xv, fig. 2) with a solid projecting pyramidal cardinal tooth, having well defined layers of growth, with two long posterior lateral teeth or rather flanges, no anterior. Right valve (pl. xv, fig. 3) with a smaller projecting cardinal which fits and drops in in front of the left valve cardinal. One posterior flange. Anterior muscle scars well impressed, the adductor large, circular, protractor pedis small, anterior retractor above rather larger and deeper. Posterior muscle scar eliptical, smooth. Nacre pale cerulean blue and extremely smooth. Diameter 29·0, length 40·0, breadth 127 mm.

The figures of this shell are from the excellent photographs of my friend and neighbour Mr. J. S. Gladstone.

Dr. Annandale informs me, this subgenus was not found by him in Inlé Lake, Woodthorpe must, therefore, have obtained it in one of the larger streams that flow into the lake, and it may possibly have habits somewhat like those of *Solenaia* of Cachar. How far the anatomy will compare with that subgenus has to be ascertained. As to the extension west in the Salween basin of *Margaritanopsis* is also of interest. I found nothing like it in Manipur nor would it be likely to be found there. The streams of that valley are nearly all very sluggish, with discoloured water and muddy bottoms, as far as the Logtak lake. I do not know the country to the south of that, the subgenus might possibly occur there.

A few notes on the Genus *Solenaia* may be introduced here.

The exact locality in Cachar and the conditions in which *U. soleniformis* lives have been recently given me by Mr. F. Ede of Silchar. He says: "It is only possible to obtain this bivalve when the rivers are extremely low in the height of the dry or cold season. I found specimens in the Daleswari in Hailakandy between Katlicherra and Cookicherra, also (once only) on some rocks by diving in a very dry season, in the centre of the Barak River opposite the old pukka club in Silchar, but since then have only

found them in the Daleswari. They are much sought after, and esteemed as a great delicacy by the Uriya coolies in the tea gardens. My first specimen was obtained from a couple of Uriyas, who had been out with axes, splitting up the hard blue shale rock to obtain them. The rock in question is soft as rocks go, and is recent Tertiary, possibly Pliocene. .... The specimens found by me seem to prefer fairly rapid running water. Their borings are generally on the outside of curves or bends, where the current is fairly high. They seem to change about from hole to hole, descending as the river falls. I am not certain how they bore, but they periodically eject muddy water from their holes, of the colour of the rocks in which they live. I have seen them doing this in the cold weather, when the water in the river is quite clear. .... I think the specimens I found under the laterite rocks, in the centre of the Barak in Silchar, must have been casual specimens, swept down by some big flood." This is possible, that is to say if *U. soleniformis* occurs in the Barak and more likely in the Sonai from the south—they could not have been derived from the Daleswari, which joins the Soorma many miles below Silchar.

I know the Daleswari valley and ascended the river by boat to close up to the Looshai country (Sookpilal's of that time). I was fully occupied at a reconnaissance survey so had very little time for collecting and missed seeing this interesting species of *Unio*.

Mr. Ede feels certain that they make the holes they occupy. Some further examination of these holes is required to ascertain their depth, proximity, and section. The animal would lie with the inhaling and exhaling siphons pointing upwards, throwing out as he describes the dirty water in their bodies into the clear water of the river.

It would be interesting to know also how far up the Daleswari the species is to be found and still more to know its exact distribution in South Cachar, whether it is to be found in the Sonai and Barak. The Daleswari is of considerable length some 60 miles to Gootur Mukh. The embryonic forms of any colony would be carried down stream, but after attaching themselves to their hosts, such as species of Mahsir, they would at the proper season and rise of the rivers be carried far up into the hills and start their existence as Unios wherever the conditions were suitable: thus the range on this river may be very great.

ADDENDUM.

FURTHER NOTE ON THE BURROWS OF *SOLENAIA SOLENIFORMIS*.

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

As Col. Godwin Austen has referred to the burrows of *Solenaia soleniformis*, I have added to his manuscript a note based on a specimen in the Indian Museum. This specimen is a block of friable sandstone 51·5 cm. long by 13 cm. broad by 17·5 cm. deep and contains four burrows in which the shells have been replaced.

It was presented many years ago by Mr. F. J. Ede and is labelled as being from a stream in Cachar. Two of the burrows completely penetrate the block, one is incomplete and one has been cut open in removing the mass. The entrance to all the burrows is oblique and each has been commenced at a point at which the surface was uneven or sloping. The calibre is even throughout and the cross-section is narrowly lanceolate with a distinct notch at both the broad and the narrow end. The height in a completed burrow is 89 mm. and the greatest breadth 46 mm., the depth of the lower notch about 8 mm. The inner surface is smooth except for a number of shallow but rather broad longitudinal grooves on the sides.

If the shell removed from the burrow be examined it will be found to resemble it closely in cross-section but to be a little smaller in all directions, and coarse longitudinal ridges on its surface will be noted corresponding roughly with the grooves on the wall. There is no possibility of the excavation having been made by the rotation of a body of the size and shape of the shell, and it is evident from a comparison of old and young specimens that the instrument used must be the anterior margin of the valves, which is worn and smoothed in old shells.

In young shells the anterior region differs considerably in shape from that in old shells and has distinctly the appearance of a cutting tool. The valves are strongly compressed, their margin is very sharp and the curvature is of a convenient type.

The foot[1] of *Solenaia* resembles that of *Physunio*[2] in shape but is considerably more elongate. As I have recently shown[3] the latter form makes its way through mud with the shell in a vertical position and with a swaying motion, by alternately protruding and retracting the foot, and I believe that *Solenaia* cuts its way into the rock in a similar manner. Having found a suitable spot where the surface is irregular or shelved, it applies the anterior end of its shell to the surface and by alternately thrusting out and drawing in its foot moves the sharp margin up and down against the rock, thus cutting a groove into which it thrusts itself. The movement is probably complicated by a laterally swaying motion and the coarse ridges on the shell assist in enlarging the aperture. A great deal of the excavated matter must be taken into the mantle cavity and expelled in the manner indicated by Mr. Ede.

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[1] Ekendranath Ghosh, *Rec. Ind. Mus.* XV, p. 111, pl. xvi, fig. 2 (1918).

[2] *Id., ibid.*, fig. 3. See also Baini Prashad, *Rec. Ind. Mus.* XIV, pl. xxii, fig. 1 (1918).

[3] Annandale, *Rec. Ind. Mus.* XIV, p. 141 (1918).

EXPLANATION OF PLATE XV.

Margaritanopsis woodthorpi n. sp.

FIG. 1.—Left valve (outside), nat. size.
,, 2.— ,, ,, (inside), ,, ,,
,, 3.—Right valve (inside), ,, ,,
,, 4.—Viewed from above, ,, ,,

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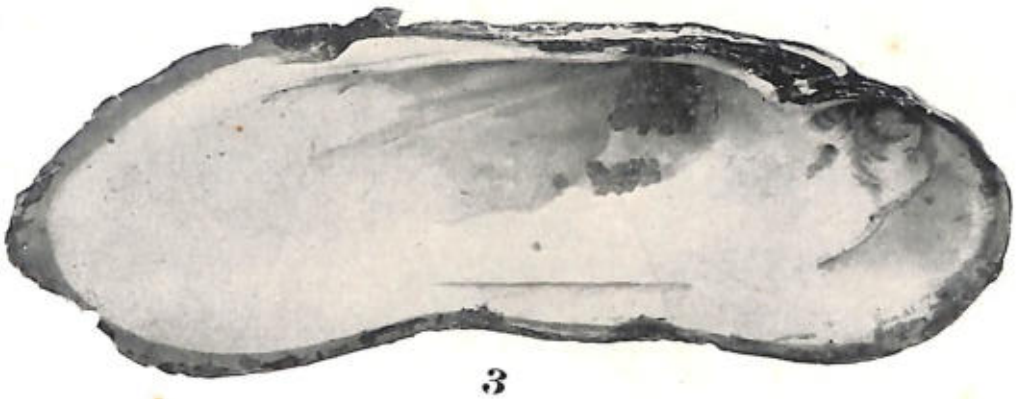

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MARGARITANOPSIS WOODTHORPI, n. sp.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

XII. DESCRIPTIONS OF THREE NEW BATRACHIANS FROM THE GARO HILLS, ASSAM.

By G. A. BOULENGER, *LL.D., D.Sc., F.R.S.*

Dr. N. Annandale has kindly submitted to me for study and description, examples of four new Batrachians obtained in the Garo Hills, by Mr. and Mrs. S. W. Kemp. Descriptions of three of these are here given, the fourth, *Rana garoensis*, being reserved for a monograph of the genus *Rana* which is shortly to be published in the *Records of the Indian Museum*.

Nectophryne kempi, sp. nov.

Head moderately large, broader than long, flat above, distinct from 'neck'; snout short, truncate at the end, feebly projecting beyond the mouth; canthus rostralis distinct; loreal region nearly vertical, slightly concave; nostril near the tip of the snout; interorbital region broader than the upper eyelid; tympanum hidden. Fingers moderately elongate, much depressed, with feebly dilated, truncate tips, $\frac{1}{3}$ webbed; first finger about $\frac{2}{3}$ the length of second; subarticular tubercles indistinct. Hind limb short, the tibio-tarsal articulation reaching the shoulder; tibia $\frac{2}{5}$ the length of head and body. Toes $\frac{3}{4}$ webbed, the tips broadly rounded but not dilated; subarticular tubercles small, flat; two small metatarsal tubercles; no tarsal fold. Upper parts rough with granules and small round tubercles; a rather prominent, elliptic parotoid gland; lower parts granulate. Blackish brown above, dark brown beneath; lower surface of fore limb and thigh yellowish; a large round yellowish spot on each side of the breast, at the base of the arm.

From snout to vent 34 millim.

Two specimens from above Tura, 2,500 ft., obtained by Mr. Kemp. *N. maculata*, Mocquard, from Kina Balu, Borneo, was the only Asiatic species known in which the tympanum is completely hidden, but it is distinguished from the toad here described by a very slender form.

Ixalus garo, sp. nov.

Snout truncate, scarcely projecting, a little shorter than the diameter of the orbit; canthus rostralis distinct; loreal region slightly oblique, concave; nostril equally distant from the eye and the tip of the snout, interorbital region broader than the upper eyelid; tympanum distinct, one-thrid the diameter of the eye. Fingers short, free; toes short, webbed at the base; discs of

fingers and toes large, quite as large as the tympanum. The tibio-tarsal articulation reaches the eye; heels overlapping when the limbs are folded at right angles to the body; tibia $\frac{1}{2}$ the length of head and body. Skin smooth above; a glandular fold from the eye to the shoulder; throat smooth; belly granulate. Greyish above, with a large sharply defined dark brown hourglass-shaped blotch covering the head from between the eyes and the back; loreal and temporal regions dark brown; limbs with dark cross-bands; lower parts greyish, dotted with white.

From snout to vent 13 millim.

A single specimen was obtained by Mr. Kemp above Tura. The nearest ally of this species is *I. annandalei*, Blgr., from the Kurseong Himalayas, which differs in the pointed and very prominent snout and in the smaller digital discs.

Ixalus kempiae, sp. nov.

Snout rounded, scarcely projecting, a little shorter than the diameter of the orbit; canthus rostralis indistinct; loreal region oblique, feebly concave; nostril equally distant from the eye and the tip of the snout; interorbital region broader than the upper eyelid; tympanum hidden. Fingers short, free; toes short, webbed at the base; discs of fingers and toes large. The tibio-tarsal articulation reaches the tip of the snout; heels overlapping when the limbs are folded at right angles to the body; tibia $1\frac{4}{5}$ times in length of head and body. Upper parts with small warts; throat smooth; belly granulate. Greyish above, with small blackish spots; a blackish cross-band between the eyes and a)(-shaped marking on the back; limbs with irregular blackish cross-bands; upper lip with vertical dark bars; throat and belly whitish, spotted and marbled with brown.

From snout to vent 17 millim.

A single specimen, obtained by Mrs. Kemp above Tura. Closely allied to *I. parvulus*, Blgr., from the Karin Hills, Burma. Distinguished by the longer hind limb.

XIII. ON THE SUPPOSED OCCURRENCE OF THE MIOCENE GENUS *FOSSARULUS* RECENT IN INDIA.

By Lt.-Col. H. H. Godwin-Austen, *F.R.S.*

In the *Fauna of British India, Mollusca, Freshwater Gastropoda and Pelecypoda*, Mr. H. B. Preston, on page 78, places *Bithynia costigera*, Küster (= *marginata*, Chm.) in the fossil genus *Fossarulus*, following Geoffrey Nevill in his "*Hand-List*," Vol. II, p. 42, with a ?. Having recently been looking over Indian species of *Bithynia* in my own and the Natural History collection this generic position has been brought into question. It appeared to me to be so impossible that a fossil genus of Miocene age and European habitat should be still living in Peninsular India. I sought Mr. Bullen Newton's kind help, and he was able to not only show me a *Fossarulus* but the type of the genus from Dalmatia quoted by G. Nevill. The first glance cleared up a great deal, and showed how great was the difference between the Recent and Fossil shells, in every important character. It is surprising that Nevill came to the conclusion he did in 1884. He may have had grounds at the time for doing so, certainly at the time he was at work he did not have in Calcutta the type shell of *Fossarulus* to refer to. Mr. Preston has perpetuated Nevill's determination, when the means of verification were close at hand in the Natural History collection.

To show the difference in question I give the original description of both the genus and its type.

Fam. PALUDESTRINIDAE.

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt, Wien, XIX, p. 361, pl, xii, figs. 7*a–c*.

"*Fossarulus* novum genus. Testa parva, subglobosa, rimata, "longitudinaliter nodoso-costata; apertura late ovata, superne et "ad basin effusa; peristomate continuo, incrassato, duplicato."

"Type *Fossarulus stachei*, Miocene, Dalmatia.

"Schale annähernd kugelig, fest, mit einer Nabelspalte "versehen, aus 4 stark gewölbten Umgängen bestehend, von wel-"chen der letzte fast ¾ der Gesammthöhe einnimpt; obere Win-"dungen mit 3, die letzte mit 5 kräftigen, geknoteten Längs-"rippen verziert; Naht vertieft; Mundöffnung breit eiförmig, "oben und unten mit einem kleinen Ausguss; Mundränder stark "verdickt, doppelt, zusammenhängend. Grössenverhältniss des "abgebildeten Exemplares: Höhe 7 mm. Durchmesser 5 mm."

Bithynia costigera is a small shell differing considerably from the common, widely spread, smooth form in having ribbing on the whorls: *vide* figure in *Conchologia Indica*, plate 151, fig. 10. The generic distinction is indicated even on shell character and is also to be expected in the animal, which should be examined. It does not occur in Bengal as stated by Preston. At least I have never met with specimens from the Gangetic delta. It is a common shell in Peninsular India, recorded by Nevill in his *Hand-List* from Karnul, Conjeveram and S. India (30) *ex.* W. T. Blanford and Madras Museum collections; also from Ceylon (30) *ex.* E. L. and F. Layard coll., together with a subvar. *curta*, G. Nevill, obtained by him at Bangalore.

The Blanford collection presented to the British Museum contains specimens from South India named *B. sulcata*, Eyd. and Soul.

As it was so important that the animal of *Bithynia costigera* should be examined I asked my friend Dr. N. Annandale if he could

a. *b*.

FIG. 1*a*.—*Fossarulus stachei*, Neumayer.
(Enlarged from Neumayer's original figure).
FIG. 1*b*.—*Mysoria costigera* (Küster) var. *curta* (Nevill).
(Enlarged photograph (× 4) of shell from type locality).

help me. This he has not only been able to do, but he has most kindly had photographs and drawings made of the shell, radula, and operculum, together with an enlarged photo of Neumayer's original figure of *Fossarulus stachei*, which now illustrates this paper,—for which I thank him much.[1]

I cannot do better than give in full the result of his examination of specimens he had collected at Bangalore, the original locality of var. *curta*, Nevill; for they add much to the value of this communication, and confirm my idea we are dealing with a new genus of freshwater shells very distinct from *Bithynia*. For this the name *Mysoria* seems applicable, if it has not been used

[1] Since this was written I have obtained fresh specimens of *M. costigera* in the neighbourhood of Madras. The animal, so far as appears on a superficial examination, does not differ from that of *Bithynia* except in having shorter tentacles. As, however, I am just starting on a long journey I have not been able to make a detailed examination. I hope that Col. Godwin-Austen will do this later and publish the results. *N. Annandale*, 8-x-1918.

before. This interesting species has a limited range in Southern India, which was a land surface in pre-Cretaceous times, during which its early development possibly took place.

Mysoria, gen. nov.

Type: *Bithynia costigera*, Küster, var. *curta*, Nevill.

Range. South India and Ceylon.

Shell perforately rimate, ovately conical or depressedly conical, solid, longitudinally striate, having 3 markedly birate ribs above with 2 below the periphery, aperture sub-circular, continuous; peristome simple, somewhat thickened on the columella side. Operculum not like that of *Bithynia*. Calcareous, not very thick, sub-circular or broadly ovate, centre concave, nucleus small with indication of spiral origin

Radula. Centre tooth quadrate with a centre cusp and 3 or 4 adjacent. Lateral tooth elongate, narrow at base gradually widening to a many cusped straight edge. First marginal of same length,

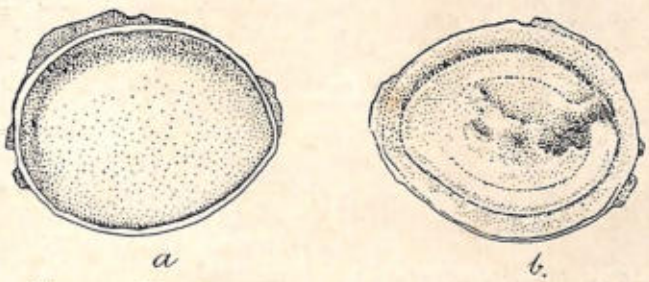

FIG. 2.—*Mysoria costigera* (Küster) var. *curta* (Nevill). Operculum, × 8. *a*. Internal view. *b*. External view.

narrower, edge finely serrate; 2nd same length, narrow throughout, edge rounded, finely serrate.

Touching Dr. Annandale's reference (see below) to the genus *Cremnoconchus* there is certainly in *C. syhadrensis*, W. Blf. from Bombay a very curious resemblance, so much so that an examination of its radula and other parts of the animal is much wanted, although William Blanford gave a very good account of it, it remains to be properly dissected. I am in hopes Dr. Annandale [1] will be able to do this, and better define the position of this genus, with its peculiar amphibious habits.

Under date 15th June, Calcutta, Dr. Annandale writes to me: "I have examined the radula and the operculum of my specimens of *Bithynia costigera* var. *curta*, and enclose a note upon them. Have you noticed the extraordinary superficial resemblance be-

[1] Since this was written Dr. Baini Prashad and I have published notes on and figures of this species. See *Rec. Ind. Mus.* XVI. pp. 148, 149, pl. iv, figs. 2-4 (1910). *N. Annandale*, 16-ii-19.

tween the species and *Cremnoconchus*. . ." and proceeds to describe the var. *curta*.

"The specimens I have examined particularly were collected by myself at the edge of a tank near Bangalore some years ago. They belong to the var. *curta*, Nevill, and differ from the typical form not only in being rather shorter, with the spire less exserted, but also in having a chestnut-brown epidermis. The operculum is sub-circular or broadly ovate. It differs considerably from that of any species of *Bithynia* with which I have been able to compare the specimens, but closely resembles that of the new genus *Pseudovivipara* from China which I am descibing in the "Memoirs of the Asiatic Society of Bengal."[1] Externally it is covered with a thick brownish epidermis and varies considerably in appearance in accordance with the age of the specimen. In large shells it is always more or less eroded, and there are as a rule at least two areas marked off by concentric ridges. The centre is always concave and numerous concentric striae can be detected on the surface if it is not eaten away. The nucleus is small and has a slight indication of spiral origin. The substance of the operculum is calcareous and, though not very thick, white and porcellaneous. The inner surface is convex and smooth, without sculpture. It has a raised margin forming the outer wall of a rather deep peripheral groove. This raised margin is, however, very delicate and apt to be destroyed in removing the operculum.

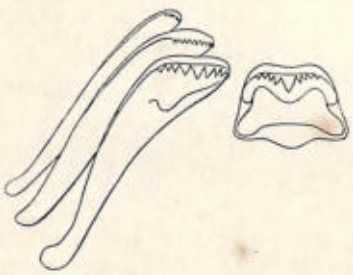

FIG. 3.—*Mysoria costigera* (Küster) var. *curta* (Nevill). Radula teeth, × 250.

The radula in general structure resembles that of *Bithynia*, but the central tooth differs in three important points:—(1) there are no basal denticulations, (2) there is a single lateral denticulation on each side, connected by a continuous ridge with a central prominence on the disk of the blunt finger-shaped tooth, (3) the base of the tooth is turned upwards in the middle to form a broad process directed opposite to that of the anterior denticulations. The central tooth is very small compared with the others.

These features of the radula and operculum probably indicate that the species should be made the type of a new genus. Unfortunately the soft parts of my specimens are not sufficiently well preserved to show anything except that the foot is relatively short and certainly not bifid."

This radula is a very different one to that of *Bithynia tentaculata* (fig. 4), which I have looked at and drawn. It shows beyond doubt the generic value of *Mysoria*. A glance at the central tooth

[1] Annandale, *Mem. As. Soc. Bengal*, VI, pp. 309-312, pl. x, figs. 3, 3*a* (1918).

shows how distinct the two genera are. They cannot be placed in the same family. If the living animals of the Palaearctic and South Indian species could be looked at side by side I imagine they would differ considerably one from the other. In drawings of *Bithynia tentaculata* I made many years ago, the tentacles are shown to be very long and finely pointed.

A figure of the radula of this species, the type of the genus, is given by Dr. Paul Fischer in *Manuel de Conchyliologie*, p. 723; he alludes to and shows what he calls "basal denticulations." These are rather nearer to the marginal edge of the tooth, a folding over of the same, and would appear to represent lateral cusps—an indication I think I have seen put forward by some writers that

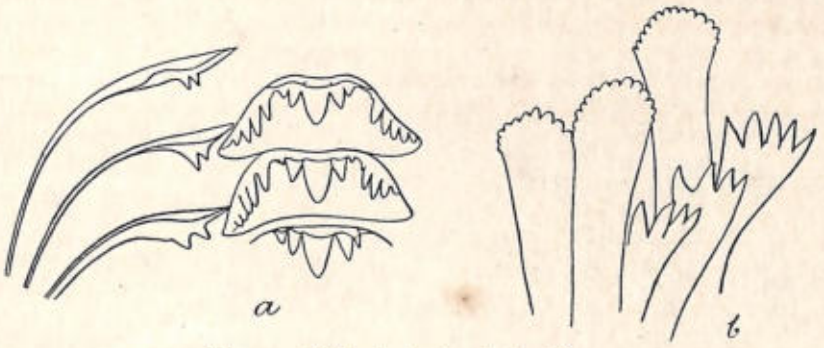

FIG. 4.—*Bithynia tentaculata*, Linn.

a. Centre and admedian teeth of radula, × 360. In the first are seen the "basal denticulations" representing the marginal cusps by the folding over of the margin: in the second the teeth are seen from the side.

b. The two marginal teeth, × 360.

the central tooth of these operculates was orginally a series of separate teeth now merged together.

The radula of other species of Indian *Bithynia*, that of *kashmirensis* for instance, should be looked at; they may not all be like that of *B. tentaculata*. Dr. Annandale has kindly sent me for perusal his valuable notes on "The Aquatic Mollusca of the Inle Lake and connected waters, Shan States." He includes the species collected of Nevill's genus *Hydrobioides*. He says the radula is like that of *Bithynia*, but with no further detail. This, however, is made good by excellent figures of the radulae of *H. nassa*, Theobald and two new species (plate xiv, figs. 4, 4*a*; 2*c*; and 5). These show the basal denticulations of the central tooth, so typical of *Bithynia*, present in every case; they are 3 in number, fewer than in *B. tentaculata*, in which 4 or 5 are present.

XIV. NOTES FROM THE BENGAL FISHERIES LABORATORY, No. 6.

Embryological and Developmental Studies of Indian Fishes.

By T. Southwell, *A.R.C.Sc., F.Z.S., Director of Fisheries, Bengal and Bihar and Orissa, and* B. Prashad *D.Sc., Superintendent of Fisheries.*

(With Plates XVI—XIX.)

This paper consists of four parts; part one deals with two new species of Leptocephalids found in the brackish waters of the Gangetic Delta; in part two we have described the life-history of an Indian Teleost—*Notopterus chitala*; the third part is a description of the egg-capsule of an Indian dogfish, and the fourth consists of descriptions of intra-uterine embryos of some Indian sharks and rays, together with a discussion of various points of general zoological interest resulting from this study.

I. Leptocephalids.

On the occasion of a visit, by one of us, to the Sunderbans, during March 1918, well preserved specimens of two species of Leptocephalids were obtained.

Leptocephalus milnei, sp. nov.

(Pl. XVI, fig. 1.)

This species has the usual band-like form.

Description.—Number of segments in a specimen, 120.

Length 55·4 mm.; height 8·3 mm.; head 4 mm.; distance of anus from the end of the tail, 13·2 mm.; eye 1·1 mm.; snout 1·3 mm.; post temporal part of the head 1·6 mm.; height 6·7 mm.; head 13·8 mm.; tail 4·2 times in total length. Snout rounded, head portion posterior to it slightly convex. Eye 3·6 times in the head, slightly smaller than the snout and about one and a half times in the post temporal part of the head. Gape of the mouth extending behind the eye.

Anus below 79th segment, three times farther from the tip of the snout than from the tail. Very minute teeth are present on the lower and the upper jaws.

Pectorals very small, rounded. Dorsal and anal fins with a large number of fin-rays, three to each myosegment.

There is a minute pigment spot at the base of each of the dorsal, caudal, and anal fin-rays, otherwise the animals preserved in spirit are of a creamy colour. When alive they were quite pellucid, but could just be distinguished swimming in the muddy water.

Specimens obtained in a small beam-trawl at Doorakara, Sunderbans (Gangetic Delta), Bengal, on 15th and 16th of March 1918.

Type-specimens registered in the collection of the Zoological Survey of India, No. F $\frac{87}{1}$.

We have much pleasure in naming this species in honour of Mr. Milne, M.A., I.C.S., Director of Agriculture, Bihar and Orissa, in recognition of much assistance rendered to the Fisheries Department.

Leptocephalus vermicularis, sp. nov.

(Pl. XVI, figs. 2, 3.)

This species, instead of having the usual band-like form, is rounded like a worm.

Description.—Number of segments in a specimen, 122.

Length 61·2 mm.; height 4·1 mm.; head 4·3 mm.; distance of anus from the end of the tail, 37·8 mm.; eye ·6 mm.; snout 1·1 mm.; post temporal part of the head 1·8 mm. Height 14·9, head 14·2, tail 1·6 times in total length. Snout acutely rounded, leading gradually to the post temporal portion which is very broad, even more so than the body. Eye 7·2 times in the head, about half the size of the snout and three times in the post temporal portion of the head.

Gape of the mouth extends a little behind the eye. Anus below the 47th segment, its distance from the tip of the tail being one and a half times the distance from the snout. Minute teeth on the upper jaw, none on the lower. Small rounded pectoral fins. The dorsal, caudal and anal fins rather small, with a large number of fin-rays, three to each myosegment.

There is a minute black spot at the base of each fin-ray, and a large number of scattered pigment spots, specially collected in groups on the ventral surface of the body. These pigment spots are visible only when specimens are examined under a high magnification, otherwise the specimens appear of a creamy colour when preserved. When alive they were quite pellucid and wriggled very quickly in the muddy water.

Only two specimens were obtained along with those of the other species described above, in a small beam-trawl at Doorakara, Sunderbans, Gangetic Delta, Bengal, on the 15th and 16th of March 1918.

Type-specimens registered in the collection of the Zoological Survey of India, No. F $\frac{87}{1}$.

II. LIFE-HISTORY OF *NOTOPTERUS CHITALA* (Ham. Buch.).

(Pl. XVI, figs. 4–10.)

During the months of June and July 1915, Mr. S. M. Mohsin, Superintendent of Fisheries, found eggs of *Notopterus chitala* attached to the masonry work of a bathing ghat on the banks of the river Ganges at Buxar, Bihar. He made a few observations on the nature of the nest, the guarding of the nest by the parent fish and the manner in which the eggs are deposited. Mr. Mohsin collected eggs from the first nest and from other nests which were subsequently found in the vicinity. He also hatched a few eggs in a large earthenware vessel and thus obtained specimens of some of the later larval stages. Our account is based on the material collected by Mr. Mohsin. This material, besides being far from complete, is in a very poor state of preservation. The exact age of the specimens is not stated and cannot now be ascertained. As, however, nothing is known about the life-history of this, or of any of the nearly related forms, we have thought it advisable to give the following description even though it is very incomplete. Field notes from Mr. Mohsin's report on the subject are also incorporated, but it should be understood that we have, as yet, had no opportunity of verifying or extending his investigations.

Breeding habits.—As a result of his observations and local enquiries Mr. Mohsin arrived at the conclusion that the spawning season of this fish extends from the end of May to the middle of July. This statement must, however, be taken with a certain amount of reservation as we know from experience that the information supplied by fishermen is generally inaccurate, and Mr. Mohsin's observations were of too limited a character to have enabled him to arrive at a very definite conclusion.

This species prefers to deposit its eggs on solid substances (such as brick-walls, stones, masonry, etc.) close to the banks of the river. The female, when shedding eggs, lies close to the object on which they are to be deposited, the body of the fish being inclined at a certain angle to the vertical. The eggs, being glutinous, adhere firmly to the object on which they are deposited. The male, later on, emits the milt over them. This very simple type of nest was the only one observed in this case. Usually, from three to five hundred eggs are laid at a time. During the period of laying and hatching, the nest is very carefully guarded by the parent fish and any intrusion is vigorously resented, fishermen attempting to go near the nest are frequently bitten. Unfortunately, no observations were made as to whether both the male and the female fish guard the eggs, or whether it is done by one of the parent fishes, or by both together, or alternately. Further, nothing is known as to whether parental care extends to the fry stages or not. According to Mr. Mohsin the eggs hatch out in about two weeks. When hatched, the fry have a large yolk-sac, and, during the four to five days

which elapse before this is absorbed, the fry lie quiet and idle, and do not swim unless disturbed.

The following stages were present in the collection :—

(i) Stages with the embryos still enclosed in large globular eggs (figs. 4–6).

(ii) Embryos hatching out, some having the egg membrane still attached.

(iii) Stages with the embryos having the yolk-sac in various stages of absorption (figs. 7–10).

The following descriptions are based on whole mounts or dissections only, as the specimens were found to be too poorly preserved for section cutting :—

The eggs are of a yellow colour owing to the contained yolk being of this colour in preserved specimens. Nothing is known regarding the colour of this mass in the living eggs. The eggs are large, measuring about 5·2 mm. in diameter. The egg-membrane, on the surface of attachment, is raised up into small projections (fig. 4) by means of which the eggs are attached to stones or other objects in the nest. Some clusters of from three to five eggs were also found adhering to one another by their sides, and these also showed similar surface projections.

On the following page we have given in a tabular form the sizes of five of the later stages and other details of measurement of various organs, etc., in the respective stages. Other details will be found in the detailed description.

Stage I (fig. 4).—This stage is a fairly advanced one, the contained embryo having already grown to 7·1 mm. in length. The embryo lies within the egg-membrane in a slightly coiled position over the yolk-sac, and shows a continuous fin-fold along the dorsal and ventral surfaces and over the tail, the division into the various portions not being marked off at this stage. The head is differentiated but still attached to the yolk-sac ventrally. The eye and the ear are formed, but the pigment has not been deposited as yet in the eye. Lying posterior to and below the eyes is the heart, its demarcation into chambers has already commenced but has not advanced sufficiently for the various divisions to be identified. The notochord has a straight course in the tail, and is not turned upwards. The mouth opening is seen as a slit and the rudiments of the branchial arches are also present. The tube of the alimentary canal and the liver mass are just distinguishable. The air bladder is present as a small, slightly oval sac. In the body and in the tail region the myocommas of a < shape are present; fifty-seven were counted in a specimen but in the terminal portion of the tail their boundaries could not be seen.

Stage II (figs. 5–6).—This stage is only a little more advanced than the previous one, and but for the lobes of the brain being better marked, the myocommas better developed, the myosepta having a more wavy outline and the eye and the air-bladder being more distinct, there is nothing special to mark in this stage.

Stage of the larvae.	Total length	Maximum depth of the body.	Dimensions of the yolk-sac.	Head length.	Size of the dorsal fin.	Size of the pectoral fin.	Size of the anal fin.	Size of the caudal fin.	Length of the air bladder.	Remarks.
III.	13·8 mm.	1·6 mm.	Diameter 5 mm.	2·1 mm.	...	Just appearing.	6·9 mm.	1 mm.	1·2 mm.	Just hatching out.
IV.	14·2 mm.	1·8 mm.	5·2×4·8 mm.	2·5 mm.	...	·8 mm.	7·1 mm.	,,	,,	Head separated from yolk-sac.
V.	17·1 mm.	2·6 mm.	5·3×3·6 mm.	3 mm.	Slightly indicated.	1·5 mm.	11 mm.	1·2 mm.	1·6 mm.	
VI.	18·4 mm.	3·2 mm.	5·2×3·1 mm.	3·3 mm.	Undifferentiated, about ·8 mm.	1·6 mm.	11·3 mm.	1·4 mm.	2 mm.	
VII.	19·5 mm.	4·1 mm.	...	4·5 mm.	1·5 mm.	2·1 mm.	11·5 mm.	1·9 mm.	4·3 mm.	Last larval stage with no trace of an external yolk-sac.

Stage III.—This is a much more advanced stage than the last one. Some of the larvae have already hatched out while others are still enclosed in the egg-capsule. In hatching, the free posterior portion of the body and the tail (both of which are well developed) are the first to come out of the egg-capsule. The head and the rest of the body, with the large yolk-sac, are then separated out by violent movements of the tail. Some of the larvae show the body still enclosed in the egg-capsule but have the tail protruding.

In this stage only a part of the head is free, the rest is very closely applied along the ventral surface to the yolk-sac, as shown (to some extent) in fig. 7. The mouth is present as a distinct, horizontal slit and the opercular limits are also marked, specially on the ventral surface. The head, which has not developed to any great extent as yet, is broadest in the region of the hind brain. This latter structure is well developed, and shows the large cerebellum getting marked from it. The pectoral fins are just appearing and the continuous dorso-ventral fin has, besides increasing in size, begun to show rudiments of the fin-rays, in the caudal region. The supporting elements of the fin-rays (or pterygiophores) are already well developed. There is nothing particular to note about the sense organs except that the external narial opening is well developed. The gill slits are well advanced and the arches show traces of the development of gill filaments on them. The air-bladder is elongated and sac-like, measuring about 1·2 mm. in length, it shows no constriction.

Stage IV (fig. 8).—The mouth, which was ventral in the last stage, has, owing to the separation of the head from the yolk-sac and the better development of the middle portion, shifted to a position far forward and is now more or less anterior. The head is becoming marked off as a prominent structure owing to the special development of the optic lobes and the cerebellum. The eyes are now partly enclosed in the optic capsules and do not protrude as much as in the last stage. The pectoral fins are better developed and the fin-rays are making their appearance both in the pectoral and in the anal fin-portion of the dorso-ventral fin. The yolk-sac is being gradually absorbed and has become transformed from a rounded to an ovoidal structure. The gill filaments are better developed and even gill-rackers are developing on the arches. The outline of the jaws is also indicated.

Stage V (fig. 9).—This stage, except for showing the beginning of the dorsal fin, is very near the last one. The various organs, however, are better developed and there is a distinct increase in size.

Stage VI.—This stage has still a fairly massive yolk-sac. It shows the operculum quite separated as a flap on either side and forming the posterior limit of the head. The flexure of the brain is better marked, and the medulla oblongata is much better

developed. The eye has become still more enclosed in the capsule. In the skull, the jaws are already nearly complete, the enveloping bones and the teeth are beginning to be laid down. In the vertebral column the body of the vertebrae, the neural and the haemal arches are formed in the anterior part of the body region but not further in the region adjoining the tail. So far as the fins are concerned, this is the first stage in which the fin-rays have begun to make their appearance in the region of the dorsal fin, though the basal pterygiophores could be distinguished in this situation even in the last stage. In the anal and the caudal fins the rays are already quite well developed and the limit between these two fins is also just indicated by the direction of the fin-rays. The alimentary canal, the liver, and the air-bladder are better developed. In the gills, the filaments are larger and are present on all the four gill-arches.

Stage VII (fig. 10).—This is the most advanced stage in the collection and shows no trace of an external yolk-sac. The general colour is milky white in the preserved state. Irregularly scattered chromatophores of the usual shape and of a brownish colour are present on the head and on the abdominal portion; none, however, can be distinguished in the tail region. No scales are developed as yet, but in sections of a portion of the body-wall, scales can be distinctly seen developing in the scale-sacs. There is still a continuous fin-fold, in which the dorsal fin is distinctly marked off about the middle of the animal, and it has well developed fin rays. The thin covering of the fins is still directly in continuation of the original dorso-ventral fin, which latter has become greatly reduced posterior to the dorsal fin but is fairly broad anteriorly. The pectoral fins are much larger and have fully developed fin-rays. The yolk-sac is entirely withdrawn into the body-cavity and is not visible externally. Unfortunately, the condition of the material at our disposal does not allow of a description of the internal yolk-sac, as the structure may now be termed. The operculum is quite well developed, its posterior boundary lies a little behind the middle of the distance between the snout and the anus. In the operculum, the opercular, pre-, inter- and sub-opercular elements are marked off, and ossification has commenced. Five branchiostegal rays are already formed and traces of three others can also be seen. The anus lies at a distance of about one-third the total length from the anterior end. The eye is contained about four times in the head length and its distance from the snout is equal to its diameter. The external narial opening, which is seen as a distinct aperture in this stage, is situated near the middle of the distance between the eye and the snout. In the skull region also, ossification has commenced, but the stage is too young to show the various elements. All the jaw-bones are, however, well developed and teeth are present on the maxillaries, dentaries, vomers and palatines. A few can also be seen on the urohyals.

In the body, the irregular myosepta are to be distinguished

only in the middle region. The alimentary canal is very short and shows only the beginning of the stomach and the pyloric caecae. The liver is better developed. The chambers of the heart are becoming more consolidated and the air-bladder is distinctly notched about the middle. The gills are much better developed. The kidneys can be distinguished as faint thickenings, but no genital organs can be satisfactorily identified.

III. THE EGG-CASE OF *CHILOSCYLLIUM GRISEUM*.

(Pl. XIX, fig. 5.)

In 1914, Sundara Raj contributed to the "*Records of the Indian Museum*," Vol. X, pp. 318–319, a note on the breeding habits of *Chiloscyllium griseum*, Müll. and Henle. In his note a description of the egg-case of this dogfish was included. The egg-cases were laid in the marine aquarium at Madras in January 1913. Unfortunately the figure accompanying the note is very poor and, further, is inserted wrong side upwards. Moreover, the egg-cases obtained by one of us differ in certain important characters from those described from Madras. We have, therefore, thought it advisable to give a detailed descriptive account, and a good diagram of the egg-case of this fish. Through the courtesy of Dr. N. Annandale, Director, Zoological Survey of India, we were able to compare our specimens with one of the Madras specimens, now in the collection of the Zoological Survey of India (Indian Museum, Calcutta).

A few words regarding the nomenclature of the Indian species of the genus *Chiloscyllium* would not be out of place here. Day in his "*Fishes of India*," p. 726, pl. clxxxviii, fig. 3 (1878), and later in his "*Fauna of British India, Fishes*," Vol. I, pp. 34–35, fig. 14 (1889), recognized only a single species, viz. *C. indicum* (Gmel.), with *C. griseum*, Müll. and Henle and *C. plagiosum* (Bennet) as synonyms. Tate Regan in his revision of the dogfishes[1] came to the conclusion that the three species are quite distinct. The same view was further confirmed by Garman[2] and has also been found by us to be quite sound. Sundara Raj in his paper describes the egg-cases as belonging to *C. griseum* = *C. indicum* of the "*Fauna*" not saying, however, that the two are distinct species. We are indebted to Dr. B. L. Chaudhuri, Assistant Superintendent, Zoological Survey of India, for the confirmation of the identification and for help in working out the synonymy of the species.

The two egg-cases on which the following description is based were obtained in the Gangetic Delta at Port Canning, Bengal, in March 1918, from a gravid female. Each oviduct contained a

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[1] *Proc. Zool. Soc. London*, 1908, pp. 347–364, pls. xi–xiii.
[2] *Mem. Mus. Comp. Zool. Harvard*, XXXVI, p. 66 (1913).

single fully developed egg-case, besides a large quantity of yellowish fluid secretion surrounding a number of eggs.

The egg-cases when fresh were of a light yellowish colour. The specimens preserved in spirit are dark yellow, the margins being still darker, whereas the sides are brownish. It is of a quadrangular shape, much broader in the middle than at the ends. Two of the four sides of this quadrangular structure are very much narrower than the other two, and hence the longer sides, instead of being straight, curve inwards near the two ends, and in a contracted specimen, seem to meet each other. In the middle, the egg-case is much thicker owing to the egg and the yolk contents. Near the upper and lower edges the two surfaces of the chitinous case meet and are united to form a flat surface, which in contracted specimens is wrinkled. The four angles are prolonged into small thin filaments, which, compared with those of the European species of dogfishes, are rudimentary structures, and would be of little use for the attachment of the egg-cases to foreign objects in the sea after these have been laid. But another structure of a different type, and probably more suited to the conditions under which these fishes live, has been developed. Attached to one of the longer sides is a very long (134 mm.) and thick cord of a silky material. Where it joins the egg it broadens out and is attached along a large area on the side. It then gradually tapers to a cylindrical cord. This long cord would be very useful for mooring the egg-cases to any object at the bottom of the sea. A few strands of a white colour also arise from two places on the opposite side.

The two specimens are of the same size, the measurements of one of these are as follows :—

Maximum length	.. ..	.. 60·8 mm.
,, breadth	.. ..	.. 31·1 mm.
,, thickness	..	.. 16·5 mm.

IV. INTRA-UTERINE EMBRYOS.

In this part of the paper we have given descriptions of the intra-uterine embryos of a number of Indian Elasmobranchs. In addition to the material described we had before us a number of embryos as to the specific identification of which we are not certain. These, however, were found to be of great use in elucidating certain general conclusions which are given at the end of this paper.

Scoliodon walbeehmi, Bleeker.

(Pl. XVII, figs. 1, 2, 4, 7 and 8.)

1889. *Carcharias walbeehmi*, Day, *Faun. Brit. Ind., Fishes*, I, p. 10.
1913. *Scoliodon walbeehmi*, Garman, *Mem. Mus. Comp. Zool. Harvard*, XXXVI, p. 112.

In the young embryo 106 mm. long the head is not at all elongate and the snout much less pointed than in the adult. The

snout measured from the mouth is just equal to the length of the mouth. The mouth is slightly narrowed forwards. The extent of the labial folds which are poorly developed is nearly the same on the two jaws. The distance of the nostrils from the point of the snout is approximately the same as that from the mouth, and the distance between the two nostrils is much less than the length of the mouth. The eyes are large and prominent, much longer than half the length of the mouth and the distance from the nostril or even the width of the gill-opening. The gill-openings are of the same shape as in the adult. The ventrals, second dorsal and the anal fins are of the same type as in fully grown specimens. The pectorals have their outer margin slightly curved and the posterior nearly straight and not at all showing the characteristic appearance of the fins of the adult. The anals in a male embryo of the size noted have stout elongated claspers not reaching the tip of the fins. The caudal fin is broad in the region of the sub-caudal lobe, where there is a distinct notch; a second notch is situated posteriorly at a short distance from the tip.

The placental cord is attached at a point in line with the anterior edge of the pectoral fins and midway between them (fig. 1).

The colour of the specimens preserved in spirit is slightly greyish with traces of brown on the fins.

Measurements :—

Total length	106 mm.
Snout to caudal pits	76·4 mm.
Snout to fifth gill-opening ..	29·8 mm.
Snout to mouth .. .	10·6 mm.
Length of placental cord	65 mm.

Placental cord.—The nomenclature of the parts, the appendicula and other points about the external structure are dealt with in the general section at the end of this paper. Here we will, however, describe the internal relations with the foetal organs and the histological structure

The placental cord after entering the body of the embryo is seen to consist of an artery and a vein, the outer wall of the cord is not to be seen inside the body. The artery, which is thinner in diameter, passes through the mesentery and, as shown in fig. 2, joins the dorsal aorta. The venous branch, after a short course, opens into the portal vein.

The placental cord as seen in a transverse section (fig. 7) consists of an artery and a vein surrounded by four main channels, and on the outside surrounded by a wall formed of epithelium two to three cells thick, and having a thin connective tissue lining inside. The wall of the channels mentioned above is also formed of connective tissue. The outer wall of the placental cord is raised into elongated tubular processes, the appendicula; the structure of these is dealt with further on.

Two specimens of embryos of this fish were obtained from an adult shark trawled in Portugal Bay, Ceylon, on the 27th of February, 1911.

Scoliodon sorrakowah (Cuv.).

(Pl. XVII, figs. 6, 9 and 10.)

1889. *Carcharias laticaudatus*, Day, *Faun. Brit. Ind., Fishes*, I, pp. 9, 10, fig. 1.
1913. *Scoliodon sorrakowah*, Garman, *Mem. Mus. Comp. Zool. Harvard*, XXXVI, p. 110.

In embryos 135 mm. long the head is slightly depressed, the snout is long, gradually narrowing anteriorly and a little rounded at the end. The distance of the snout from the mouth is much longer than the distance between the eye and the first gill-opening. The nostrils are much nearer the mouth than the snout. The mouth is a little wider than long, rounded in front and with feebly developed labial folds on the lower jaw, none on the upper. The teeth are not fully developed.

Fins.—The pectorals are much longer than wide and do not reach the origin of the first dorsal; they have the hind margin nearly straight. The base of the first dorsal is much longer than the distance between the ventral and the anal, and is nearly equal to that between the anal and the caudal; it ends slightly in front of the ventrals. The base of the second dorsal is much less than that of the anal. The caudal is well developed with a large subcaudal lobe. The claspers in male specimens are feebly developed rods.

The attachment of the placental cord is of the same type as in *S. walbeehmi* described already.

Colour.—The back is of a bluish-grey colour, lighter on the sides and with the ventral surface whitish.

Measurements :—

Total length ..	..	135 mm.
Snout to caudal pits	..	72 mm.
Snout to fifth gill-opening	..	36 mm.
Snout to mouth ..	..	12·1 mm.
Length of placental cord	..	95 mm.
Yolk-sac placenta	..	11·5 mm. × 9 mm.

The above description is based on a well developed specimen out of a large series obtained at Puri, Orissa, during the months of June and August, 1918. There are some younger embryos as well but these do not show any special peculiarities.

Pristis cuspidatus, Latham.

1909. *Pristis cuspidatus*, Annandale, *Mem. Ind. Mus.*, II, pp. 5, 6.

The external characters of the embryos before us, which were collected by one of us from off the coast of Ceylon, have been

dealt with at length by Southwell[1] and later by Hussakof.[2] The embryos were all presented to the Colombo Museum, Ceylon, and we are indebted to the Director of the Museum for kindly sending two of them to us. We are thus able to add a few notes about the internal anatomy and especially the disposition and connections of the yolk-stalk.

The liver is yellow-ochre in colour and consists of a large undivided right lobe and a much larger left one, which is divided into two. The gall-bladder is small and lies embedded in the left inner lobe of the liver at its upper end; the bile duct after receiving the branches from the liver-lobes opens dorsally into the colon close to its commencement. The stomach is large, of a pale yellowish colour and lies on the left side partly covered by the liver; in the specimen dissected it was found to be quite empty. The duodenum is small and of a bluish-green colour. The colon, which is very large and has a well developed spiral valve, lies on the right side. The contents of the colon were found to be a large quantity of partly digested yolk, which is received from the large internal yolk-sac. The internal yolk-sac lies dorsal to the colon and opens into it close to its commencement. The rectum is bent on itself and has a large pear-shaped gland opening into it dorsally.

The specimen dissected was a female, and had well developed kidneys and oviducts, but only a trace of the ovary was to be seen.

As has been described above there is a large internal yolk-sac connected with the colon internally. This internal yolk-sac is only an enlargement of the end of the yolk-stalk after it enters the body of the embryo, and forms a sort of reservoir for the yolk from the external yolk-sac before its transference into the colon. Unfortunately the external yolk-sac in both the specimens was cut off and so the relations of the blood vessels of the sac and stalk can not be fully described. At the inner end, where the yolk-stalk enters the body of the embryo, a single artery and a vein were seen. The artery passes dorsally and becomes connected with the dorsal aorta, while the vein enters the hepatic portal vein. The other relations are probably the same as are described further on for *Rhinobatis columnae.*

Rhinobatis columnae, Bonaparte.

(Pl. XVIII, figs. 1–6.)

1832-41. *Rh. columnae*, Bonaparte, *Fauna Italica, Pesci*, No. 152, plate.
1909. *Rh. columnae*, Annandale, *op. cit.*, pp. 14–15.

Annandale in the paper cited above has discussed the name, etc., of the Indian species. We have before us two stages of very different ages,—one of a shark-like form and the second in which the embryos resemble the adult in general shape, though still

[1] *Spolia Zeylanica*, VI, pp. 137–139, 1 pl. (1910).
[2] *Bull. Amer. Mus. Nat. Hist.*, XXXI, pp. 327-330, figs. 1, 2 (1912).

showing certain embryonic characters. We will treat of these stages separately.

I. *Shark-like form* (fig. 1).—We have two specimens of this stage, one a male and the other a female. Unfortunately in both cases nearly the whole of the yolk-cord and the yolk-sac are missing.

The embryos have a large number of branchial filaments coming out of the gill-openings ventrally. The eyes are large and project on the sides of the head; the interorbital distance is much longer proportionately than in the adult. The snout is very small and rounded instead of being pointed as in the adult. The mouth owing to the snout hanging forwards comes to lie in a depression. The spiracles are situated just behind the eyes and have a slightly ovoid outline. The nasal openings have all the valves as in the adult. The branchial region is only slightly inflated. The pectoral fins are attached laterally by a very small base behind the branchial region, but the anterior edge is already growing forwards to unite with the snout to form the disc. The pelvic fins are very small and so are both the dorsal fins. The claspers in the male specimen are merely flat lobes of skin. The tail-fin is not well developed as yet.

There is nothing special to note regarding the internal anatomy of this stage; the various points of interest are dealt with further on in the description of the more advanced specimens.

Measurements of the male specimen:—

Total length	36·5 mm.
Maximum breadth of the pectoral fins ..	12 mm.
Length of the pectoral fins ..	9·2 mm.
Distance of the pectoral fins from the snout	7·8 mm.
Snout measured from the mouth ..	4·2 mm.
Interorbital distance	3·8 mm.
Tail	21·1 mm.

II. *Stage with adult form* (figs. 2, 3).—The snout is not at all pointed and is rather acutely rounded; its length is contained less than six times in the total length; the distance between the outer angles of the nostrils is a little more than half that between the mouth and the end of the snout. The anterior nasal valve is produced far beyond the internal margin of the nostril but does not reach the valve of the opposite side; there is a large valve arising from the outer angle which is connected with a similar valve from the posterior margin. The valve from the posterior margin has in addition a small lobe arising from its inner surface and covered by the anterior nasal valve. The back is slightly arched owing to the large and swollen branchial region. The pectoral fins are evenly rounded and do not possess the straight margin so clearly shown in Bonaparte's excellent figures of the adult (*op. cit*); the breadth across the widest part of the pectoral fins is contained a little more than three times in the total length,

The pelvic fins have a rounded tip and do not show the shape characteristic of the adult. In the male specimens the claspers have developed into small rod-like structures, arising at a point about $\frac{2}{3}$ the length of the fins from the base, and have slightly pointed apices. The pelvic fins are at this stage proportionately much smaller than in the adult; they arise more ventrally and their tips do not reach the base of the first dorsal; the distance between their tips and the base of the first dorsal being a little less than that between it and the second dorsal. The rostral ridges are broadly separated. The back is quite smooth but small tubercles are just indicated along the mid-dorsal line, others are scattered in two rows parallel to the middle and a few are also to be seen round the orbits.

The *mouth* is slightly arched. The teeth are very minute; those along the inner and outer margins of both the jaws are much larger than the others, which are to be seen all over the jaws. The roof of the pharynx also has a large number of small denticles.

The *colour* of specimens in spirit is dark yellowish; the fins are much lighter and appear of a creamy colour; the membrane connecting the snout with the pectoral fins is light yellow; the ventral surface and the yolk-stalk creamy. The yolk-sac, however, is dark yellow.

Measurements of a female specimen :—

Length	114	mm.
Maximum breadth of the disc	38	mm.
Length of snout measured from the mouth ..	20·5	mm.
Distance between the nostrils	12·5	mm.
Length of the yolk-stalk ..	16	mm.
Yolk-sac	22	mm. × 28 mm.

Internal anatomy (fig. 4).—We do not propose dealing with the internal anatomy at length; a few of the outstanding features of general interest alone are described. In the pharynx fairly large semilunar openings of the spiracles are to be seen on either side. The oesophagus is small, the stomach is long, having the usual **U**-shaped form, with well developed longitudinal folds on its inner walls and a thick valve at the pylorus. The duodenum is very short and, like the oesophagus and stomach, quite empty. The colon is very large and has a fully developed spiral valve; the internal yolk-sac opens into it dorsally very near its anterior end on the right side. The colon is full of yolk granules. The rectum is a much thinner tube and has a large rectal gland. In the cloacal region of the rectum the oviducts and ureters also open (fig. 4). The liver and the gall-bladder are fully developed. The former is brownish but the gall-bladder is of the usual greenish tinge. The pancreas and spleen are of a dark yellow colour. The single ovary is as yet poorly developed.

The internal yolk-sac is an ovoidal structure lying slightly

dorsal and to the right of the colon; it is connected with the external yolk-sac through the yolk-stalk and internally with the colon as has been described above.

Histology of the yolk-stalk, etc. (figs. 5, 6).—As seen in a transverse section the yolk-stalk is nearly circular, with a fairly thick wall bounding a spacious internal circular cavity. The thick wall (fig. 6) is formed of:—

(i) A single layer of very flat epithelial cells of epiblastic origin.

(ii) A fairly thick mesoblastic portion, many-layered and with a large number of blood vessels,—both arteries and veins, arranged near the inner periphery in a circle; all the blood vessels are full of blood corpuscles. The cells forming this portion are more or less polygonal with slightly wavy walls and with a small nucleus.

(iii) The innermost hypoblastic layer consisting of a single layer of flat epithelial cells.

The wall of the yolk-sac is also formed of the same three layers, but the mesoblastic portion is not so thick and the hypoblastic layer is indistinguishable in some places.

The blood vessels as ascertained by dissection and serial sections were found to unite with one another, the arteries with arteries and the veins with veins, until, near the point where the yolk-stalk enters the body of the embryo, only a single large artery and a single vein are to be seen. The connections of these blood vessels with those of the embryo are as follows: the artery opens into the dorsal aorta and the vein joins the hepatic portal vein. The exact arrangement of the finer blood vessels on the yolk-sac could not be followed.

The contents of the yolk-sac and the stalk were minute, nearly circular yolk granules.

The arrangement of the blood vessels and the connections of the yolk-sac point to a double mode of absorption of its contents, *viz.* (i) the direct transference of the yolk granules into the colon through the yolk-stalk, and (ii) through the blood vessels.

The above description is based on specimens obtained by dissection from two female specimens trawled at the south end of Periya Paar on the coast of Ceylon, on 23rd of February, 1911. There are nine well preserved specimens besides some in poor condition. The two young shark-like embryos were also obtained from the same locality on the 8th of December, 1910. The disc of the parent fish measured about 2 feet 10 inches in breadth and there was a single embryo in each oviduct.

Trygon kuhlii (Müller and Henle).

(Pl. XIX, fig. 1.)

1909. *Trygon kuhlii*, Annandale, *op. cit.*, pp. 34, 35.

As shown in fig. 1 the outline of the disc of the single female embryo before us is a quite regular curve, not at all angulate.

Anteriorly, owing to the pectoral fins not having grown forwards sufficiently to meet in the middle, there is a very distinct notch on either side separating the fins from the rounded papilla-like tip of the snout. The disc is only slightly longer than broad and the specimen still possesses the original shark-like form, except that the pectoral fins are better developed though not quite lateral in position even yet. The head at this stage is a prominent structure projecting far above the level of the fins, particularly in the region of the fore- and mid-brain. The eyes are large and prominent, hanging outwards. The spiracles are large, broad and more or less semicircular openings, situated one on either side of the head in a lateral rather than a dorsal situation. The other gill-slits, with the large elongated branchial filaments springing out of them, are situated on the ventral surface, but, owing to the thin and transparent skin, can be seen through it from the dorsal surface. The branchial region is only slightly inflated. The number of gill-filaments is very large. Only a few, however, are shown in the figure for the sake of clearness; one of these measured over 50 mm. in length. The skin is quite smooth without any tubercles either on the disc or the tail. The pectoral fins show distinct fin-rays. The tail has a rather thin continuous fin-membrane on the dorsal and ventral surfaces; on the distal half it is better developed on the ventral than on the dorsal side, but there are no fin-rays to be seen. The yolk-sac is rather small and the yolk-stalk has the same structure as has been described in detail for *Rh. columnae* (p. 229).

The specimen preserved in spirit is of a white colour except for the pectoral fins, which have a brownish tinge. The yolk-stalk is of the same colour as the embryo but the yolk-sac is yellowish. Ventrally the embryo appears brownish owing to the colon shining through it.

Measurements of the female specimen:—

Length of the disc	..	29·1 mm.
Maximum breadth of the disc	..	26 mm.
Interorbital distance	..	5·5 mm.
Snout (measured from the mouth)	.. ..	5·3 mm.
Mouth to vent	.. ..	23·4 mm.
Tail ..	.. ..	38·2 mm.
Yolk-sac	.. ..	10 mm. by 7 mm.
Yolk-stalk	.. ..	16·5 mm.

Internal anatomy.—The colon is the largest of all the parts of the alimentary canal and lies on the right side; it has the yolk-stalk opening directly into it on the dorsal side, there being no internal yolk-sac. In embryos of *T. bleekeri* the duct, according to Alcock,[1] opens ventrally, but in the specimens of this species and of *T. uarnak* dissected by us it opens dorsally. The duode-

[1] *Ann. Mag. Nat. Hist.* (6), IX, p. 425 (1892).

num and the stomach both contain large quantities of coagulated material of the nature of a secretion from the uterine glands of the mother and probably absorbed through the large spiracles. The rectal gland, it may be remarked, is a very large elongated sac opening distally into the rectum. The lobes of the liver, of which the left one is the largest, are of a yellow colour. The gall-bladder is a small and thin-walled sac with very little secretion in it. The ovary is not to be distinguished in this stage.

Only a single female specimen of this species was obtained, from a large female trawled at Periya Paar on the coast of Ceylon, on the 7th of February, 1911.

Trygon uarnak (Forskål).

1909. *T. uarnak*, Annandale, *op. cit.*, pp. 22–24, fig. 2.

The embryo is slightly more advanced than that of *T. kuhlii* described above. The disc has assumed a more definite form, the pectoral fins having grown further forwards; otherwise the shape of the disc and head is very similar. The fins-rays also are better developed.

The skin is thicker and a few tubercles along the mid-dorsal line are to be seen. The colour is slightly brownish.

The measurements of the male specimen are as follows:—

Length of disc ..	..	25·2 mm.
Breadth of disc	..	20 mm.
Interorbital distance	..	5·6 mm.
Snout (measured from the mouth) ..	..	5 mm.
Mouth to vent ..	..	17·4 mm.
Tail	..	25 mm.
Yolk-sac ..	..	12 mm. by 7 mm.
Yolk-stalk ..	..	14 mm.

Branchial filaments.—The specimen has only a few small filaments coming out of the gill-slits ventrally.

We have only a single male specimen before us, though three were obtained from a large female trawled on the 4th of March, 1910, at Portugal Bay, Ceylon.

Hypolophus sephen (Forskål).

(Pl. XIX, fig. 2.)

1916. *Hypolophus sephen*, Chaudhuri, *Mem. Ind. Mus.*, V, pp. 409-410.

Chaudhuri in the paper cited above has given measurements, etc., of two embryos from the Chilka Lake. The specimen before us, also from the Chilka Lake, need not, therefore, be discussed at length; we only mention a few additional facts on the external characters and the internal anatomy.

The embryo is certainly more advanced than those of either of the two species of *Trygon* described above, even though it shows a large number of filaments hanging out of the gill-slits. (The branchial filaments, the yolk-sac and the yolk-stalk are not shown in the dorsal view of this specimen, fig. 2). The pectoral fins have developed further on the two sides, but the papilla of the snout separating them is quite distinct. The pectoral and pelvic fins have well developed fin-rays. The claspers are as yet only flap-shaped structures. The tail has a distinct fold of skin forming a fin-membrane.

The general shape of the body has become more like the rays in that the head does not protrude so much and the body is more depressed to form a flat disc.

Internal anatomy.—The colon is relatively smaller as is also the rectal gland. The stomach and the duodenum both contain a large quantity of coagulated material of the same nature as in *T. kuhlii*. The connection of the yolk-stalk with the colon is also similar.

Pteroplatea poecilura (Shaw).

(Pl. XIX, figs. 3, 3*a*.)

1909. *Pteroplatea micrura*, Annandale, *op. cit.*, p. 39.
1913. *Pteroplatea poecilura*, Garman, *op. cit.*, pp. 412–413.

As Garman has shown in the paper cited above the name of this Indian species must be *P. poecilura*, the name *P. micrura* being confined to the West Indian form.

In the single embryo (fig. 3) before us, the lines of union of the pectoral fins with the snout are still indicated and the fins have not as yet met in front. The eyes do not protrude so much, the spiracles (fig. 3*a*) are comparatively smaller than they are in the younger stages figured by Wood-Mason and Alcock,[1] and the appearance of the embryo is more like that of the adult. There are no branchial filaments at this stage and the yolk-sac and the yolk-stalk are already absorbed to a very large extent.

Measurements of a female specimen :—

Length of disc	..	73 mm.
Maximum breadth of disc	..	115 mm.
Interorbital distance	..	14·4 mm.
Snout	..	12 mm.
Mouth to vent	..	51·2 mm.
Tail	..	65 mm.
Yolk-sac	..	6·5 mm. × 4 mm.
Yolk-stalk	..	9 mm.

There is a single specimen of this stage before us. It was dissected out of a large adult specimen trawled in Portugal Bay,

[1] *Proc. Roy. Soc.*, XLIX, p. 359, pls. vii, viii (1891).

Ceylon coast, on 7th November, 1910. There was a single specimen in the right oviduct.

This specimen, though evidently much older than the ones described by Wood-Mason and Alcock, has a vestige of a yolk-sac and yolk-stalk, whereas the specimens described by these authors had no trace of a yolk-sac or yolk-stalk (p. 364, *loc. cit.*).

Aetomylaeus nichofii (Schneider).

(Pl. XIX, figs. 4, 4*a*.)

1909. *Myliobatis nieuhofii*, Annandale, *op. cit.*, p. 51.
1913. *Aetomylaeus nichofii*, Garman, *Mem. Mus. Comp. Zool. Harvard*, XXXVI, p. 436.
1916. *Aetomylaeus nichofii*, Chaudhuri, *op. cit.*, V, p. 413.

This is a very interesting stage in that it is slightly more advanced in the absorption of the yolk-sac and the yolk-stalk than the embryo of *Pteroplatea poecilura* described above.

Only the anterior part of the head can be said to be distinct from the disc (figs. 4, 4*a*). A horn or tentacle nearly 2 mm. in length projects slightly in front of the spiracles and below the eyes. The rostral fin has a fringe along its posterior margin.

The shape of the spiracles is very characteristic (fig. 4*a*) and brings into mind the peculiar modification brought about for the large trophonemata from the mother's uterus pouring their secretion into the pharynx. The upper margin of the skin which forms a covering over the spiracles is raised upwards and forwards.

The abdomen is very much swollen ventrally owing to the large colon, which can be seen through the skin. The dorsal fin arises just at the origin of the tail. The claspers in the male specimen are small rod-like structures tapering to a point at their free end; they measure 6 mm. in length.

The body is quite smooth. The yolk-sac and the yolk-stalk have already been very largely absorbed.

The embryos have a brownish colour. In one of them a dark brown line at a little distance from the margin of the disc and closely following its outline is very distinctly to be seen. The long tail has a deep chocolate colour banded with yellowish rings, ventrally its distal portion is entirely yellowish.

Measurements of a male specimen:—

Breadth of the disc	..	111 mm.
Mouth to vent ..	..	47 mm.
Length of snout ..	..	8·5 mm.
Rostral fin ..	..	11 mm. × 7 mm.
Interorbital space	..	16·5 mm.
Size of spiracle ..	..	13 mm. × 6 mm.
Tail	..	235 mm.
Diameter of yolk-sac	..	1·5 mm.
Yolk-stalk ..	..	0·4 mm.

Internal anatomy.—The only features worth noting are:—(i) The very large colon with a well-developed spiral valve. The colon measures 21 mm. in length; on being slit open it was found to be filled with yolk granules. Lying dorsal to and opening into the colon is (ii) the large internal yolk-sac. It is connected with the small external yolk-sac through the yolk-stalk. The stomach was quite empty. (iii) The rectal gland is a large structure, (iv) The liver is comparatively small. The specimen dissected was a male and shows the male organs, but not fully developed. Leydig's organ is not quite developed, the vas deferens is also small and not so convoluted.

Two specimens, a male and a female, were obtained from a large fish trawled in Portugal Bay on the 16th of February, 1910.

THE YOLK-STALK AND THE PLACENTAL CORD.

A few remarks about these structures will not be out of place here. In the sharks, as will be shown further on, the placenta is purely of the nature of a yolk-sac placenta, in some more highly evolved than in others. The arrangement and relations of the blood vessels in the yolk-stalk of the Batoids, *e.g.* in *Rhinobatis columnae*, are of a type essentially similar to that of the sharks. In the more highly advanced or evolved forms of placenta of sharks such as *Scoliodon walbeehmi*, the channel of the yolk-sac is obliterated in the later stages of development, owing to there being no yolk to absorb and the channel in the yolk-stalk being therefore unnecessary, and further owing to the blood vessels having developed to a much greater extent. The yolk-stalk now becomes the placental cord and instead of the channel in the yolk-stalk there is now a large artery and a large vein. The cavities of unknown function lying next to the blood vessels described in the account of the structure of the placental cord of *Scoliodon walbeehmi* may possibly be the remains of the original channel. Another point worthy of note is that the connection between the yolk-stalk and the intestine of the embryo must be stopped before the transformation of the yolk-stalk into the placental cord takes place. As in the earlier stages of the development of the sharks there is a yolk-sac and a yolk-stalk, the stage where there is a direct communication between the yolk-sac and the intestine must exist even in forms that later on have a placental arrangement. Unfortunately we have no material of the very young stages of these sharks at our disposal that would support these theoretical conclusions.

In their descriptions of the embryos, some authors have designated the yolk-stalk of the aplacental Batoids the umbilical cord. This apparently is a misnomer, as in view of what has been stated above, though the yolk-stalk or the stalk of the yolk-sac is transformed in the sharks into the placental cord on the development of the placenta, the converse is never true. In the Batoids with the condition of aplacental viviparity the yolk-stalk has

persisted as such, and not resulted from a retransformation of the placental cord into a yolk-stalk. Further, the condition of aplacental viviparity amongst the Batoids is to be derived directly from that in the oviparous Elasmobranchs and not that in the viviparous forms with a placental development. In fact, there are two distinct lines of development from the oviparous condition. (i) Viviparity with the development of a placenta, (ii) aplacental viviparity. The correct name, therefore, for the structure in these aplacental viviparous Batoids is the yolk-stalk or the stalk of the yolk-sac.

THE APPENDICULA OF SOME OF THE INDIAN CARCHARIDAE.

We have thought it necessary to deal with these structures as a whole in the various species that we have had a chance to examine.

Johannes Müller[1] in his admirable résumé of all that was known up to 1840 regarding the uterine structures, etc. in the Selachians does not mention any such processes in the text, or show any of them in the beautiful figures of the various species at the end of his paper. The species dealt with by him are *Mustelus laevis*, *Mustelus vulgaris* and *Carcharias* (*Prionodon*) *sp.* Alcock[2] is the only author, so far as we know, who has given an account of these structures, and it is to him that we owe the very appropriate name of appendicula. He described these structures for *Zygaena blochii* as follows:—"The placental cords, which were much more delicate, were uniformly covered, except at the extreme foetal end, with flattened, leaf-like, bilobed or trilobed appendicula, from one-eighth to one-quarter of an inch in length, each lobe being one-eighth of an inch broad." For the embryos of the other two species (*viz. Carcharias melanopterus* and *Carcharias dussumieri*), also described in the same paper, no appendicula are mentioned as being present on the placental cord. There are no other references to these structures in the literature consulted.

We have examined the embryos of the following species: *Scoliodon sorrakowah*, *S. palassorah*, *S. walbeehmi* and two other species of *Scoliodon*, the specific identification of which we are not certain, and of a *Cestracion* sp.[3] The results of our study of these structures show that there are at least four different types of appendicula in the species studied.

Type (i).—In a single specimen of *Scoliodon* sp. collected from the coast of Ceylon the placental cord is very long, measuring about 19 cm. The placenta is of the usual arborescent type and is attached to a portion of the uterine wall which was preserved along with the embryo. The placental cord is fairly thick, 5 mm. in diameter exclusive of the appendicula; its wall is thrown into

[1] *Abhand. Ak. Wiss. Berlin*, 1840, p. 188.

[2] *Journ. As. Soc. Bengal*, LXIX (ii), p. 51 (1890).

[3] According to Garman, *loc. cit.*, p. 155, *Cestracion* is the correct generic name for what has until recently been known as *Zygaena*.

folds, which, as shown in pl. xvii, fig. 3, become quite separated here and there to form small flat processes. These processes seem to be the starting point for the formation of the more highly evolved types of appendicula described further on.

Type (ii).—In *Scoliodon walbeehmi* the appendicula are of a more advanced type. As seen with the naked eye the whole surface of the placental cord is raised up into small tubular processes (pl. xvii, fig. 4). The processes or appendicula measure 1·4 mm. in length and ·3 mm. to ·5 mm. in breadth. The appendicula on being examined with the microscope are seen to be small flattened processes, broad at their free end and gradually narrowing to the point of attachment. Some of them as shown in the figure (where they are shown magnified 25 times) have notches anteriorly in positions where division might have taken place. With the low power of the microscope the wall of the appendiculum, which is formed of many layers of epithelial cells, appears of a much darker colour. There is, however, in the appendicula of this type no vessel of any kind such as that mentioned by Alcock (*loc. cit.*) for *Z. blochii*. Otherwise the appendicula of *Z. blochii* are very near those of this type.

Type (iii).—There are two embryos of a species of *Scoliodon* before us from Madras preserved *in situ* in the uterus of one side. The placenta in this species is of a type intermediate between the simple one found in *S. sorrakowah* and the more highly evolved arborescent one of *S. walbeehmi*. The placental cord, which measures 72 mm. in length, is thickly covered with appendicula. The appendicula as shown in pl. xvii, fig. 5 are elongated, much branched structures; the branches arise from a main axis and the further branching is more or less dichotomous. The appendicula are about 15 mm. in length, but not more than ·25 mm. thick. Each of the daughter branches is swollen at its extremity. No vessels can be seen in preparations of this type of appendicula.

Type (iv).—In *S. sorrakowah* and *S. palasorrah* the appendicula are elongated threads, simple or forked at a distance from the point of origin (pl. xvii, fig. 6); they measure up to 60 mm. in length. The appendicula in these two species have the same structures as in the other three types, except that there is a blood vessel in each. The placenta in the forms with this type of appendicula is the least highly evolved, being a true yolk-sac placenta, formed by the processes jutting out from the surface of the yolk-sac and embedding themselves in the uterine wall

It will be clear from what has been stated, that we can trace a nearly complete series in the evolution of long thread-like single or branching appendicula from mere projections on the wall of the placental cord. It may also be noted here that the appendicula may be present or absent in nearly related species of the same genus; for example, though they were described by Alcock (*loc. cit.*) for *Cestracion blochii*, they are absent on the placental cord of a foetus of another species of *Cestracion*, from the collections of the 'Golden Crown' from the Bay of Bengal. It should

also be borne in mind that though we have a nearly complete series from small projections on the wall of the placental cord to long thread-like appendicula, this does not give us any clue as to the evolution of these structures; nor does it indicate any relationships between the various forms; because in the species with the best-developed appendicula the placenta is of the most primitive and least evolved type and *vice versa*. Indeed, this last-stated fact seems to show that the forms with a less highly organized type of placenta requiring some other mode of absorption of food have developed these additional structures. The appendicula, if this is so, would be more of the nature of acquired or adaptive structures than indications of any genetic relationships.

Histological structure.—As seen in longitudinal sections (pl. xvii, fig. 8) the wall of the appendicula is found to be formed of three to four layers of more or less polygonal cells; the core of the finger-shaped processes is filled up by loose connective tissue, which reaches up to the walls of the channels in the placental cord. In the connective tissue portion stellate cells can also be distinguished here and there.

Function.—Alcock, with some doubt, considered the appendicula to be of the nature of lymphatic glands, provided the channels of the placental cord be considered as lymphatices. Their structure and various grades of development, and the blood vessels in the appendicula of *S. palasorrah* and *S. sorrakowah*, together with the grades of development of the placenta, tend to show that they might, like villi, serve in absorbing the food material secreted by the uterine wall of the mother. This secretion, as was seen in the case of the specimens at Puri, surrounds the embryos completely, just as the amniotic fluid does in the mammals.

PLACENTA.

Having already dealt with the placental cord we will now record a few observations about the placenta in some of the Indian sharks that we have seen, besides adding some notes about the forms previously described.

It may be stated at the outset that the placenta in these forms is of the nature of a yolk-sac placenta. When all the yolk in the yolk-sac has been absorbed, nourishment must be obtained by the embryo from the maternal uterus. This is done in a variety of different ways. In the earlier stages in the aplacental forms the branchial filaments are probably of use in absorbing the nutritous secretions of the uterus in which the embryos are lying. Later on special processes or trophonemata are developed from the uterine wall and these, entering the spiracles of the foetus, pour the nutritious secretion into the alimentary canal of the embryo. In the placental forms the yolk-sac is utilized for the formation of a placenta and the connection of the yolk-stalk with the intestine becomes obliterated; the blood vessels on the other hand become specially enlarged and nourishment is taken to the embryo directly through

the circulation of blood. We have been able to distinguish three distinct grades in the development of the placenta in these forms:—

(i) In *S. sorrakowah* and *S. palasorrah* we have the least modified type of placenta. As shown in pl. xvii, fig. 10, it is the original yolk-sac of the typical rounded to slightly ovoid form. At its lower free extremity it has a number of small protuberances which, as seen in pl. xvii, fig. 9, are embedded in the maternal uterine tissue and form a very simple type of yolk-sac placenta.

(ii) A placenta of a slightly more advanced type is the one mentioned by Müller, *op. cit.*, in his description of the placenta of *Mustelus laevis* and a species of *Carcharias*, where there is a distinct placenta-like interdigitation of folds of the yolk-sac, and these villi-like projections fit into corresponding depressions in the uterine mucous membrane of the mother like the cotyledons of the ruminant placenta.

(iii) In a specimen of *Scoliodon* sp. from Ceylon the yolk-sac has practically disappeared as such, and in its place we find that the placental cord broadens out into a flattened structure showing traces of division and transformation into an arborescent mass. The placenta in the two specimens of *Scoliodon* from Madras is still simpler than this, and is of a character intermediate between that of the second type and the one found in *Scoliodon* from Ceylon. This type when fully evolved is a fairly large arborescent structure formed by the continued subdivision of the distal extremity of the placental cord and the remains of the yolk-sac. The blood vessels in the placental cord also divide again and again to supply the various subdivisions of the placenta, which is a highly vascular structure. The placenta is in close connection with a flat highly vascular portion of the maternal uterine wall. Each embryo is connected by a separate placental connection with a separate part of the uterine wall. This type is found in *Scoliodon walbeehmi* (pl. xvii, fig. 1, shows a side view of only the foetal placental portion with the embryo and the placental cord), and has been shown by Alcock to occur in *Carcharias melanopterus*, *Cestracion blochii* and *Carcharias dussumieri*.

BRANCHIAL FILAMENTS.

In the earlier stages of the intra-uterine embryos of many Batoids large numbers of delicate and much elongated branchial filaments protruding out of the branchial openings of the embryos have been described by many authors. In the course of our studies we also have found these to be present in a number of species from which they had not been recorded previously. These filaments are the greatly elongated gill-processes which issue out of all the branchial slits ventrally except for the spiracles, and are so numerous as to form about one-third of the whole volume

of the embryo in *Pteroplatea micrura*.[1] In the more advanced embryos, however, the branchial clefts are tightly closed and there are no filaments, those which were formerly present having apparently atrophied. These structures, it thus seems, are present only in the earlier stages of the embryonic existence.

The structures have been called by many different names such as branchial or gill-filaments (Wood Mason and Alcock)[2], external gills or gill-filaments (Wood-Mason and Alcock)[3] and trophonematous filaments (Chaudhuri).[4] The name external gills or gill-filaments suggests that they function as gills and may lead to wrong conclusions being drawn as to their being homologous with or even analogous to the external gills of Amphibia. On the other hand the name trophonematous filaments would lead one to think that they were structures for the absorption of nutriment. But as the name trophonemata has been used by Wood-Mason and Alcock for the "narrow, strap-shaped nourishing processes" of the uterine wall of Batoids, we do not think it desirable that the same or an essentially similar name should be given to processes of the embryo. In our opinion the name branchial filaments is the most suited, as, besides showing their origin, it does not suggest or imply any function for these structures.

The branchial filaments have been already described in the descriptions of the various embryonic forms, their histological structure has been admirably treated by Alcock in his description of the "Embryonic History of *Pteroplatea micrura*" (*Ann. Mag. Nat. Hist.*, Vol. X, pp. 3, 4, 1892), and we have nothing to add to that account.

As to their function, Alcock in the paper cited above considered them to be of use for absorbing the nutriment in the yolk-sac of the embryo. Their very elaborate vascular supply, on the other hand, points to their being of the nature of respiratory structures, possibly in addition to their being of use in the absorption of yolk and the free secretions of the maternal uterine wall.

SUMMARY.

In the general observations we have described certain structures developed by Elasmobranch embryos during different periods of their intra-uterine existence. These structures result in very definite changes in the modes of obtaining nourishment, and may be summed up as follows :—

I. In the *placental* forms, in the earlier embryonic stages, there is no placenta and the yolk-sac functions as such. Later on,

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[1] Alcock, *Ann. Mag. Nat. Hist.* (6), X, p. 2 (1892). The correct name of the fish according to Garman as stated previously is *P. poecilura*.

[2] *Proc. Roy. Soc.*, XLIX, p. 363 (1891).

[3] *Proc. Roy. Soc.*, L, p. 204 (1891).

[4] *Mem. Ind. Mus.*, V, p. 409 (1916).

with the development of the placenta by the modification of the yolk-sac, nourishment is obtained directly from the blood of the mother through the blood-vascular system. In some cases additional structures or appendicula are developed on the placental cord, and these probably absorb the secretion of the uterine wall in which the embryos are floating.

II. In the *aplacental* forms the yolk-sac persists as such through a greater part of the embryonic life and the yolk in it is directly taken into the alimentary canal with or without the intermediation of an internal yolk-sac; possibly, as has been suggested, the branchial filaments also help in its absorption. In the earlier stages, when the branchial filaments are present, these help in the absorption of the secretion of the uterine glands. The blood vessels in the mesoblastic portion of the yolk-sac are also of use in absorbing the nourishment contained within it. During the later stages of development special processes are developed in some cases from the maternal uterine wall and these processes or trophonemta, entering the embryonic spiracles directly, pour the secretion into the pharynx of the embryo. It may also be mentioned here that during the embryonic portion of the life-history the stomach does not function as such, but merely acts as a channel for the transport of food to the colon, where absorption mostly takes place.

EXPLANATION OF PLATE XVI.

FIG. 1.—Lateral view of *Leptocephalus milnei*; same size.

,, 2.—Lateral view of *Leptocephalus vermicularis*; same size.

,, 3.—Dorsal view of the head-region of *L. vermicularis*; much enlarged.

Notopterus chitala.

FIGS. 4–6.—Three stages of embryos in the egg-membranes.

FIG. 7.—Embryo with the head still attached to the large yolk-sac.

,, 8.—Embryo of stage IV.

,, 9.— ,, ,, ,, V.

,, 10.— ,, ,, ,, VII.

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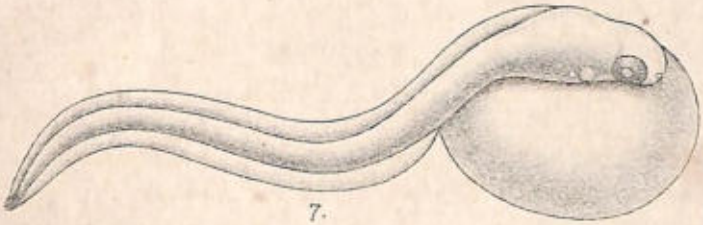

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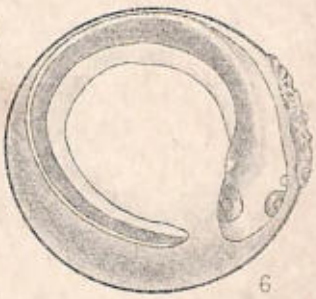

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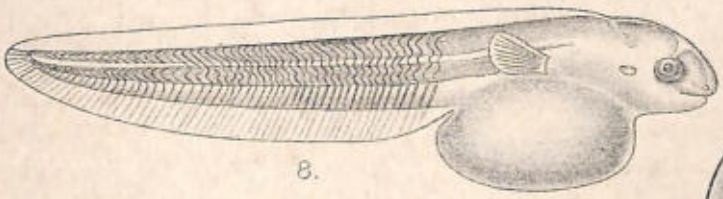

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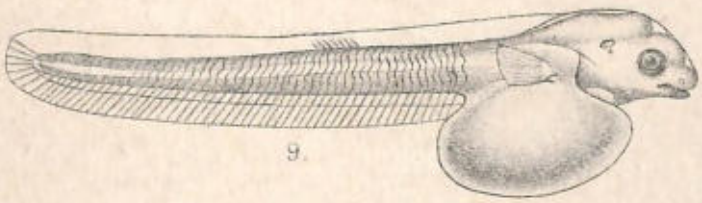

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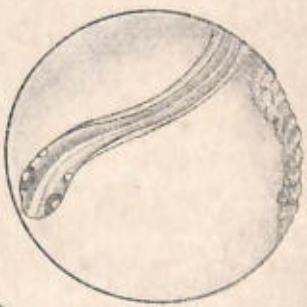

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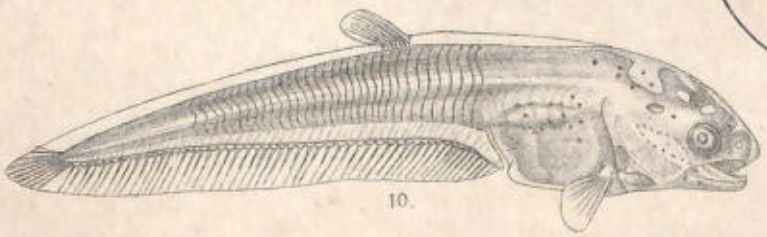

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B.P. & D. Bagchi del. A. Chowdhary lith.

EXPLANATION OF PLATE XVII.

FIG. 1.—Lateral view of an intra-uterine embryo of *Scoliodon walbeehmi*.

,, 2.—Diagram of a dissection of an embryo of *S. walbeehmi* from the ventral surface to show the connections of the blood-vessels of the placental cord. × 1½.

,, 3.—Appendicula of type (i) with a part of the placental cord of a specimen of *Scoliodon* sp. from Ceylon.

,, 4.—Appendicula of type (ii) found on the placental cord of *S. walbeehmi*. × 25.

,, 5.—Appendicula of type (iii) found on the placental cord of *Scoliodon* sp. from Madras.

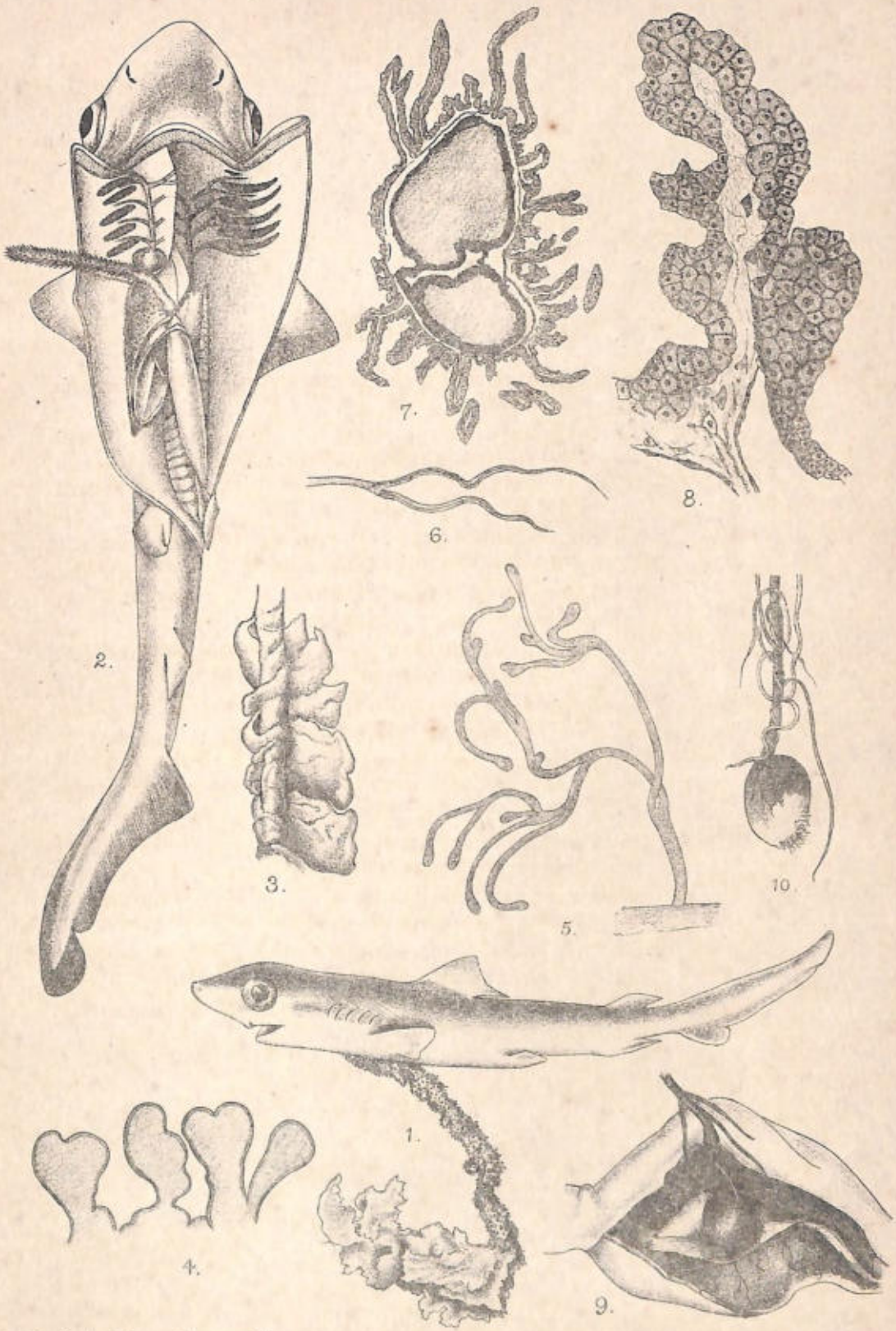
,, 6.—Appendicula of type (iv) found on the placental cord of *Scoliodon sorrakowah*.

,, 7.—Transverse section of the placental cord of *S. walbeehmi* as seen with the low power of the microscope.

,, 8.—A longitudinal section of an appendiculum of *S. walbeehmi*, highly magnified.

,, 9.—A portion of the uterus of *S. sorrakowah* opened out to show the disposition of the yolk-sac placenta.

,, 10.—The yolk-sac placenta and the placental cord of *S. sorrakowah* separated out to show the protruberances on the yolk-sac.



B. P. & A. Chowdhary del. A. Chowdhary lith.

EXPLANATION OF PLATE XVIII.

Rhinobatis columnae.

FIG. 1.—Dorsal view of a very young intra-uterine embryo; the yolk-sac and the yolk-stalk are not shown. × 1½

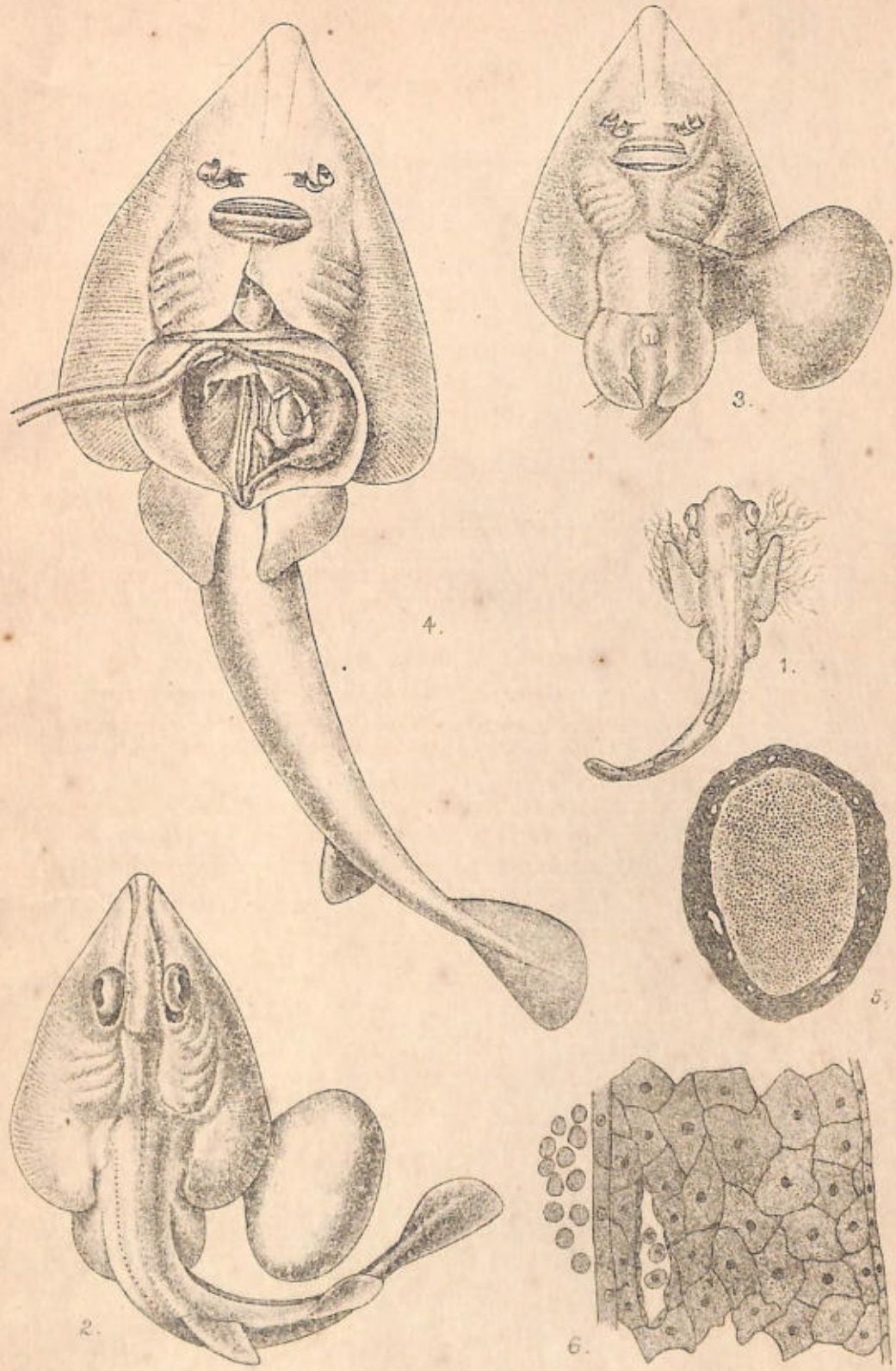
,, 2.—Dorsal view of an embryo of a much later stage

,, 3.—Ventral view of the above; the tail is not shown.

,, 4.—Diagram of a specimen dissected from the ventral side to show the relations of the yolk-stalk, etc. × 1½.

,, 5.—Transverse section of the yolk-stalk as seen with the low power of the microscope.

,, 6.—A portion of the above highly magnified to show the constitution of the wall.



B. P. & A. Chowdhary del. A. Chowdhary lith.

EXPLANATION OF PLATE XIX.

FIG. 1.—Ventral view of an embryo of *T. kuhlii*; only a few of the gill-filaments are shown.

,, 2.—Dorsal view of an embryo of *Hypolophus sephen*; the yolk-sac, yolk-stalk and the branchial filaments are not shown.

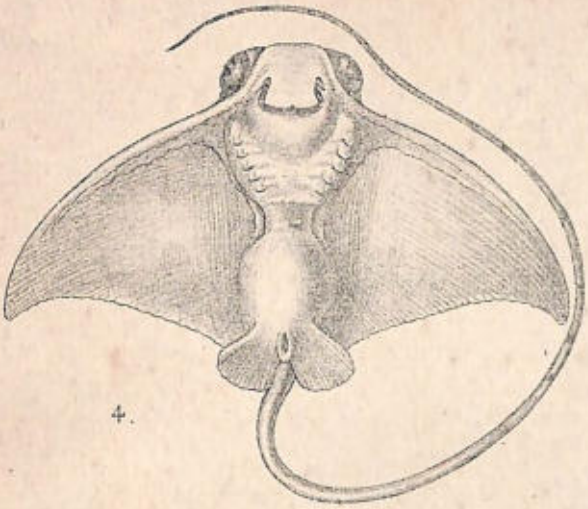
,, 3.—Ventral view of a specimen of *Pteroplatea poecilura*. × $\frac{2}{3}$.

,, 3(*a*).—Lateral view of the head of *P. poecilura*.

,, 4.—Ventral view of a specimen of *Aetomylaeus nichofii*. × $\frac{2}{3}$.

,, 4(*a*).—Lateral view of the head of *A. nichofii* to show the characteristic shape of the spiracle.

,, 5.—An egg-case of *Chiloscyllium griseum*.



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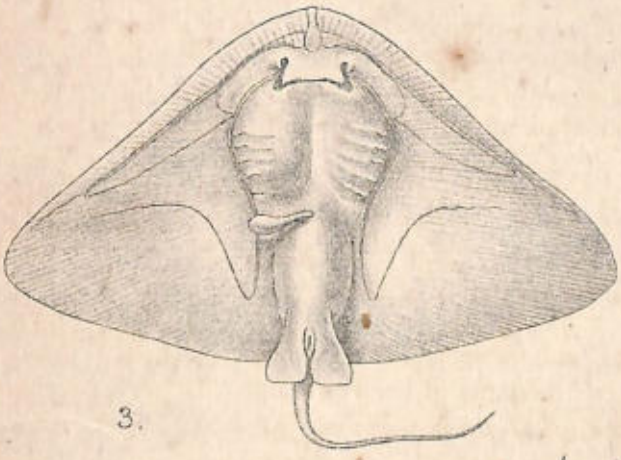

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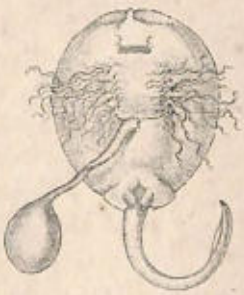

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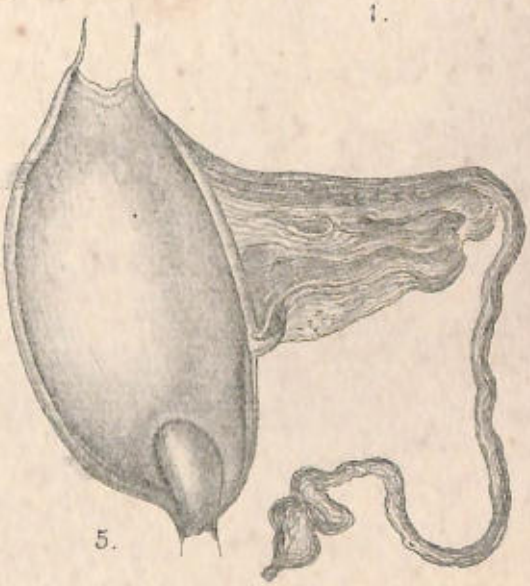

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B.P. & A. Chowdhary del.

A. Chowdhary lith.

EXPLANATION OF PLATE XIX.

FIG. 1.—Ventral view of an embryo of *T. kuhlii*; only a few of the gill-filaments are shown.

,, 2.—Dorsal view of an embryo of *Hypolophus sephen*; the yolk-sac, yolk-stalk and the branchial filaments are not shown.

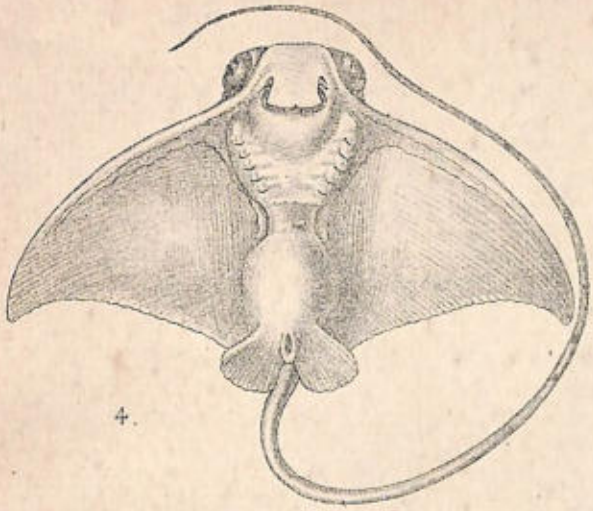
,, 3.—Ventral view of a specimen of *Pteroplatea poecilura*. × $\frac{2}{3}$.

,, 3(*a*).—Lateral view of the head of *P. poecilura*.

,, 4.—Ventral view of a specimen of *Aetomylaeus nichofii*. × $\frac{2}{3}$.

,, 4(*a*).—Lateral view of the head of *A. nichofii* to show the characteristic shape of the spiracle.

,, 5.—An egg-case of *Chiloscyllium griseum*.



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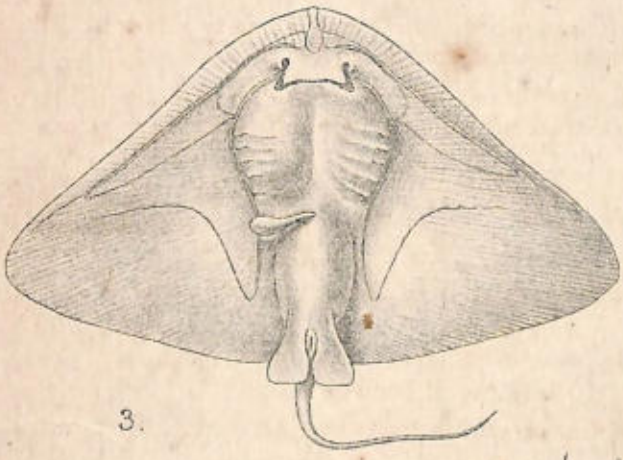

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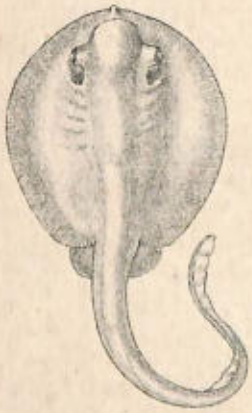

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B.P. & A. Chowdhary del.

A. Chowdhary lith.

XV. SOME GASTROPOD MOLLUSCS FROM THE GANGETIC DELTA.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India, and* B. PRASHAD, *D.Sc., Superintendent of Fisheries, Bengal, Bihar and Orissa.*

(With Plate XX).

The molluscs described or discussed in this paper live in the waterways of the Gangetic Delta or lead an amphibious existence on their shores. A large proportion of the species that do so in the delta have already been described by Benson, Stoliczka, Blanford or Nevill, or by more than one of these authors, to all of whom we owe invaluable information about the brackish-water fauna of the Indian estuaries. It is much to be regretted that Nevill did not live to complete his Hand List of the Molluscs in the Indian Museum, in which work almost alone exact data as to localities are to be found. We hope later to discuss the invertebrate fauna of the lower part of the delta as a whole; for the present we will consider only those Gastropods about which we have something new to say from a strictly taxonomic point of view.

We have figured the radular teeth of most of the species discussed, but it has seemed to us unnecessary to give elaborate descriptions of these teeth. Our figures, if they are as correct as we believe them to be, should prove much clearer than any written description. We have to thank Babu D. N. Bagchi for the accuracy with which he has drawn the figures under our supervision. The figures of the shells have been prepared with equal care by Babu A. C. Chowdhury.

We have also to thank Mr. T. Southwell, Director of Fisheries, Bengal, Bihar and Orissa, for the facilities that he has given us in collecting specimens. The majority of those on which we base the following notes were collected by Mr. S. W. Kemp and ourselves on a recent trip from Calcutta to Khulna on board the Bengal Fishery launch "Kitty."

Family NERITIDAE.

Genus **Dostia**, Gray.

1840. *Dostia*, Gray, *Syn. Contents Brit. Mus.*
1879. *Neritaeae Mitrulae*, von Martens, *Neretina* in Chemitz's *Conch. Cab.*, pp. 16, 37.
1915. *Septaria*, Preston, *Faun. Brit. Ind., Freshwater Moll.*, p. 6 (in part).

This genus seems to us to be well characterized by the following features :—

(i) The spire is vestigial, but distinctly lateral and spiral.

(ii) The shell has no wing-like lateral projections.

(iii) The columellar plate extends as a transverse septum along the aperture of the shell for at least half its length.

(iv) The operculum is semicircular and completely exposed.

Preston (*op. cit.*) includes species of *Dostia* in *Septaria*, Fér., but this genus differs in the still more reduced spire, which is hardly coiled and does not project at its base beyond the body-whorl ; in its much narrower columellar plate, and specially in the fact that the operculum, which is nearly square, is concealed in the muscles of the foot.

We are convinced by a study of specimens from a number of different localities that at least three distinct species can be distinguished in the Gangetic Delta alone, and that none of these are synonymous with the true *D. violacea* (Gmelin). Two of these species have already been described by Benson, but we can find no record of any form with which the third can be identified.

Dostia cornucopia (Benson).

(Plate XX, fig. 2*a*).

1836. *Neretina cornucopia*, Benson, *Journ. Asiat. Soc. Bengal*, V, p. 748.
1867. *Neretina* (*Dostia*) *cornucopia*, Blanford, *Ibid.*, XXXVI, pt. 2, p. 60, pl. xii, figs. 23–25.

In this species the shell is relatively large, porcellaneous, thin and high. The columellar plate extends very little more than half way across the true mouth of the shell, *i.e.* the part occupied by the operculum when the soft parts are retracted. The periostracum is pale olivaceous, sometimes with well-defined transverse zig-zag black lines. The collumellar plate is blackish and there is a blackish margin to the true mouth of the shell.

The differences between shells from the Irrawady Delta and those from that of the Ganges noted by Blanford are not constant.

The operculum is relatively short, its breadth being two-thirds of its length. The lateral projection is stout and blunt, but of considerable length. Its distinctive features in other respects can be seen from our figures.

We have examined specimens of this species from the upper part of the Gangetic Delta, from that of the Irrawady, from the Patani river on the east coast of the Malay Peninsula and from Cochin-China.

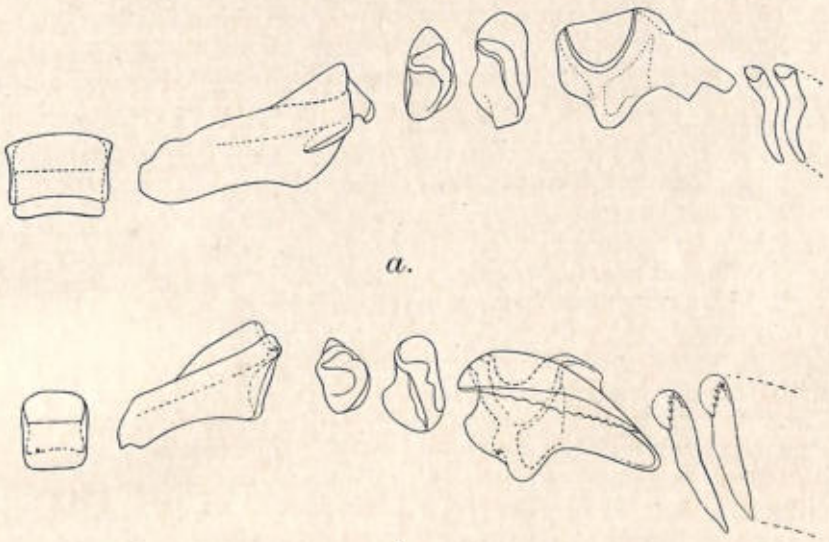
Blanford says that in the Irrawady Delta *D. cornucopia* is usually found on tree-trunks covered at high-tide by brackish water. In the delta of the Ganges, however, it seems to occur chiefly, if not exclusively, at the edge of creeks of fresh or almost fresh water near the upper limits of tidal influence. The species is, however, scarce in Bengal.

Dostia depressa (Benson).

(Plate XX, fig. 2*b*).

1836. Benson, *op. cit.*, p. 748.
1868. Blanford, *op. cit.*, p. 60.
1915. *Septaria crepidularia* and *S. depressa*, Preston, *Rec. Ind. Mus.*, XI, p. 480.

The shell of this species differs from that of *D. cornucopia* in being as a rule narrower in proportion to its length, in having the true mouth still smaller, in the smoother edge of the columellar septum and in colour. The shell substance is rather thicker and has a yellowish tinge. The columellar plate and the outer lip are tinged more or less deeply with orange or coral-red, but this tint is somewhat evanescent. The periostracum is brownish, sometimes



TEXT-FIG. 1.—Radular teeth of Gangetic species of *Dostia*.
(*a*) *D. depressa*, Benson. (*b*) *D. platyconcha*, sp. nov.

with transverse greenish lines, and occasionally marbled with green. When the periostracum is worn away, the surface of the shell is whitish with transverse zig-zag pink or purple lines and stripes. The operculum differs from that of *D. cornucopia* in being relatively broader, in having the lateral process longer and more pointed, and in other characters shown in our figure.

We have seen this species from the deltas of the Ganges and the Irrawady, where it is usually found in slightly brackish water. It is common on the banks of the Hugli about twenty miles below Calcutta. Captain R. B. Seymour Sewell, I.M.S., has recently sent us specimens from swampy pools at Calicut on the

Malabar coast, and from a small stream twenty-eight miles east of that place.

We figure (fig. 1*a*) the radula of a specimen from the Hugli. Both the lateral and marginal teeth differ considerably from those of the next species; the marginals being considerably smaller and having the denticulation stronger. The differences between the laterals are of a very complicated nature, and will be understood best by a reference to the figures.

Dostia platyconcha, sp. nov.

(Plate XX, figs. 1, 2*c*).

This species differs from both the other Gangetic forms and from all others of the genus known to us in its much thinner and more transluscent shell, its depressed form and non-protruding spire. Its lateral profile is regular and forms an arch, less than a semicircle; the spire hardly protrudes beyond the anterior margin of the body-whorl. The spire though very minute is, however, distinctly lateral and spiral. In ventral view the shell is broadly oval, slightly truncated posteriorly. The upper part of the shell is invisible or practically invisible in this view. The columellar plate is separated from the lower margin of the shell, and extends considerably more than half way across its true mouth. The margin is irregularly and minutely crenulated. The posterior lip is very broad below the anterior margin of the true mouth of the shell. The dorsal surface is marked with well defined and regular transverse striae; minute longitudinal striae can also be detected with a strong lens. The periostracum is dull olivaceous green with minute black specks and with obscure longitudinal rays. The interior of the shell including the columellar plate has a faint glaucous tinge and is very highly polished.

The operculum is rather short and instead of bearing a single prominent lateral process has two short rather broad tubercles one of which may be obscure.

We figure the radular teeth (fig. 1*b*).

Type specimen: M $\frac{11\frac{1}{2}10}{}$ in the collection of the Zoological Survey of India.

Locality.—The species is not uncommon in the lower parts of the Gangetic Delta, on bushes at the edges of creeks containing brackish water of considerable salinity.

Family LITTORINIDAE.

Genus **Littorina**, Férussac.

A number of species of this genus lead an amphibious or almost terrestrial existence on the banks of the waterways in the lower part of the Gangetic Delta. At present we will deal with only three of these, namely *L. melanostoma*, Gray, *L. subintermedia*, Nevill and *L. delicatula*, Nevill.

Littorina melanostoma, Gray.

1882. *Litorina melanostoma*, Weinkauff, "Die Gatt. *Litorina*" in Chemitz's *Conch. Cab.*, p. 41.
1887. *Littorina melanostoma*, von Martens, *Journ. Linn. Soc. Zool.*, XXI, p. 170.

This is by far the commonest of the Gangetic Littorinidae. It occurs in large numbers on grass and bushes exposed at low tide, but submerged when the tide rises. The geographical range extends to the Malay Archipelago

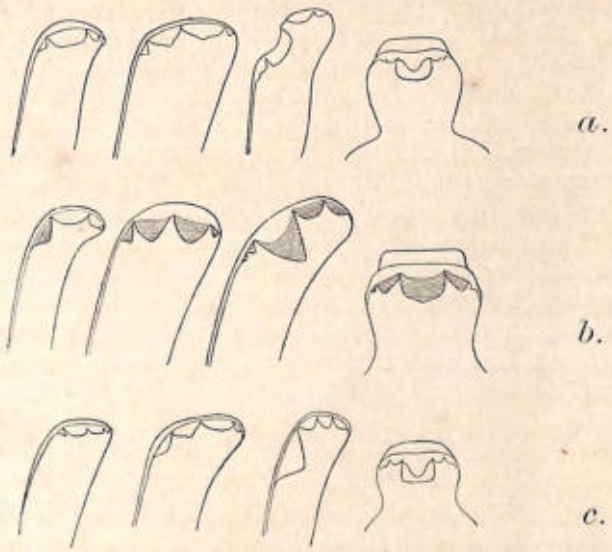
We figure the radular teeth (fig. 2*a*); their most remarkable feature is the assymetrical form of the inner lateral tooth.

Littorina subintermedia, Nevill.

(Plate XX, fig. 3).

1884. *Littorina conica* var. *subintermedia*, Nevill, *Hand-list Moll. Ind. Mus.*, II, p. 149.

This form appears to be less like *L. conica* and the true *L. intermedia* than Nevill thought, and we think it best to regard



TEXT-FIG. 2.—Radular teeth of Gangetic species of *Littorina*.
(*a*) *L. melanostoma*, Gray. (*b*) *L. subintermedia*, Nevill.
(*c*) *L. delicatula*, Nevill.

it as distinct. The shell is much thinner than that of either of Philippi's species, and has a slightly transluscent appearance. It is also narrower and more conical, and the sculpture is more delicate. The columella is narrow, but has a very distinct spindle-shaped depression upon its surface. The body-whorl is hardly angulate. The colour of all the shells we have seen is pale-yellow-

ish profusely spotted with dull purplish-brown. The spots are transversely elongate in the lower parts of the whorls, and often alternate with shorter spots of a whitish colour. Towards the upper part of the three lowest whorls the dark marks tend to take the form of longitudinal streaks nearly as broad as the pale interspaces.

The most striking feature of the radular teeth (fig. 2*b*) is that the central cusp of the central tooth is very large, with a distinct lateral cusp on either side; the thicker more prominent part of the former extends right across the cusp and occupies more than one half of its area. Most of the denticulations of all the teeth are transversely striate.

The species is only known from the lower parts of the Gangetic Delta.

Littorina delicatula, Nevill.

(Plate XX, fig. 4).

1884. *Littorina conica* var. *delicatula*, Nevill, *op. cit.*, p. 150.

The shell of this form is thinner than that of any other species of the genus we have examined, and is always very brightly coloured when fresh. The colours, however, as Nevill has noted, are somewhat evanescent. The columella is shorter than in *L. subintermedia* and the longitudinal depression upon it is much less well defined. The body-whorl is distinctly angulate in adult shells owing to one of the ridges being much more strongly developed than the others, but as this ridge is situated not very far from the anterior margin of the whorl, it is not found in young shells.

We figure the radular teeth (fig. 2*c*). The central tooth is smaller than in the other two species we have discussed; its central cusp somewhat resembles that of the central tooth of *L. melanostoma*, but is much smaller, and has the membranous marginal portion less well developed. The inner lateral is much more symmetrical.

This species, like the last, is apparently endemic in the lower parts of the Gangetic Delta. The two are often found together on trees and bushes far above high-tide mark. They seem to be very largely terrestrial in habits.

Family HYDROBIIDAE.

Genus **Stenothyra**, Benson.

This is one of the most characteristic genera of the upper estuarine waters of South-eastern Asia. It is often found in fresh water, but rarely in places permanently unaffected by tidal influence. Both the species here described are from water that was quite fresh at the time of their capture, but is slightly brackish at other seasons.

Stenothyra echinata, sp. nov.

(Plate XX, fig. 5).

The shell is small, solid, transluscent and pale in colour. It has a very regular conoidal form except that the ventral surface of the body-whorl is flattened and the anterior part narrowed. The apex is pointed but not acutely. There are $5\frac{1}{2}$ whorls. The suture is not deeply impressed, but is oblique and irregular; the whorls of the spire increase gradually and evenly. The body-whorl is broad; in dorsal view it appears to be transverse and almost quadrate, but as seen from below it is truncato-ovoid, the truncation being posterior. The mouth of the shell is very small and oblique; it has a regularly oval form. Its rim projects little and the shell is not umbilicate. The whorls of the spire are apparently smooth, but are covered with a deposit in the specimen examined. The penultimate whorl and the one behind it bear a single spiral row of sharp, flattened, horny spines, which are directed towards the apex and slightly inwards; they have a golden yellow colour. The body-whorl is sculptured with the spiral punctured lines common to most species of the genus.

The operculum is thin and horny, of the normal paucispiral type.

Measurements of type-shell (in millimetres).

Length	4·0
Breadth of body-whorl	2·5
Length of spire (dorsal view)	1·6
Breadth of spire (dorsal view) .. .	2
Length of aperture	1·2
Breadth of aperture	1 0

Type-specimen: M $^{11\frac{1}{2}38}$ in the collection of the Zoological Survey of India.

Locality.—A single specimen was found among semi-aquatic vegetation at the edge of the river Pussur at Khulna, July 22nd, 1918.

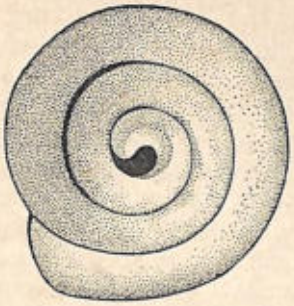
The most characteristic feature of the shell is the row of spines on the basal part of the spire. Otherwise it is very like that of *S. deltae* (Benson), specimens of which were found with it, but it is much smaller, narrower and less inflated in the body-whorl and the mouth is a little larger and relatively narrower.

Stenothyra soluta, sp. nov.

(Plate XX, fig. 6).

The shell is of moderate size, thick, globose, with the spire flattened, concave at the apex (fig. 3); the whorls are very distinct

and swollen and the body-whorl relatively short and stout, not at all flattened on the ventral surface. The suture is barely impressed. There are three and a half whorls. The aperture is large, oval, rounded posteriorly, very prominent, and with the peristome thick and somewhat plicated concentrically. There is no umbilicus. The periostracum is olive-green, opaque; the surface is smooth, but not highly polished; minute longitudinal striae and still more minute transverse striae are present, but punctured lines are entirely absent.



Text-fig. 3.—*Stenothyra soluta*, sp. nov., view of the shell-whorls as seen from above.

Measurements of type-shell (in millimetres).

Length	4·1
Breadth of body-whorl	2·8
Length of spire (dorsal view)	1·5
Breadth of spire (dorsal view)	2·4
Length of aperture	2·0
Breadth of aperture	1·6

Type-specimen: M $^{11\frac{1}{2}12}$ in the collection of the Zoological Survey of India.

Locality.—A single specimen was found in flood refuse at the edge of a creek in the Gangetic Delta at Basanti, July 20th, 1918.

The species is distinguished by the looseness of its spire, its swollen whorls, the flattened apex, and the absence of punctured spiral lines; the peristome is well developed. Although the shell has a somewhat abnormal appearance, we know of no species to which it could be assigned as an aberration.

Genus **Bithinella**, Moquin-Tandon.

So far as we have been able to discover, only one species of this genus has as yet been found in India. This species is confined to brackish water of considerable but variable salinity.

Bithinella miliacea (Nevill).

1880. *Hydrobia (Belgrandia) miliacea*, Nevill, *Journ. As. Soc. Bengal*, XLIX, p. 161, pl. viii, fig. 7.

1884. *Hydrobia (Bythinella) miliacea*, Nevill, *Hand-list Moll. Ind. Mus.*, II, p. 52.

1907. *Bithinella canningensis*, Preston, *Ann. Mag. Nat. Hist.* (7) XIX, p. 216 (fig. in text).

We have compared Nevill's types with Preston's, and can find no difference. The species appears to be very variable and the varieties described, or rather named, by Nevill in his Handlist are possibly mere individual variations. The var. *minor*, however, may be worthy of varietal nomenclature.

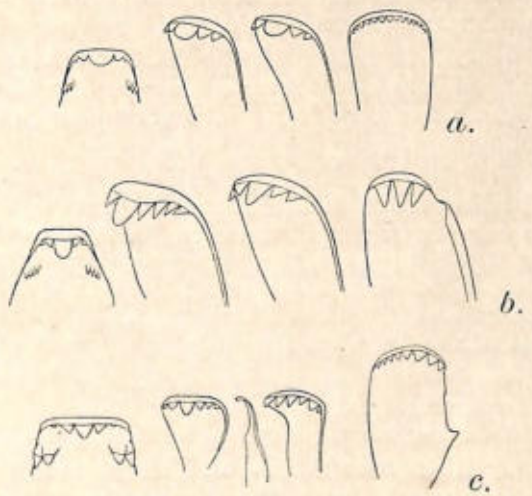
The species is very common among weeds in pools of brackish water at Port Canning.

Family ASSIMINEIDAE.

Genus **Assiminea**, Leach.

1887. *Assiminea*, Böttger, *Jahrb. deutsch. Malalakozool. Ges.*, XIV, p. 158.
1880? *Assiminea*, Heude, "*Moll. Terr. Mem. Hist. Nat. Chin.*," I, p. 82.
1897. *Assiminea*, von Martens in Weber's *Zool. Ergeben. Neiderl. Ost.-Ind.*, IV, p. 212.

Böttger in his monograph of the genus arranges the species alphabetically, among the Chinese forms Heude recognizes three



TEXT-FIG. 4.—Radular teeth of Gangetic species of *Assiminea*.
(*a*) *A. brevicula* (Pfr.). (*b*) *A. beddomiana*, Nevill.
(*c*) *A. francesiae* (Gray).

divisions, which he calls Euassimineae, Pseudomphalae and Salenomphalae; while von Martens discussing the species of the Malay Archipelago, divides the genus into two groups, *Cyclotrophis* and *Assiminea*, *s.s.*, which is distinguished from *Cyclotrophis* by the presence of a sharp rim at the inner edge of the umbilicus of the shell. We have here to consider three species, two of which [*A. brevicula* (Pfr.) and *A. beddomiana*, Nevill] belong to *Assiminea*, *s.s.*, while the third [*A. francesiae* (Gray)] perhaps represents *Cyclotrophis* but may ultimately call for generic distinction.

Assiminea brevicula (Pfr.).

1887. *Assiminea brevicula*, Böttger, *op. cit.*, p. 163.
1897. *Assiminea brevicula*, von Martens, *op. cit.*, p. 213.

Further references will be found in the papers cited.

We have nothing fresh to say about the shell or the living animal. We figure the radular teeth (fig. 4*a*), they are not unlike those of *A. violacea* as figured by Heude,[1] but the upper part of the central tooth is still more constricted, its cusp is larger, and it has four basal denticulations on each side; the denticulations of the lateral teeth are also better developed.

The species is very common on mud between the tide-marks in the lower part of the Gangetic Delta. Its distribution extends from the estuaries of the Ganges to those of Central China.

Assiminea beddomiana, Nevill.

1881. *Assiminea beddomiana*, Nevill, *Journ. As. Soc. Bengal*, L. (ii), p. 158, pl. vii, fig. 3.

The animal is very like that of *A. brevicula*, but the radula differs considerably (fig. 4*b*), in that the upper part of the central tooth is not constricted, the denticulations at its base are feebly developed and its cusp is smaller. The denticulations of the lateral teeth are also less well developed, and those of the marginal, which is more symmetrical, are much smaller and more numerous.

This species occurs with *A. brevicula*, but is much less abundant. It is only known from the estuaries of the Ganges and the Irrawady and from intermediate localities.

Assiminea (? Cyclotrophis) francesiae (Gray).

(Plate XX, fig. 7).

1887. *Assiminea francesi*, Böttger, *op. cit.*, p. 176.

The shell of *A. francesiae* is, as Böttger points out, extremely variable. We do not think that the different forms named by Nevill as varieties or sub-varieties should be regarded as distinct. At some localities, however, notably at the edge of the river Pussur at Khulna, many adult shells have a number of ridges or varices running across the lower part of the body-whorl and probably representing periods of aestivation.

The radula (fig. 4*c*) differs considerably from that of the two species we have just discussed, and also from that of *A. scalaris*, Heude, which on shell characters alone comes in the same group.[2] The chief differences are: (*a*) there is a minute but elongate bifid

[1] *Op. cit.*, XXI, fig. 4*c*.

[2] See Heude, *op. cit.*, XXI, fig. 5. We have examined a radula of this species and find that while there are small variations in the denticulation of the teeth, the general outline as shown in Heude's figure is correct.

tooth interpolated between the two laterals on either side; the dental formula thus being 1.3 1.3.1. instead of 1.2.1.2.1. (*b*) The central tooth is quadrangular and broadly transverse; it has three stout subequal cusps and a pair of extremely large denticulations arranged side by side at each side of its base. (*c*) The denticulation of both the lateral teeth is very coarse but short. (*d*) That of the marginal tooth is similar to and intermediate between that of *A. brevicula* and *A. beddomiana*; there is besides on the outer margin of the tooth a peculiar pointed, but apparently membranous process.

It is possible that this species may have ultimately to be recognized as a distinct genus, but we have no information as to the radular characters of the typical species of *Cyclotrophis*—*C. papuensis* (Albts.), which was found on the south coast of New Guinea. As we have shown above, those of the Chinese *A. violacea*, which would be assigned to this group on shell characters alone, are quite different from those of *A. francesiae*.

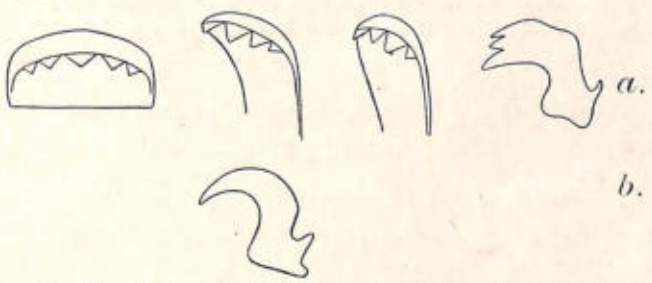
Family MELANIIDAE.

Genus **Melania**, Lam.

Sub-genus **Mainwaringia**, Nevill.

1886. *Mainwaringia*, Nevill, *Hand-List Moll. Ind. Mus.*, II, p. 286.

Although Nevill refers to the only known species as a "new generic type," he places it as a sub-genus of *Melania*, a view with



TEXT-FIG. 5.—Radular teeth of *Mainwaringia paludomidea*, Nevill.
(*a*) Teeth viewed from above. (*b*) Lateral view of marginal tooth.

which we agree. His statement that it is intermediate between that genus and *Paludomus* seems to be based on the form of the operculum, and perhaps on the consistency of the shell. Both Blanford,[1] however, and the Sarasins[2] have shown from different points of view that the former can hardly be regarded as of great generic importance in the Melaniidae. The form of the shell differs little from that of *Melania*, and we are of the opinion

[1] *Trans. Linn. Soc.*, XXIV, pp. 166–167 (1864).
[2] *Die Susswasser Mollusken von Celebes*, pp. 5–9 (1898).

that the only known species is a depauperated form modified in accordance with an amphibious life partly spent in water of considerable salinity.

The sub-genus may be redescribed as follows, using Nevill's terms to a large extent:—Melaniidae with imperforate, conically produced shell; its spire turretedly acuminate; shell-substance thick and almost porcellaneous, but becoming much thinner in the lower part of the body-whorl; columella strongly arched, not greatly incrassate, outer lip sharp; external surface decorated with deep-cut spiral striae; a thin epidermis present, bearing minute scattered hairs or chaetae. Operculum horny, extremely thin, paucispiral, with the nucleus eccentric.

Animal differing from that of the groups *Plotia*, *Striatella*, *Melanoides*, and *Tarebia* in the following characters:—Foot pointed and produced into a short filamentous process behind; a distinct mid-dorsal groove on posterior part of the foot extending on to the terminal process. Radula (fig. 5*a*) like that of *Melania*, but without a distinct cusp to the median tooth and with marginal teeth of peculiar form (see figure 5*b*).

Type: Mainwaringia paludomidea, Nevill.

Distribution.—Only known from the lower parts of the Gangetic Delta.

Melania (Mainwaringia) paludomidea, Nevill.

(Plate XX, fig. 8).

Nevill's description of the shell, which is quoted by Preston on p. 37 of his volume in the "Fauna," needs no elaboration. The animal has the characters noted above. Its foot is rather small; the tentacles are very long, slender and tapering, with the eyes situated on distinct prominences at their base externally. The snout is prominent, blunt and slightly notched in front. The foot and tentacles are transluscent white, suffused with black pigment above; the snout is brownish. The branchial chamber resembles that of *Melania*, but the branchial folds are exceptionally deep. The osphradium is well developed and ridge-like.

The species is not uncommon between tide-marks in the lower parts of the Gangetic Delta. At low-tide it adheres tightly by means of a gummy secretion to the trunks of trees, and particularly to the upright aërating roots of mangroves. When placed in water it emits a bubble of air and immediately becomes active. It would seem, therefore, to breathe air while in a comatose condition at low-tide, but never to be active while doing so.

Family NASSIDAE.

Genus **Nassa**, Lamarck.

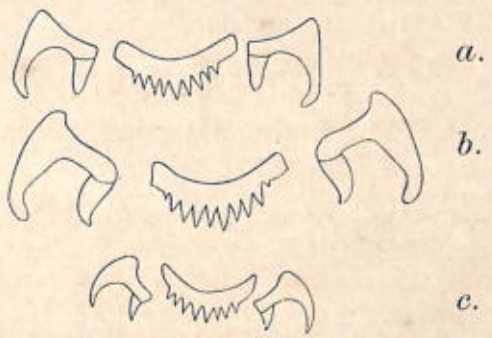
The small species of this genus that occur in brackish water on the coast of India, all of which have recently been described by Preston, seem to form a very distinct little group, in which

the radula is somewhat simplified, while the shell is remarkable for its small size and elongate form. These species are—*N. denegabilis*, *N. orissaensis* and *N. ennurensis*, to all of which we refer in the following note.

Nassa ennurensis, Preston.

1916. *Nassa orissaensis* var. *ennurensis*, Preston, *Rec. Ind. Mus.*, XII, p. 28, figs. 2, 2*a*.

This form appears to us to be specifically distinct. In addition to the differences between it and the typical *N. orissaensis* noted by Preston, we may draw attention to a very distinct feature, well shown in his figures, in the shape of the mouth of the shell, near the posterior extremity of the inner border of which there is always a blunt tooth in fully adult shells of *N. ennurensis*, while no such projection ever occurs in *N. orissaensis*. The typical form of the former, which reaches a length of over 10 mm., has



TEXT-FIG. 6.—Radular teeth of brackish water species of *Nassa*.
(*a*) *N. orissaensis*, Preston. (*b*) *N. denegabilis*, Preston.
(*c*) *N. ennurensis* var. *depauperata*, nov.

been recorded from the outskirts of Calcutta by Preston. A smaller form with a rather broader aperture, and a much thinner shell is common in the lower part of the Gangetic Delta. For this form we propose the name :—

var. **depauperata**, nov.

(Plate XX, fig. 9).

We have already stated the characters by which the shell of this form can be distinguished. The animal is very like that of *N. orissaensis*,[1] but differs in the following characters : (*a*) The foot is proportionately narrower and a little more deeply notched posteriorly, the two posterior lobes being distinctly pointed. (*b*) The anterior processes of the foot and also the tentacles are

[1] See Annandale and Kemp, *Mem. Ind. Mus.*, V, p. 343, fig. 1.

rather longer and more slender. (*c*) The siphon is shorter than the shell.

The whole animal is transluscent white, there is a tinge of pale grey on the siphon and the dorsal surface of the foot. The eyes are small but quite distinct.

The radula (fig. 6*c*) is very similar to that of *N. denegabilis* (fig. 6*b*) and *N. orissaensis* (fig. 5*a*); all of which we figure. The lateral teeth have two distinct branches, which are quite smooth.

N. orissaensis var. *depauperata* lives in creeks of brackish water (sp. gravity corrected to 15°C. 1·01175–1·01725) on a muddy bottom at a depth of 4–6 fathoms. It crawls with extreme rapidity both in water and on damp surfaces, and can float adhering shell downwards to the surface film by means of the foot.

Type-specimen: M $\frac{11418}{2}$ in the collection of the Zoological Survey of India.

Locality.—Kaikal Maree near Port Canning, Gangetic Delta; 17th July, 1918.

Family RINGICULIDAE.

Genus **Ringicula**, Deshayes.

1844. *Ringicula*, Hinds, *Proc. Zool. Soc. London*, XII, p. 97.
1875. *Ringicula apicata*, Nevill, *Journ. As. Soc. Bengal*, XLIV, (ii), p. 101.
1878. *Ringicula*, Morelet, *Journ. de Conch.*, (3) XVIII (xxvi), pp. 113–133, pls. v–viii.
1878. *Ringicula* (Anatomie de l'animal), Fischer, *Ibid.*, pp. 114–115.
1884. *Ringicula*, Watson, *Journ. Linn. Soc. London*, XVII, p. 291.

Ringicula caeca, sp. nov.

(Plate XX, fig. 10).

The shell is small, very solid and of the usual shining white colour. The spire is narrow, conical and sharply pointed, about half as long as the body-whorl, which is relatively broad and nearly square. The main axis of the shell occupies a line much nearer the inner than the outer margin of this whorl, which projects inwards at an angle from the base of the spire. The suture is impressed and the whorls somewhat flattened outside it. The mouth of the shell is contracted but relatively long, extending backwards at an acute angle with the main axis to a point at about four-fifths the length of the body-whorl. The lips are very thick. The outer lip runs nearly straight for the greater part of its length, and turns inwards somewhat abruptly, but at an angle less than a right angle, in front; at the point at which it does so it bears a broad oval prominence. The outer callus extends about half way up the outer surface of the shell, and is strongly corrugated. The siphonal notch is well developed, but not very prominent. The columella is oblique and has three very prominent folds; the posterior fold is very broad, the median fold ridge-like and

the anterior fold intermediate. The columellar callus is well developed. The surface of the shell is polished, shining and somewhat opalescent, but is partly covered by a thin blackish-brown deposit. There are two fine but clear-cut spiral ridges on the whorls of the spire, extending on to the upper part of the body-whorl, the central region of which is quite smooth. At the base of the body-whorl there are five other still finer spiral ridges, which are more closely approximated behind than in front.

Measurements of type-shell (in millimetres).

Length	3·25
Breadth of body-whorl	2·0
Breadth of spire at base (dorsal view) ..	1·0
Length of spire (dorsal view)	1·0
Length of aperture	2·2
Breadth of aperture	0·5

The living animal is devoid of external pigment and is of much the same shade as the shell. There are no eyes. The foot is relatively small, broadly rounded behind, expanding in front into a flattened, bluntly pointed almost triangular process on each side. The cephalic disc is large and extends over the anterior part and the lateral margins of the shell; in front it is notched in the middle line, and it is expanded at each side into a broad flattened process like that of the foot, but larger; the posterior margin is nearly straight, but folded in the middle line in such a way as to form an incomplete siphon, which, however, hardly projects at all.

Type-specimen: M $\frac{11}{2}$ in the collection of the Zoological Survey of India.

Locality.—Creek at Kaikal Maree, near Port Canning, Gangetic Delta, from a muddy bottom in 4–6 fathoms: specific gravity of water (reduced to 15°C) 1·01725.

The shell resembles that of *R. apicata*, Nevill, in some respects, but is larger and has the body-whorl much broader, the mouth more contracted and the lateral callus much more strongly developed.

The animal differs from that of *R. auriculata* as figured by Fischer (*Man. Conch.*, p. 36, fig. 322, 1887) in being devoid of eyes, in the different shape of its foot and cephalic disc, and in its much less well-developed cephalic siphon.

Family AURICULIDAE.

Genus **Auricula**, Lam.

At least three species of this genus, to which we give a somewhat broad application, occur commonly in the lower parts of the Gangetic Delta, namely—*A. auris-judae*, Lam., *A. gangetica*, Benson, and the form we describe below. Benson, Stoliczka and

Nevill seem to have regarded this last as a dwarfed form of *A. gangetica*, but it appears to us to be perfectly distinct.

Auricula translucens, sp. nov.

(Plate XX, fig. 11).

The shell is small, exceptionally thin, colourless, transluscent and (without the periostracum) semi-hyaline; the periostracum is thin and of a pale greenish olivaceous tint. The shape is elongate-ovate; the apex is bluntly pointed; there are 5½ or 6 whorls, but the apical whorl is usually eroded. The spire is short, less than a third as long as the body-whorl in dorsal view. Though the whorls increase gradually and evenly, the suture is narrowly impressed; it is not markedly oblique. The body-whorl is long and narrow, distinctly spindle-shaped and almost pointed anteriorly; its inner profile is regularly arched, but its outer profile, proceeding from behind forwards, first slopes outwards and backwards for a short distance, then runs almost straight backwards for the greater part of its length, and finally becomes concave and slopes inwards to the anterior extremity. The mouth of the shell is long and narrow, extending backwards for nearly six-sevenths of the length of the body-whorl, curving inwards posteriorly and tapering to a point; anteriorly it is very narrowly rounded. The margin of the outer lip is thin, but there is a slight and perfectly smooth ridge running parallel to it just inside the mouth, and the anterior margin is slightly thickened. Only two columellar folds are visible; they are not very prominent and are situated in the anterior third of the aperture. The external surface of the shell is marked with fine longitudinal, rather widely separated curved striae, and with much finer and more numerous transverse striae; it is also minutely and lightly pitted. The pits or punctures are much larger and deeper on the posterior part of the body-whorl and on the spire than on the anterior two-thirds of the former. The inner surface is highly polished, iridescent, and microscopically transversely striate.

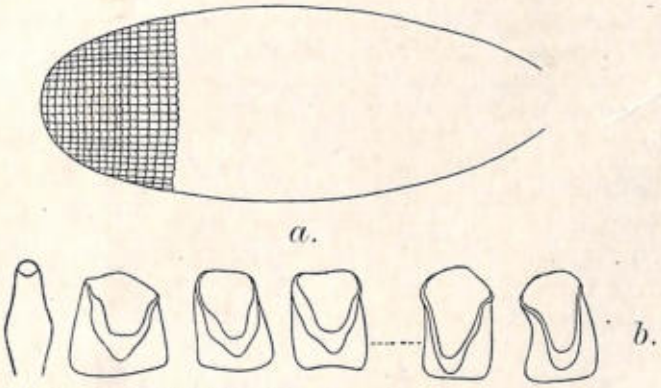
Measurements of shells (in millimetres).

	Type.		
Length of shell ..	.. 8·5	8·1	·8
Greatest breadth of body-whorl	.. 3·6	3·4	3·5
Breadth of spire at base	.. 2 3	2·1	2·3
Length of spire ..	.. 1·4	1·1	1·2
Length of aperture ..	.. 6·2	6·1	6·3
Greatest breadth of aperture	.. 1·6	1·5	1·8

The animal is white and transluscent, with a brownish tinge on the tentacles. The foot is rounded, slightly emarginate in front and rounded behind. The tentacles are long and slightly inflated at the tips, which are often invaginated when the animal

is crawling. The eyes are visible as small black spots at the base of the tentacles.

The upper jaw, which is very conspicuous in the living animal, is fully cornified and lunate in form; there is a broad transverse thickened median region, the anterior and posterior regions being almost membranous. The radula is narrowly tongue-shaped (fig. 7*a*), and bears about 60 transverse rows of teeth; these rows are practically straight. There are about 27 longitudinal rows; the dental formula being 7·6·1·6·7. The central tooth (fig. 7*b*) is minute, with a single cusp, which is nearly symmetrical and ob-



TEXT-FIG. 7.—Radula of *Auricula translucens*, sp. nov.
(*a*) Radula as a whole. (*b*) Radular teeth further enlarged.

scurely trilobed. The laterals are similar but much larger, and the marginals differ from the laterals in having the cusps narrower, simpler and directed somewhat inwards.

Type specimen: M $\frac{11.4.11}{2}$ in the collection of the Zoological Survey of India.

Locality.—A single living specimen of this species was taken in a creek at Basanti in the Gangetic Delta. In the collection of the Zoological Survey there are also a number of specimens from Port Canning which had hitherto been confused with *A. gangetica*.

The shell resembles that of *A. socotrana*, Smith, in sculpture and texture, and that of *A. layardi*, H. Adams, in shape.

EXPLANATION OF PLATE XX.

The line drawn next to or between the different views of the shells shows the actual length of the specimen.

FIGS. 1*a*, 1*b*, 1*c*.—*Dostia platyconcha*, sp. nov., shell of the type-specimen.

,, 2.—Opercula of the Gangetic species of *Dostia*, × 2.
(*a*) *D. cornucopia* (Benson).
(*b*) *D. depressa* (Benson).
(*c*) *D. platyconcha*, sp. nov.

The opercula are drawn from actual specimens. That of *D. platyconcha* is always smaller than those of the other two species; but that of *D. cornucopia* is not always smaller than that of *D. depressa*.

,, 3.—*Littorina subintermedia*, Nevill, shell of a specimen from the Gangetic Delta.

,, 4.—*Littorina delicatula*, Nevill, shell of a specimen from the Gangetic Delta.

,, 5.—*Stenothyra echinata*, sp. nov., shell of the type-specimen.

,, 6.—*Stenothyra soluta*, sp. nov., shell of the type-specimen.

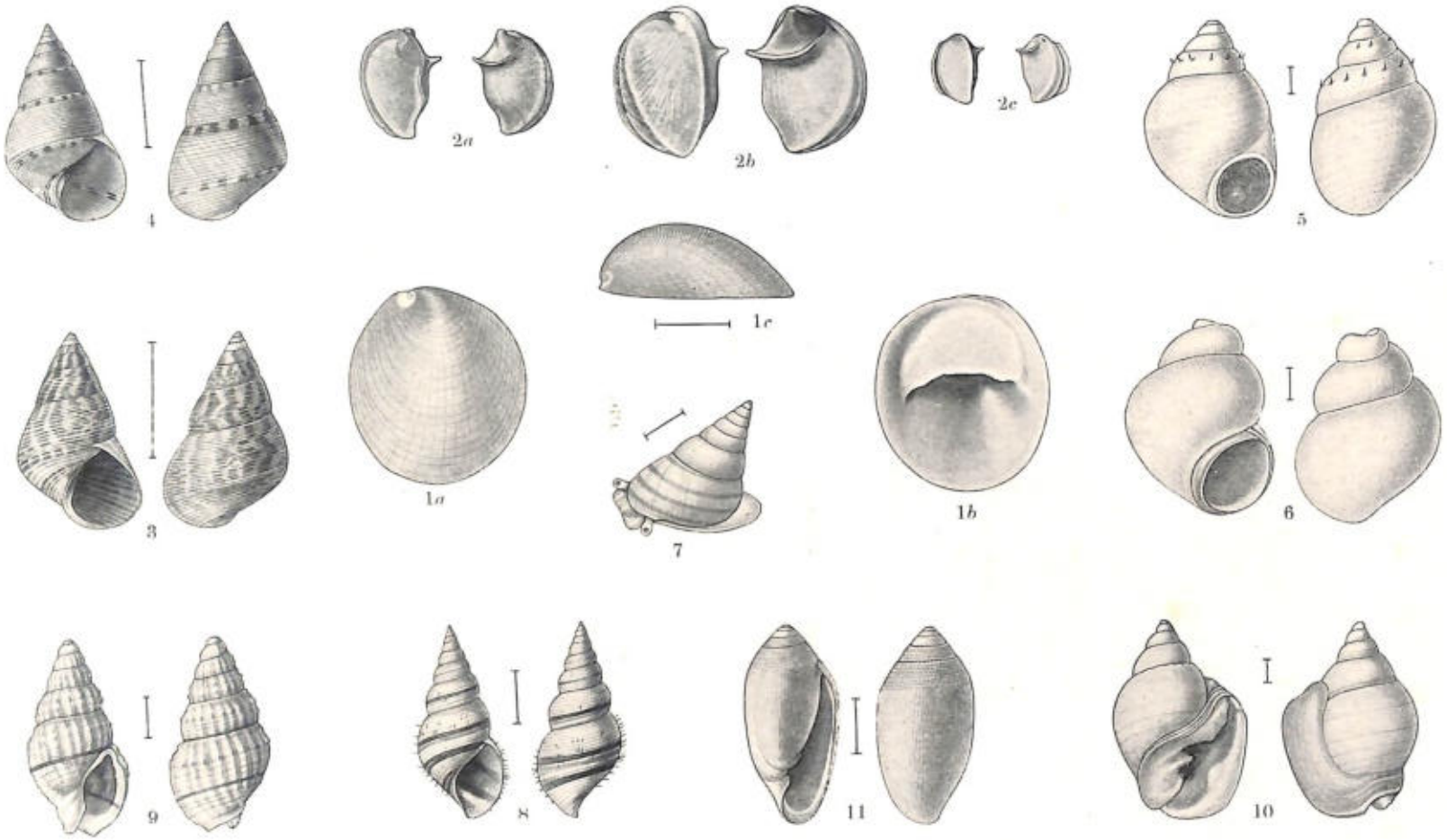
,, 7.—Lateral view of an expanded living individual of *Assiminea francesiae* (Gray).

,, 8.—*Melania* (*Mainwaringia*) *paludomidea*, Nevill, shell of a specimen from the lower reaches of the Gangetic Delta.

,, 9.—*Nassa ennurensis* var. *depauperata*, nov., shell of the type-specimen.

,, 10.—*Ringicula caeca*, sp. nov., shell of the type-specimen.

,, 11.—*Auricula translucens*, sp. nov., shell of the type-specimen.



A. C. Chowdhary del.

MOLLUSCA OF THE GANGETIC DELTA.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919

XVI. DESCRIPTIONS OF THREE MALE MUTILLIDS FROM INDIA.

By G. R. DUTT, *B.A., Assistant to the Imperial Entomologist.*

Mutilla dives, Sm. ♂.

Head, thorax and legs black, abdomen varying from ferruginous to dark castaneous, the apical segments almost black; the joints of the flagellum and the tarsi castaneous.

Pubescence glittering silvery white, short and thick on the face, front, posterior margin of the prothorax, and propleurae; very dense and matted on the median segment; short and thin on the scape and the basal joints of the flagellum; on the apical joints of the abdominal segments it forms transverse bands which are entire on the two basal segments and abraded from the middle on the third and the following segments; long and erect hairs behind the vertex, on the sides of the thorax, on the legs and the basal abdominal segment.

Head coarsely punctate, punctures visible only on the portion between the eyes and the ocelli, front above the base of the antennae raised, face between the lower portions of the inner orbits and the sides of the clypeus scooped out; the clypeus above bearing two longitudinal keels which are blunt at the apex.

Mesonotum above deeply punctured, punctures with a tendency to run into longitudinal striae, the disc with a median longitudinal carina above and four parallel grooves, two on each side of it, those nearer to the carina running across the entire length of the mesonotum and the outer ones over the posterior half only.

Scutellum excavate at base, rising to a prominent tubercle posteriorly; median segment depressed below the surface of the postscutellum, somewhat flat above, only very slightly sloping towards the sides from the middle, which is consequently raised a little and appears like a medial longitudinal carina, apex truncate; metapleurae covered with large and shallow punctures. Abdomen above shining, sparsely punctured, punctures getting closer laterally.

Wings dark fuscous with a purple effulgence, basal third clear hyaline; there is a faint white streak in the first cubital, a sharper one in the second cubital, and a spot in the second discoidal cell of the forewing.

Length 12—15 mm. Expanse 18—23 mm.

Described from 10 specimens.

Hab. Punjab, Lyallpur (*G. R. Dutt and T. B. Fletcher*); Bihar, Chapra (*Mackenzie*).

In the Pusa collection we had a few examples of this species from Chapra in the box of unidentified Mutillids. It could not be referred to any previously described species, but came very close to *Mutilla fumipennis*, described by Bingham in the *Journal of the Bombay Natural History Society*, Vol. XII, p. 118, pl. A, fig. 6. Mr. Fletcher brought a few more specimens of it from Lyallpur in August 1911. On referring to the Pusa collection again, I was struck with the fact that we had this undescribed male Mutillid only from localities from which we had *Mutilla dives* ♀. Later on in September 1911 when I went to Lyallpur I netted this species "in cop" with *Mutilla dives* ♀ and this settled the question definitely.

Mutilla lilliputiana, Andre. ♂.

Head, thorax, legs, base of the first abdominal segment and the apical two segments black, the remaining segments red; the pubescence on the front, vertex, pronotum, sides of the scutellum, and the base of the median segment golden; on the face, sides of the clypeus, along the outer orbits of the eyes white, few erect hairs on the mesonotum, and the scutellum brownish, erect hairs forming somewhat ill-defined bands on the apical margins of the basal five segments, ferruginous.

Head, thorax, and abdomen punctured, punctures on the head, scutellum and abdomen fine, deep and coarse on the mesonotum, large and shallow on the median segment which appears consequently widely and strongly reticulate. On the clypeus a very distinct tubercle is noticeable. On the posterior half of the mesonotum there are two longitudinal grooves present, the second abdominal segment bears a prominent transversely compressed gibbosity above, the median segment is rounded posteriorly.

Wings fusco-violaceous, paler towards base; a white streak is visible in the first, second and third cubital cells and a spot in the second discoidal cell of the forewing.

Length 7—10 mm. Expanse 14—18 mm.

Described from one specimen.

Hab. Coorg, Pollibetta (*T. B. Fletcher*).

Mr. Fletcher captured two males "in cop" with *M. lilliputiana* females at Pollibetta in October 1915.

Mutilla agnata, Andre. ♂.

Closely resembles *M. lilliputiana*, Andre, with the difference that it is a bigger insect and has the pubescence on the posterior margin of the pronotum short and dense and richer in colour, the mesonotum bears a medial longitudinal carina in addition to the parallel grooves; the median segment is obliquely truncate, the basal portion very widely and strongly reticulate, bearing two parallel carinae in the middle, reaching up to the verge of the truncated portion of the segment; the clypeus without any tubercle, the basal portion of the third, fourth and fifth abdominal seg-

ments transversely aciculate; white streak in the 3rd cubital cell shorter in length.

Length 13 mm. Expanse 25 mm.

Described from a single specimen.

Hab. Coorg, Sidapur, 3,000 ft.

I have ascribed this male to this species with some hesitation, because it was not taken "in cop." There are only two points in favour of this conclusion; the first is that a few *M. agnata* ♀ were found in the same locality about the same date; and the second is that this species looks very much like *Mutilla lilliputiana* ♂. And as the female *M. agnata* very closely resembles the female *M. lilliputiana* (the resemblance has been noted by Bingham also; *vide Fauna India, Hymenoptera*, Vol. I, p. 11), it is possible that the male which looks so much like the male *M. lilliputiana* may be the male *M. agnata*.

XVII. DESCRIPTIONS OF INDIAN BEETLE LARVAE.—III.[1]

By F. H. GRAVELY, *D.Sc., Asst. Supdt., Zoological Survey of India.*

(With Plate XIV.)

In this paper Lamellicorn larvae only are dealt with. The Passalid larvae have been identified solely by their association with adults. In all other cases pupae or newly emerged adults with their cast larval skins have been examined.

PASSALIDAE.

For bibliography and descriptions of other larvae see Gravely, 1916, pp. 138–145, pl. xx, figs. 1–4.

The importance of the anus in the classification of Passalid larvae appears hitherto to have escaped attention. In the Aulacocyclinae (pl. xiv, fig. 1) and Leptaulacinae the lower margin is deeply cleft, and this appears to be the case in the Pseudacanthinae and Passalinae also, though different observers describe it in somewhat different terms. In the Macrolininae, on the other hand, both lips are as a rule entire (pl. xiv, fig. 3), the only exception known to me being *Macrolinus*; in this genus (pl. xiv, fig. 2) the cleft found in other subfamilies, though not actually present, is represented by a distinct suture.

Taeniocerus bicuspis, Kaup.

Pl. xiv, fig. 1.

Locality.—Assam: above Tura, Garo Hills, 3,500–3,900 ft. Four larvae, about 18–22 m.m. long, collected by Mr. S. W. Kemp.

The head bears a single hair behind each antenna. All three thoracic segments bear two hairs on each side, arising close together, one behind the other, at the level of the stigmata; and the first bears an additional hair about half way between these hairs and the stigma. The first nine abdominal segments all bear one hair on each side above the level of the stigmata, and a second is present above these on the last three or four segments and some-

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[1] I. "The Larvae and Pupae of some beetles from Cochin." *Rec. Ind. Mus.* XI, 1915, pp. 353–366, pl. xx–xxi.

II. "Some Lignicolous Beetle-Larvae from India and Borneo." *Rec. Ind. Mus.* XII, pp. 138–175, pl. xx–xxii.

times on segments further forward as well. The tenth abdominal segment bears three hairs on each side, one about on a level with the transverse portion of the anus, one above and one below this. No other hairs of any sort are present on any part of the body.

Ophrygonius cantori (Percheron) *s. str.*

Pl. xiv, fig. 3.

Localities.—Darjiling District: Pashok, 5,000 ft. and Sureil, 5,000 ft.

A number of larvae, varying in length from about 18 to 45 mm., have recently been collected. They are indistinguishable from those of the subsp. *convexifrons* previously described (Gravely, 1916, pp. 141–142); but the larger series shows that there are commonly 3 (not 2) dorsal hairs on all segments from the second thoracic to the ninth abdominal and that the pairs of ventral hairs on the thoracic segments are often undifferentiated from the hairs beside them.

LUCANIDAE.

I am unable to distinguish any of the following from the larvae of *Dorcus parallelopipedus*, Linnaeus, described by Schiødte (*Naturhist. Tidssk.* IX, 1874, pp. 345–349, pl. xvii, figs. 1–10, pl. xix, figs. 14–15), apart from the fact that in all the claws are spined, the tibiae are not bituberculate and the anterior margin of the clypeus is not concave.

Hemisodorcus nepalensis, Hope.

Locality.—Darjiling District: Sureil, 5,000 ft.

Numerous larvae about 20–80 mm. long, found in association with a macrognathous male pupa and larval exuvium. A female of *Dorcus hopei*, Saunders, was found in the same stump.

Eurytrachelus reichei, Hope.

Locality.—Darjiling District: Pashok, 5,000 ft.

Several larvae about 30–60 mm. long, found in association with a male pupa and larval exuvium and with adults, none macrognathous.

Eurytrachelus tityus, Hope.

Locality.—Darjiling District: Pashok, 5,500 ft.

One macrognathous male pupa and larval exuvium.

Gnapholoryx velutinus, Thomson.

Locality.—Darjiling District: Pashok, 5,000 ft.

Five larvae and two pupae, found in association with adults, two of which were found with their larval exuviae. An adult male

and female of *Eurytrachelus tityus* were present with them. The larvae vary in length from about 20–50 mm. The spines on the legs are somewhat less stout than in the three preceding species.

SCARABAEIDAE.

RUTELINAE.

Perris has given a key to a number of Lamellicorn genera, including *Adoretus* ("*Larves de Coléoptères*," Paris 1877, pp. 98–103, reprinted from *Ann. Soc. Linn. Lyon*, XXIII).

For Ohaus's account of the habits of American Rutelinae, with notes on larval structure, see *Stet. Ent. Zeit.* LX, 1899, pp. 230–245; LXI, 1900, pp. 175–202 and 267–273.

The larvae of the following Rutelinae have been described[1]. Works marked with an asterisk are not available in Calcutta.

Anisoplia austriaca, Herbst.

1908. *Krasiliscik, I. M. "Experimentelle Untersuchungen zur Erörterung der Frage über das Vermögen der *Microphtalma longifacies*, Rond., Larven des *Anisoplia austriaca* und einiger anderer Lamellicornia anzustecken." *Kisinev Trd. Obsc. jest.* I, 1904–1908, pp. 358–395.

1909. *Golovianko, Z. "Kurze Angaben über *Anisoplia austriaca* und deren Bekämpfung." *Lesn. zurn.* XXXIX, 1909, pp. 1340–1343.

1912. *Bragina, A. P. "Zur Biologie und Morphologie des Getreide-Laubkäfers." *Choziajstvo Kiev.* VII, 1912, pp. 303–310, 357–364.

Anisoplia deserticola, Fisch.

1909. *Golovianko, Z. "Die Lebensweise der Laubkäfer im Forst von Chrenov, Gouv. Woronest." *Trd. lesn. opyty. del Ross.* XXI, 1909, pp. 1–56 (*Anisoplia* larvae, pp. 33–35).

Anisoplia fruticola, Fabricius.

1909. *Golovianko, Z. "Kurze Angaben über *Anisoplia austriaca* und deren Bekampfung. *Lesn. zurn.* XXXIX, 1909, pp. 1340–1343.

1830. *Bouché, P. F. "Naturgeschichte der schaedlichen Garten-Insekten," 1830, p. 21.

Anisoplia segetum, Herbst.

1909. *Golovianko, Z. "Die Lebensweise der Laubkäfer in Forst von Chenov, Gouv. Woronest." *Trd. lesn. opyty. del Ross.* XXI, 1909, pp. 1–56 (*Anisoplia* larvae, pp. 33–35).

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[1] See also below, p. 270, note.

Anisoplia villica.

1892. *Xambeu. "Moeurs et Métamorphoses d'Insectes II." *Echange*, 1892, supplement, 46 pp. (p. 76).

Phyllopertha horticola, Linnaeus.

1830. *Bouché, P. F., "Naturgeschichte der schaedlichen Garten-Insekten," 1830, p. 19.
1837. *Kollar, V. "Naturgeschichte der schaedlichen Insekten," 1837, p. 261.
1872. *? *Entomologist*, VI, p. 62.
1874. Schiødte, J. C. "De Metamorphosi Eleutheratorum Observationes; Bidrag til Insekternes Udviklingshistorie." *Natur. Tidsskr.* IX, 1874, pp. 226–376, pl. viii–xix (*Phyllopertha horticola*, pp. 307–310 and 362, pl. xii, figs. 8–14, pl. xix, figs. 6–7).
1908. *Krasiliscik, I. M. "Experimentelle Utersuchungen zur Erörterung der Frage über das Vermögen der *Microphtalma longifacies*, Rond., Larven des *Anisoplia austriaca* und einiger anderer Lamellicornia anzustecken. *Kisinev Trd. Obsc. jest.*, I, 1904–1908, pp. 358–395.

Anomala frischii, Fabricius.

1736. Frisch, J. L. "Vom Weinblat-Keper, oder Julius-Keper." *Beschreibung von allerley Insecten in Teutschland* IV, Berlin, 1736, pp. 28–30, pl. xiv, figs. 1–4.
1874. Schiødte, J. C. "De Metamorphosi Eleutheratorun observationes: Bidrag til Insekternes Udviklingshistorie." *Natur. Tidsskr.* IX, 1874, pp. 226-376, pl. viii–xix (*Euchlora frischii*, pp. 304–307 and 361, pl. xii, figs. 1–7, pl. xix, fig. 5).

Anomala elata, Fabricius.

1910. Lefroy, H. M. "Life-Histories of Indian Insects—Coleoptera I." *Mem. Dep. Agric. Ind.* II, 1908–1912, pp. 139–163, pl. xiii–xix (*Anomala varians–elata*), pp. 143–146, pl. xiv.

Anomala vitis, Fabricius.

1869. *Mulsant, E. & Mayet, V. "Description des Métamorphoses de l'Anomala vitis." *Ann. Soc. Linn. Lyon* (*n.s.*) XVI, pp. 277–281.

Parastasia confluens, Westwood.

1874 Schiødte, J. C. "De Metamorphosi Eleutheratorum Observationes: Bidrag til Insekternes Udviklingshistorie."

Natur. Tidsskr. IX, 1874, pp. 226–376, pl. viii–xix (*P. confluens*, pp. 294–296 and 261, pl. x, figs. 1–10, pl. xix, fig. 3).

Pelidonota punctata, Linnaeus.

1870. *Riley, C. V., "Insects Injurious to the Grape Vine." *Amer. Ent. & Bot.* V (2), 1870, p. 295, fig. 185.

Cotalpa lanigera, Linnaeus.

1869. Lockwood, S. "The Goldsmith Beetle and its Habits." *Amer. Nat.* II, 1869, pp. 186–192, figs. 1–2.

1870. Lockwood, S. "Destructiveness of the Larva of the Goldsmith Beetle." *Amer. Nat.* III, 1870, pp. 49–50.

1879. *Saunders, W. *Canad. Ent.* XI, pp. 21–22.

Anoplognathus analis, Boisduval, and **A. porosus**, Dalman.

1901. Froggatt, W. W. "Cockchafer (*Anoplognathus*) Grubs destroying Strawberry Plants." *Agric. Gaz. N. S. W.*, XII, 1901 (1902), pp. 473–476, 5 text-figs.

Adoretus vestitus, Boheman.

1915. [1]*Friederichs, R. "Ueber *Adoretus vestitus*, Boh., als Schädling im Samoa und seine früheren Stände." *Zeitschr. Wiss. Insbiol.* X, pp. 41–47, figs.

Adoretus lacustris, Arrow.

Pl. xiv, figs. 5–6.

Locality.—Salt Lakes near Durgapur, Calcutta. Three larvae varying from about 30–40 mm. in length, and a number of pupae and adults with cast larval skins. They were found about a foot above the water's edge in lumps of firm clayey soil that were falling away from a narrow banked-up footpath separating two pieces of brackish water. One of the larvae was found among roots of *Acanthus ilicifolius* in very wet, and doubtless salt, mud at the water's edge, but no others and no pupae or adults were found at this level.

The larvae closely resemble those of *Adoretus vestitus* described by Friederichs, and those of *Anomala frischii* and *Phyllopertha horticola* described by Schiødte in their general characters. They are greyish in colour.

The head resembles that of *Phyllopertha horticola*, having hair-bearing punctures sparsely scattered all over it. The antennae are slenderer than in that species, the basal joint being spherical, the second (first of Schiødte) three times, the third five times and the

[1] Kindly lent by the Imperial Entomologist, Pusa.

fourth three times as long as broad. The fourth joint is prolonged distally on the posterior or inner side into a slender conical process. The fifth joint is slightly shorter than the fourth, broadest a little beyond the middle, bluntly pointed distally. A pair of pigmented ocelli is present immediately behind the antennae.

The mandibles appear broad from in front, but very narrow from the side. They are convex in front and concave behind and are strongly arched distally. There are three terminal teeth on the left side and two on the right, the most ventrally situated being apical in each case. The left molar tooth is a large hollowed cusp with two transverse ridges, the distal of these uniting with the anterior margin to form a distinct denticle and the proximal uniting to form a large spine. The anterior margin of the cusp is very strongly elevated. The right molar tooth consists of two distinct cusps, of which the distal is triangular with the angles raised into small denticles and the proximal is broadly L-shaped, its most proximal portion being very strongly produced in the same plane as the mandible.

The lobe of the maxilla bears a stout and somewhat conical terminal spine with two similar but smaller spines, united at the base, in a line with it on the inner side. The inner margin bears a row of strong spines, followed on the dorsal surface by others which become weaker and disappear towards the base on the outer side. The ventral surface bears two rows of spines distally between the rows on the inner and outer margins, the distal spine alone being specially stout in the outer row, and the distal and penultimate in the inner row. The stridulatory spines are ⌓-shaped. The maxillary palps are mounted on a broad protuberance and are four-jointed. The first joint is short and broad, more or less transverse. The second is narrower, and perhaps a little more than twice as long as broad. The third resembles the second but is perhaps a little shorter. The fourth is about as long as the second but tapers slightly at both ends.

The labial palps are two jointed, each joint being about twice as long as broad. The labium is set with long spines in front of the palps and bears a pair of very long hairs between them. There is a pair of similar hairs on the membrane between the labium and the mentum. There is a spine on each side of the mentum near the posterior margin.

The legs bear long and slender spines below, which tend to be more or less filamentous on the proximal joints but stronger on the distal ones. There are a few long hairs, not very definitely arranged, between the anterior legs; there is also a line of them between the legs on each of the two remaining thoracic segments and across the lower surface of each of first nine abdominal segments, becoming sparser behind.

The thoracic segments are each divided into three transverse ridges above, and each of these ridges bears a line of long hairs.

The first abdominal segment is undivided above, and bears a line of similar hairs mixed with slender spines of a darker colour.

The next five segments are divided into three ridges above, each ridge bearing a broad band of these hairs and spines.

The seventh abdominal segment consists above of an anterior ridge resembling in all respects the ridges of preceding segments, and an extensive posterior flattened area divided across the middle by a somewhat indistinct groove, and more or less covered with hair which is longest in two places, in front of and behind this groove respectively.

The eighth and ninth abdominal segments resemble the seventh, except that the anterior ridge is absent, and that the groove dividing the flattened area is distinct, especially in the eighth segment.

The tenth abdominal segment bears a large oval hairless area above, bounded by a fine dark line which is incomplete behind, and surrounded by dense and moderately long hair (pl xiv, fig. 5). Ventrally the posterior border is set with long erect spines, bent over backwards at the tip. This border is terminated on each side by a small patch of slender hairs, and there are a few scattered spines and hairs further back.

The eleventh abdominal segment is hairless and scarcely exposed above; below it is covered with long erect spines bent over backwards at the tip, the lower margin of the anus bearing a line of long slender hairs.

Adoretus versutus, Harold.

Pl. xiv, fig. 4.

Locality.—Museum compound, Calcutta.

Numerous larvae, about 7–30 mm. long. They were found, together with pupae and adults with larval exuviae, in flower-pots in which cannas were growing.

The larvae of *A. versutus* resemble those of *A. lacustris* in general appearance, except that they are of a pale yellowish colour.

The head is much less hairy than in larvae of *A. lacustris*, especially towards the vertex, and the clypeus is somewhat deeper. The antennae are somewhat shorter, and the distal prolongation of the fourth joint is blunter.

The mandibles resemble those of *A. lacustris* in their general structure, but the distal denticle of the triangular cusp on the right mandible is very weak, and the second cusp, though strongly elevated, is not strongly produced proximally, being in consequence less distinctly L-shaped and more or less transverse to the mandible. The rest of the mouthparts closely resemble those of *A. lacustris*, but the palps are somewhat shorter and stouter.

The legs and body up to the ninth abdominal segment closely resemble those of *A. lacustris*, except that the hair and spines on the dorsal surface are weaker and less numerous. The tenth abdominal segment resembles that of *A. lacustris* below, except that the spines are much shorter. It is sparsely hairy all over above, the hairs being most numerous and mixed with small spines near the

posterior margin (pl. xiv, fig. 4). The eleventh abdominal segment resembles that of *A. lacustris* in form. Its ventral spines resemble those on the preceding segment. The anus is bordered below by a line of hairs as in *A. lacustris* and is bordered above by a line of small spines such as are found on the dorsal surface of the preceding segment.

The larva of this species appears to be particularly close to that of *A. vestitus* and, in the absence of specimens of the latter, I am unable to distinguish between them. Both appear to be separated from *A. lacustris* by the structure of the right mandible and by the vesture of the ninth and tenth abdominal segments.

Note.—Since the above was written illustrations of the life-histories of *Anomala biharenis*, Arrow and *Adoretus caliginosus*, Burmeister, have been published by Mr. Bainbrigge Fletcher (*Sci. Rep. Agr. Res. Inst., Pusa*, 1917 18, pl. x-xi), who has lent me a specimen of the latter larva for examination. Apart, possibly, from the mouth parts, which are not exposed, this larva closely resembles

Text-fig.—*Adoretus caliginosus*, tenth and eleventh abdominal segments of larva from above.

that of *A. versutus*. The chief difference is found on the dorsal surface of the tenth abdominal segment (see text-fig.). The fine line separating the mid-dorsal area of this segment from the rest is very distinct, as in *A. lacustris*, but it is abruptly bent inwards on each side behind as in *A. versutus* and the area is distinctly transverse. The tuft of spines situated on each side obliquely behind this line are slightly denser and longer than *A. versutus*.

EXPLANATION OF PLATE XIV.

FIG. 1.—*Taeniocerus bicuspis*, Kaup; larval anus.

,, 2.—*Macrolinus andamanensis* (Stoliczka); larval anus.

,, 3.—*Ophrygonius cantori* (Percheron); larval anus

,, 4.—*Adoretus versutus*, Harold; posterior end of larva from above.

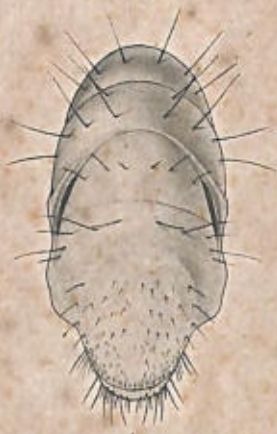
,, 5.—*Adoretus lacustris*, Arrow; posterior end of larva from above.

,, 6.—*Adoretus lacustris*, Arrow; larval mouth-parts, with mandibles forced wide apart to show structure more clearly.

1

3

2



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D. Bagchi, del.

Photogravure, Survey of India Offices, Calcutta, 1919.

INDIAN BEETLE LARVÆ

XVIII. REPORT ON A SMALL COLLECTION OF FISH FROM PUTAO (HKAMTI LONG) ON THE NORTHERN FRONTIER OF BURMA.

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(With Plate XXII.)

The fish described or discussed in this paper were recently collected by Dr. Murray Stuart of the Geological Survey of India. The collection though small and not including any specimens of large size is of considerable interest. No fish has hitherto been reported from the extreme northern corner of Burma, and several interesting new forms are represented, the most remarkable of which is an undescribed species of the genus *Channa*, which, though known from both Ceylon and China, has not hitherto been discovered in the eastern parts of the Indian Empire.

In Dr. Stuart's collection there are altogether twenty-one specimens, all from mountain streams in the Putao Plains (Hkamti Long of the old maps) on the northern Frontier of Upper Burma. These plains are entirely separated by very high mountain ranges from the watersheds of the Brahmaputra system (including the Dihang and the Lohit) of the Assam and Tibetan Frontiers on the west and the Mekong system (Yunnan) on the east. The Sen-Ben-Ti, the Nam-Yak and the Nam-Ti-Sang mentioned in the text belong to the Irrawaddy system.

The twenty-one specimens examined belong to twelve species, which fall into eleven genera representing five different families. Except in three or four instances all the species, belonging to quite unrelated families, have developed some kind of adhesive or sucking apparatus—an interesting instance of convergence or plasticity in the formation of specialized organs of a similar nature in a restricted environment.

LIST OF SPECIES OBTAINED.

Sub-order OSTARIOPHYSI.

Division *SILUROIDEA*.

Family SISORIDAE.

Amblyceps murray-stuarti, Chaudhuri, sp. nov.

,, *mangois* (Hamilton Buchanan).

Erethistes asperus (M'Clelland).
Exostoma vinciguerrae, Regan.
Pseudecheneis sulcatus (M'Clelland).

Division *CYPRINOIDEA*.

Family COBITIDAE.

Aborichthys kempi, Chaudhuri.
Nemacheilus botia (Hamilton Buchanan).

Family CYPRINIDAE.

Sub-family *CYPRININAE*.

Semiplotus cirrhosus, Chaudhuri, sp. nov.
Barbus stoliczkanus, Day.

Sub-family *RASBORINAE*.

Danio aequipinnatus (M'Clelland).

Sub-order PERCESOCES.

Family OPHICEPHALIDAE.

Channa burmanica, Chaudhuri, sp. nov.

Sub-order ACANTHOPTERYGII.

Division *PERCIFORMES*.

Family NANDIDAE.

Badis badis (Hamilton Buchanan).

DESCRIPTION OF SPECIES.

Genus **Amblyceps**, Blyth.

Amblyceps murray-stuarti, sp. nov.

(Plate XXII, figs. 1, 1*a*, 1*b*.)

The family Sisoridae[1] consists of small cat-fishes found in swift mountain streams in Northern India, Burma, Tibet and China. In most of the genera (e.g. *Pseudecheneis*, etc.) a sucking-disk, made up of folds or plates of skin, is formed on the region of the chest. The disk enables these fishes to resist the force of the water. In some genera plates or lobes of skin about the mouth serve the purpose of a sucking organ. The following Indian genera are included in this family :—

Amblyceps, *Olyra*, *Akysis*, *Chimarrichthys*, *Exostoma*, *Parex-*

[1] Jordan, *A Guide to the Study of Fishes*, Vol. II, p. 184.

ostoma, *Erethistes*, *Glyptosternon*, *Euglyptosternum*, *Pseudecheneis* and *Sisor*.

The generic character "caudal fin being forked" of the genus *Amblyceps* has to be modified. The genus was orginally founded on a single species (*A. mangois*) with a forked tail-fin. In the new species, however, as well as in *A. marginatus*, Günther,[1] from mountain streams running into the Min River, in the province of Sze-chuen, China, the caudal fin is square-cut. Nor is the generic character "no adhesive thoracic surface" strictly true of this new species as there appears to be about thirteen loose folds of skin over the posterior part of the chest continued to the anterior portion of the abdominal region. These folds are likely to possess some adhesive function. Instead of founding a new genus on these slight differences it is considered reasonable to extend the definition of *Amblyceps* so as to include these three closely related species in the genus, which the author very graphically alluded[2] to as "cobitis looking siluroid."

The head, which is depressed and is broader than high, slopes rapidly down to a spatulate snout. The dorsal profile is almost straight from the point of orign of the rayed dorsal fin, which is small and slender, to the anterior end of the low and long adipose dorsal fin; the ventral profile is, however, straight throughout. The body is broad and round from behind the head to the anal opening, posterior to which it is highly compressed. The eyes and the head are covered with soft skin; the eyes are very small and are placed in the anterior part of the head with two parts of its length in front and three parts behind, the interorbital distance being contained about five times in the length of the head. There are two nostrils on each side quite close to each other, the posterior one almost reaching the front of the eye and having a barbel attached to the front wall. The mouth is wide and anterior and the opening is horizontal, the upper jaw being slightly longer than the lower. The teeth on the jaws are villiform, arranged in the upper jaw in a broad crescentic band and in the lower jaw in a straight narrow band. The margins of the lips are slightly fringed in both.

There are altogether eight barbels. The maxillary barbels have flat and expanded roots with loose dilated flaps and are as long as the head. The nasal and the outer mandibular barbels are equal to each other, and are two-thirds the length of the head. The inner mandibular barbels are about half as long as the head.

The gill openings are wide and continue up to one-third of the depth of the body on the dorsal side all the way from the notch below the chin in the ventral aspect; the gill membranes from two sides unite in front of a slender gular plate-like structrue at the middle point between the two roots of the outer mandibular

1 Pratt, *To the Snows of Tibet Through China*, p. 245, pl. ii, fig. A.
2 Blyth, *Proc. Asiat. Soc. Bengal*, XXVII, p. 282.

barbels. The number of branchiostegal rays is twelve; they are concealed under soft thick skin.

The pectoral and the pelvic fins are low, small and narrow, covered with soft skin. The pectoral fins, which are situated immediately behind the gill openings, are very low and are on a level with the ventral surface. The small pelvic fins are on the ventral surface and arise slightly anterior to and enclose the anal opening which is placed on a slightly raised cushion, the fins reaching beyond it. Immediately behind the cushion of the anal opening there is a deep fossa inside which is the slender anal papilla so common among the siluroids. At about the middle of the interval on the ventral surface, between the roots of the pectoral and pelvic fins, the loose skin appears to be folded into twelve or thirteen corrugations which may be considered as a rudimentary structure analogous to the adhesive disks found in some of the genera (e.g. *Pseudecheneis*, *Glyptosternon*, *Euglyptosterum*, etc.) belonging to this family. The pelvic fins reach beyond the fossa behind the anal opening, but do not reach the anal fin which is high and long. The caudal fin is flat and well spread out, but is sub-truncated. Some very short and compact fin-rays continue round the caudal peduncle to a slight extent along both the ventral and dorsal edges.

The colour in spirit is brownish-black above and lighter below. The maxillary barbels are white-tipped and the nasal and the inner mandibular barbels are dusky white.

The measurements of the specimen in hundredths of total length without the caudal fin are as follows:—

Length of body in millimeters	81
Depth of body expressed in hundredths of length ...	14·8
Depth of caudal peduncle ,, ,, ,, ,, ...	13·5
Length of head ,, ,, ,, ,, ...	18·5
Depth of head at occiput ,, ,, ,, ,, ...	10
Width of head ,, ,, ,, ,, ...	13·5
Width of interorbital space ,, ,, ,, ,, ...	5
Length of snout ,, ,, ,, ,, ...	6
Distance from end of snout to dorsal fin ,, ,, ...	22
Distance from end of snout to root of pectoral fin ,, ...	17·3
Distance from end of snout to root of pelvic fin in hundredths of length	44·5
Distance from end of snout to anterior root of anal fin in hundredths of length	63
Distance from last anal ray to root of caudal fin in hundredths of length	22
Height of longest dorsal ray in hundredths of length ...	11
Height of longest anal ray ,, ,, ,, ,, ...	11
Length of caudal fin ,, ,, ,, ,, ...	14·8
Length of pectoral fin ,, ,, ,, ,, ...	12·3
Length of pelvic fin ,, ,, ,, ,, ...	7·4
Length of adipose fin ,, ,, ,, ,, ...	31·2
Depth of adipose fin ,, ,, ,, ,, ...	4
Base of anal fin ,, ,, ,, ,, ...	18·5
Number of rays in dorsal fin	15
Number of rays in anal fin	13
Number of rays in pectoral fin	17
Number of rays in pelvic fin	7
Number of long rays in caudal fin	20

The single spines of the dorsal and of the pelvic fins are round, smooth and hyaline, but that of the pectoral fin is flat and striated.

The species superficially resembles *Amblyceps marginatus* Günther, collected by Mr. Pratt in mountain streams running into the Mīn River in the province of Sze-chuen in China, but it differs in possessing a shorter head, in being of a lesser depth, in having the upper jaw longer instead of shorter than the lower jaw, in having a longer adipose dorsal and shorter barbels, in having corrugated folds of skin on the ventral side, and also in the position of the fins and in proportions. The colouration is also different; in particular the new species does not possess the broad whitish border round the margins of all the fins. It resembles *A. marginatus* in having a subtruncated caudal, and a short pelvic fin not reaching the anal. The widely distributed Indian species *Amblyceps mangois* (H.B.)—hitherto the sole representative of the genus in the continent of India—differs from the new species in having a prominent lower jaw, a divided caudal fin, longer barbels with non-dilated roots, a smooth ventral surface, a shorter and higher adipose fin and in the number of fin-rays as well as in proportions.

The type specimen is 81 mm. in length without the caudal fin and is entered in the register of the Zoological Survey of India under No. 9736/1. It was collected by Dr. Murray-Stuart of the Geological Survey of India from a mountain stream in the Putao Plains on the northern Frontier of Upper Burma in the month of February, 1918.

Amblyceps mangois (Hamilton Buchanan).

1822. *Pimelodus mangois*, Hamilton Buchanan, *Fish. Ganges*, pp. 199 and 379.
1842. *Pimelodus anisurus*, M'Clelland, *Calcutta Journ. Nat. Hist. Art Sci.*, II, p. 583.
1842. *Pimelodus indicus*, *Id.*, *ibid.*, p. 584.
1853. *Pimelodus mangois*, Bleeker, *Verh. Batavia Gen.*, XXV, p. 58.
1858. *Amblyceps caecutiens*, Blyth, *Proc. Asiat. Soc. Bengal*, XXVII, p. 282.
1860. *Amblyceps tenuispenis*, *Id.*, *ibid.*, XXIX, p. 153.
1864. *Amblyceps caecutiens*, Günther, *Cat. Fish. Brit. Mus.*, V, p. 190.
1864. *Amblyceps tenuispinis*, *Id.*, *ibid.*
1864. *Amblyceps mangois*, *Id.*, *ibid.*
1869. *Amblyceps mangois*, Day, *Proc. Zool. Soc.*, p. 524.
1871. *Akysis kurzii*, Day, *ibid.*, p. 704.
1877. *The Mangoi*, Hamilton Buchanan, *Stat. Act. Bengal*, XX, p. 60.
1877. *Amblyceps mangois*, Day, *Fish. Ind.*, p. 490, pl. cii, fig. 6, and pl. cxvii, fig. 1.
1889. *Amblyceps mangois*, *Id.*, *Faun. Brit. Ind. Fish.*, I, p. 123, fig. 52.
1890. *Amblyceps mangois*, Vinciguerra, *Ann. Mus. civ. Stor. Nat. Genova* (ser. 2), IX, p. 196.
1893. *Amblyceps mangois*, Boulenger, *Ann. Mag. Nat. Hist.*, (ser. 6), XII, p. 200.
1913. *Amblyceps mangois*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 252.

Two figures, one in outline from above and the other a side view in colour, are in existence on plate ix of Hamilton Buchanan's

Manuscript Drawings[1] now in the possession of the Asiatic Society of Bengal. The name "*Pimelodes Manggoi*" appears on the back of this plate in Hamilton Buchanan's handwriting. Subsequently he said of this very fish, "The Mangoi is a small very ugly Pimelode"[2] in his manuscript reports on the statistical enquiry of Bengal districts in which he was engaged from 1807 to 1813. As the type of his *P. mangois* has been lost, or at least cannot be traced, and as the description in the *Fishes of the Ganges* is not illustrated, this manuscript drawing is of additional value, as it is the protograph of the species. The type specimens were found in tanks in Northern Bihar and also probably in the R. Kusi near Nathpur.

There are only two specimens in the collection. They measure 41 mm. and 38 mm. in length. Both were secured from hill streams in the Putao Plains.

Distribution.—Fresh waters of India and Burma usually on or near the hills, including the Himalayas from Kangra to Darjiling, Ludhiana, the Jumna (for some considerable distance from the hills), Bihar districts, a stream south of Yembung (Abor country), Nampandet (Southern Shan States), Pegu and Moulmein; also the Cabul River at Jelellabad.

Genus **Erethistes**, Muller and Troschel.

Erethistes asperus (M'Clelland).

(Plate XXII, figs. 2, 2*a*, 2*b*).

1844. *Pimelodus asperus*, M'Clelland, *Calcutta Journ. Nat. Hist. Art. Sci.*, IV, p. 404, pl. xxiv, fig. 2.
1864. *Hara aspera*, Günther, *Cat. Fish. Brit. Mus.*, V, p. 189.
1873. *Hara aspera*, Bleeker, *Ned. Tijdschr. Dierk.*, IV, p. 125.

It was Günther who first pointed out that the genus was allied to *Sisor*.[3] The original description of the species by M'Clelland is very defective, and his figures even more so. M'Clelland also miscalculated the number of barbels, mentioning only six in place of eight, probably disregarding the nasal barbels which are not very conspicuous. Günther's corrections and additions, though not of great importance, enable one to recognize the species. Any attempt at redescription, however, should be postponed till specimens can be obtained from the neighbourhood of Chusan. M'Clelland also made a mistake in assigning this freshwater fish to estuaries.[4] The species has not been found previously within Indian limits.

Two specimens were obtained from Tanja, measuring 33 mm. and 31 mm. respectively. The smaller one is, however, damaged. Three figures of the larger specimen are supplied and the actual

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[1] Chaudhuri, *Mem. Ind. Mus.*, V, p. 444 and foot-note.
[2] Hunter, *A Statistical Account of Bengal*, XX, p. 60.
[3] Günther, *Cat. Fish. Brit. Mus.*, V, p. 293.
[4] M'Clelland, *Calcutta Journ. Nat. Hist. Art. Sci.*, IV, p. 395.

measurements of both specimens are given below for reference. The mouth is inferior. The lip is lobate and reflected and spreads continuously round the mouth so as to form a broad flat sucker. The teeth in the jaws are villiform in broad bands. The bases of the maxillary barbels are dilated; the mandibular barbels are short, round and thick, the surface of these barbels being studded with closely set tubules. The posterior nostril is slit-like, while the anterior one is round and terminates in a funnel-like structure. There are four or five bony tubercles in a horizontal line on each side near the gill-opening below the dorsal spine. The chest is coriaceous with slight corrugations. The body is dark brown in colour, with two white broad transverse stripes made up of white blotches. The anterior band is at the end of the dorsal fin, and the posterior one nearer to the root of the caudal. The pectoral and the pelvic fins are grey marked with black blotches; the caudal fin is greyish-brown. The maxillary barbels are annulated in white and brown while the mandibular barbels are white.

Measurements of specimens :—

Total length (without caudal fin) in millimeters	...	33	31
Length of head including opercular flap ,,	...	10	10
Depth of body ,,	...	10	9
Depth of caudal peduncle ,,	...	4	3·5
Length of snout ,,	.	6	5·5
Depth of head at occiput ,,	...	6	6
Width of head ,,	...	8·5	8
Width of interorbital space ,,	...	4	3·5
From tip of snout to anterior limit of dorsal fin ,,	...	10	10
Height of dorsal spine ,,	...	6	5
,, of longest dorsal ray ,,	...	8	8
Length of pectoral fin ,,	...	11	10
,, of pelvic fin ,,	...	6	6
Base of anal fin ,,	...	4·5	4·5
Height of anal fin ,,	...	6	6
From tip of snout to root of pectoral fin ,,	...	8	8
From tip of snout to root of pelvic fin ,,	...	18	17
From tip of snout to anterior end of anal fin ,,	...	22	22
From tip of snout to anal opening ,,	...	21	21
Number of rays in the dorsal fin ...	...	11·5	11·5
,, ,, ,, pectoral fin ...	...	1·7	1·7
,, ,, ,, pelvic fin ...	...	8	8
,, ,, ,, anal fin ...	...	1·9	1·9

Distribution.—Upper Burma (N. Frontier); China (Chusan).

Genus **Exostoma**, Blyth.

Exostoma vinciguerrae, Regan.

1890. *Exostoma labiatum* (*non* M'Clelland), Vinciguerra, *Ann. Mus. civ. Stor. Nat. Genova* (ser. 2), IX, p. 252.

1905. *Exostoma vinciguerrae*, Regan, *Ann. Mag. Nat. Hist.* (ser. 7), XV, p. 184.

There are two specimens in the collection, one measuring 56 mm., from the Putao Plains and another measuring 45 mm. from the Nam-Yak river at Tanja. The smaller specimen is damaged and distorted. From the measurements, etc. of the bigger specimen

it appears to be *Exostoma vinciguerrae*, a species (a single specimen) which was first collected by the late Leonardo Fea in the Khakhyen (Kachin) Hills, Upper Burma, but was wrongly identified by Vinciguerra as *E. labiatum* (M'Clelland). Vinciguerra mistakenly thought that it extended the distribution of *E. labiatum*, which was known only from Upper Assam (Mishmi). The type of M'Clelland's *E. labiatum* is in the British Museum (Griffith's collection).

In both the specimens the under surface of the flat spines of the pectoral and pelvic fins is finely striated, suggesting adhesive properties.

Distribution.—Upper Burma: Khakhyen Hills and Putao Plains.

Genus **Pseudecheneis**, Blyth.

Pseudecheneis sulcatus (M'Clelland).

1842. *Glyptosternon sulcatus*, M'Clelland. *Calcutta Journ. Nat. Hist.*, II, p. 587, pl. vi, figs. 1, 2 and 3.
1860. *Pseudecheneis sulcatus*, Blyth, *Proc. Asiat. Soc. Bengal*, p. 134.
1864. *Pseudecheneis sulcatus*, Günther, *Cat. Fish. Brit. Mus.*, III, p. 264.
1877. *Pseudecheneis sulcatus*, Day, *Fish. Ind.*, p. 500, pl. cxvi, fig. 1.
1889. *Pseudecheneis sulcatus*, *Id.*, *Faun. Brit. Ind. Fish.*, I, p. 107, fig. 44.
1890. *Pseudecheneis sulcatus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (ser. 2), IX, p. 252.
1913. *Pseudecheneis sulcatus*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 255.

There is one specimen from the Putao Plains measuring 93 mm. in length without the caudal fin. The barbels on the ventral side are short and thick and their surface is broken up into tubules. The lips are lobulated and expanded with a suctorial mouth. The spines of the pectoral and the pelvic fins are flat and expanded and are covered with thick skin. The under surface of these flat spines is finely striated, converting these fins also into an additional adhesive apparatus. The conspicuous adhesive disk on the chest is oval and is made up of sixteen thick and broad transverse folds with a broad margin; posterior to this apparatus the skin over the anterior portion of the abdomen is loose and corrugated in finer folds. The gill-opening is not entirely confined to the dorsal side as in *Exostoma*, but continues just a little on the ventral surface to the border of the transverse folds.

Distribution.— Darjeeling; Khasi Hills; Yembung (Abor country); and Khakhyen (Kachin) Hills, Upper Burma.

Genus **Aborichthys**, Chaudhuri.

Aborichthys kempi, Chaudhuri.

1913. *Aborichthys kempi*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 245, pl. vii, figs. 1, 1*a* and 1*b*.

There are two specimens in the collection, measuring 82 mm. and 80 mm. in length, obtained from hill streams near Tanja. The two specimens differ slightly from one another and from the

type in colouration and some other particulars. The ground colour of the body of the longer fish is greyish-white. The obliquely transverse dark bands anterior to the dorsal fin are very narrow, but those below the fin are broader and posterior to the dorsal fin the stripes are replaced by irregular blotches. The ocellus at the upper corner of the root of the caudal fin is intensely black. The colour of the two limiting bands of alternate black and white round the free border of the caudal fin is somewhat diffused. In the smaller specimen the colour of the upper side of the head is not marbled, as is usually the case in the species, but is of a uniform dark brown, and the ground colour of the body is dirty brown to black. There are no transverse stripes on the sides in front of the dorsal fin. Below the dorsal fin and in front of the pelvic fins there are some dark but faint transverse stripes, very narrow and of diffused colouration. There are no transverse stripes behind the dorsal fin. The caudal fin has two bright white bands, both broad, one at the root and the other just interior to the terminal black band round the free end of the fin. The ocellus at the upper corner of the root of the caudal fin is just as in the longer fish. The dorsal fins in both the specimens bear three black bands made up of black dots. This fish may belong to a distinct race if not a new species.

Distribution.—Egar stream, between Renging and Rotung, the Dihang River near Yembung and the Sirpo River near Renging in the Abor country; mountain streams in the Garo Hills, Assam; and similar streams near Tanja, Putao, in Upper Burma.

Genus **Nemacheilus**, Hasselt.

Nemacheilus botia (Hamilton Buchanan).

1822. *Cobitis botia*, Hamilton Buchanan, *Acct. Fish. Ganges*, pp. 350, 394.
1822. *Cobitis bilturio*, *Id.*, *ibid.*, pp. 358 and 395.
1846. *Cobitis bilturio*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XVIII, p. 35.
1846. *Cobitis botia*, *Id.*, *ibid.*, p. 72.
1839. *Cobitis bimucronata*, M'Clelland, *Asiat. Researches*, XIX, pp. 304 and 433, pl. li, fig. 4.
1839. *Cobitis scaturigina*, *Id.*, *ibid.*, pp. 308 and 443, pl. liii, fig. 6.
1839. *Cobitis ocellata*, *Id.*, *ibid.*, p. 436, pl. li, fig. 6.
1839. *Somileptes unispina*, Swainson, *Lardner's Cab. Cyclop. Nat. Hist.* (*Fish. Amph. Rep.*), II, p. 311.
1841. *Cobites mooreh*, Sykes, *Trans. Zool. Soc.*, II, p. 366.
1853. *Cobitis botia*, Bleeker, *Verh. Bat. Gen.*, XXV, p. 70.
1853. *Cobitis bilturio*, *Id.*, *ibid.*
1863. *Cobitis botia*, Bleeker, *Versl. Akad, Amsterdam*, XV, p. 42.
1868. *Nemachilus urophthalmus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 348.
1868. *Nemachilus botia*, *Id.*, *ibid.*, p. 349.
1869. *Nemacheilus botia*, Day, *Proc. Zool. Soc.*, p. 382.
1877. *Nemacheilus botia*, Day, *Fish. Ind.*, p. 614, pl. clvi, fig. 5.
1877. *Nemacheilus aureus* (var.), *Id.*, *ibid.*, p. 614, pl. clvi, fig. 4.
1889. *Nemachilus botius*, *Id.*, *Faun. Brit. India, Fish.*, I, p. 227.
1893. *Nemachilus botia*, Boulenger, *Ann. Mag. Nat. Hist.* (ser. 6), XII, p. 203.
1918. *Nemachilus botia*, Annandale, *Rec. Ind. Mus.*, XIV, p. 35.

There is only one specimen measuring 72 mm. in length without the caudal fin, collected from a stream near Tanja. The preorbital has no projection wholly free and movable nor is it entirely concealed by the skin, but there is a narrow concave slit or groove just underneath it, commencing from below the middle of the eye and reaching to about the middle of the snout. The eyes are in the middle of the head and the anterior root of the dorsal fin is equidistant from the tip of the snout and the root of the caudal fin. The distance of the vent from the snout is sixty-one in hundredths of its length without the caudal fin. The caudal fin is almost square-cut and slightly emarginate. The ground colour of the body is dull grey or dirty white with fourteen broken-up transverse bands of dark brown above the lateral line and seven or eight wedge-shaped transverse markings below it, alternating with the bands above. There are four transverse dark brown bands on the caudal fin instead of five, and these bands are rather wavy and not at all oblique or > shaped as is usual in the species. It approaches nearer to the variety *N. aureus*, Day than to the typical form. M'Clelland's figures, *viz.* figs. 4 and 6 of plate li and fig. 6 of plate liii, are only imperfect reproductions of three figures in plates numbered 49, 50 and 53 of the manuscript drawings of Hamilton Buchanan.[1] These figures are labelled *Cobitis bilturi*, *Cobitis botya*, and *Cobitis scaturigina* in Buchanan's handwriting. The name on plate 53 of the collection of MSS. drawings in the possession of Asiatic Society of Bengal, however, has been inadvertently cut off by the binder. Günther considered *N. scaturigina* to be a doubtful species of the genus.[2]

Distribution.—Punjab; Sind; Poona; Madras, as far south as the R. Kistna; Orissa; Bihar; Bengal; Assam; Burma, Southern Shan States and North-Eastern frontier; Ceylon.

Genus **Semiplotus**, Bleeker.

Semiplotus cirrhosus, Chaudhuri, sp. n.

(Plate XXII, figs. 3, 3*a*.)

Bleeker, who founded the genus *Semiplotus* on a single Assamese species, *Cyprinus semiplotus*, M'Clelland, attributed to the genus among several other characters the possession of a knob at the symphysis and the absence of barbels. The new species, however, has two maxillary barbels and is without any knob at the symphysis of the lower jaw. In all other respects it so very naturally fits into the genus that it would be going against all sound principles not to include it. The practice of multiplying the number of genera should, as far as possible, be discouraged, as it only makes the path of systematic study unnecessarily difficult.

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[1] Chaudhuri, *Mem. Ind. Mus.*, V, p. 444 (foot-note).
[2] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 347.

The fish is broad and deep with a round belly and thick head. The dorsal profile is highly convex: from the anterior root of the dorsal fin it suddenly slopes towards the snout, which is broad, blunt and moderately round and thick; the posterior portion of the dorsal profile runs in a more gentle curve to the caudal peduncle where, about the middle of the peduncle, it is slightly concave. Beyond this the curvature is again convex to the upper corner of the root of the caudal fin. The ventral profile, with its lowest point at the root of the pelvic fin, nearly corresponds to the curvature of the dorsal profile but with less abruptness in the frontal portion from the root of the pelvic fin towards the lower jaw. The curvature from this point is still less convex than the dorsal profile, towards the caudal peduncle.

The mouth is terminal and inferior, and its opening is wide; the upper jaw is thick and deep with a movable upper lip; the lower jaw is extremely thin with a horny or cartilaginous plate with a little prominence in the middle. On the broad and obtuse snout there is a row of open pores four in number, two on each side. The maxillary extends nearly to below the front of the eye and there are two maxillary barbels. On each side below the preorbital there is a narrow slit. The eye is nearly in the middle of the head and the diameter of the orbit is contained nearly three times in the length of the head. The latter is contained three and two-third times in the total length without the caudal fin. The length of the barbel is equal to that of the snout, which is slightly less than the length of the orbit. The gill openings are almost restricted to the sides and the gill membranes are confluent with the skin of the isthmus; the surface underneath the lower jaw and below the neck from the chin to the isthmus appears to be in part corrugated; immediately below the lower jaw it is somewhat fleshy and spongy probably with adhesive function.

The height (the greatest depth at the anterior root of the dorsal fin) is contained two and four-fifth times in the total length without the caudal fin and the least depth of the caudal peduncle is contained nearly seven times in that length.

The anterior end of the dorsal fin, though nearly equidistant from the tip of the snout and the root of the caudal fin, is slightly nearer to the snout. There are thirteen scales in front of the dorsal fin and ten between the last ray at its posterior end and the root of the caudal fin. There are three spines, all entire, and twenty-five branched and divided rays. The length of the longest dorsal ray is contained about four times in the total length. The distance between the tip of the snout and the superior root of the pectoral fin is contained three and a half times and the length of the fin about four times; there are altogether fifteen rays in the fin which almost reaches the root of that of the pelvic.

The tip of the snout and the root of the caudal fin are nearly equidistant from the root of the pelvic fin which has nine rays; the length of the rays is contained five times in the total length

and they reach as far as the vent; the ends of these rays are soft, thin, slender and almost silky. The anal fin has two spines and nine rays and there are seven scales betwen the last anal ray and the root of the caudal fin; the height of the anal fin is contained seven times in the total length. The caudal fin is deeply lobed and contains twenty long rays; the length of the longest rays of the borders is contained three times and that of the short middle rays seven times in the total length; the lobes of the caudal fin are equal.

The scales are fairly large and are nondeciduous. There are thirty-three perforated scales in the lateral line, which is complete and runs concave to the dorsal profile from the gill opening to below the end of the dorsal fin and thence straight about the middle of the fish to the root of the caudal fin. Below the anterior root of the dorsal fin there are seven transverse rows of scales above the lateral line and five transverse rows between the lateral line and the mid-ventral line. There are four rows of scales between the lateral line and the pelvic fin. The number of scales round the narrowest part of the caudal peduncle is eleven.

Measurements in hundredths of total length without caudal fin :—

Depth of body	36·5
Depth of caudal peduncle	14·3
Length of head	26·8
Depth of head	24·6
Width of head	17
Length of snout	7·3
Diameter of orbit	9·7
Width of interorbital space	12·2
Width of mouth	12·2
Length of maxillary	7·3
Length of barbel	7·3
Distance from tip of snout to anterior root of dorsal fin	48·78
Height of longest dorsal rays	24·6
Distance from tip of snout to root of pectoral fin	29·27
Length of pectoral fin	24·6
Distance from tip of snout to root of pelvic fin	51·2
Length of pelvic fin	19·5
Distance from tip of snout to vent	68·3
Distance from tip of snout to anterior root of anal fin	73·2
Height of longest anal rays	17
Length of caudal peduncle	17
Width of root of caudal fin	18
Length of longest rays of caudal fin	34·1
Length of shortest middle rays of divided caudal fin	14·6
Total length without caudal fin in mm.	41

The colour of the body of the fish in spirit is steel blue, but lighter in the belly. The upper edge of the orbit is black and the dorsal edge and the upper side of the head are dark; the fins are dull white with dark edges.

There are only two other species belonging to the genus: *S. semiplotus* (M'Clelland) from Assam and Burma and *S. modestus*, Day, from the hill ranges near Akyab. The new species differs considerably from both of them in possessing barbels, and in not being provided with a knob at the symphysis of the lower jaw—two characters which originally were thought to be of generic im-

portance as already noticed. The species agrees with *S. semiplotus* in having the last osseous spine smooth and entire, and differs in this respect from *S. modestus*, in which the last spine is serrated; on the other hand it agrees with the latter in having the lateral line concave to the dorsal profile and not almost straight as in *S semiplotus*. It has on the snout a row of pores like *S. semiplotus*, but the number of pores is four in place of eight in *S. semiplotus*. There are differences in proportion and colouration also. Both the previously known species are denizens of hilly tracts, though examples of *S. semiplotus* have been found as far down as Goalpara in the valley of the Brahmaputra. Griffith, however, observes that smaller examples of *S. semiplotus* are usually found near rapids. The adhesive apparatus below the chin, and further posteriorly down to the isthmus, is very interesting and significant of the habits of the new species if not of the genus.

There is only one specimen, the holotype, collected by Dr. Murray Stuart in February 1918, from a hill stream in the Putao Plains (Hkamti Long of the old maps), Upper Burma. It is entered in the register of the Zoological Survey of India under No. 9747/1.

Genus **Barbus**, Cuvier.

Barbus stoliczkanus, Day.

1869. *Barbus m'clellandi*, Day, *Proc. Zool. Soc.*, p. 619.
1871. *Barbus (Puntius) stoliczkanus, Id., Journ. Asiat. Soc. Bengal*, XL., p. 328.
1877. *Barbus stoliczkanus, Id., Fish. India*, p. 577, pl. cxliv, fig. 8.
1889. *Barbus stoliczkanus, Id., Faun. Brit. Ind. Fish.*, p. 326.
1893. *Barbus stoliczkanus*, Boulenger, *Ann. Mag. Nat. Hist.* (ser. 6), XII, p. 202.
1918. *Barbus stoliczkanus*, Annandale, *Rec. Ind. Mus.*, XIV, p. 35.

There is only one specimen measuring 38 mm. collected in a hill stream near Tanja. The anal fin is rolled on itself and looks like a tuft at the free-end. The colouration is very well preserved.

The first name cited above is preoccupied.[1]

Distribution.— Burma (Pegu, Moulmein, Shan States and Putao Plains).

Genus **Danio**, Hamilton Buchanan.

Danio aequipinnatus (M'Clelland).

1839. *Perilampus aequipinnatus*, M'Clelland, *Asiat. Researches*, XIX, p. 393, pl. lx, fig. 1.
1853. *Leuciscus aequipinnatus*, Bleeker, *Verh. Bat. Gen.*, XXV, p. 66.
1858. *Leuciscus lineolatus*, Blyth, *Journ. Asiat. Soc. Bengal*, p. 219.
1860. *Perilampus affinis, Id., ibid.*, p. 163.
1868. *Danio micronema*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 282.
1868. *Pteropsarion aequipinnatus, Id., ibid.*, p. 285.
1877. *Danio aequipinnatus*, Day, *Fish. Ind.*, p. 596, pl. cl, fig. 6.
1889. *Danio aequipinnatus, Id., Faun. Brit. Ind., Fish.*, I, p. 356, fig. 111.
1890. *Danio aequipinnatus*, Vinciguera, *Ann. Mus. Civic. Stor. Nat. Genova* (ser. 2), IX, p. 304.

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[1] Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XVI (1842), p. 390.

1893. *Danio aequipinnatus*, Boulenger, *Ann. Mag. Nat. Hist.* (ser. 6), XII, p. 203.
1913. *Danio aequipinnatus*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 252.
1917. *Danio aequipinnatus*, Annandale, *Note on Fisheries Inlé Lake*, p. 3.
1918. *Danio aequipinnatus*, *Id.*, *Rec. Ind. Mus.*, XIV, pp. 35, 211.

There is only one specimen, from a hill stream in the Putao Plains, measuring 56 mm. There are a series of rows of small wart-like beads on and around the chin and below the neck. The body is more dusky than usual; the colour appears to have faded though some of the longitudinal stripes are conspicuous. There is a round white blotch on the upper anterior corner of the opercle.

Distribution.— The Himalayas (Darjiling); Assam (Garo Hills, Naga Hills, Sadiya, Yembung); Burma (Tenasserim, Shan States); Deccan; and Ceylon.

Genus **Channa**, Gronovius.

Channa burmanica, Chaudhuri, sp. n.

(Plate XXII, figs. 4, 4*a*, 4*b*).

The body is round in front but is very much compressed behind the vent, which is situated about the middle. The dorsal profile from the anterior root of the dorsal fin slopes gently to the snout. The ventral profile, which is more convex in the region of the lower jaw than the upper, continues parallel to the dorsal profile as far as the vent, behind which both profiles continue in a straight line but converge towards the caudal peduncle, about the middle of which there is a slight concavity in both.

The height of the body at the anterior end of the dorsal fin is contained six and a half times in the total length without the caudal fin, and the width at the same region six and one-fourth times; the height about the middle of the caudal peduncle is contained ten and a half times and the width at the same part twenty-six and a half times in the total length.

The head is wide and is greatly depressed; its length is contained nearly four times in the total length without the caudal fin. The depth at the occiput is eight times and the width of the head six and one-third times in the total length. The opening of the mouth continues behind the orbit; the length of the maxillary is contained ten and three-fifth times and the width of the mouth eight and five-sixth times in the total length. The eyes are placed far forward; the diameter of the orbit is equal to the length of the snout and is contained five and three-fifth times in the length of the head. The interorbital space is very flat and its width is twice as long as the length of the snout. There are two nasal tubes over the tip of the snout, slightly longer than half the diameter of the orbit. The gular plate is rather long and narrow, rounded in front and notched behind, its length being contained six and a half times in the total length and its breadth five times in the width of the head. Round the gular plate on the margin of the gill membranes, which continue close to the chin,

there is a series of openings of mucuous glands, the largest of which is far forward and is directly under the chin. The surface of the posterior portion of the gular plate has slight corrugations which may possess some adhesive function; in places on it, as well as on the edge of the gill membrane round it, there are coriaceous patches which probably help the fish to stick against the force of the current.

There are fifteen scales in front of the dorsal fin (*i.e.* from the snout to the anterior end of that fin), and six scales between the hind margin of the orbit and the pre-opercle; there are the same number of scales between the last ray of the dorsal fin and the root of the caudal. The number of rays in the dorsal fin is thirty-eight, none of which are divided; the height of the longest ray (which is the seventh from the last) is contained eight times in the total length. The distance between the tip of the snout and the root of the pectoral fin is contained three and a half times in the total length, and the length of the pectoral fin five times. The latter has twelve flat rays. The anal fin commences one scale behind the vent and has twenty-eight undivided rays; the seventh ray from behind being the highest—nearly as high as the highest ray in the dorsal fin. The length of the caudal peduncle is equal to its height; there are nine scales between the last ray of the anal and the root of the caudal and eighteen scales round the caudal peduncle. The caudal fin is fan-shaped and consists of twelve rays; the middle rays are the longest; their length is contained nearly six times in the total length and they are just twice as long as the height of the root of the caudal fin.

There are fifty-one scales in the lateral line of which fifty scales are perforated; the line bends down after twelve scales and then, with one unperforated scale intervening, continues to the root of the caudal with thirty-seven perforated scales. In the transverse series there are three rows of scales above the anterior twelve perforated scales and seven rows below this and above the mid-ventral line. In the posterior portion of the lateral line there are four transverse rows above and five and half rows below. There are twenty scales in the mid-ventral line between the posterior end of the gular plate and the vent.

Measurements in hundredths of total length without caudal fin:—

Depth of body	15
Depth of caudal peduncle	10·3
Length of head	26·4
Depth of head	13·2
Width of head	18·8
Length of snout	4·7
Diameter of orbit	4·7
Width of interorbital space	9·4
Distance from tip of snout to anterior root of dorsal fin	35
Height of longest dorsal rays	12·2
Distance from tip of snout to root of pectoral fin	28·3
Length of pectoral fin	17
Distance from tip of snout to vent	49
Distance from tip of snout to anterior root of anal fin	50·94
Height of longest anal rays	11·3

Length of caudal peduncle	...	...	... 10·38
Width of caudal peduncle	...	...	... 3·8
Length of longest rays of caudal fin	...	...	... 17
Height of root of caudal fin	...	...	... 8·5
Total length without caudal fin in mm.		...	... 106

The colour of the head and of the sides is dark brown; the ventral surface is dull white. In the young there are transversely oblique stripes of a deeper shade on the light brown or grey colour on the sides of the body. The pectoral fin is alternately variegated in bright white and black broad bands with an annular white zone round the black root of the fin; the caudal fin is alternately banded in white and black in their transverse stripes. There is no ocellus in the upper corner of the root of the caudal fin; the extreme ends of all the rays of the dorsal and anal fins are tipped with pure white.

This is the first time that any fish belonging to the genus *Channa* is reported from the Indian continent. The only species hitherto known from the Indian Region is *Channa orientalis*, Bloch and Schneider,[1] which is found in Ceylon and China. Two other names in the same genus (*C. ocellata*, Peters[2] and *C. formosana*, Jordan and Evermann[3]) are in all probability synonyms of one another and priority decides for *C. ocellata*. *Ophicephalus apus*, Canestrini,[4] is in reality a *Channa* and differs very little from *C. orientalis*. *Channa burmanica* differs widely from these two hitherto known species in proportions, in the number of rays in the fins, in the arrangement and number of scales in the lateral line and other parts, as well as in colouration.

There are altogether four specimens in the collection, two of which, measuring 106 mm. and 79 mm. in length, are from the bed of the Sen-Bin-Ti, which further down becomes the Nam-Ti-Sang; the other two measure 45 mm. and 43 mm. in length; one is from a hill stream in the Putao Plains (Hkamti Long). The larger of these two is very much damaged. The specimen 106 mm. long from the river Sen-Bin-Ti is the holotype, and is entered in the register of the Zoological Survey of India under No. F 9755/1.

Genus **Badis**, Bleeker.

Badis badis (Hamilton Buchanan).

1822. *Labrus badis*, Hamilton Buchanan, *Acct. Fish. Ganges*, pp 70 and 368, pl. xxv, fig. 23.
1853. *Badis buchanani*, Bleeker, *Verh. Bat. Gen*, XXV, p. 106, pl. ii, fig. 3.
1861. *Badis buchanani*, Günther, *Cat. Fish. Brit. Mus.*, III, p. 367.
1875. *Badis buchanani*, Day, *Fish. Ind.*, p. 128, pl xxxi, fig. 6.
1876. *Badis buchanani*, Bleeker, *Arch. Neerl. Sc. Nat.*, XI, p. 318.
1877. *Galpuri* (*Labrus badis*), Hamilton Buchanan, *Stat. Acct. Bengal* XX, p. 40.

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1 Bloch and Schneider, *Syst. Ich.*, p. 496, pl. xc, fig. 2 (1801).
2 Peters, *Monat. Preuss. Akad. Wissen. Berlin*, 1864, p. 392 (1865).
3 Jordon and Evermann, *Proc. U.S. Nat. Mus.*, XXV, pp. 316, 331 and 332, fig. 11 (1903).
4 Canestrini, *Archiv. Zool. Anat. Fisiol. Genova*, I, p. 77, pl. iv, fig. 7 (1861).

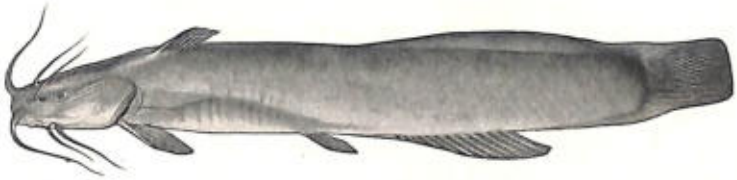
1877. *Dhalo* (*Labrus badis*), *Id.*, *ibid.*, pp. 87 and 97.
1889. *Badis buchanani*, Day, *Faun. Brit. Ind. Fish.* II, p. 80, fig. 38.
1890. *Badis buchanani*, Vinciguerra, *Ann. Mus. Civic. Stor. Nat. Genova* (ser. 2), IX, p. 166.
1912. *Badis badis*, Sewell and Chaudhuri, *Ind. Fish. Prov. Util.*, p. 12, fig. 6.
1913. *Badis badis*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 256.

There are only three specimens in the collection, two of which are damaged. Their lengths without the caudal fin are 25, 26 and 29 mm. They were collected from hill streams in the Putao Plains.

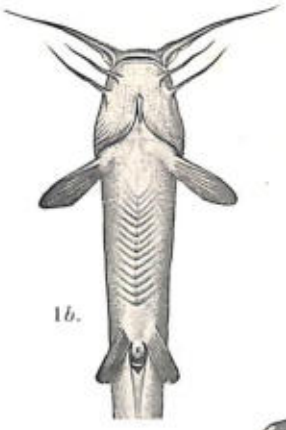
Distribution.—Fresh water of the hills and plains of India and Burma.

EXPLANATION OF PLATE XXII.

FIG. 1.—*Amblyceps murray-stuarti*, Chaudhuri, sp. nov.
,, 1*a*. ,, ,, dorsal view of head.
,, 1*b*. ,, ,, ventral view of body.
,, 2.—*Erethistes asperus* (M'Clelland).
,, 2*a*. ,, ,, ventral view of head and body.
,, 2*b*. ,, ,, upper and lower jaws, × 4.
,, 3.—*Semiplotus cirrhosus*, Chaudhuri, sp. nov.
,, 3*a*. ,, ,, ventral view of head and chest, × 2.
,, 4.—*Channa burmanica*, Chaudhuri, sp. nov., × $\frac{2}{3}$.
,, 4*a*. ,, ,, dorsal view of head, × $\frac{2}{3}$.
,, 4*b*. ,, ,, ventral view of head and body, × $\frac{2}{3}$.



1.



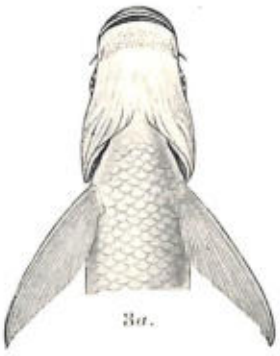
1*b*.

2.

1*a*.

2*a*.

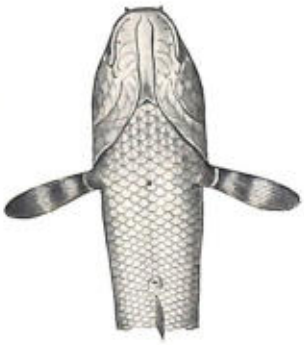
3.



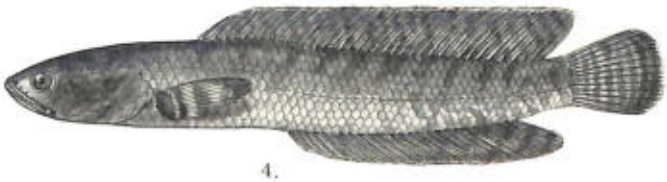
3*a*.

4*a*.

2*b*.



4*b*.



4.

FISH FROM PUTAO (HKAMTI LONG).

S. Chowdhary *del*. Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

XIX. STUDIES ON THE ANATOMY OF INDIAN MOLLUSCA.

3. The soft parts of some Indian Unionidae.

By B. Prashad, *D.Sc., Officiating Director of Fisheries, Bengal, Bihar and Orissa, Calcutta.*

Ortmann [1] writing in 1911 about the glochidia of the Unionidae summed up in the following sentence, "I have no doubt that this finally will be a very important systematic criterion, but unfortunately we do not know the glochidia of a single Asiatic species." Since then I have in two papers [2] described the structure of the marsupia and glochidia of the Indian genera *Physunio*, *Parreyssia*, *Lamellidens* and *Indonaia*. The results of my work have amply justified Ortmann's criticism [3] of Simpson's classification,[4] in which shell-characters alone were utilised to a large extent for the classification of the Naiades. On studying the soft parts of the animals of the genera *Physunio*, *Lamellidens*, *Parreyssia* and *Pseudodon* it was found that the position assigned to those genera, from shell-characters only, was quite wrong, while two new genera *Indonaia* and *Balwantia* had to be established for the Indian species hitherto included in the genera *Nodularia* and *Solenaia* respectively.

In my second paper I included a description of the soft parts of the animal of *Indonaia*, but refrained from discussing these in the other genera as Dr. Ekendranath Ghosh was engaged in a study of the comparative anatomy of some of the forms. His results, however, which were published in a recent paper,[5] are far from complete from the point of view of the systematist and many important details are neither mentioned in the text nor shown in the figures. In the present communication I have, therefore, tried to ratify these omissions for the genera dealt with by Ghosh, and have in addition given descriptions of the animals of the genera *Parreyssia* and *Pseudodon*. In dealing with the various genera I have discussed their position in both Simpson's and Ortmann's classifications, and at the end of the paper I have given a key for the identification of these genera based on the soft parts of the animals.

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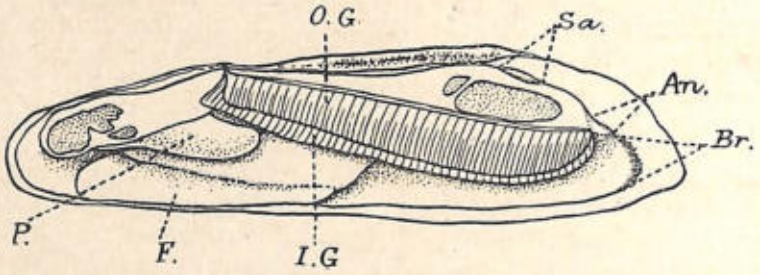
[1] *Ann. Carnegie Mus.*, VIII, p. 239 (1911-12).
[2] *Rec. Ind. Mus.*, XIV, pp. 183-185, pl. xxii (1918), and *ibid.*, XV, pp. 143-149 (1918).
[3] *Mem. Carnegie Mus.*, IV, pp. 279-347, pls. lxxxvii-lxxxix (1911).
[4] *Proc. U.S. Nat. Mus.*, XXII, pp. 501-1075 (1900).
[5] *Rec. Ind. Mus.*, XV, pp. 109-123, pl. xvi (1918).

Balwantia, gen. nov.

Ghosh (*loc. cit.*) has recently described the gross anatomy of the species *Solenaia soleniformis* (Benson) in a comparative way only. Godwin-Austin and Annandale [1] have since added valuable notes on the habits and burrows of the animal and this discussion of the habits has brought out interesting facts about the use of the very large and well-developed foot. On comparison of the anatomy of the Indian species with that of the other known species of the genus *Solenaia*, Conrad, it was found that the former differs materially from the others and must be separated as a distinct genus. The question of the name of this genus is discussed at length below.

Animal:—In accordance with the greatly elongated condition of the shell, the animal (fig. 1) also is drawn out in the antero-posterior axis, as are organs like the gills, palps, foot, etc.

The gills are eight to ten times as long as broad, the inner pair being a little wider than the outer. The inner lamellae of



TEXT-FIG. 1.—Animal of *Balwantia soleniformis*. *An.* = anal aperture; *Br.* = branchial aperture; *F.* = foot; *I.G.* = inner gill; *O.G.* = outer gill; *P.* = palp; *Sa.* = supra-anal.

the inner pair are attached to the abdominal sac along more than half of their anterior portion; posteriorly the lamellae of the two sides unite with one another to form the diaphragm, which extends on either side up to a ridge of the mantle that separates the branchial from the anal aperture. Other attachments of the gills are the same as in some of the more primitive genera, *viz.* the outer lamellae of the outer pair of gills are attached to the mantle of either side, while the inner lamellae of the outer pair are attached to the outer lamellae of the inner pair. All the four gills are marsupial and are used for the development of the glochidia. The free margins of the gills do not swell up when the gills are filled with glochidia. The water-tubes are simple, formed of 17-20 gill-filaments each; the number in each gill, however, is variable. The placentae are of the shape of inverted triangles. The palpi are very large elongate-elliptical in outline; the axis of

[1] *Rec. Ind. Mus.*, XVI, pp. 204-206 (1919).

attachment is rather short. The foot is very large and has a well developed musculature. The mantle has a very much thickened entire margin; near the branchial aperture it has a few papillae developed on its edge. The branchial aperture is large, with two to three rows of large conical papillae; its margin is of a yellowish-brown colour. The anal aperture is about half the size of the branchial; it is quite smooth and much lighter in colour. Separating the branchial from the anal is a well-developed ridge of the mantle; in the living animal the ridges of the opposite sides, meeting each other in the middle, would form a continuation of the diaphragm and completely separate the branchial from the anal aperture. The supra-anal is slightly larger than the anal, while the mantle connection between it and the anal is much larger than either.

The glochidium (fig. 2) may be said to be suboval in outline, with a nearly straight hinge line. It measures ·26 mm. × ·21 mm.

Systematic position:—The species was originally described by Benson [1] as *Anodonta soleniformis*. Lea [2] considered it to be a *Margaron* and redescribed it as *M.* (*Unio*) *bensoni*. Hanley and Theobald,[3] differing from both authors, included it in the African genus *Spatha*. Fischer,[4] after an elaborate discussion of the whole situation, assigned it to the genus *Mycetopus*. Simpson [5] in his monograph separated it from the genus *Mycetopus* and included it, with a number of species from China, Siam, South Eastern Asia and a doubtful one from Australia, in the genus *Solenaia*. Preston [6] has, following Simpson, described it as *S. soleniformis* (Benson); some of his references to the previous works, however, are incorrectly cited. The animal of the Indian species is quite different from that of a species of *Solenaia* described by Fischer (*loc. cit.*, p. 11). I have, therefore, found it necessary to separate the only known Indian species as a new genus, for which the name *Balwantia* is proposed.

TEXT-FIG. 2.—Glochidium of *Balwantia soleniformis*, × 75.

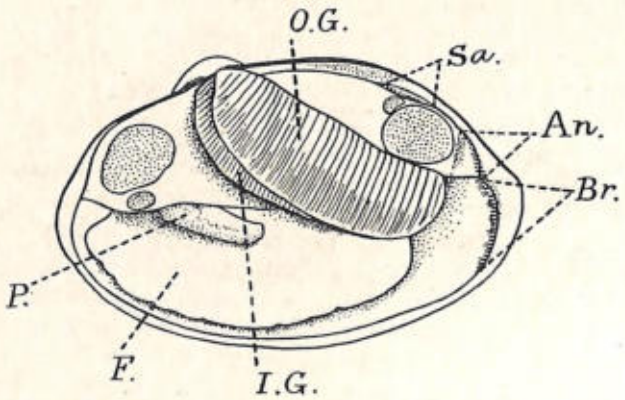
Simpson was right in including the species in the sub-family Unioninae and in the group Exobranchiae, but made a mistake in assigning it to the subgroup Homogenae, because, as has been described above, this species carries the glochidia in all the four gills and should be placed amongst the Tetragenae. Following the later and more natural classification of Ortmann (*loc. cit.*, pp. 224-225) the genus will be placed in the family Unionidae, Swainson, as restricted by Ortmann, and in the sub-family Unioninae.

[1] *Journ. Asiat. Soc. Bengal*, V, p. 750 (1836).
[2] Lea, *Syn.*, p. 57 (1870).
[3] *Conch. Ind.*, p. 5, pl. ix, fig. 1 (1876).
[4] *Journ. Conchyliol.*, XXXVIII, pp. 11, 94 (1890).
[5] *Proc. U.S. Nat. Mus.*, XXII, p. 656 (1900).
[6] *Faun. Brit. Ind., Mollusca*, pp. 132-134 (1915).

Parreyssia, Conrad.

Ortmann [1] has described the animals of this genus and of *Lamellidens*. I have unfortunately not been able to see the original papers but have consulted his later publication,[2] in which he has given a fairly complete résumé of his first paper.

The animal (fig. 3) may be described as follows :—The gills are three to five times as long as broad. Anteriorly the outer pair of gills is a little shorter than the inner, so that the margin of the latter projects beyond that of the former. The inner lamellae of the inner pair of gills are connected along more than three fourths of their length to the abdominal sac; the posterior one fourth part unites with the lamella of the opposite side to form the diaphragm ; other connections of the gills are the same as in *Balwantia* described already. All the four gills are marsupial. The margin of



TEXT-FIG. 3.—Animal of *Parreyssia favidens*, reference lettering same as in fig. 1.

the gills, even when full of glochidia, is quite sharp. The water-tubes are simple and the placentae are slightly compressed, elongate structures. The palpi are well developed, sub-triangular with a broad base, along which they are attached to the abdominal mass and have the free outer angle rounded. The mantle has a slightly thickened entire margin. The foot is very large, occupying about half of the shell cavity. The branchial aperture is large with three rows of small pointed papillae of a light brown colour. The anal is less than half the size of the branchial and is marked off from it by a feebly developed ridge of the mantle. The supra-anal is of the same size or a little larger than the mantle connection between it and the anal.

The glochidia [3] are semi-circular or semi-elliptic.

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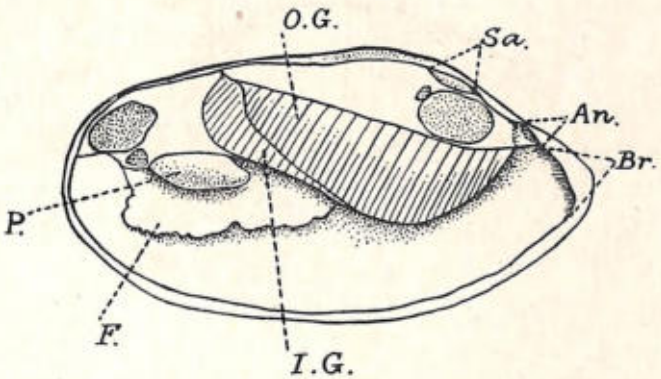
[1] *Nautilus*, XXIII, pp. 139-142 (1910) and XXIV, pp. 103-108 (1911).
[2] *Ann. Carnegie Mus.*, VII, pp. 222-365 (1911-12).
[3] *Rec. Ind. Mus.*, XV, pp. 145-146 (1918), may be consulted for details.

Lamellidens, Simpson.

The animal (fig. 4) may be described as follows:—The gills are much broader in the posterior than in the anterior half of their length, and the inner pair is broader than the outer throughout. The inner lamellae of the inner pair of gills are attached to the abdominal mass along more than half of their length anteriorly, and posteriorly they are united with one another to form the diaphragm. Only the outer pair of gills are marsupial,[1] the entire length of the gills being filled up with glochidia and the margin of the gills remaining sharp even when they are quite full of glochidia. The water-tubes are simple, and the placentulae are flat elliptic plates, thick and broad above, thin and tapering below. The palpi are rhomboidal with the angles rounded, and are attached along one of the longer sides. The margin of the mantle is entire and slightly thickened beyond the pallial con-



TEXT-FIG. 4.—Animal of *Lamellidens marginalis*, reference lettering same as in fig. 1.

nection. The foot, which is elongate, is not very large. The branchial aperture is comparatively large with two to three rows of well-developed pointed papillae, and is of a brownish colour. The anal is very much smaller than the branchial and has a row of small papillae along the margin. In continuation of the attachment of the diaphragm to the mantle of each side is a feebly developed ridge separating the branchial from the anal aperture. The supra-anal is a little larger than the anal and of about the same size as the mantle connection between the two apertures.

The glochidia are semi-elliptic in outline.

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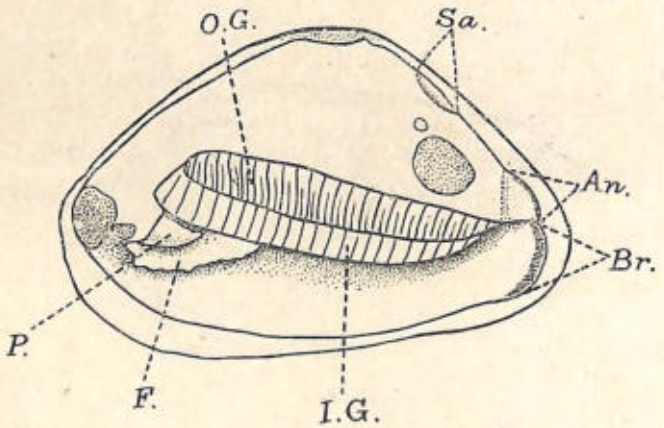
[1] For further details about the marsupium and glochidia see p. 145 of my second paper (*Rec. Ind. Mus.*, XV). Unfortunately there is a typographical error in the statement about the margins of the gills, which reads 'sharp and distended' instead 'of sharp and not distended.'

Physunio, Simpson.

Ghosh (*loc. cit.*, p. 112) has described the gills of the animals of two species of this genus, but the structures are variable.

The animal (fig. 5) may be described as follows :—The gills are much broader in the anterior than the posterior half and the outer pair is much smaller in breadth than the inner, so that the latter projects below it all along. The attachments of the gills are similar to those in *Parreyssia* and *Lamellidens*, except that the portion of the inner lamellae of the inner pair of gills, which is attached to the abdominal sac, is much less than half their length. Only a portion of the outer pair of gills is marsupial, a small anterior and a much larger posterior portion of them remaining unmodified for respiratory purposes; the marsupial part is formed by 11-17 simple water-tubes. The free margin of the marsupial part of the gills in this genus also remains sharp.[1] The outlines of the placentulae



TEXT-FIG. 5.—Animal of *Physunio ferrugineus*, reference lettering same as in fig. 1.

cannot be definitely described, as the glochidial membranes are very loosely attached to one another and a compact structure is not formed. The palpi are triangular with the apex rounded and attached by a broad base. The margin of the mantle is feebly thickened and is entire. The foot is comparatively small in preserved specimens, though it is an important organ for burrowing in the mud.[2] Dr. Annandale tells me that it is capable in life of considerable expansion. The branchial aperture is about one and a half times as large as the anal, and its margin has three rows of elongated tubercles. The mantle ridge separating the branchial from the anal aperture is well developed, but small, owing to the diaphragm extending to very near the margin. The mantle con-

[1] Detailed description of the marsupium, etc., is given in my paper *Rec. Ind. Mus.*, XIV, pp. 183-185 (1918).

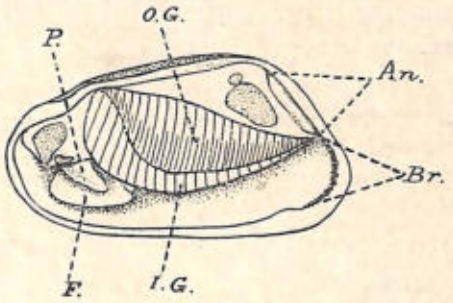
[2] See Annandale, *Rec. Ind. Mus.*, XIV, p. 141 (1918).

nection between the anal and supra-anal is of about the same size as the anal and the supra-anal also is not much larger.

The glochidia are semi-circular.

Pseudodon (Pseudodon), Gould.

Deshayes and Julien[1] published a fairly good figure of the animal of *P. moreleti*, Crosse and Fischer, but gave no description; the figure also, owing to its being drawn from the lower surface, does not show some important details. Simpson from this figure described (*loc. cit.*, p. 834) the animal as follows: "Animal having the branchiae wide and rounded behind, becoming narrow in front; palpi enormously long, apparently slender, pointed behind where they project free for some distance, mantle thin with slightly thickened border, faintly papillose behind, there seeming to be but little distinction between anal and branchial openings; anal opening apparently smooth." Unfortunately no more in-



TEXT-FIG. 6.—Animal of *Pseudodon salvenianus*, reference lettering same as in fig. 1.

formation can be got from Deshayes and Julien's figure and such important points as the presence or absence of a supra-anal, the mantle connection between the anal and supra-anal and even the distinction between the anal and branchial apertures cannot be made out. Simpson placed *P. moreleti* in the section *Pseudodon*, but the animal of *P. salvenianus* described below differs materially from that of the other known species of this section, and as *P. salvenianus* is the type-species of the section *Pseudodon*, it seems that the whole grouping requires revision.

In Simpson's classification the genus is included amongst the Endobranchiae, but the marsupium in *P. salvenianus*, at any rate, is formed by all the four gills and hence it should be included amongst the Exobranchiae, Homogenae. In Ortmann's classification it will be included in the family Unionidae and the sub-family Unioninae.

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[1] *Nouv. Arch. du Mus.*, X, pl. v, fig. 3 (1874).

The following description of the animal (fig. 6) is based on a few small spirit specimens in the collection of the Zoological Survey of India, collected by Dr. A. R S. Anderson in the year 1898 at Ye-Bu, Tenasserim, Burma.

The gills are rather broad; the inner pair being all along broader than the outer, more so in the anterior half than in the posterior. The inner lamellae of the inner pair of gills are attached to the abdominal sac along the anterior third only; posteriorly they are united with one another to form an elongated diaphragm extending to very nearly the margin of the mantle. The marsupium is formed by all the four gills, which have a sharp free margin. The water-tubes are simple and the placentae elliptical. The triangular palpi are not very large. The free margin of the mantle is entire and only slightly thickened. The foot is comparatively small. The branchial opening is large with well developed papillae. The anal aperture, owing to the absence of a mantle connection, is very large and extends to the point where the supra-anal would be; it is papillose only in the lower one-fourth of its extent. The ridge of the mantle separating the branchial from the anal is very small and poorly developed.

Text-fig. 7.—Glochidium of *Pseudodon salvenianus*, × 75.

The glochidia (fig. 7) are sub-circular, measuring ·19 mm. × ·18 mm.

Synoptic table for the various genera.

A. No supra-anal aperture ... ... *Pseudodon.*
B. A distinct supra-anal separated from the anal by a mantle connection
  I. Marsupium formed by all the four gills.
    a. Gills 8-10 times as long as broad .. .. *Balwantia.*
    b. Gills not more than 5 times as long as broad.
      1. Inner pair of gills much broader than outer throughout their length ... ... *Indonaia*[1].
      2. Inner pair of gills nearly as broad as the outer except in the anterior part ... ... *Parreyssia.*
  II. Marsupium formed by the outer pair of gills only.
    a. Entire length of the outer pair of gills marsupial ... *Lamellidens.*
    b. Gills modified for marsupial function only near the middle of the outer pair ... ... *Physunio.*

[1] See also Ortmann, *Nautilus*, XXXI, pp. 128-131 (1918). I have been able to consult all original papers by Ortmann since this paper was sent to press.

XX. ON THE OCCURRENCE OF A SYMMETRICAL SPECIES OF *EPISPHENUS* (PASSALID COLEOPTERA) IN ANNAM.

By F. H. GRAVELY, *D.Sc., Asst. Supdt., Zoological Survey of India.*

Of the four species of *Episphenus* already described, *E. moorei* is symmetrical and appears to be confined to Ceylon, where it is not very abundant. *E. comptoni* is slightly asymmetrical and is much more abundant in Ceylon, to which island it also appears to be confined. *E. neelgherriensis* and *E. indicus* are more markedly asymmetrical, and appear to be confined to the Indian Peninsula, where both are abundant. In Annam, as in other parts of tropical Continental Asia, east of the Gangetic delta, *Episphenus* is replaced by the allied genera *Ophrygonius* and *Aceraius*, in whose most highly specialized forms asymmetry is even more pronounced. The occurrence of a symmetrical species of *Episphenus* in Annam is therefore somewhat remarkable. An almost symmetrical species of *Ophrygonius* has, it is true, recently been described[1] from Tonkin, but the hair on the sides of its elytra and its horizontally divided left anterior lower tooth, as well as traces of asymmetry, clearly show that it has been derived from one of the highly asymmetrical species transitional between the more typical species of *Ophrygonius* and the genus *Aceraius*, and not from a primtive symmetrical species like *Episphenus moorei* and the species which I have now to describe.

Head of *Episphenus annamensis* (× 4).

Episphenus annamensis, n. sp.

Four specimens collected by Mr. C. Boden Kloss in Southern Annam in 1918, and presented by him to the Indian Museum.

Length 33–37 mm.

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[1] *O. aequalis*, *Mem. Ind. Mus.* VII, 1918, p. 88, fig. xi (1).

This species differs from *E. moorei*, the only other symmetrical species of the genus known, in having six instead of five well-developed antennal lamellae, all somewhat short and stout. The cephalic ridges between and in front of the frontal tubercles are absent. The frontal tubercles are situated as in *Episphenus*, not as in *Tiberiodes* (also symmetrical) from Assam and adjoining the hills. The central tubercle is more strongly elevated than in *E. moorei*, with shorter parietal ridges. The punctures and hair on the lower surface of the prothorax are very feebly developed. The large punctures on the posterior intermediate areas of the metasternum are somewhat shallower than in *E. moorei*, and the puncturing of the grooves on the elytra is less coarse.

XXI. DESCRIPTIONS OF TWO NEW SPECIES OF DIPTERA FROM SEISTAN, EASTERN PERSIA.

By E. BRUNETTI.

In a small collection of Diptera made in Seistan by Dr. N. Annandale and Mr. S. W. Kemp in November and December, 1918, there are two undescribed species of which the material justifies the publication of diagnoses. These two species are here described at the request of Dr. Annandale, in order that he may refer to them in a forthcoming report on the aquatic fauna of Seistan.

Family SYRPHIDAE.

(?) Didea annandalei, sp. nov.

Seistan, E. Persia. Long. 8 mm.

Almost intermediate between *Didea* and *Syrphus*.

Head. Frons and face bright chrome yellow; former with short stiff black pubescence, latter with softer pale yellow hairs; antennae orange, upper side brownish; arista orange; mouth border brownish. Eyes quite bare; occiput black, entire margin with fringe of whitish hairs; vertex with stiff black hairs; ocelli ruby red.

Thorax shining black; dorsum without trace of median grey stripes on anterior margin, wholly with quite whitish pubescence; side margins distinctly yellowish; pleurae mainly shining black, with whitish pubescence; mesopleura aeneous with yellowish pubescence. Scutellum wholly rather dull yellow with all yellowish pubescence.

Abdomen with yellow spots as in *D. fasciata*, Macq., except that the fifth segment is wholly orange yellow except at middle of base. Belly yellowish; an indistinct black mark about middle of each segment.

Legs, except the black coxae, wholly yellow.

Wings with 3rd longitudinal vein barely dipped.

Described from a single ♂ from Nasratabad, Consulate Garden, Seistan. The specimen is in the collection of the Indian Museum.

The present specimen possesses two out of the three characters which may be regarded as typical of *Didea*, namely the general *facies* due to the shape and size of the abdominal spots, and the ridged edge to the abdomen, but it lacks the third and equally important character of the considerably dipped third vein,

as in *annandalei* it is barely as much dipped as in *Syrphus annulipes*, Zett. of Europe. This latter species has hairy eyes.

Didea is supposed to have almost but not quite bare eyes, and wholly black antennae, both characters appearing to me weak as generic ones. The present species differs from *fasciata* by the nearly wholly orange fifth abdominal segment, the entirely yellow legs (excepting the coxae), the absence of greyish stripes on the thoracic dorsum and by its yellowish side margins, the whitish pubescence on the thorax and pale yellowish on the scutellum.

Family EPHYDRIDAE.

Halmopota viridescens, sp. nov.

Seistan, E. Persia. Long. about 3¼ mm.

Head broad, transverse, a little broader than thorax. Frons and face extremely broad, occupying, seen from the front, fully three fifths of the head; frons very flattened, face strongly projecting, seen from above almost semicircular; cheeks broad, forming a conspicuous hind angle to lower part of head in profile; the whole head sharply cut off horizontally at the mouth border. Proboscis with large labella, appearing like a large lower lip, the whole mouth exceedingly frog-like. Eyes comparatively small, bare. Frons greenish-grey, shining; ocellar triangle barely elevated, yellowish, with a weak upper pair of erect bristles and a much stronger lower, proclinate pair. Vertical bristles long and strong, inner pair convergent, outer pair divergent; post vertical bristles absent. Three pairs of strong fronto-orbital bristles, placed near eye-margins, with a weaker bristle above the 1st and between 1st and 2nd (making five in all) nearly equidistant. A linear depression on frons and face near eye-margins, making the eyes appear a trifle bulging. Antennae short, ash grey; 1st joint very short, 2nd thick, bluntly triangular, 3rd as long as 2nd, bluntly conical; arista bare, moderately long, black, distinctly plumose on upper side only. Face ash grey, with a row of distinct bristles from side to side, a little below eyes and antennae, following the curvature of these organs; a second row of similar bristles, though longer ones, on mouth border, dwindling in point of size towards sides. Entire face with minute black stiff hairs; a slight greenish-grey tinge to extreme upper part of face immediately below antennae. Proboscis and labella brownish-grey; occiput grey with short pale pubescence.

Thorax subquadrate, a trifle longer than broad, moderately arched, greenish-grey, a little shining, with whitish dust. Five pairs of dorso-central bristles, long and strong; two humeral (perhaps three) of unequal size; two notopleural; apparently three supra-alar. A perpendicular row of stiff hairs, directed backwards, on hind margin of mesopleura. Scutellum with one bristle towards middle of side margin and one long apical one.

Abdomen greenish-grey with short stiff black pubescence.

Legs. Coxae and femora black, grey dusted; tips of latter narrowly, and remainder of legs brownish-orange; stiff black hairs on tarsi. Pubescence of legs black, meagre.

Wings greyish, a little yellowish at base; halteres dull orange.

Described from 3 specimens, apparently ♂ ♂ (two in indifferent condition), taken on the surface of a watercourse, Chilling, Seistan, 20-xii-18 (*Annandale* and *Kemp*). These specimens are in the collection of the Indian Museum.

The present species does not quite fulfil the generic characters of *Halmopota,* owing to the presence of the row of very conspicuous bristles directed downwards from the lower edge of the mouth border, and which Becker distinctly states should not be present. There is also no prominent bristle on each side of the face near the lower angle of the eye. Apart from these points *viridescens* agrees remarkably closely with Becker's figure of the head in profile.[1]

Specifically the present species differs from the European *salinarum,* Bouché, by the greenish (not velvet black) frons and abdomen and also by the blackish (not reddish) femora.

From the only other known species, *mediterranea,* Lw., it principally differs (in addition to the above two characters) by the third and fourth veins not being convergent towards the tip. It is rather smaller than both the known species.

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[1] *Berl. Ent. Zeits.* XLI, pl. v, 4 (1896).

MISCELLANEA.

BATRACHIA.

The tadpoles of *Nyctibatrachus pygmaeus* and *Ixalus variabilis*: a correction.

In a recent number of the "Records of the Indian Museum" (Vol. XV, p. 21, pl. i, figs. 5, 5*a*) I described and figured a tadpole which I believed to be that of *Nyctibatrachus pygmaeus*. I was, however, led astray by a break in my series of specimens, and while the young frog to which I referred was undoubtedly a *Nyctibatrachus*, those tadpoles in which the characteristic structure of the mouth remained were larvae of *Ixalus variabilis*. I have been able to substantiate this fact by a recent examination of a large number of fresh specimens in the Nilgiri Hills. The posterior part of the tail in this tadpole is often quite black, while the anterior part is dull yellow more or less spotted with black. The colouration is, however, variable. The larva of *Ixalus variabilis* is the commonest Ranid tadpole in hill-streams round Coonoor and Kotagiri in April.

The true tadpole of *Nyctibatrachus*, of which I have now obtained specimens, is, curiously enough, very like that of *Rana semipalmata* (*op. cit.*, p. 20), which it resembles in having no horny teeth on its mouth-disk. I am sending my specimens, with those of a number of other species, to Dr. G. A. Boulenger for description, having been forced by stress of other work to give up all herpetological studies for the present.

N. ANNANDALE.

XXII. NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

XII. SCOPIMERINAE.

By STANLEY KEMP, *B.A., Superintendent, Zoological Survey of India.*

Plates XII, XIII.

This subfamily of Ocypodidae comprises a number of very small crabs found on the sea shore or in estuaries and backwaters. Four genera have hitherto been recognised :—*Scopimera*, de Haan, *Dotilla*, Stimpson (= *Doto*, de Haan), *Ilyoplax*, Stimpson and *Tympanomerus*, Rathbun (= *Dioxippe*, de Man). A fifth is here described under the name *Dotillopsis*.

The range of the subfamily extends from the southern and western coasts of Africa and the Red Sea to the Banda Sea, the Philippine Is. and Japan. Its headquarters appear to be on the Indian coasts on which all the genera except the problematical *Ilyoplax* occur.

Including the new forms here described thirty species of Scopimerinae are now known: of these I have seen twenty-one. Eighteen species are known from the Indian coasts and of these I have seen all but one and the types or paratypes of thirteen.

The Scopimerine crabs are of small size as compared with the Ocypodinae. They are all littoral or estuarine and strictly amphibious in habits. Unlike *Ocypoda* the coastal species live only in sheltered bays on the shores of which surf never breaks. The species of *Dotilla* and *Scopimera* burrow in damp sand between tide-marks and different forms are as a rule restricted to different levels on the beach. For example, both in Mormugao Bay on the west coast of India and at Tuticorin on the south-east coast *Scopimera proxima* and *Dotilla myctiroides* occur, the former inhabiting the zone near high-water mark, while the latter is to be found near low-water mark. *Tympanomerus* burrows in rather stiff clay or muddy sand, while *Dotillopsis* affects estuarine mud of the softest consistency.

All the species construct small oblique burrows, from which they remove the sand or mud in little pellets. This is done as often as the tide sinks and exposes the area in which they are living. In nearly all cases the pellets are disposed with some care, in such a way that one or more pathways are left clear on the surface round the mouth of the burrow. The pathways themselves are smoothed and apparently hollowed out by the crab. The

arrangement of the pellets gives the burrow a very characteristic appearance, enabling it to be distinguished at a glance from that of young *Ocypoda* and other forms of similar habits.

The crabs are gregarious and sometimes occur in very large numbers. Beaches occupied by them can occasionally be recognised at a considerable distance by their freshly raked surface. Little is known as to what occurs in these communities at high tide, but as they are very seldom obtained in nets hauled on suitable ground near the shore it is probable that they remain in their burrows. When the tide is out they may often be seen sitting at the mouths of the burrows or in the pathways leading to them, but seldom if ever wander further afield. Each crab or pair of crabs keeps rigidly to its burrow.

The habits of the Indian species of *Dotillopsis* seem to be somewhat different from those of the other genera because the mud in which it burrows is too soft to retain a definite impression. It is often impossible to distinguish its holes, though it appears to excavate them in the same way. The dense tomentum on the walking legs in this genus and in certain species of *Tympanomerus* is probably an adaptation to life on muddy ground.

Most of the species of *Dotilla* and *Scopimera* live on the sea-shore. A few make their way into backwaters, where the water is brackish or of very variable salinity, but the environment in such situations is as a rule unfavourable. The crabs usually fail to reach their normal size, and in species in which there are marked structural differences between the sexes, the males seem unable to attain their full development.

Most species of *Tympanomerus* are found in estuaries, often near or even beyond the extreme limit of tidal influence. Both species of *Dotillopsis* are essentially estuarine, but the Indian form has been found in a small backwater near the open sea as well as a considerable way up the Gangetic delta. No species has been found at any great distance from the coast, but *T. deschampsi* and *T. stapletoni* are able to live on the banks of large rivers at places where the water is always fresh. *T. stapletoni* is said to have destroyed a dynasty of kings in Eastern Bengal by burrowing through the embankments their people had constructed and so letting brackish water in to the rice-fields.

In examining the Indian species of Scopimerinae I have met with instances of dimorphic forms in the female as well as in the male sex. In *Dotilla intermedia* two perfectly distinct types of adult male exist which differ conspicuously in the structure of the first segment of the abdominal sternum and chela and in the form of the copulatory appendage. *Scopimera proxima* presents still more interesting features, for it exhibits dimorphism of the female—a phenomenon not, I think, hitherto noticed in Decapod Crustacea. The dimorphism in this instance is to be found in the form of the abdomen and is very peculiar in that the scarcer and more aberrant form of female has characters approximating closely to those of the male. The remarkable point is that in this form the sides of

the abdomen are constricted as in the other sex. We have thus a female possessing a male character that can hardly be called secondary, for it can be demonstrated without difficulty that the purpose of the constriction in the male abdomen is that of permitting the copulatory appendages to remain exserted, while the abdomen is folded against the carapace.

This paper was almost completed before I became acquainted with Dr. Tesch's report on the Catometope crabs obtained by the 'Siboga' Expedition, published in 1918. In this report (pp. 40 *et seq.*) will be found a summary of the characters of the genera and species of the Scopimerinae and full descriptions of certain forms. My own work thus to a great extent covers the same ground as that traversed by Tesch, but there are considerable differences in our treatment, and, apart from the new species I have to introduce, an independent consideration of the subfamily will, I believe, have its uses.

Tesch gives to the subfamily the name Mictyrinae and includes in it Latreille's *Mictyris*, usually placed in a separate family. This view is not supported by any discussion and, having examined both the species belonging to Latreille's genus, I am unable to give my adherence to it.

Mictyris differs from the members of all other Catometope families in a number of very important features. Apart from the absence of defined orbits and the extraordinary disposition of the third maxillipeds, the mouth-parts differ widely from those of all genera of Ocypodidae with which I am acquainted, while in the possession of an unpaired accessory branchial orifice at the extreme posterior end of the carapace the genus is unique among Decapoda.[1]

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[1] In nearly all Brachyrhynchous crabs water is normally drawn into the branchial chamber through an aperture at the base of the chelipeds and is expelled through the buccal cavern between the endostome and the distal ends of the outer maxillipeds. In *Mictyris* and in certain Ocypodid genera, all of which are amphibious in habit, accessory passages to the branchial cavity are to be found. The external orifices of these passages are rendered conspicuous by reason of a thick fringe of short hairs which doubtless serves to prevent the intrusion of particles of sand.

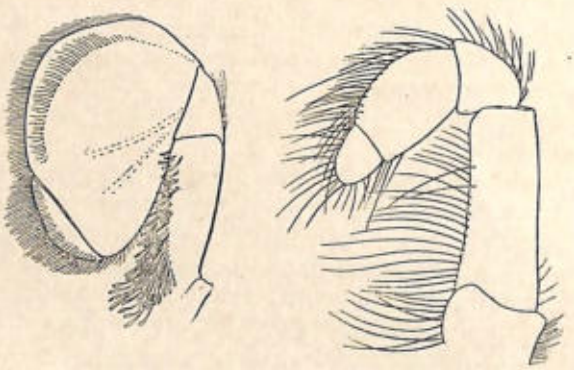
In *Ocypoda* and *Gelasimus* the orifice of the passage takes the form of a hairy-edged pouch situated between the bases of the 2nd and 3rd walking legs. From this pouch a channel passes upwards to the branchial cavity either through a gap between the upturned margins of the coxae (very conspicuous in *O. ceratophthalma*) or through an aperture behind their fused edges. In *Heloecius* similar pouches exist between both the 1st and 2nd and between the 2nd and 3rd walking legs. Of Scopimerine genera *Scopimera* possesses an accessory branchial passage with the orifice placed between the bases of the 1st and 2nd legs, and similar passages also exist in certain species of *Tympanomerus*, the orifices being found between the bases of the 1st and 2nd, 2nd and 3rd and (sometimes) the 3rd and 4th walking legs.

The unusual structure of the branchial opening at the base of the chelipeds in *Mictyris* has been described by Alcock, who does not, however, refer to the accessory passage also found in this genus. The orifice of this passage differs from that of all the Ocypodid genera referred to above in being unpaired. It is situated at the extreme hinder end of the animal and is bounded dorsally by the short posterior margin of the carapace and ventrally by a strong transverse ridge on the first abdominal segment, both upper and lower borders being heavily

I am of the opinion that the resemblances between *Mictyris* and the Scopimerinae are convergent rather than genetic and I cannot believe that the two have had a common origin distinct from that of the Ocypodinae and Macrophthalminae.

Apart from the position of *Mictyris* I differ from Dr. Tesch on a number of points of lesser importance.[1] With more material before me than was at his disposal I believe that I have been able to discover generic characters of more constant value than those utilised by him on p. 41 of his report.

In the possession of tympana, curious membranous areas found on the meral segments of the legs and sometimes on the thoracic sterna, the Scopimerinae differ from all other Decapoda; in some of the genera, however, they are ill-defined and in certain species of *Tympanomerus* they are altogether absent. The subfamily may be distinguished from the Ocypodinae by the presence



TEXT-FIG. 1.

Endopod of second maxilliped.

a. Scopimera globosa, de Haan.

b. Tympanomerus gangeticus, sp. nov.

of a fully formed pleurobranch above the base of the second walking legs and from the Macrophthalminae by the more oblique position and rudimentary character of the antennules and by the greater breadth of the interantennular septum.

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fringed with short hairs. From the slit-like opening thus formed a narrow channel passes forwards on either side to the branchial cavity,

On placing a living specimen of *Gelasimus acutus* in a bowl of water and introducing a little coloured fluid at the base of the chelipeds I found that the fluid was immediately drawn in and expelled in the ordinary way through the upper part of the buccal cavern. I failed, however, to demonstrate that the accessory openings were similarly used in submerged individuals, even though an attempt was made to inject the fluid into the pouch, and think it probable that they are employed only for taking in air. The presence of the fringe of hairs suggests that they are inhalent rather than exhalent.

[1] For instance I regard *Dotilla sigillorum* as a species of *Scopimera*, *D. clepsydrodactylus* as a synonym of *D. intermedia* and *Cleistostoma lingulatum* as a species of *Tympanomerus*.

In recent years a large number of specimens of Scopimerinae have been added to the collection of the Zoological Survey of India. We are indebted to Lt.-Col. C. R. Stevens, I.M.S., for a most valuable series from Karachi, comprising examples of several new and scarce forms. Lt.-Col. H. J. Walton, I.M.S., has contributed further specimens of *Dotilla blanfordi*, hitherto known only from the types, and Mr. J. Hornell, a small but interesting collection from Tuticorin. I have to thank Dr. F. H. Gravely for a very long series of *Dotilla intermedia* from the Orissa coast, material which has enabled me to demonstrate the existence of dimorphism among the males. Dr. J. G. de Man has kindly sent me examples of *Tympanomerus pusillus*, Dr. Nakazawa and Dr. Bruno Parisi specimens of *Scopimera globosa*.

Excluding *Ilyoplax*, which cannot be recognised with certainty until the type species has been rediscovered, the genera of Scopimerinae may be distinguished by the following characters:—

I. Penultimate segment of 2nd maxilliped greatly expanded, with ultimate segment applied to it laterally as a narrow strip (text-fig. 1*a*).
  A. A conspicuous brush of hairs, indicating the position of the accessory branchial orifice, between bases of 1st and 2nd walking legs; 4th segment of abdomen not overlapping 5th, nor with a brush of hair at its distal end; abdomen of male with 4th or 5th segments constricted, the 5th occasionally linear. [Lateral walls of carapace usually without conspicuous sculpture.] ... *Scopimera*, p. 310.
  B. No brush of hairs between bases of walking legs; 4th segment of abdomen overlapping 5th and with a thick brush of hair at its distal end in both sexes; abdomen of male not constricted. [Lateral walls of carapace with deep convolute sculpture] ... ... *Dotilla*, p. 324.

II. Penultimate segment of 2nd maxilliped not expanded, with ultimate segment attached terminally (text-fig. 1*b*). [4th segment of abdomen not overlapping 5th, nor with a brush of hair at its distal end.]
  A. Lateral walls of carapace with deep convolute sculpture; upper surface strongly sculptured; 4th segment of abdomen of male remarkably expanded, nearly 3 times as broad as fifth ... *Dotillopsis*, p. 334.
  B. Upper surface and lateral walls of carapace not conspicuously sculptured; 4th segment of abdomen of male not remarkably expanded though it may be broader than 5th ... ... *Tympanomerus*, p. 336.

The tympana are well-defined and usually conspicuous in *Scopimera* and *Dotilla*, ill-defined in *Dotillopsis* and ill-defined or absent in *Tympanomerus*. The merus of the third maxilliped is longer than the ischium in *Dotilla* and *Dotillopsis* and longer than or equal to the ischium in *Tympanomerus*; in some but not all the species of *Scopimera* the ischium is longer than the merus. A dense tomentum is found on the first three walking legs in *Dotillopsis* and similar but less extensive patches of hair are found in certain species of *Tympanomerus*.

The genera exhibit rather complex inter-relations. In the form of the abdomen and in the possession of hairy-edged pouches indicating openings into the branchial cavity *Scopimera* is related to *Tympanomerus*, while *Dotilla* and *Dotillopsis* agree in the deep sculpture of the upper surface and side-walls of the carapace. On the other hand *Scopimera* and *Dotilla* resemble each other and differ widely from *Dotillopsis* and *Tympanomerus* in the structure of the ultimate segments of the second maxilliped.

The genus *Ilyoplax*, which was described in 1858,[1] is based on a single species, *I. tenella*, "found at Whampoa, China, along the banks of the Canton River (brackish water), living in holes in the mud, exposed at low water." The fact that the meral segments of the legs possess tympana indicates that the genus must be referred to the Scopimerinae. Stimpson compares it with *Macrophthalmus* and remarks that it forms "a connecting link between the Macrophthalmidae and the Dotillidae." To my mind it is unquestionably a very close ally of *Tympanomerus* and I strongly suspect that it will prove to be synonymous with that genus. This, however, cannot be accurately determined until *I. tenella* has been rediscovered.

Genus **Scopimera**, de Haan.

1833. *Ocypode*, subgen. *Scopimera*, de Haan, in Siebold's *Faun. Japon., Crust.*, pp. 5, 24.
1852. *Scopimera*, Milne-Edwards, *Ann. Sci. nat., Zool.*, (3) XVIII, p. 153.
1900. *Scopimera*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 369.
1918. *Scopimera*, Tesch, *Decap. Brachyur.* '*Siboga*' *Exped.* I, pp 41, 45.

The species may be distinguished by the following characters :—

I. Ischium of third maxillipeds longer than merus.
  A. Mid-dorsal surface of carapace with large symmetrical puckers or vesicles; chela with strong carina near inferior border; last three segments of abdomen of male racket-shaped, the 5th linear, very much narrower than 6th or 7th ... ... *S. crabricauda.*
  B. Mid-dorsal surface of carapace not conspicuously puckered; chela with inferior border rounded; 5th segment of abdomen of male not linear, little if at all narrower than 6th and 7th.
    1. Tympana on meral segments of walking legs not divided by a ridge.
      a. Lateral border of carapace defined by a crest throughout its length; upper surface strongly granular; chelipeds of adult male little more than twice length of carapace ... ... *S. globosa.*
      b. Lateral border of carapace defined by a crest only in its anterior half; upper surface feebly granular; chelipeds of adult male usually quite three times length of carapace. ... ... *S. pilula.*
    2. Tympana on meral segments of walking legs (except for that on upper surface of last leg) divided longitudinally by a narrow ridge.

[1] Stimpson, *Proc. Acad. Nat. Sci. Philadelphia* X, p. 98 (1858) and *Smithson. Misc. Coll.* XLIX, p. 100 (1907).

a. Antero-lateral portions of carapace much inflated and separated by an abrupt declivity from outer orbital angles; 4th segment of male abdomen anteriorly emarginate, not constricted, 5th longitudinally channelled; abdomen of female with convex lateral margins ... *S. investigatoris.*

b. Antero-lateral portions of carapace not greatly inflated, sloping gently to outer orbital angles; 4th segment of male abdomen much constricted anteriorly, 5th not channelled; abdomen of female with concave lateral margins ... *S. proxima.*

II. Ischium of third maxillipeds shorter than merus. [Chela with strong carina or row of granules near inferior border.]

A. Ischium and merus of outer maxilliped studded with coarse tubercles. [Merus about twice as long as ischium; carpus of male cheliped without tooth at inner angle.] ... ... *S. kochi.*

B. Ischium and merus of outer maxilliped smooth, or nearly so.

1. Upper surface of carapace sculptured; merus of third maxilliped three times as long as ischium; carpus of male cheliped?... ... ... *S. sigillorum.*

2. Upper surface of carapace without evident sculpture; merus of third maxilliped only a little longer than ischium; carpus of male cheliped with a tooth at inner angle .. ... *S. inflata.*

The species fall into four groups. Firstly the very highly specialized *S. crabricauda* which differs widely in the form of the male abdomen from any other species of the genus. Secondly *S. globosa* and *S. pilula* which are normal forms. Thirdly *S. investigatoris* and *S. proxima*, allied to the foregoing but distinguished by the presence of a ridge which bisects the tympana on the walking legs, and fourthly *S. kochi*, *S. sigillorum* and *S. inflata* which, though true Scopimeras, show affinity with *Dotilla* in the proportions of the merus and ischium of the third maxillipeds and in the presence of a certain amount of sculpture on the lateral walls of the carapace.

The brush of hairs between the bases of the first and second walking legs is very conspicuous in all the species of the genus that I have seen. A similar character is sometimes found in *Tympanomerus*, but occurs between the bases of other legs as well and is always much less easily detected.

S. crabricauda, *S. pilula*, *S. investigatoris* and *S. proxima* are Indian species.

Scopimera crabricauda, Alcock.

1900. *Scopimera crabricauda*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 370, and *Illustr. Zool. R.I.M.S. 'Investigator,' Crust.*, pl. lxiii, figs. 5, 5*a*, 5*b*.

In addition to the particulars given by Alcock it may be noted that in both sexes on the inner face of the chela there is a large blunt ridge, dorsally convex, extending from the base of the fixed finger to the carpal articulation. There are three finely serrate carinae on the fixed finger; the outer and inner reach only a short

distance on to the palm, but the median traverses its whole length, running externally a little above the lower border.

Two additional males of this scarce species, recently obtained by Lieut.-Col C. R. Stevens, I.M.S., are considerably smaller than the large male examined by Alcock; the carapace of the larger is only 5 mm. in length and 8·3 mm. in greatest breadth.

$\frac{4133}{4}$	Karachi.	A. O. Hume and F. Day.	Two. Types.
$\frac{9849}{10}$	Karachi.	C. R. Stevens.	Two.

Only these four specimens are known.

Scopimera globosa, de Haan.

Plate XII, fig. 2.

1835. *Ocypode (Scopimera) globosa*, de Haan, in Siebold's *Faun. Japon., Crust.*, p. 53, pl. xi, figs. 3, 3 *a*, *b*.
1852. *Scopimera globosa*, Milne-Edwards, *Ann. Sci. nat., Zool.* (3) XVIII, p. 153.
1858. *Scopimera tuberculata*, Stimpson, *Proc. Acad. Sci. Philadelphia* X, p. 98.
1894. *Scopimera globosa*, Ortmann, *Zool. Jahrb., Syst.*, VII, p. 747.
1898. *Scopimera globosa*, Koelbel, in *Wiss. Ergebn. Reise Grafen Béla, Széchenyi in Ostasien*, p. 572.
1902. *Scopimera globosa*, Doflein, *Abh. K. Bayer. Akad. Wiss.* XXI, p. 668.
1907. *Scopimera tuberculata*, Stimpson, *Smiths. Misc. Coll.* XLIX, p. 102.
1918. *Scopimera globosa*, Tesch, *Decap. Brachyur. 'Siboga' Exped.* I, p. 46, pl. iii, fig. 3.
1918. *Scopimera globosa*, Parisi, *Atti Soc. Ital. Sci. Nat.* LVII, p. 97, text-fig. 2.

The carapace is more than one and a half times as broad as long and its depth is slightly greater than its length. The upper surface is widest posteriorly, but the lateral walls slope outwards as well as downwards, the widest point being between the bases of the second pair of walking legs. The distance between the outer orbital angles is a little greater than the length.

The upper surface is covered with a very regular microscopic pitting, which gives it a dull appearance, and bears numerous smooth and shiny tubercles. The tubercles are most distinct on the lateral parts of the upper surface and on the branchial regions they tend to form transverse and oblique rugae; above the base of the last leg there is a clearly marked curved and serrulate ridge. On either side of the gastric region there is a conspicuous indentation from which shallow puckers or grooves radiate forwards, outwards and backwards. The gastric and cardiac regions are partially separated from one another by a very inconspicuous transverse furrow; their lateral boundaries are sharply defined.

The front is bluntly pointed and narrow, its breadth between the bases of the eyestalks being little more than a fifth the extra-orbital width. The edges of the front are raised and on each side there is a low granular ridge which curves inwards proximally, the

two almost meeting between the bases of the eyestalks. The central portion is depressed and smooth with a low longitudinal ridge or elevation.

The orbits have a strong dorsal inclination, the greater part of the cavity being visible in dorsal view. The upper border is sinuous and slopes obliquely backwards; it has a smooth raised rim and terminates in a blunt extra-orbital tooth. The lower border is sharply denticulate and strongly curved. On the floor of the orbit there is a fine beaded ridge which runs outwards from the base of the eyestalks and meets the lower border in the outer third of its length.

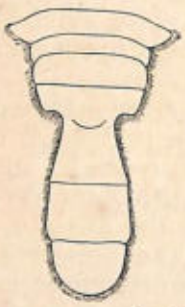
The lateral margin of the carapace is defined as a sharp crest extending from the orbital tooth to the base of the last legs; it is finely crenulate throughout and fringed with short setae. Both above and below the crest there is a smooth longitudinal groove. The side-walls of the carapace are finely granular and setose.

The endostomial margin almost touches the basal segments of the antennules and antennae, the epistome consisting merely of a median triangular plate bearing a sharp transverse carina. The expanded penultimate segment of the second maxilliped (text-fig. 1*a*, p. 308) is not covered with long hairs as in *S. pilula.*

The third maxillipeds bulge strongly. The ischium is longer than the merus and its breadth is a little greater than its length. The merus is nearly twice as broad as long and the suture between it and the ischium is decidedly oblique. The ischium is smooth except for some obscure granules postero-externally and for a raised line fringed with setae near the antero-lateral angle. There is a deep groove on the merus near its lateral border and on the inner side of the groove some low granules. A short blunt ridge runs to the articulation of the carpus. Antero-internally the surface of the merus is smooth and concave, with the margin reflected upwards.

The chelipeds of the male, if straightened, would be rather more than twice the length of the carapace. The merus has a tympanum on its outer side, in breadth about half that of the segment, and another, larger and less well defined on its inner surface; except for the tympana the segment is closely granular. The carpus is also granular and its upper surface is less than twice as long as broad in males. The three edges of the merus and the inner and outer edges of the carpus are rounded, not crested as in *S. pilula.* The chela is a little longer than the carapace and is nearly three times as long as high; its height near the carpal articulation is fully three quarters its greatest height. Both upper and lower borders of the palm are rounded and the entire surface, both within and without, is closely covered with squamiform granulation. The fingers are longer than the upper border of the palm, but shorter than its total length; each is glabrous with four longitudinal, finely serrate carinae. Except near the tip the prehensile edges of the fingers bear small teeth, a group on the dactylus a little behind its middle point being rather larger than the others.

The first and second walking legs are nearly three times the length of the carapace; the fourth pair is little more than two-thirds their length. The meri are expanded and bear very large tympana on both upper and lower surfaces. The dactyli in all four pairs are dorsally flattened; in the first three pairs they are a little longer than, in the last pair nearly one and a half times as long as the propodus. Except for the dactyli all the segments of the walking legs are finely granular and bear long scattered black bristles.



Text-fig. 2.—*Scopimera globosa*, de Haan. Abdomen of male.

In the abdomen of the male (text-fig. 2) the first three segments are short and broad. The fourth and fifth segments, taken together, are about as long as broad at base; in their proximal half they are deeply constricted, the least breadth being about half the length of the two combined. The suture between the fourth and fifth segments is deficient, not meeting the lateral margin on either side; it may be seen as a fine, anteriorly concave groove crossing the narrowest part of the constriction. The sixth and seventh segments are each broader than long.

The carapace of a large male is about 8·7 mm. in length and 14 mm. in greatest breadth. I have not examined any females.

I agree with Koelbel that Stimpson's *S. tuberculata* is synonymous with *S. globosa*. Müller's record from Trincomali[1] is almost certainly erroneous and probably refers to *S. pilula*.

$\frac{97.81}{10}$	Kisarazu, Tokyo Bay.	K. Nakazawa.	Four.
$\frac{98.19}{10}$	Yokohama.	Mus. Milano (B. Parisi).	Five.

De Haan gives no precise locality for the specimens he described. Other records are Sagami Bay (Ortmann, Doflein), Nagasaki (Ortmann), Simoda (Stimpson) and Hongkong (Koelbel).

Scopimera pilula, sp. nov.

Plate XII, fig. 1.

? 1887. *Scopimera globosa*, Müller (*nec* de Haan), *Verh. Ges. Basel* VIII, p. 475.

This species is very closely allied to *S. globosa*, differing only in the following particulars.

The carapace is similar in shape to that of *S. globosa* and exhibits a shallow depression on either side of the gastric region. The puckers radiating from this depression are, however, much less

[1] Müller, *Verh. Ges. Basel* VIII, p. 475 (1887).

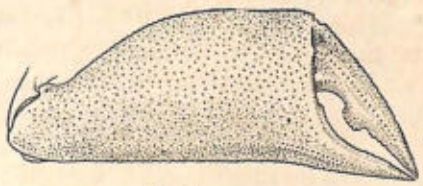
conspicuous and the entire upper surface more smooth. There are tubercles, most evident laterally, but all are smaller than in *S. globosa* and they do not tend to form transverse rugae. There is, however, a granular elevation near the extra-orbital angle and a protuberance near the base of the last pair of legs.

The lateral border, defined in *S. globosa* as a sharp crest running the whole length of the carapace, is deficient. It is visible for a short distance behind the orbital angle and the side-walls beneath it are longitudinally grooved, but further back it is altogether wanting, the side-walls in the posterior half of the carapace meeting the upper surface without interruption.

The front is slightly broader than in the allied species and is minutely nicked at the apex. The distal edge is thickened and behind it there is a large circular and completely circumscribed depression. There is a beaded ridge on the floor of the orbit as in *S. globosa*, but it is shorter and meets the lower orbital border at about its middle point.

The basal segments of the second maxillipeds bear very long woolly hairs which entirely conceal the distal segments when the appendage is normally flexed. The outer maxillipeds closely resemble those of *S. globosa*, but the merus is without granules and its sculpture is much less conspicuous.

The chelipeds of the adult male are very much longer than in *S. globosa*; in adults they are fully three times the length of the carapace. The edges both of the merus and carpus are crested. The carpus is proportionately much longer than in the allied species, the upper surface being more than two and a half times as long as broad. The segment is transversely rugulose above, not simply granular. The length of the chela (text-fig. 3) is distinctly greater than that of the carapace and differs in shape from that of *S. globosa*; the greatest height of the palm is about twice its height at the carpal articulation. The length of the dactylus is only about two-thirds that of the upper border of the palm. On both outer and inner surfaces the palm is covered with very fine granules which are arranged round small interspaces so as to give a reticulated appearance. The ridges on the fingers are similar to those of *S. globosa*, but the cluster of enlarged teeth near the middle of the inner margin of the dactylus is much more conspicuous.

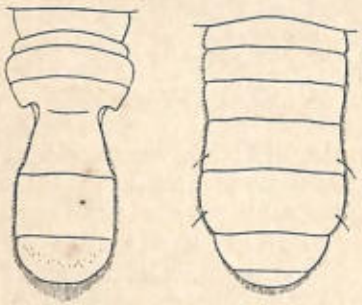


TEXT-FIG. 3.—*Scopimera pilula*, sp. nov. Chela of male.

In the female the cheliped is only about twice the length of the carapace; the carpus is proportionately much shorter and the chela shorter, with fingers longer than the upper border of the palm The limb in consequence bears a close resemblance to that of male *S. globosa*, but the borders of the merus and carpus are crested.

The first and second walking legs are about two and a half times the length of the carapace and are thus a little shorter than in *S. globosa*. In other respects the legs show little difference: the merus is expanded, of similar proportions and bears large tympana.

The abdomen of the male (text-fig. 4*a*) is similar to that of the allied species but the fourth and fifth segments are a little longer than their basal breadth and are less deeply constricted; the breadth at the narrowest point is a little more than half the length. The sixth segment is about two-thirds as long as broad and the seventh nearly twice as broad as long. In the female (text-fig. 4*b*) the segments from the first to the fifth increase regularly in length; the fifth is about twice as broad as long and a shade wider than the fourth. The lateral margins of the abdomen are very slightly concave. In all the females the pleopods are covered with a thick felted growth which under low magnification resembles colonies of small Polyzoa and is usually extruded in bunches between the abdomen and the sternum. The growth in reality consists of stalks and broken shells of eggs from which the young crabs have escaped.



Text-fig. 4.—*Scopimera pilula*, sp. nov.
a. Abdomen of male.
b. Abdomen of female.

In large males the carapace is about 7·0 mm. in length and 10·6 mm. in greatest breadth. The females are a little smaller.

In a young male from the vicinity of Tuticorin with carapace 3·7 mm. in length the chelipeds do not show the characteristic sexual development, though they are normally developed in an individual from the Burma coast with carapace 4·0 mm. in length. The Tuticorin specimen appears to be abnormal and the collection of further specimens in the same locality might prove of interest.

There can be little doubt that Müller's record of *S. globosa* from Trincomali refers to this species.

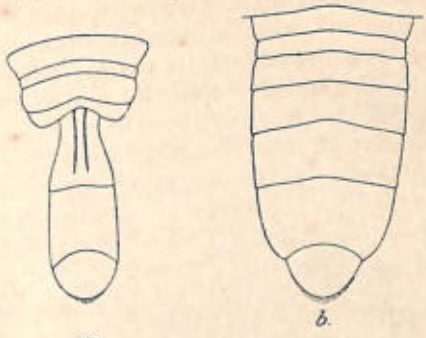
$\frac{9850-2}{10}$	Backwater at Pamban, Ramnad dist., S. India.	S. Kemp, Feb. 1913.	Many.
$\frac{9853}{10}$	Small lagoon near Tuticorin, S. India.	J. Hornell, Feb. 1918.	One.
$\frac{9854}{10}$	Paway (Pawe) I., Mergui Archipelago.	'Investigator,' Feb., 1914.	Two.

The types are from Pamban and bear the number 9850/10, *Zool. Surv. Ind.*

Scopimera investigatoris, Alcock.

1900. *Scopimera investigatoris*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 369, and *Illustr. Zool. 'Investigator,' Crust.*, pl. lxiii, figs. 4, 4*a*, *b*.

This species and *S. proxima* differ from all other members of the genus by the fact that the tympana on the meral segments of the walking legs, except for that on the upper surface of the last pair, are longitudinally divided by a narrow ridge; the tympana on the merus of the cheliped do not share this character. The two species may be contrasted with *S. inflata* and *S. kochi*, in which the tympana of the walking legs are normal, while that on the inner face of the merus of the cheliped is bisected.



TEXT-FIG. 5.—*Scopimera investigatoris*, Alcock.
a. Abdomen of male.
b. Abdomen of female.

I give a fresh figure of the abdomen in this species for comparison with that of the closely allied *S. proxima*.

The specimens of *S. investigatoris* described by Alcock are from Burma. Additional examples are from the western side of the Bay of Bengal:—

1888-74	Diamond I., off C. Negrais, Burma.	'Investigator.'	Eleven. TYPES.
9810/10	False Point, Orissa.	'Investigator.'	One (juv.)
9811/10	Chandipur, Balasore, Orissa.	F. H. Gravely, May, 1916.	Three.

At Chandipur the species was found in company with *Dotilla intermedia*, de Man.

Scopimera proxima, sp. nov.

Plate XII, fig. 3.

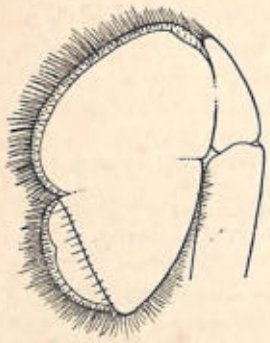
This species is an extremely close ally of *S. investigatoris*, but may be distinguished by its smoother carapace, less inflated antero-laterally and, in particular, by the different form of the abdomen.

The carapace is of similar proportions to that of the allied species and is about one and a half times as broad as long, with its depth about equal to its length.

In *S. investigatoris* a characteristic feature of the upper surface is the presence of an inflated and conspicuously granular area on each side near the antero-lateral angles. This area rises high above the orbital margin and is sharply defined anteriorly and externally by the steep and almost vertical declivity of its frontal and lateral borders, its separation from the outer orbital angle being conspicuous; posteriorly and internally it merges gradually into the general surface of the carapace. The granules of

this elevated area are continued backwards in irregular fashion, terminating in a cluster near the base of the last pair of legs. There are also scattered granules on other parts of the carapace, the gastric and cardiac regions excepted, and a few on either side of the basal part of the front near the insertion of the eye-stalks

In *S. proxima* the condition is different. The antero-lateral portions of the carapace are only a little swollen, the surface sloping gently upwards and backwards from the orbital border without any indication of the abrupt declivity seen in the allied species. The granules are fewer and much less conspicuous, though they may sometimes be traced backwards to the base of the last pair of legs. The other parts of the carapace are quite smooth and there are no tubercles at the base of the front.



Text-fig. 6.—*Scopimera proxima*, sp. nov. Endopod of second maxilliped.

When the carapace is viewed from in front the lower orbital border appears more strongly sinuous than in the allied species and the facet at its inner end more sharply defined.

The third maxillipeds closely resemble those of *S. investigatoris*; they do not, however, show any trace of the obscure granules often seen in large specimens of the latter species and there is merely a shallow furrow parallel with the outer border of the merus, in place of an incised groove.

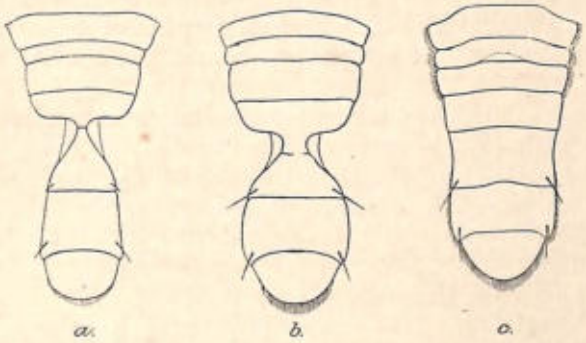
The chelipeds are short in both species and otherwise resemble each other very closely. In *S. proxima* all three edges of the merus are sharp and serrate, whereas in *S. investigatoris* the upper edge, though compressed, is distinctly rounded. In the latter species the inner limit of the upper surface of the carpus is defined proximally by a short crest which is wanting in *S. proxima*. The upper and lower borders of the palm are rounded in both species and there is little difference in the shape of the chela; the granulation is, however, a little coarser in *S. proxima* and the teeth on the prehensile edges of the fingers are larger and sharper. I have not found any distinctions in the walking legs.

The abdomen of the male of *S. investigatoris* has been figured by Alcock, but the form of the fourth segment is not quite correct, the distal angles being a little more produced than he has shown. I give a fresh figure of the male and female abdomen (text-fig. 5) for comparison with those of *S. proxima* (text-fig. 7). In *S. investigatoris* the fourth segment in the male is broad distally with produced outer angles, the fifth narrow, constricted at the base and deeply channelled, the sixth longer than broad with parallel sides. In *S. proxima* there is a very deep constriction at the junction of the fourth and fifth segments, the anterior end of the

former being exceedingly narrow [1]; the fifth segment is not channelled and the sixth is a little broader than long with straight, slightly divergent sides.

In the abdomen of the female the differences are less marked. In *S. investigatoris* (text-fig. 5*b*) it is rather broad, with slightly convex sides and with the seventh segment narrow; in *S. proxima* (text-fig. 7*c*) it is proportionately narrower, with the sides a trifle concave and the seventh segment broader.

Among a large number of specimens of *S. proxima* I have found ten in which the abdomen does not correspond with the normal type of either sex. In general outline (text-fig. 7*b*) the abdomen is similar to that of the normal male, but the constriction at the junction of the fourth and fifth segments is less deep, the fifth segment is proportionately broader and shorter and the sixth broader with convex lateral margins. On raising the abdomen four pairs of pleopods are found as in normal females.



TEXT-FIG. 7.—*Scopimera proxima*, sp. nov.

a. Abdomen of male.
b. Abdomen of abnormal female.
c. Abdomen of normal female.

At first it seemed probable that these specimens were males, infected by some parasite which had castrated them and rendered abortive the normal development of the secondary male characters. No parasite could, however, be discovered and on dissection ovarian eggs were found which differed in no respect from those obtained by the same method from normal females. There is, in consequence, very little doubt that the specimens are females and capable of breeding.

That very aged females occasionally assume some of the secondary sexual characters of the male is well known, but it does not seem probable that this will afford an explanation of the abnormal females in *S. proxima*. None of them is at all excep-

[1] The sides of the constricted portion are bevelled, so that the segments would appear broader if viewed from beneath.

tional in size and the presence of ovarian eggs indicates that they are capable of breeding and not, therefore, senile. The instance appears to be one of female sexual dimorphism, a phenomenon not, I believe, hitherto noticed among Decapod Crustacea.

It is very remarkable that the abdomen should be constricted in the abnormal females. In males the copulatory appendages can be exserted through the notches formed by the constriction and can remain in this position with the abdomen folded against the sternum: at the time of their capture many males of *S. proxima* were found with the appendages exposed. The modification of the abdomen seems thus to have a definite function in the male; in the female it is difficult to see how it can serve any useful purpose.

Of 87 specimens of *S. proxima* collected in Mormugao Bay in Portuguese India 50 are males, 31 normal females (2 ovigerous) and 6 abnormal females. Of 14 specimens from the neighbourhood of Tuticorin in S. India 9 are males, 4 normal females (1 ovigerous) and 1 an abnormal female. Of 16 specimens from Ennur backwater, near Madras, 6 are males, 7 normal females and 3 abnormal females.

In large males the carapace is about 4·4 mm. in length and 7 mm. in breadth.

$\frac{9812-4}{10}$	Vasco da Gama Bay, Mormugao Bay, Portuguese India.	S. Kemp; Aug., Sept., 1916.	Seventy-one.
$\frac{9815-6}{10}$	Donna Paula Bay, Mormugao Bay.	*do.*	Eleven.
$\frac{9817-8}{10}$	Bay N.W. of Nazareth Point, Mormugao Bay.	*do.*	Five.
$\frac{9855}{10}$	Silavathurai lagoon, nr. Tuticorin, S. India.	J. Hornell; Feb., May, 1918.	Fourteen.
$\frac{9867}{10}$	Ennur backwater, near Madras.	S. Kemp; May, 1918.	Sixteen.

Both in Mormugao Bay and near Tuticorin the species was found associated with *Dotilla myctiroides*, but the colonies of the latter were situated close to low-water mark, whereas those of *S. proxima* were higher up the beach, near high-water mark. In Mormugao Bay the species was found on ground that was sandy with a small admixture of mud. The burrows were widely separated, with pellets of sand neatly arranged in the customary manner. In many cases two, three or four 'runs' led to the mouth of the burrow, in place of the single one usually found in *Dotilla*. The 'runs' are long, sometimes as much as 1 ft.

The salinity of the water in Mormugao Bay varies with the state of the tide and doubtless also according to the season of the year; at the time of my visit, towards the end of the monsoon, it was everywhere brackish. The specific gravity in Vasco da Gama Bay was on one occasion 1·0165 (corrected).

The types are from Vasco da Gama Bay and bear the number 9812/10, *Zool. Surv. Ind.*

Scopimera inflata, A. Milne-Edwards.

1873. *Scopimera inflata*, A. Milne-Edwards, *Journ. Mus. Godeffroy*, Heft IV, p. 83.

In the collection of the Zoological Survey is preserved a single individual bearing the label "1423. *Scopimera inflata*, A. M.-Edw. Indian Ocean. Purchased." This specimen is one of very considerable interest and, though its history is not altogether free from doubt, there is every reason to believe that it is one of the original examples determined by A. Milne-Edwards.

The register of the Crustacean collections contains under No. 1423 no information additional to that on the label, except that it is noted that only one specimen of the species was obtained. On the same page, however, are entries of a number of other Crustacea, also acquired by purchase and all apparently forming a single consignment, from Upolu, Samoa and the Viti Is. The entries were evidently made in 1875 or 1876. In the Annual Report of the Trustees of the Indian Museum for 1874-75 there is a statement that a collection of Crustacea "mostly from Southern Seas" was purchased from the Godeffroy Museum, while in the issue for 1875-76 it is noted that over 100 species of Crustacea (evidently a second consignment) were obtained from the same source. Mr. J. Wood-Mason, who came to Calcutta in 1869 as assistant Curator of the Indian Museum, devoted a great deal of time to the acquisition of a representative collection of named Crustacea—of this the registers and annual reports from 1873 and onwards contain abundant proof. He evidently took steps to obtain a set of duplicates from the Godeffroy Museum as soon as Milne-Edwards' paper appeared, and there can hardly be a doubt that the example of *S. inflata* was one of the specimens then acquired. It will be observed that in the original description the only note regarding locality is "Habite la mer des Indes."

The specimen is an adult female and is unfortunately in poor condition; the carapace is partially detached and the only legs remaining are those of the first two pairs. It is not possible to measure the carapace satisfactorily, but there can be no doubt that it is proportionately much broader than in other species of the genus. The length appears to have been 6·5 mm. or a little more, and the breadth at the orbital angles nearly 10 mm., the greatest breadth apparently exceeding 12 mm. These figures do not agree with those given by Milne-Edwards, who gives the length as 10 mm. and the breadth as 13 mm.; the former measurement perhaps represents the total length and not, as stated, that of the carapace only.

The upper surface of the carapace is very strongly convex antero-posteriorly, but in transverse direction is almost flat over the greater part of its breadth, sloping abruptly downwards on either side. Antero-laterally the surface is very greatly inflated, bulging upwards and forwards to such an extent that in a true dorsal view the upper orbital border is, in the middle of its length,

altogether concealed. The gastric and cardiac regions are smooth, but laterally the tubercles mentioned in the original description can be made out; apart from these the upper surface appears to be without evident sculpture. The side-walls are finely granular and seem to show traces of a rather deep sculpture, the grooves apparently forming a pattern somewhat similar to those found in *Dotilla myctiroides*; it is, however, difficult to be certain about this point owing to the poor condition of the specimen.

The epistome is very broad and exceptionally short. The penultimate segment of the second maxilliped is broader and the last segment more parallel-sided and proportionately longer and narrower than in other species of *Scopimera*. The third maxillipeds are also unusually broad and differ from normal species of the genus in having the ischium shorter than the merus (text-fig. 8). The ischium has a rather thick patch of hairs near its postero-lateral angle and the suture between it and the merus is nearly transverse. The merus is one third broader than long and decidedly longer than the ischium; it is very little narrowed distally and is angled antero-internally. The anterior margin is reflected upwards, a short ridge runs backwards from the carpal articulation and there is a deep groove parallel with the lateral margin.

TEXT-FIG. 8.—*Scopimera inflata*, A. Milne-Edwards. Third maxilliped.

The chelipeds are about 15 mm. in length. There is a large tympanum on the inner face of the merus, subdivided longitudinally by a ridge as in Roux's *S. kochi*. The tympanum on the outer face is without this ridge and is a little smaller, though broad and in length about half that of the segment. Except for the tympana the entire segment is finely granular. A. Milne-Edwards in his description says " avant-bras allongé et armé d'une épine à son angle interne." This statement refers to the male. In the female there is no tooth, but the inner margin is concave and sharp-edged anteriorly and is obtusely angled in front of its middle point: in this respect there is a great difference between *S. inflata* and *S. globosa*. The carpus of the female is not elongate; its upper surface is about one and a half times as long as broad and is closely covered with granules. The chela is about 8 mm. in length and its greatest height, which is about twice that at the articulation of the carpus, is 3·7 mm. The whole palm is strongly compressed and the entire outer surface is conspicuously granular. The upper border is not carinate. On the outer side near the lower border there is a sharply defined beaded carina which extends from the proximal end to the distal third of the fixed finger; on the inner side a similar, but even more strongly marked, carina reaches from the carpal articulation to the middle of the inner side of the fixed finger.

The lower surface of the palm, bounded by these two crests, is only slightly convex; it bears rather large scattered granules, some of which towards the distal end are arranged in a single row and thus form a low ridge which extends to the middle of the finger. The fingers themselves are nearly twice the length of the upper border of the palm. On the prehensile edge of the fixed finger there is, in the basal two thirds, a series of small inconspicuous teeth; the same margin of the dactylus is similarly armed, but some of the teeth at the proximal end are situated on a low convex crest, the counterpart it would seem of the large triangular tooth found in this position in the male. On the upper and outer borders of the dactylus are longitudinal rows of granules.

In the first pair of walking legs, which alone remains in the specimen examined, the merus is a little more than twice as long as broad; it bears large tympana on both sides, not divided by a longitudinal ridge. The propodus is stout, a trifle more than twice as long as broad, and bears on its anterior face a strong longitudinal ridge. The dactylus is one and a half times as long as the propodus. The abdomen is very broad covering practically the whole of the sternum.

Scopimera inflata is allied to *S. kochi*, Roux, and *S. sigillorum* (Rathbun). The three species resemble *Dotilla* and differ from normal members of the genus in two points,—(i) the merus of the outer maxillipeds is longer than the ischium and (ii) the side-walls of the carapace are to some extent sculptured. In *S. inflata* and *S. kochi* the tympanum on the inner face of the merus of the cheliped is divided longitudinally by a narrow ridge and the same character, though not mentioned in the description, is perhaps also to be found in *S. sigillorum*. In other species of *Scopimera* the tympana on the chelipeds are not bisected; but those on the walking legs are divided in an exactly similar manner in *S. investigatoris* and *S. proxima*.

There can be little doubt that *S. inflata* is correctly referred to the genus *Scopimera*. In the female I have examined the accessory branchial orifice is situated between the bases of the first and second walking legs and is thickly fringed with hair, while the abdomen does not possess the peculiar form invariably met with in *Dotilla*. The abdomen of the male, as described by Milne-Edwards, is similar to that of *S. globosa*.

Scopimera kochi, judging from Roux's excellent description, is a closely related form, differring in the sculpture of the upper surface of the carapace, in the form and coarse tuberculation of the outer maxillipeds and in the absence of a tooth at the inner angle of the carpus of the cheliped in the male.

S. sigillorum, described by Miss Rathbun as a species of *Dotilla*, is unfortunately known only from a single female specimen. The statement that the abdomen is subcircular indicates that it cannot be included in the genus *Dotilla* as here defined. In most respects the species appears to be very closely related to *S. inflata*, but the carapace is more distinctly areolated and

the merus of the outer maxilliped is proportionately much longer, being three times the length of the ischium. The brush of hair between the bases of the first two walking legs is not mentioned either by Roux or by Miss Rathbun.

Scopimera kochi, Roux.

1917. *Scopimera kochi*, Roux, in *Nova Guinea: Résultats Expéd. Sci. Néerl. Nouvelle-Guinea* V, Zool., p. 610, pl. xxvii, figs. 21-24.

Merauke, New Guinea.

Scopimera sigillorum (Rathbun).

1914. *Dotilla sigillorum*, Rathbun, *Proc. U.S. Nat. Mus.* XLVII, p. 83.

Sandakan Bay, Borneo.

I have not seen examples of either of these species. As noted above they appear to be related to *S. inflata*.

Genus Dotilla, Stimpson.

1835. *Doto*, de Haan, in Siebold's *Faun. Japon., Crust.*, p. 24.
1852. *Doto*, Milne-Edwards, *Ann. Sci. nat., Zool.*, (3) XVIII, p. 152 (*nom. praeocc.*).
1858. *Dotilla*, Stimpson, *Proc. Acad. Sci. Philadelphia*, p. 98.
1900. *Dotilla*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 363 (*in part*).
1918. *Dotilla*, Tesch, *Decap. Brachyur. 'Siboga' Exped.* I, pp. 41, 43 (*in part*).

From this genus I have separated two species, *D. brevitarsis*, de Man and *D. profuga*, Nobili, and have placed them in a new genus to which I have given the name *Dotillopsis*. The remaining species—in my opinion only eight in number—form a very homogeneous group, distinguishable at a glance from any other genus of crabs by the curious formation of the abdomen. The fourth segment overlaps the fifth and is furnished at its distal end with a conspicuous brush of hair.

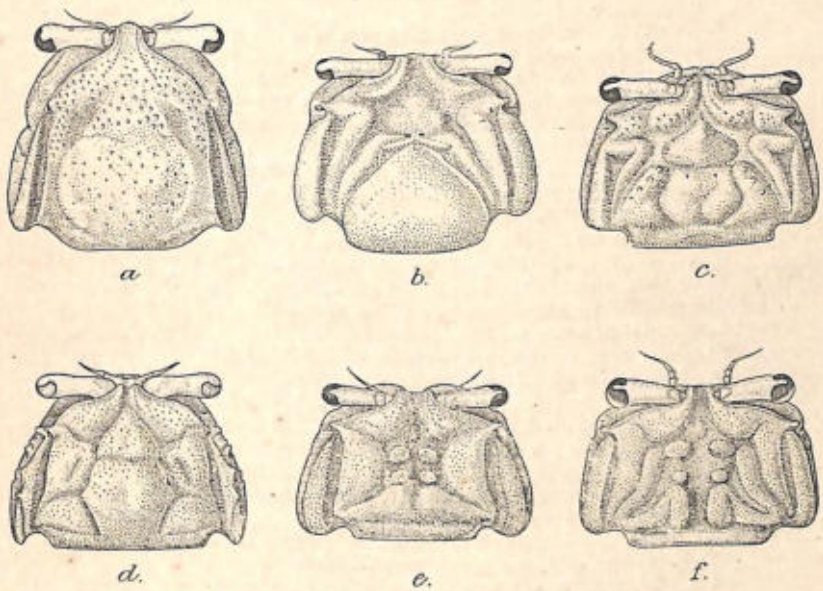
Many authors have remarked that they have seen no female *Dotilla*, but it does not appear that females are really scarce. The sexes, however, resemble each other so closely in the form of the abdomen that it is next to impossible to distinguish them without examination of the pleopods.

The genus shows affinity with *Scopimera* in the form of the distal segments of the second maxilliped, but lacks the accessory branchial passage found in that genus. In the deep convolute sculpture of the side-walls of the carapace it resembles *Dotillopsis* and, less markedly perhaps, the species of the *inflata*-group of *Scopimera*.

As regards the species, I have already referred Miss Rathbun's *D. sigillorum* to the genus *Scopimera* and, as noted above, two other species are placed in *Dotillopsis*. I agree with Nobili and Laurie that Alcock's *D. affinis* is synonymous with *D. sulcata*,

Forskål. *D. clepsydrodactylus*, Alcock, appears to me to be nothing more than a fully developed form of *D. intermedia*, de Man, while Stebbing's *D. clepsydra* does not seem to be distinguishable from Hilgendorf's *D. fenestrata*.

The mutual affinities of the species are best understood by a study of the grooves of the carapace. In text-fig. 9 will be found illustrations of the carapace of six species, the figures representing all the known types of sculpture. Two species I have not seen,—*D. fenestrata*, in which the sculpture is almost identical with that of *D. sulcata*, and *D. malabarica*, which in this respect bears a close resemblance to *D. pertinax*.



TEXT-FIG. 9.—Carapace sculpture in *Dotilla*.

a. D. myctiroides (Milne-Edwards).
b. D. sulcata (Forskål).
c. D. pertinax, Kemp.
d. D. wichmanni, de Man.
e. D. blanfordi, Alcock.
f. D. intermedia, de Man.

The species are often difficult to determine, partly owing to the fact that the grooves of the carapace are not easy to observe and partly because samples from a particular locality frequently consist only of comparatively small individuals, to the exclusion of large males with well developed secondary sexual characters. I have already remarked (p. 306) that the absence of full grown males is, in certain cases at any rate, to be attributed to an unfavourable environment. Males of *D. intermedia* are subject to a well-marked dimorphism.

With the exception of *D. fenestrata* all the known species of *Dotilla* have been found on the Indian coast. They may be distinguished thus :—

I. Carapace as long as broad, except for the lateral grooves practically devoid of sculpture; chelipeds at least three times length of carapace. [Tympana on all segments of sternum][1] ... ... *D. myctiroides.*

II. Carapace broader than long, its surface strongly sculptured; chelipedes at most little more than twice length of carapace.

A. Groove parallel to lateral margin of carapace anteriorly bifurcated or Y-shaped.

1. Two long parallel ∧-shaped grooves on dorsum of carapace, the lower enclosing a large triangular plane area with base occupying the whole of the posterior margin.

a. Tympana present on 2nd and 3rd segments of sternum; fingers of chela longer than palm, each in the adult male with a large tooth on its inner edge ... ... *D. fenestrata.*

b. No tympana on sternum; fingers of chela not longer than palm and without large teeth ... *D. sulcata.*

2. No parallel ∧-shaped grooves on dorsum of carapace; a cardio-intestinal area (much narrower than posterior margin) defined by lateral grooves.

a. Gastric area triangular; a faint transverse groove near posterior margin; dactylus of last leg not 1½ times as long as propodus ... *D. pertinax.*

b. Gastric area pentagonal; no posterior transverse groove; dactylus of last leg 2ee as long as propodus ... ... *D. malabarica.*

B. Groove parallel to lateral margin of carapace simple, not bifurcated anteriorly.

1. Gastric and cardiac areas entire, not divided by a median longitudinal groove; transverse groove near posterior margin incomplete in the middle; no lobules isolated by grooves on gastric region; adult male with a tooth below orbital angle and a strong compressed tubercle on inner and proximal aspect of carpus of cheliped; tympana on all segments of sternum ... ... *D. wichmanni.*

2. A deep mid-dorsal groove extending from front to posterior margin; transverse posterior groove complete; 4 (or 5) small lobules on gastric region isolated by grooves; no tooth below orbital angle and no tubercle on carpus of cheliped; no tympana on sternum.

a. Only a single oblique groove running from side of cardiac region towards postero-lateral angle; lower surface of palm not carinate ... *D. blanfordi.*

b. Two oblique grooves running from side of cardiac region towards postero-lateral angle; lower surface of palm strongly carinate ... *D. intermedia.*

Dotilla myctiroides (Milne-Edwards).

1900. *Dotilla myctiroides*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 368.

1900. *Scopimera myctiroides*, Lanchester, *Proc. Zool. Soc. London*, p. 760, pl. xlvii, fig. 14.

1907. *Dotilla myctiroides*, Stimpson, *Smithson. Misc. Coll.* XLIX, p. 101.

1907. *Dotilla myctiroides*, Willey, *Spolia Zeylanica* V, p. 38.

1915. *Dotilla myctiroides*, Kemp, *Mem. Ind. Mus.* V, p. 227, fig. 8.

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[1] Sternal tympana otherwise occur only in *D. fenestrata* and *D. wichmanni*.

References prior to 1900 are given by Alcock, who records the species from the Andamans and the Coromandel coast. Additional specimens are from the following localities:—

$\frac{9804}{10}$	Vasco da Gama Bay, Mormugao Bay, Portuguese India.	S. Kemp; Aug., Sept., 1916.	Thirty.
$\frac{9805}{10}$	Bay N. W. of Nazareth Pt., Mormugao Bay, Portuguese India.	*do.*	Six.
$\frac{9806}{10}$	Tuticorin, S. India.	J. Hornell; Feb., 1918.	Twenty-four.
$\frac{8935}{10}$	Pamban backwater, Ramnad dist., S. India.	S. Kemp; Feb., 1913.	Seven.
$\frac{8934}{10}$	Ennur backwater, nr. Madras.	N. Annandale; Oct., 1913.	One (ovig.).
$\frac{8933}{10}$	Outer channel of Chilka Lake, Orissa.	Chilka Survey, March, 1914.	One.
$\frac{8836}{10}$	Maungma-gan, Tavoy, Burma.	J. Coggin Brown.	Five.
$\frac{8930}{10}$	Paway (Pawe) I., Mergui Archipelago.	'Investigator,' Feb., 1914.	Four.
$\frac{9807}{10}$	Port Blair, Andamans.	R. P. Mullins; June, 1918.	Seven.

In the first of these localities the species was exceedingly abundant on sandy ground with a small admixture of mud. The colonies occupied extensive tracts near low-water mark; the burrows were very closely packed together and the whole surface of the sand was covered with pellets to a depth of nearly an inch. It is perhaps due to this overcrowding that the specimens are decidedly smaller than usual, none exceeding 6·5 mm. in length of carapace. With the species, but in isolated burrows near high-water mark, was found *Scopimera proxima* and Mr. Hornell found the two forms associated in the same way at Tuticorin

Dotilla myctiroides is frequently found in places where the water is brackish. Dr. Annandale found an ovigerous female in such a situation at Ennur and, at the time specimens were taken, the specific gravity of the water in Vasco da Gama Bay was 1·0165 (corrected).

The species has been recorded from Mahé (Milne-Edwards),[1] Rameswaram I., Tuticorin and Ennur (Henderson), Singapore (Walker, Lanchester), Java (Brit. Mus., *fide* Henderson), Gaspar Straits (Stimpson) and Billiton I. and Mindanao (Aurivillius). Henderson gives "Seychelles (Miers)," but I have not succeeded in tracing the record.

Dotilla fenestrata, Hilgendorf.

1843. *Doto sulcatus*, Krauss, *Südafrik.-Crust.*, p. 39 (Stuttgart).
1869. *Dotilla fenestrata*, Hilgendorf, in von der Decken's *Reisen Ost.-Afrika* III, p. 85, pl. iii, figs. 5, 5*b*,*c*.
1879. *Dotilla fenestrata*, Hilgendorf, *Monatsb. K. Preuss. Akad. Wiss.*, 1878, p. 806.
1884. *Dotilla fenestrata*, Miers, *Zool. H.M.S. 'Alert,'* p. 543.
1893. *Dotilla fenestrata*, Aurivillius, *Nov. Act. Reg. Soc. Sci. Upsala*, ser. III, p. 12, pl. i, figs. 14, 15.

[1] Presumably the Mahé on the Malabar coast.

1894. *Dotilla fenestrata*, Ortmann, *Zool. Jahrb., Cyst.*, VII, p. 748.
1905. *Dotilla fenestrata*, Lenz, *Abh. Senck. Naturf. Ges. Frankfurt* XXVII, p. 367.
1917. *Dotilla clepsydra*, Stebbing, *Ann. Durban Mus.* II, p. 18, pl. v.

Stebbing records *D. clepsydra* from Durban Bay and compares it with Alcock's *D. clepsydrodactylus* (=*D. intermedia*, de Man), which it resembles in the structure of the chela of the adult male. Apparently, however, he has failed to notice that *D. fenestrata*, which also inhabits the S. African coast, possesses a chela of precisely this type.

I have little doubt that the two are synonymous. Judging from the very rough figure the sculpture of the carapace is of the type found in *D. fenestrata* and in the figure of the under surface there appears to be an indication of a tympanum on the second segment of the abdominal sternum, the third segment not being represented.

The only discrepancy is that *D. clepsydra* possesses a tooth at the proximal end of the lower surface of the merus of the cheliped. In males of *D sulcata* this tooth may be present or absent, but its existence is not mentioned in any description of *D. fenestrata*.

Of this species, which is restricted to the southern and eastern coasts of Africa, I have seen no specimens. It has been recorded from Zanzibar (Aurivillius, Lenz), Ibo (Hilgendorf), Mozambique (Hilgendorf, Miers), Inhambane (Hilgendorf), Durban Bay (Stebbing) and the Cape of Good Hope (Ortmann).

Dotilla sulcata (Forskål).

1775. *Cancer sulcatus*, Forskål, *Descript Anim.*, p. 92 (Hauniae).
1809. *Myctiris sulcatus*, Audouin, *Descript. de l'Egypte, Hist. Nat.*, I, *Explic. sommaire des planches*, p. 81; Savigny, *ibid.*, *Planches, Crust.*, pl. i, figs. 3, i-iv (1817).
1829-44. *Myctiris sulcatus*, Guérin, *Icon. Regne Anim., Crust.*, pl. iv, figs. 5, 5*a-b*.
? *Myctiris sulcatus*, Milne-Edwards, in Cuvier's *Regne Anim., Atlas*, pl. xviii, figs. 3, 3*a*, *b*.
1833. *Ocypode* (*Doto*) *sulcata*, de Haan, in Siebold's *Faun. Japon., Crust.*, p. 24.
1837. *Doto sulcatus*, Milne-Edwards, *Hist. nat. Crust.* II, p. 92.
1850. *Doto sulcatus*, Lucas, *Hist. Nat. Anim. Artic., Crust.*, p. 61, pl. ii, fig. 1.
1861. *Doto sulcatus*, Heller, *Fitz. Kais. Akad. Wiss. Wien* XLIII, p. 361.
1888. *Dotilla sulcata*, de Man, *Journ. Linn. Soc., Zool.* XXII, p. 130.
1889. *Doto sulcatus*, Cano, *Boll. Soc. Nat. Napoli* III, p. 249.
1892. *Dotilla sulcata*, de Man, in Weber's *Zool. Ergebn. Reise Ned. Ost-Ind.* II, pp. 309-13.
1900. *Dotilla affinis*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 365, and *Illustr. Zool. 'Investigator,' Crust.*, pl. lxiii, figs. 1, 1*a*, *b*.
1906. *Dotilla sulcata*, Nobili, *Ann. Sci. nat., Zool.*, (9) IV, p. 315.
1915. *Dotilla sulcata*, Laurie, *Journ. Linn. Soc., Zool.* XXXI, p. 467.

I agree with Nobili and Laurie that *D. affinis* is synonymous with *D. sulcata*. The tooth at the proximal end of the lower surface of the male cheliped is well developed only in large individuals; the types of Alcock's species are all small, but the tooth

is present in a rudimentary condition in the two largest males. In a series of five specimens recently obtained by Capt. R. B. Seymour Sewell, I.M.S., in the Gulf of Suez, the tympanum on the upper surface of the last leg is present in two very small specimens and in a female of medium size; in a small male and large female it is altogether absent.

The specimens examined are:—

1133	Red Sea.	Berlin Mus.	Three.
1173	Aden and Mekran coast.	'Investigator.' TYPES of *D. affinis*, Alc.	Four.
9807	Ain Musa, Gulf of Suez.	R. B. Seymour Sewell.	Five.

Other precisely localized records of *D. sulcata* are,—Suez (Forskål, Laurie), Tor (Heller), Aden (Nobili) and Djibouti (Nobili).

Dotilla pertinax, Kemp.

1915. *Dotilla pertinax*, Kemp, *Mem. Ind. Mus.* V, p. 222, pl. xii, fig. 4.

Examination of further specimens shows that, as in *D. sulcata*, the tympanum on the upper surface of the last pair of legs may be present or absent. This character, therefore, will not serve to distinguish the species from Nobili's *D. malabarica*, to which in the pattern of the grooves on the carapace it is clearly related.

8937/8	Outer channel of Chilka Lake, Orissa.	Chilka Survey, March, Oct., 1914.	Many (including TYPES).
9133	Puri, Orissa.	S. Kemp: March, 1916.	Seventeen.

The specimens obtained at Puri were found at the edge of a small pool of brackish water separated by a sandbank from the open sea. At exceptional tides sea-water made its way into the pool.

Dotilla malabarica, Nobili.

1903. *Dotilla malabarica*, Nobili, *Boll. Mus. Torino* XVIII, No. 452, p. 20, fig. 6.

I have not seen this species, which is evidently closely related to *D. pertinax*. It differs in the sharply pentagonal form of the gastric area—clearly shown in Nobili's figures, in the generally deeper sculpture of the carapace and in the absence of a transverse groove near the posterior border. The fingers also appear to be much shorter in relation to the palm and the dactylus of the last leg longer, twice the length of the propodus. On actual comparison of specimens other distinctions will probably be discovered.

Dotilla malabarica is known only from the original examples obtained at Mahé on the Malabar Coast (E. Deschamps coll.). I have endeavoured without success to obtain further specimens.

Dotilla wichmanni, de Man.

1892. *Dotilla wichmanni*, de Man, in Weber's *Zool. Ergebn. Reise Nied. Ost.-Ind.* II, p. 308, pl. xviii, fig. 8.

1895. *Dotilla wichmanni*, de Man, *Zool. Jahrb., Syst.*, VIII, p. 577.

1910. *Dotilla wichmanni*, Rathbun, *Dansk. Vid. Selsk. Skrift.* (7), *naturvid. og math.*, V, p. 324.
1918. *Dotilla wichmanni*, Tesch, *Decap. Brachyur. 'Siboga' Exped.* I, p. 45.
1918. *Dotilla wichmanni*, Kemp, *Mem. Asiat. Soc. Bengal* VI, p. 227, text-fig. 1.

In the last-quoted paper I have given an account of a series of very large specimens obtained by Dr. Annandale in Lower Siam. Large males from this locality exhibit strong secondary sexual characters in the presence of certain angular projections on the sides of the carapace, the most conspicuous being spinose in character and situated beneath the outer orbital angle. There is also in the fully developed male a prominent compressed tubercle on the inner face of the carpus close to the meral articulation.

Tesch notes the presence of two tympana on the outer face of the merus of the chelipeds; both are distinct in the specimens I have seen and a similar character is frequently, but not always, met with in *D. intermedia*.

In the conformation of the grooves on the carapace *D. wichmanni* differs markedly from any other species of the genus. In the form of the lateral grooves it shows affinity with *D. blanfordi* and *D. intermedia* but otherwise there are few points of resemblance. Apart from *D. myctiroides* it is the only species which possesses tympana on all the segments of the abdominal sternum.[1]

$\frac{9\,4\,3\,0}{10}$	Kaw Deng, near Singgora, Gulf of Siam.	N. Annandale; Jan., 1916.	Thirty-one.
$\frac{9\,4\,3\,1}{10}$	Corbyn's Cove South, Port Blair, Andamans.	S. Kemp; March, 1915.	Sixty-five.

The specimens from Port Blair are all small and the secondary sexual characters of the males are not developed. One of Dr. Annandale's specimens is ovigerous.

The species has been recorded from Celebes, Makassar and Atjeh in Sumatra (de Man), the Talaut Is. (Tesch) and from Koh Kong in the Gulf of Siam (Rathbun).

Dotilla blanfordi, Alcock.

1900. *Dotilla blanfordi*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 366, and *Illustr. Zool. 'Investigator,' Crust.*, pl. lxiii, figs. 3, 3*a*.

We are indebted to Lieut.-Col. H. J. Walton, I.M.S., for further examples of this species, which like most other Scopimerinae appears to be local rather than rare. The additional specimens are considerably smaller than the types; the carapace of the largest male is only 4·2 mm. in length and that of the single ovigerous female only 3·0 mm.

In the sculpture of the carapace this species shows affinity with *D. intermedia*, a form which appears to be restricted to the Bay of Bengal.

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[1] For my observations on this point see the paper cited above.

$\frac{41.32}{4}$ $\frac{37.00}{10}$	Bombay and Karachi.	A. O. Hume, F. Day and W. T. Blanford.	Four. TYPES.
$\frac{0.85.9}{10}$	Oran I., Bombay.	H. J. Walton; April, May, 1918.	Thirty-eight.

Not known from any other locality.

Dotilla intermedia, de Man.

1888. *Dotilla intermedia*, de Man, *Journ. Linn. Soc. Zool.*, XXII. p. 135, pl. ix, figs. 4-6.
1900. *Dotilla clepsydrodactylus*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 367, and *Illustr. Zool. Investigator, Crust.*, pl. lxiii, figs. 2, 2*a*.
1915. *Dotilla clepsydrodactylus*, Kemp, *Mem. Ind. Mus.* V, p. 226.

Examination of a very fine series of specimens, recently collected by Dr. F. H. Gravely at Chandipur in Orissa, has convinced me that *D. clepsydrodactylus* is synonymous with *D. intermedia*. I have seen the types of both forms and find that the configuration of the grooves of the carapace is identical. *D. intermedia* was described by de Man from a number of small specimens [1] in which the characters of the adult male chela were not developed.

Altogether I have examined 316 specimens of this species, of which 235 (148 males and 87 females) were obtained by Dr. Gravely at Chandipur on the Orissa coast. Among the males from this locality two very distinct dimorphic forms occur, which may be termed "high" and "low."

In the "high" male, which is the type described by Alcock, the first abdominal sternum bears a sharp transverse ridge on either side of the trough formed to receive the terminal segment of the abdomen and well behind its anterior limit. The fingers of the chela each bear a large lobe or tooth near the middle of their prehensile edge. The copulatory appendage is blunt at the tip and furnished with numerous setae.

In the "low" male the first abdominal sternum bears anteriorly a pair of large outstanding triangular teeth; these are in advance of the anterior limit of the abdominal trough and are thus placed considerably further forwards than the ridges in the "high" male. The dactylus of the chela bears a low rounded lobe near the base of its prehensile edge (further back than in the "high" male) and there is no lobe or large tooth on the fixed finger. The copulatory appendage is more slender, strongly sinuous, and terminates in a fine point which is turned inwards and does not bear conspicuous setae.

That these two types of male belong to the same species is, I believe, incontestable. In the form and areolation of the carapace they resemble each other exactly and they were, moreover, all found in the same locality.

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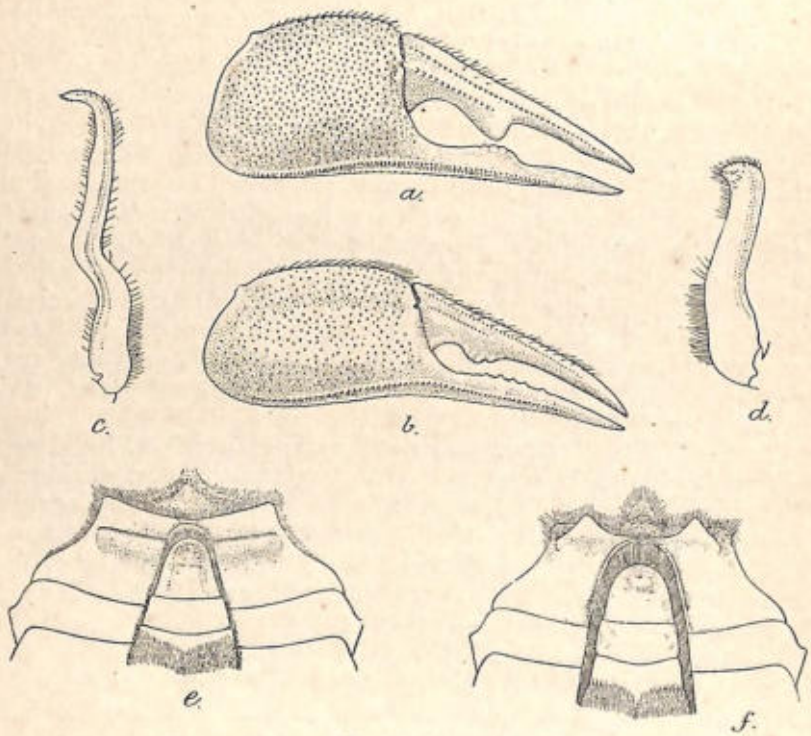
[1] De Man described the species from 32 specimens, "all males." Of these 14 are in the collection of the Zoological Survey of India, labelled "types" in de Man's handwriting. De Man was mistaken as to the sex of his specimens, for 7 of those examined are females.

All well-grown males can be referred without the least hesitation to one or other dimorphic form; the "high" males reach a larger size, the carapace being sometimes as much as 5·5 mm. in length, whereas the "low" males rarely exceed 4·5 mm. In specimens of medium size the characters of the sternum and chela are less well developed, though as a rule perceptible, but in very small individuals, from 2·0 to 3·0 mm. in length, it is usually not possible to detect them. The form of the copulatory appendage appears,



Text-fig. 10.—*Dotilla intermedia*, de Man.

a. Chela of "high" male.
b. Chela of "low" male.
c. Copulatory appendage of "low" male.
d. Copulatory appendage of "high" male.
e. Abdominal sternum of "high" male.
f. Abdominal sternum of "low" male.

however, to be quite constant; I have examined it in all the specimens and have never once been in doubt.

At Chandipur Dr. Gravely collected specimens on three occasions, the numbers being as follows:—

	"High" males.	"Low" males.	Females.
June, 1915.	17	6	15 (1 ovig.)
May, 1916.	46	18	39 (17 ovig.)
May, 1917.	41	20	33 (3 ovig.)
	104	44	87

It seems therefore that "high" males are very much commoner than "low" males, and that males (both forms included) are nearly twice as abundant as females.[1]

I am not at all certain as to the meaning of the dimorphism in this species. Of both types of male there is a series ranging from very small to full-grown specimens, a fact which perhaps discounts the possibility that they represent breeding and non-breeding phases. On the other hand it is very improbable that more than one type of copulatory appendage can be employed in the sexual process. In other species of *Dotilla* the appendage is generally blunt at the tip, resembling that of the "high" male, a circumstance which points to the conclusion that the "low" males do not breed.

The examples of *D intermedia* that I have seen from other localities are mostly of small size and (determined mainly by the form of the copulatory appendage) consist entirely of "high" males and females.

Several observations indicate that environment has a great influence on species of *Dotilla*, its effects being shown both in the size of the specimens and in the degree of development of the secondary sexual characters of the male. Thus the individuals of *D. intermedia* that we obtained in the outer channel of the Chilka Lake in Orissa were all small and it was only with difficulty that a few specimens were obtained which showed in an imperfect degree the peculiar character of the "high" male chela. In this locality with its extreme seasonal changes in salinity, there can be little doubt that the environment is unfavourable. A somewhat similar instance has been noticed in *D. wichmanni* (see p. 330).

At Chandipur it is clear that the environment is peculiarly favourable for *D. intermedia* and that "low" males were found here and not in any other place in which the species has been collected, is perhaps in some way correlated with this fact.

The following specimens have been examined:—

$\frac{8236}{6}$	Sullivan I., Mergui Archipelago.	Mus. Coll.	Fourteen. TYPES.
$\frac{135-13}{7}$	False Point, Orissa.	'Investigator.' TYPES of *D. clepsydrodactylus*, Alc.	Seven.
$\frac{8939}{10}$	Outer Channel, Chilka Lake, Orissa.	Chilka Survey; March, 1914.	Thirty-five.
$\frac{9193}{10}$	Ennur backwater, nr. Madras.	N. Annandale.	Twenty (juv.).
$\frac{9192-3}{10}$	Chandipur, Balasore, Orissa.	F. H. Gravely; June 1915; May, 1916; May, 1917.	Two hundred and thirty-five.
$\frac{9869}{10}$	Maungma-gan, Tavoy, Burma.	J. Coggin Brown.	Five.

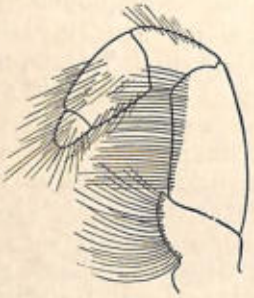
The species has not been recorded from any other locality.

[1] The abdomen in the genus *Dotilla* shows little difference in outline in males and females. In determining the sex it is therefore necessary to examine the pleopods, unless the specimens are ovigerous or with the male secondary characters strongly developed.

Genus **Dotillopsis**, nov.

This genus, which is established for *Dotilla brevitarsis*, de Man and *D. profuga*, Nobili, may be recognised by the following combination of characters :—

The carapace is cuboidal rather than globose and deeply grooved above. The side-walls possess the deep convolute sculpture seen in *Dotilla*. The penultimate segment of the second maxilliped is but little expanded and the ultimate segment is terminal in position. The merus of the outer maxilliped is longer than the ischium and is gyrous-sulcate. The meral segments of the legs bear ill-defined tympana. In the first three pairs of walking legs the merus, carpus and propodus are densely tomentose inferiorly. The abdomen consists of seven distinct segments; the fourth segment does not overlap the fifth and does not bear a brush of hairs at its distal end. In the male the fifth, sixth and seventh segments are narrow, the fifth not deeply constricted; the fourth segment is greatly expanded and produced on either side, its breadth being nearly three times that of the fifth. In the female the abdomen is broadly oval.



TEXT-FIG. 11.—*Dotillopsis brevitarsis* (de Man).
Endopod of second maxilliped.

Type.—*Dotilla brevitarsis*, de Man.

The genus is in some respects intermediate between *Dotilla* and *Tympanomerus*; it agrees with the former in the deep sculpture of the upper surface and lateral walls of the carapace and with the latter in the structure of the ultimate segments of the second maxilliped. The abdomen differs altogether from the very characteristic type found in *Dotilla*; in the male it shows signs of considerable specialization and has little resemblance to that found in any other genus of the subfamily.

The presence of a dense tomentum on the first three walking legs, a character also found in a few species of *Tympanomerus*, is almost certainly an adaptation to environment; the species of *Dotilla* are in my experience always found burrowing in clean firm sand, whereas *Dotillopsis brevitarsis* lives in the softest mud. Nobili's *D. profuga*, which I have not seen, probably also lives in mud, being described from the Upper Sadong River in Borneo.

The two species of the genus may be distinguished thus :—

I. Sculpture of carapace sharp; frontal groove continued almost to posterior margin; palm with conspicuous longitudinal carinae on its lower and inner aspects ... *D. brevitarsis.*

II. Sculpture of carapace indistinct; frontal groove reaching only to gastric region; palm without longitudinal carinae. ... ... *D. profuga.*

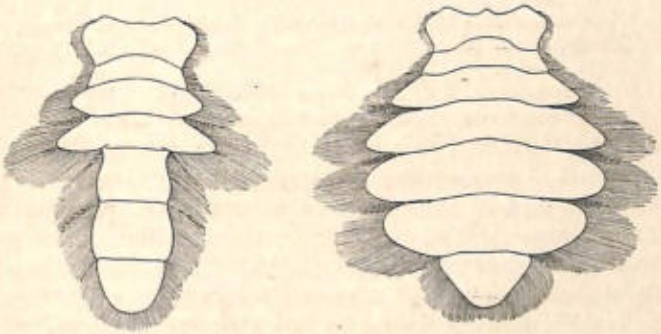
Dotillopsis brevitarsis (de Man).

1888. *Dotilla brevitarsis*, de Man, *Journ. Linn. Soc., Zool.*, XXII, p. 130, pl. ix, figs. 1-3.
1900. *Dotilla brevitarsis*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 367.

Plate XIII, fig. 1.

A number of additional specimens of this species have recently been obtained in the Gangetic Delta. The species was found at Port Canning and near the junction of the Matlah and Biddah rivers, living between tide-marks on a bank of exceedingly soft mud. The crab appears to have habits similar to those of the species of *Dotilla*; but, owing to the semiliquid consistency of the mud, the burrows do not retain their form and the pellets brought to the surface rapidly disappear. On one of the occasions on which specimens were obtained, in December 1916, the water was brackish, its specific gravity (corrected) being about 1·0105.

I have nothing to add to de Man's excellent description, but



TEXT-FIG. 12.—*Dotillopsis brevitarsis* (de Man).
Abdomen of male (left), of female (right).

give a fresh figure of the animal (pl. xiii, fig. 1) and outline drawings of the second maxilliped (text-fig. 11) and of the abdomen in each sex (text-fig. 12).

In adult males the carapace is grey, white above the bases of the legs and on the outer maxillipeds. The chelipeds are entirely bright orange red except for the upper surface of the carpus, which is grey. The walking legs are grey at the base, with the two terminal segments pure white. In the first three pairs there is a large red or orange-red patch on the anterior surface of the merus and, in the first two pairs, a similar patch on the posterior surface of the same segment. Adult females are similarly coloured, but frequently with orange instead of red or orange-red pigment and with the colour less pronounced on the walking legs. The eggs are deep reddish-purple, turning yellow in spirit.

In the largest specimen obtained the carapace is about 8 mm. in length and 10·5 mm. in breadth.

$\frac{8255}{6}$	Mergui Archipelago.	Mus. Collr.	Three (fragmentary).
$\frac{257.5}{7}$	Diamond I., off C. Negrais, Burma.	'Investigator.'	One.
$\frac{9803-5}{10}$	Kaikal Maree, nr. junction of Matlah and Biddah Rs., Gangetic Delta.	S. Kemp; Dec., 1916.	Eighty.
$\frac{8809}{10}$	Matlah R., opposite Port Canning, Gangetic Delta.	Bengal Fish. Dept. (B. Prashad); March, 1918.	Seven.

The species is not known from any other locality. The fragmentary specimens from the Mergui Archipelago appear to be paratypes.

Dotillopsis profuga (Nobili).

1903. *Dotilla profuga*, Nobili, *Boll. Mus. Torino* XVIII, No. 447, p. 22.

Upper Sadong R., Borneo.

Genus Tympanomerus, Rathbun.

1835. *Cleistostoma*, de Haan, in Siebold's *Faun. Japon., Crust.*, p. 26.
1888. *Dioxippe*, de Man, *Journ. Linn. Soc., Zool.*, XXII, p. 137 (*nom. praeocc.*).
1897. *Tympanomerus*, Rathbun, *Proc. Biol. Soc. Washington* XI, p. 164.
1900. *Tympanomerus*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX, p. 371.
1918. *Tympanomerus*, Tesch, *Decap. Brachyur. 'Siboga' Exped.* I, p. 48.

This genus shows signs of affinity with *Scopimera* in the form of the abdomen and in the presence of accessory branchial passages between the bases of the walking legs. It differs, however, from both *Scopimera* and *Dotilla* and resembles *Dotillopsis* in the form of the ultimate segments of the second maxilliped. From *Dotillopsis* it is readily distinguished by the absence of convolute grooves on the side-walls of the carapace, by the much less strongly sculptured dorsal surface and by the less broadly expanded fourth segment of the male abdomen.

Tympana, which are uniformly found in all other Scopimerinae, are sometimes absent in species of this genus; when present, they are usually ill-defined and difficult to observe.

Tesch has drawn attention to the presence of hairy-edged pouches or orifices of accessory branchial passages in species of this genus. In both *T. ceratophora* and *T. integer* he found two pairs, situated between the bases of the first and second and the second and third walking legs. I have found these pouches in *T. pusillus*, *T. lingulatus* and *T. stapletoni*,—in the last-named species they occur between the third and fourth legs also. In five other forms that I have examined the tufts of hair are absent or very poorly developed and I am not satisfied that accessory branchial passages exist.

Stimpson's genus *Ilyoplax*, which cannot be identified with certainty until the type species has been rediscovered (see p. 310), is evidently related to *Tympanomerus* and it seems very probable that the two will prove to be synonymous. Should this happen

the unfortunate term *Tympanomerus* will disappear from nomenclature, for *Ilyoplax* has long priority.

The species may be distinguished thus:—

1. Eyestalk without projecting terminal style.
   A. Carpus of cheliped without a tooth on its inner aspect. [Carpus short, its upper surface about 1½ times as long as broad.]
      1. Carapace pentagonal, the orbits being decidedly oblique; outer surface of palm granular or with squamiform rugosities.
         a. Lateral border of carapace notched behind outer orbital angle; male abdomen with all segments distinct, distal angles of 4th segment not produced.
            i. Granules on outer surface of palm arranged in a reticulate manner; a strong crenulate carina on outer side of both fingers; fixed finger horizontal in relation to palm; meri of walking legs with large tympana on underside ... ... *T. pusillus.*
            ii. Granules on outer surface of palm not arranged in a reticulate manner; no carinae on outer sides of fingers; fixed finger bent downwards in relation to palm; meri of walking legs without tympana ... *T. philippinensis.*
         b. No notch on lateral border of carapace behind outer orbital angles; 4th and 5th segments of male abdomen fused, distal angles of 4th segment produced and acute. [No carinae on outer sides of fingers; meri of walking legs with conspicuous tympana] ... ... *T. integer.*
      2. Carapace quadrilateral, the orbits being almost or quite transverse; outer surface of palm quite smooth or with very inconspicuous microscopic granules near lower border.
         a. Front narrow, less than one fifth anterior breadth of carapace; a well-defined groove on side-walls of carapace extending from anterior angles of buccal cavern to base of penultimate legs; abdomen of male with 5th segment only a little constricted, 7th broader than long. [Lower surface of palm flattened and bordered by carinae.]
            i. Front not more than one eleventh anterior breadth of carapace; upper surface of carapace not wider at the middle than anteriorly; chela of adult male weak, similar to that of female; male with a patch of tomentum on carpus and propodus of 2nd walking legs *T. stevensi.*
            ii. Front not less than one seventh anterior breadth of carapace; upper surface of carapace wider at the middle than anteriorly; chela of adult male strong, dissimilar to that of female; male without tomentum on 2nd walking legs ... ... *T. frater.*
         b. Front broader, more than one quarter anterior breadth of carapace; groove on side-walls of carapace visible only near angles of buccal cavern; abdomen of male with 5th segment deeply constricted, 7th at least as long as broad.
            i. Anterior breadth of carapace less than 1½ times its length; front angular at sides; crest defining lateral border of carapace discon-

tinuous posteriorly; outer surface of palm without a carina, its upper border rounded *T. stapletoni.*

ii. Anterior breadth of carapace more than 1½ times its length; front rounded; crest defining lateral border of carapace continuous throughout its length; outer surface of palm with a fine carina running to tip of fixed finger, its upper border crested ... *T. deschampsi.*

B. Carpus of cheliped with a tooth on its inner aspect. [Front not less than one quarter anterior breadth of carapace; male abdomen with 5th segment very slightly constricted.]

1. Surface of carapace with numerous small furry patches; carpus of cheliped short, its upper surface about 1½ times as long as broad; palm without carinae on lower surface; fingers with large teeth in male ... . *T. lingulatus.*

2. Surface of carapace without furry patches; carpus of cheliped elongate, its upper surface twice as long as broad; lower surface of palm bounded by fine carinae; fingers without large teeth.

a. Lower border of orbit with a large projecting lobe near its outer end; lateral margin of carapace sinuous ... ... *T. orientalis.*

b. Lower border of orbit without a projecting lobe; lateral margin of carapace regularly convex ... *T. gangeticus.*

II. Eyestalk with a long terminal style projecting far beyond cornea. [Front about one fifth anterior breadth of carapace; orbits oblique; lateral border concave; carpus of cheliped elongate] ... ... *T. ceratophora.*

Koelbel has suggested that *T. ceratophora* should be placed in a separate subgenus, *T. methypocoelis*, but I do not think this necessary.

Of the eleven species I have seen all but *T. philippinensis*, *T. integer* and *T. ceratophora*. *T. stevensi*, *T. frater*, *T. stapletoni*, *T. orientalis*, *T. gangeticus* and *T. lingulatus* are Indian species.

Tympanomerus pusillus (de Haan).

1835. *Ocypode* (*Cleistostoma*) *pusilla*, de Haan, in Siebold's *Faun. Japon., Crust.*, p. 56, pl. xvi, fig. 1.
1852. *Cleistostoma pusilla*, Milne-Edwards, *Ann. Sci. nat., Zool.*, (3) XVIII, p. 160.
1888. *Dioxippe pusilla*, de Man, *Journ. Linn. Soc., Zool.*, XXII, p. 137.
1889. *Dioxippe pusilla*, de Man, *Zool. Jahrb., Syst.*, IV, p. 447.
1902. *Cleistostoma pusillum*, Doflein, *Abh. math.-phys. Classe K. Bayer Akad.* Wiss. XXI, p. 667.

$\frac{9.8.5}{1.0}$ Japan. J. Anderson (*per* J. G. de Man). Two.

Tympanomerus philippinensis, Rathbun.

1914. *Tympanomerus philippinensis*, Rathbun, *Proc. U.S. Nat. Mus.*, XLVII, p. 84.

Guijulugan, Negros, Philippine Is.

Tympanomerus integer, Tesch.

1918. *Tympanomerus integer*, Tesch, *Decap. Brachyur.* 'Siboga' *Exped.* I, p. 54, pl. iii, fig. 1.

Kur I., west of Kei Is., Banda Sea.

Tympanomerus stevensi, sp. nov.

Plate XIII, fig. 2.

The carapace is transversely oblong; the anterior breadth is about one and a half times the length and the depth about half the breadth. The upper surface is slightly convex in both directions and is very feebly sculptured. A broad and inconspicuous median furrow extends backwards from the base of the rostrum, disappearing before it reaches the middle of the gastric region and there is a shallow transverse depression on either side some distance behind the orbital border. The posterior limit of the gastric region is defined by a well-marked transverse groove about one third the breadth of the carapace. On the branchial regions there are a few minute tubercles, bearing short setae, arranged in three oblique rows. The two anterior rows are exceedingly short and indistinct and frequently consist of only one or two tubercles each. The most posterior of them is longer and more conspicuous; in direction the row is as much longitudinal as transverse, and if it were continued forwards the line so formed would pass through the front. In this respect a marked difference exists between *T. stevensi* and the closely allied *T. frater*. Posteriorly the carapace is traversed by a sharp and perfectly straight transverse ridge, situated nearer the hinder margin than in *T. stapletoni* and *T. deschampsi*.

The front is obliquely deflexed and at the apex is broadly rounded or with a very obtuse median point; its lateral borders are slightly but distinctly constricted near the base. The breadth of the front is only one eleventh or one twelfth the breadth of the anterior border of the carapace and is thus much narrower than in any other species of the genus.

The orbits are very slightly oblique, much less so than in *T. pusillus*, but not strictly transverse as in *T. stapletoni*. The upper orbital border is microscopically beaded; it is excavate near the base of the front, but in its outer half is almost perfectly straight. The lower border is a little sinuous in dorsal view and is finely crenulate. On the floor of the orbit there is a crest that extends throughout nearly the whole of its length; it runs close to the lower border and the space between the two is hollowed. The outer orbital angle consists of a small acute tooth directed outwards.

The lateral margins of the carapace are very slightly convergent posteriorly and are straight, not convex; the breadth of the upper surface in the middle is thus a little less than its anterior breadth. There is a small emargination or notch behind the outer orbital angles and further back a series of minute denticles. Throughout its length the margin is defined as a sharp crest bearing short setae. At the extreme posterior end, as in *T. pusillus*, it is bifurcated, one branch running to the margin at the base of the penultimate legs, while the other—the more conspicuous of

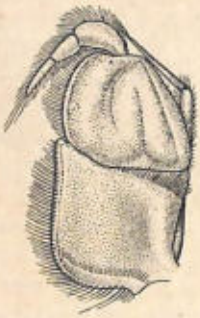
the two—trends inwards in a sinuous curve and terminates in a small angular lobule bearing a tuft of setae, immediately above the base of the last pair of legs.

There are minute tubercles, sparsely distributed, on the anterior part of the side-walls of the carapace. A conspicuous groove runs from the anterior angles of the buccal cavern to the base of the penultimate legs.[1]

The antennules and antennae do not differ appreciably from those of *T. pusillus*, but the epistome is shorter and the broadly triangular median tooth that separates the distal ends of the outer maxillipeds in other species is here exceedingly narrow.

The buccal cavern is nearly one and a half times as broad as long and is completely closed by the external maxillipeds (text-fig. 13). The ischium of the latter appendages is subquadrate with a setose line extending obliquely across it near the anterior border. The merus is a trifle shorter than the ischium and is broader than long. It bears a ∧-shaped furrow anteriorly as in *T. stapletoni*; it is, however, grooved near its inner edge, with the margin reflected upwards and in the proximal half there is a shallow median furrow which runs forward between the terminations of the ∧. The surface of the merus is smooth and shining. The exopod is entirely concealed and is furnished with a long slender flagellum.

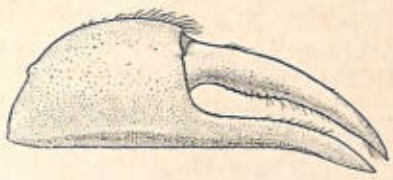
The chelipeds of the male are weak, very little stouter than those of the female, and decidedly less than twice the length of the carapace. The merus is trigonal with microscopically beaded edges; it bears a tympanum internally and sometimes, but not always, another of larger size externally. The carpus is short and smooth without a tooth on its inner aspect; the inner margin of the upper surface is crested and beneath it there is a tuft of very long hairs. The chela (text-fig. 14) is slender, nearly three times as long as the greatest height of the palm and the fingers are more than one and a half times the length of the upper border of the palm. The latter border is crested and microscopically crenulate; parallel with it on the inner face there is a longitudinal row of setae. From the tip of the fixed finger four finely beaded carinae run backwards on to the palm. The two median ridges are parallel and disappear before reaching the middle of the lower surface; the innermost curves obliquely upwards



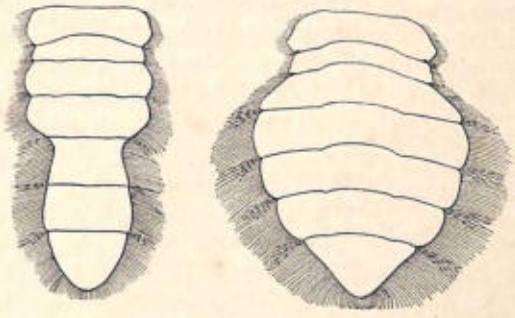
Text-fig. 13.—*Tympanomerus stevensi*, sp. nov. Third maxilliped.

[1] In this respect the species resembles *T. frater*. In *T. pusillus*, *T. stapletoni*, *T. deschampsi*, *T. gangeticus* and *T. orientalis* the groove is inconspicuous and is visible only in the anterior part of its course.

across the inner face, while the outermost runs along the lower part of the outer surface and extends to the proximal end of the palm. Between these ridges there are a few extremely minute tubercles; the remaining portions of the palm, including almost the whole of the outer surface, are quite smooth. The fingers meet only in their distal third when the claw is closed; their tips are curved a little inwards and are slightly spatulate. The fixed finger is without teeth; the dactylus is ridged above and bears a low crest of minute teeth in the proximal half of its prehensile edge.



TEXT-FIG. 14.—*Tympanomerus stevensi*, sp. nov.
Chela of male.



TEXT-FIG. 15.—*Tympanomerus stevensi*, sp. nov.
Abdomen of male (left), of female (right).

In females the chelipeds are a little more slender and the fingers are fully twice the length of the upper border of the palm. The palm is crested above with the row of setae on the inner face as in the male; but on the lower side there are only two carinae, enclosing a flattened lower surface, and each of these carinae bears long setae. The fingers are more distinctly spatulate than in the male; they gape widely at the base and there is no denticulate crest on the dactylus.

The third or penultimate pair of walking legs is the longest, nearly two and a half times the length of the carapace. There are well defined tympana on the upper and lower surfaces of the meri of the first two pairs and on the lower surface of the last two. In the proximal half of the merus of the two intermediate pairs, on the dorsal surface, there is a finely crenulate ridge running parallel to the upper border. The edges of the meri are finely spinulose, a feature specially well marked on the posterior borders of the second and third pairs. In these two pairs the carpus

and propodus each bear two carinae on their superior faces; the dactyli are flattened and in every instance shorter than the propodi. In large males there is a dense patch of tomentum on the second walking legs, extending from the middle of the carpus to the distal third of the propodus; in young males and females no trace of this tomentum can be found. The basal segments of the legs bear long plumose setae which retain fine particles of mud.

The second segment of the abdomen of the male (text-fig. 15) is narrower than the first. The third and fourth are separately rounded at the sides and about as broad as the first, the fourth being a little the longer. The fifth segment is rather more than half the breadth of the fourth and is only slightly constricted near its proximal end; at its narrowest point it is broader than long. The sixth segment is twice as broad as long and is a little wider than the fifth; the seventh is triangular, broader than long and rounded distally. The abdomen of the female (text-fig. 15) is much broader than that of the male but is comparatively narrow at the base; the fourth segment is the broadest; the seventh is triangular in shape and variable in its dimensions.

In the largest male the anterior breadth of the carapace is 7·7 mm., its breadth 5·1 mm. and the breadth of the front about 0·65 mm. In a large female these measurements are respectively 7·0, 4·7 and 0·6 mm.

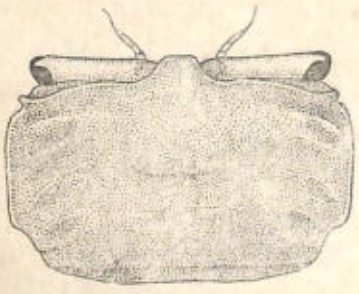
The specimens are of a bluish-grey colour in spirit.

$\frac{9796-7}{10}$ Karachi. C. R. Stevens; March, May, 1917. Twenty-eight.

One of the females is ovigerous. The types bear the number 9796/10, *Zool. Surv. Ind.*

Tympanomerus frater, sp. nov.

This species is very closely allied to the preceding and differs from it only in the following particulars:—



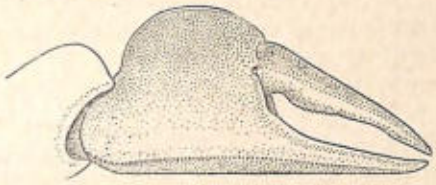
TEXT-FIG. 16.—*Tympanomerus frater*, sp. nov. Carapace.

(i) The carapace (text-fig. 16) is in most respects closely similar to that of *T. stevensi*; but the lateral borders are slightly and evenly convex, with the result that the breadth across the middle is decidedly greater than that between the outer orbital angles.

(ii) The front is very much broader, between one sixth and one seventh the anterior breadth; its lateral borders are a little convergent anteriorly, not constricted as in *T. stevensi*.

(iii) The upper orbital border is decidedly sinuous and is conspicuously concave in its outer half.

(iv) The oblique rows of tubercles on the branchial region are better developed than in the allied form and the most posterior of them is more transverse than longitudinal; if the line formed by this row were continued forwards it would cut the outer end of the orbital border on the opposite side.



TEXT-FIG. 17.—*Tympanomerus frater*, sp. nov. Chela of male.

(v) The chelae of the male (text-fig. 17) are strongly developed, much deeper and longer than those of the female.

(vi) In addition to those mentioned in the description of *T. stevensi* there is a large tympanum on the upper surface of the merus of the penultimate walking legs.

(vii) The borders of the meral segments of the walking legs are microscopically beaded, not spinulose as in the allied species.

(viii) There is no tomentum on the carpus and propodus of the second walking legs of the male.

(ix) A fringe of dark brown bristles, not found in the preceding species, occurs on the edge of the sternum between each pair of walking legs.

(x) The abdomen of the male closely resembles that of *T. stevensi*, but the fifth segment is proportionately a little longer and its sides are more sinuous.

In all other respects the species are in the closest agreement; notably in the presence of a groove extending from the edges of the buccal cavern to the base of the penultimate legs, in the carination of the palm and subspatulate form of the fingers, and in the dorsal carinae on the two intermediate pairs of legs. The two species were, moreover, found together

I was at first of the opinion that two forms of a single species were represented; but the differences, though many of them are small, are too numerous to admit of this possibility. I have been able to separate even the youngest specimens without any great difficulty and have seen adult males and females of both species.

In an adult male of *T. frater* the anterior breadth of the carapace is 5·6 mm., its length 4·0 mm. and the breadth of the front about 0·9 mm. In a female these measurements are respectively 5·0, 3·6 and 0·8 mm. and in another female, which is ovigerous, 5·0, 3·5 and 0·75 mm.

The specimens are of a bluish grey colour in spirit, sometimes rather darker than *T. stevensi*.

$\frac{9861-2}{10}$ Karachi. C. R. Stevens: March, May, 1917. Twenty-six.

Four of the females are ovigerous. The types bear the number 9861/10, *Zool. Surv. Ind.*

Tympanomerus stapletoni, de Man.

1908. *Tympanomerus stapletoni*, de Man, *Rec. Ind. Mus.* II, p. 212, pl. xviii, figs. 1, 1*a-e*.

This species has been found at a number of additional localities in Bengal and is quite common on the banks of the Hughli river at Calcutta. It is evidently an estuarine form and seems to occur only in places near or a little beyond the limit of tidal influence. At Calcutta the water of the Hughli is frequently quite fresh, but under favourable conditions a slight admixture of salt is to be found up to a point some little distance above the town.

The colour of living specimens agrees in general with de Man's description, but the carapace is frequently of a grey or dull grey-green colour and in the male the fingers of the chelae are orange and the last abdominal segment white.

The species is known only from the Gangetic delta:—

$\frac{5137}{10}$, $\frac{5851}{10}$	Jhalakati, Backergunj dist., Bengal.	H. E. Stapleton.	Many, including TYPES.[1]
$\frac{9298}{10}$	Kanaigunj, Backergunj dist., Bengal.	"	Six.
$\frac{9702}{10}$	Banks of Passur R., Khulna, Bengal.	Bengal Fish. Dept. (B. Prashad) and S. Kemp; Oct., 1917; July, 1918.	Forty.
$\frac{9703}{10}$	Banks of Hughli R., near Calcutta. (Sibpur, Shalimar, Budge-Budge and Takta Ghat.)	S. Kemp.	Many.

All the specimens are from small burrows in the mud between tide-marks.

Tympanomerus deschampsi, Rathbun.

1913. *Tympanomerus deschampsi*, Ratbbun, *Proc. U.S. Nat. Mus.* XLVI, p. 356, pl. xxxii, pl. xxxiii, fig. 1.

1918. *Tympanomerus deschampsi*, Kemp, *Mem. Asiat. Soc. Bengal* V, p. 228.

$\frac{9432}{10}$	Banks of Whangpoo R., 5-10 miles below Shanghai.	N. Annandale.	One.

Described by Miss Rathbun from Shanghai.

Tympanomerus lingulatus (Rathbun).

1909. *Cleistostoma lingulatum*, Rathbun, *Proc. Biol. Soc. Washington* XXII, p. 108.

1910. *Cleistostoma lingulatum*, Rathbun, *K. Danske Vidensk. Selsk. Skrift.* (7), *naturvid. og math.*, V, p. 323, text-figs. 7, 8.

This species was described by Miss Rathbun from an immature female found in the Gulf of Siam; two adult males and an ovigerous female have since been obtained by the R.I.M.S. 'Investigator' in the Mergui Archipelago.

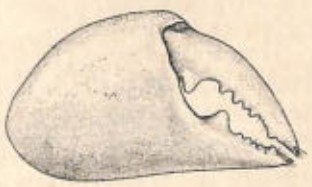
There is, I think, no doubt that the species must be transferred to the genus *Tympanomerus*. The antennular flagella are minute

[1] There seems to have been a mistake about the precise locality of these specimens; on the label sent with them to de Man "Dacca" was certainly written, but information subsequently supplied by the collector showed this to be incorrect.

and rudimentary, lying in small oblique pits close to the edge of the front and separated by a comparatively broad septum, as in *Tympanomerus pusillus* and other Scopimerinae. In the Macrophthalminae, to which the genus *Cleistostoma* belongs, the antennules are well developed, fold quite transversely, and the septum between them is very narrow. These characters constitute, so far as I am aware, the only really valid distinction between the subfamilies Macrophthalminae and Scopimerinae, for the tympana found in most species of the latter subfamily are ill-defined and occasionally absent in *Tympanomerus*. On comparing *T. lingulatus* with Alcock's *Cleistostoma dotilliforme* the differences in the antennules are quite evident.

The Mergui specimens of *T. lingulatus* agree very closely with Miss Rathbun's description, but her figure does not altogether succeed in conveying the characteristic appearance of the upper surface of the carapace. In the individuals I have seen the majority of the fine granules are aggregated into small clusters, varying a little in size and arrangement and each set with short dark brown bristles retaining mud. The carapace in specimens which have not been cleaned overmuch is, in consequence, seen to be covered with small furry patches, rather than with isolated granules as in Miss Rathbun's figure. The angle on the lateral margin of the carapace in front of its middle point is in reality more obtuse than in the figure, but it bears a setiferous patch which makes it look more prominent. The oval cavities above the edge of the front are very evident, the species differing in this character from any other known species of *Tympanomerus*. The prominent median tooth on the epistome is paralleled in *T. stevensi* and *T. frater*.

The chelipeds of the male are short. The carpus bears a strong tooth on its inner side as in *T. gangeticus* and *T. orientalis*; it is, however, much shorter than in those species, its upper surface being only about one and a half times as long as broad. Above the tooth on the inner side there are some long setae, while on the upper surface there are some short brown bristles. The palm is swollen and its height is fully as great as the length of the upper border (text-fig. 18). The outer side is smooth and convex; inferiorly it is rounded, without any traces of the longitudinal keels found in many species of the genus. The upper surface is finely granular with scattered setae. On the inner side there is a huge blunt ridge which commences near the posterior end of the upper border and curves downwards and forwards to the base of the fixed finger. The summit of the ridge is irregularly tuberculate and, in the area between it and the finger-cleft, there is a patch of long hairs.

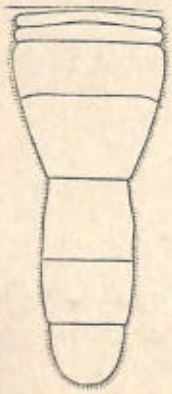


TEXT-FIG. 18.—*Tympanomerus lingulatus* (Rathbun). Chela of male.

The fingers are longer than the upper border of the palm and meet only at the apices where they are provided with corneous tips and some setae. The dactylus is strongly curved; it bears a large tooth close to the base and another, not quite so large, near the apex; between the two there are some smaller teeth. The dentition of the fixed finger is similar, the teeth being in advance of those on the dactylus; the proximal tooth is very large and conical. In the ovigerous female the chelipeds are as shown in Miss Rathbun's figure; the carpus, however, bears a small acute tooth on its inner side.

The meral segments of the walking legs bear thickly setose patches, resembling tubercles, as described by Miss Rathbun. In addition, the upper surfaces of the meri, carpi and propodi are rather closely covered with brownish hair in males, while in the same sex on the underside of each merus there is a thickly felted patch.

In the abdomen of the male (text-fig. 19) the suture between the third and fourth segments is exceedingly fine and inconspicuous, suggesting that the segments are not separably movable. The first and second segments are very short, and, though broad, do not nearly fill all the space between the last two pairs of legs. The second and third segments taken together are a little longer than broad with gently curved sides that converge strongly anteriorly. The fifth segment is about as long as its distal breadth, much narrower than the base of the third, and is very inconspicuously contracted at its proximal end. The sixth is broader than long and the seventh about as long as broad, with a broadly rounded apex.



TEXT-FIG. 19.—*Tympanomerus lingulatus* (Rathbun). Abdomen of male.

In the larger of the two males the greatest breadth of the carapace is 5·4 mm., its anterior breadth 4·8 mm. and its length about 4 0 mm. In the ovigerous female the greatest breadth is 5·2 mm.

T. lingulatus appears to find its nearest allies in *T. orientalis* (de Man) and *T. gangeticus*, sp. nov., agreeing with these species in the possession of a strong tooth at the inner angle of the wrist.

$\frac{21}{10}\frac{8}{8}^{0}$ Trotter I., Mergui Archipelago. 'Investigator.' Two males.
$\frac{22}{10}\frac{8}{8}^{0}$ Jack and Una Is., Mergui Archipelago. ,, One female.

The specimens were found in November 1913 on a shore composed of mud and sand with larger boulders. That described

by Miss Rathbun is from a mangrove swamp at Lem Ngob in the Gulf of Siam.

Tympanomerus orientalis (de Man).

1888. *Dioxippe orientalis*, de Man, *Journ. Linn. Soc., Zool.*, XXII. p. 138, pl. ix, figs. 8-10.
1900. *Tympanomerus orientalis*, Alcock, *Journ. Asiat. Soc. Bengal* LXIX. p. 371.

$\frac{8.1.0}{0}$ Mergui Archipelago. Mus. Collr. Seven. PARATYPES.

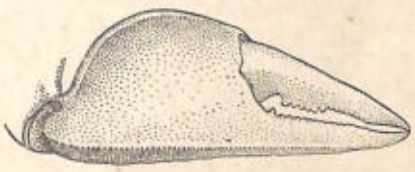
Not known from any other locality.

Tympanomerus gangeticus, sp. nov.

Plate XIII, fig. 3.

This species, which is represented only by two specimens one of which is imperfect, is very closely allied to de Man's *Tympanomerus orientalis*, resembling that species in the possession of a strong tooth on the inner face of the carpus of the chelipedes.

T. gangeticus differs from *T. orientalis* in only two conspicuous features:—(i) the lower border of the orbit shows no trace of the large obtuse lobe found near the outer end in de Man's species; (ii) the crest defining the lateral borders of the upper surface of the carapace is regularly convex behind the small anterior excavation, the upper surface being widest in front of the middle point. In *T. orientalis* the crest takes a sinuous course; it is distinctly concave anteriorly and is obtusely angled behind the middle, the upper surface being widest at this point.

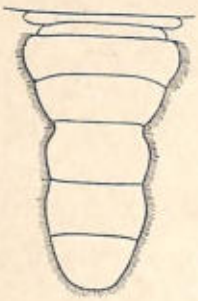


TEXT-FIG. 20.—*Tympanomerus gangeticus*, sp. nov. Chela of male.

In other respects the differences are small The front is a little broader, with its lateral angles more broadly rounded and its sides more oblique; its apex does not possess a median point. The median groove on the upper surface is deeper and the front when viewed from above is more conspicuously emarginate distally. There are numerous scattered setae on the lateral parts of the upper surface of the carapace. The buccal cavern is broader and the merus of the external maxillipeds is as broad as long (in *T. orientalis* it is longer than broad). The surface of the merus bears numerous very short setae.

The chelipeds are a little shorter: the length of the chela is considerably less than the anterior breadth of the carapace. The upper surface of the carpus is finely roughened and bears numerous minute granules antero-externally. The walking legs are a little shorter and stouter; the merus of the penultimate pair is less than two and three quarter times as long as wide, whereas in specimens

of *T. orientalis* of similar size it is rather more than three times. The carpi and propodi of the first two walking legs are thickly coated with short woolly hair.



Text-fig. 21.—*Tympanomerus gangeticus*, sp. nov. Abdomen of male.

The excavation in the lateral margin of the fifth abdominal segment of the male (text-fig. 21) is a little shallower and the distal parts of the same margin are less convergent anteriorly than in *T. orientalis*.

The carapace of the type male is 4·0 mm. in length and 5·3 mm. in anterior breadth. In life it was uniformly grey in colour, with white fingers to the chelae and with dark spots on the merus, carpus and propodus of the walking legs.

$\frac{97.84}{10}$	Kaikal Maree, near junction of Matlah and Biddah Rs., Gangetic delta.	S. Kemp; Dec., 1916.	One. Type.
$\frac{98.08}{10}$	Matlah R., opposite Port Canning, Gangetic delta.	Bengal Fish. Dept. (B. Prashad); March, 1918.	One.

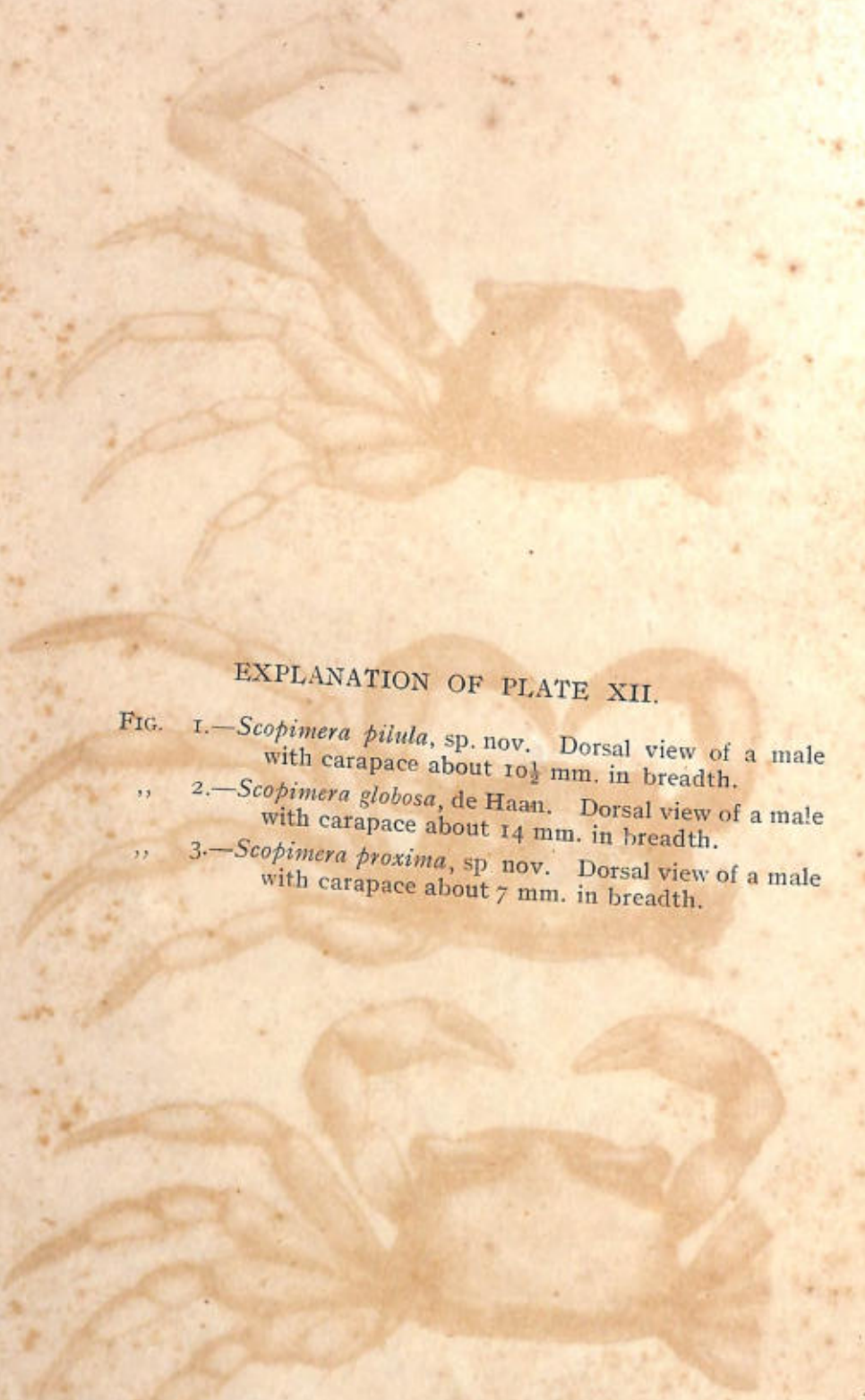
The water in both these localities probably contains some admixture of salt at all seasons. The specimens were found on banks of soft mud between tide-marks and the specific gravity of the water in the locality where the type specimen was taken was 1·0105 (corrected).

Tympanomerus ceratophora (Koelbel).

1898. *Dioxippe ceratophora*, Koelbel, in *Wiss. Ergebn. Reise Grafen Béla Széchenyi in Ostasien* II, p. 573, pl. i, figs. 8-12.

1918. *Tympanomerus ceratophora*, Tesch, *Decap. Brachyur. 'Siboga' Exped.* I, p. 50, pl. 2, fig. 2.

Hongkong (Koelbel); River near Pidjot, Lombok (Tesch).

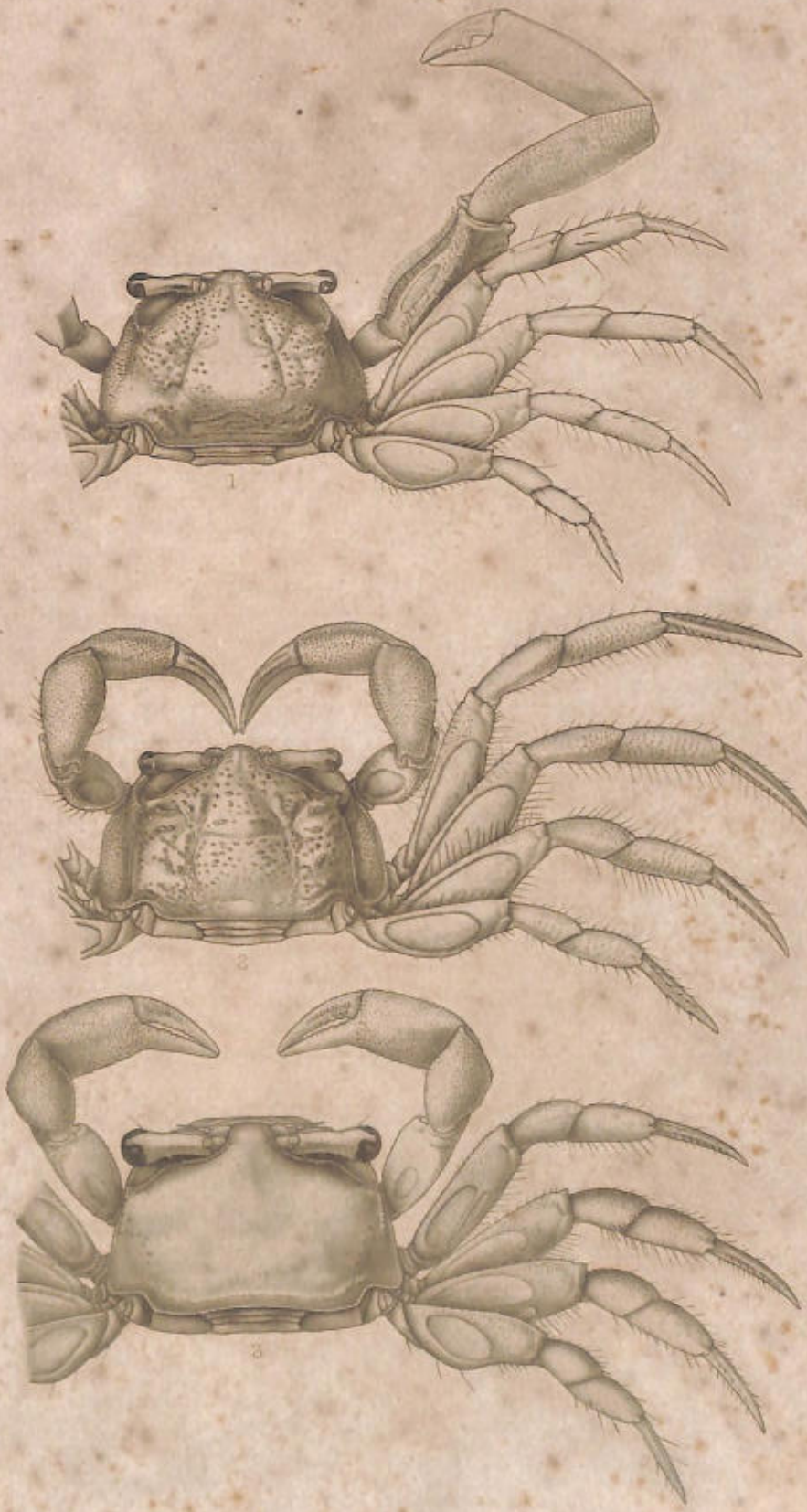


EXPLANATION OF PLATE XII.

FIG. 1.—*Scopimera pilula*, sp. nov. Dorsal view of a male with carapace about 10½ mm. in breadth.

,, 2.—*Scopimera globosa*, de Haan. Dorsal view of a male with carapace about 14 mm. in breadth.

,, 3.—*Scopimera proxima*, sp nov. Dorsal view of a male with carapace about 7 mm. in breadth.



SCOPIMERA.

EXPLANATION OF PLATE XIII.

Fig. 1.—*Dotillopsis brevitarsis* (de Man). Dorsal view of a male with carapace about 10½ mm. in breadth.

,, 2.—*Tympanomerus stevensi*, sp. nov. Dorsal view of a male with carapace about 7½ mm. in breadth.

,, 3.—*Tympanomerus gangeticus*, sp. nov. Dorsal view of a male with carapace about 5¼ mm. in breadth.

DOTILLOPSIS, TYMPANOMERUS.

XXIII. RHYNCHOTA FROM THE GARO HILLS, ASSAM.

By C. A. PAIVA, *Assistant, Zoological Survey of India.*

(Plates XXXIV–XXXVI).

[In this paper Mr. Paiva gives an account of a collection of Rhynchota (excluding the smaller Homoptera) made in the Garo Hills between June and October, 1917, by Mrs. Kemp and myself. The specimens were for the most part obtained in two localities: at Tura, the headquarters of the Garo Hills district, at an altitude of 1,200 to 1,500 ft., and on the summit of the ridge immediately above Tura at altitudes varying from 3,500 to 4,000 ft. Although these two localities are less than five miles distant from each other there are marked differences in the fauna. The differences are no doubt due mainly to the change in altitude, but may to some extent owe their origin to the different nature of the country in the two localities. In the neighbourhood of Tura the Garos have made extensive clearings for cultivation and the country consists of open land and low scrub interspersed by patches of ancient forest. On the range above Tura no cultivation has ever been attempted and the hills are entirely covered with high tree-jungle, often almost impenetrable in its density. As might be expected, it is from the latter region that the more interesting forms were obtained. Mr. Paiva has found in the collection a considerable number of forms hitherto known only from the Eastern Himalayas and has described as new two genera and eighteen species. Among the latter is a very curious cavernicolous Reduviid recently obtained by Mr. R. Friel, I.C.S., in the Siju Cave on the borders of the Garo Hills and Mymensingh districts.—*S. W. Kemp.*]

Family PENTATOMIDAE.

Cantao ocellatus (Thunb.).

Five specimens from above Tura, 15.vii–31.viii.1917; three specimens from Tura, 1,400 ft., x.1917.

Those collected in July and August are dark reddish ochraceous, while those collected in October are pale yellowish ochraceous in colour.

Found all over India.

Poecilocoris hardwickii (West.).

Two specimens from above Tura.
Common in the Hills of Assam.

Chrysocoris grandis (Thunb.) var. **baro** (Fab.).

One specimen from Tura, 1,200-1,500 ft., 15.vi–15.vii.1917; two specimens from above Tura.
Recorded from Skkim, Assam, Burma, extending to Java.

Chrysocoris stollii (Wolff).

One specimen from Tura, 1,400 ft., x.1917.
Universally distributed.

Chrysocoris pulchellus (Dall.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
This evidently rare species was originally described from Sylhet, Assam. A larger, but similarly marked, form comes from Ceylon. Hitherto the only specimen in the collection of the Zoological Survey of India was one from Trincomalee, Ceylon, collected, probably by Mr. E. E. Green, in November, 1906.

Chrysocoris garoensis, sp. nov.

Described from two specimens, one from Tura, 1,400 ft., x.1917 and one from above Tura.
Closely resembling *C. ornatus* (Dall.) from which it differs in the number and position of the spots on the scutellum and in the colour of the abdomen.
Head dark purplish with the apices of the lateral lobes bluish-green and in one specimen slightly purplish-red; antennae and rostrum black; pronotum purplish-red with the anterior margin shining green in the centre, eight bluish-black spots arranged three near anterior margin, three largest on disk of posterior area, and one at each posterior lateral angle; scutellum purplish-red with a spot at the centre of basal margin, one large, central, almost rounded spot on disk and six spots arranged in pairs, bluish-black, a distinct callosity at base of scutellum; pronotum with a fine, short, central, longitudinal carina on disk, extending from the centre of the middle anterior spot to about the middle of the central posterior spot; scutellum with a distinct, central, longitudinal carina extending through the centre of the large discal spot, this carina is connected with the basal spot of the scutellum by a fine bluish-black line; underside of head purplish, appearing bright green in certain lights; sternum bluish-black; abdomen beneath pale ochraceous with a small basal and a large apical spot black, stigmatal spots rounded, bluish, lateral margins bright orange; legs purplish.

Length 15 millim., breadth between pronotal angles 8·9 millim.

Type No. 8368/H1 in the collection of the Zoological Survey of India.

Lamprocoris lateralis (Guer.).

Three specimens from above Tura.
Not uncommon in the hills of Assam and Burma.

Lamprocoris roylii (West.).

Five specimens from above Tura.
Recorded from Nepal, E. Himalayas and hills of Assam.

Hotea curculionoides (Herr.-Sch.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
India, Burma and Ceylon.

Aspidestrophus morio, Stål.

One specimen from above Tura.
The genus *Aspidestrophus* was not hitherto represented in the collection of the Zoological Survey of India and was recorded only from the Naga Hills, Assam and Java.

Cydnus varians, Fab.

One specimen from above Tura.
A fairly common species.

Macroscytus subaeneus (Dall.).

One specimen from Tura, 1,400 ft., x.1917.
Found all over India and Burma.

Dalpada oculata (Fabr.).

One specimen from Tura, 1,400 ft., x.1917 and two from above Tura.
Common in Assam.

Dalpada jugatoria, Leth.

One specimen from Tura, 1,200-1,500 ft., 15.vi–15.vii.1917.
Recorded from Sikkim, Assam and Burma.

Dalpada varia, Dall.

One specimen from above Tura.
Found in Bhutan and Assam.

Nevisanus nagaensis, Dist.

Four specimens from above Tura, "common on tree-trunks. *S. W. K.*"

This species was not previously represented in the collection of the Zoological Survey of India and was known only from the Naga Hills.

Ochrophara montana, Dist.

Two specimens from above Tura.

The only other specimens in the collection of the Zoological Survey of India are those from Chanda, Central Provinces, about which there is an interesting note on the damage they do to bamboo seed crops, in Vol. I, p. 147 of the "Fauna of British India, Rhynchota."

Recorded also from the Naga Hills and Burma.

Cappaea taprobanensis (Dall.).

Three specimens from above Tura.

Recorded from Sikkim, N. Khasi Hills, Assam, S. India and Ceylon.

Tolumnia latipes (Dall.).

One specimen from Tura, 1,200-1,500 ft., x.1917.

Found in Sikkim, Hills of Assam, Trivandrum and Burma.

Aeschrocoris obscurus (Dall.).

Seven specimens from above Tura.

As widely distributed as the preceding species.

Eusarcocoris montivagus, Dist.

Five specimens from above Tura, 15.vii–31.viii and ix.1917.

Same distribution as the two preceding species.

Carbula crassiventris (Dall.).

Three specimens from above Tura.

This species was not previously represented in the collection of the Zoological Survey of India.

Bhutan, Naga Hills, Assam and Burma.

Hoplistodera virescens, Dall.

One specimen from above Tura.

Recorded from Sikkim, Naga Hills and Burma.

Antestia pulchra (Dall.).

Five specimens from above Tura, 15.vii–31.viii and ix.1917.

Found in Sikkim and Burma.

Exithemus similis, sp. nov.

One specimen from above Tura, IX.1917.

Resembling *E. assamensis* but differing from it in the absence of the linear, levigate fascia on the anterior area of the pronotum and head ; the scutellum is not paler in hue on its central disk, but is concolourous and evenly punctured throughout and has two small, almost contiguous, black spots near the centre of disk ; the abdomen is pale yellowish ochraceous and the black fascia on the lateral area is less distinct, and extends to the apex of the fifth abdominal segment, a large, longitudinal, black fascia occupies the centre of the remaining apical segments ; there is no large, black spot on the femora beneath a little before the apex, the apices of the tibiae and tarsi are brownish ochraceous ; the antennae are pale ochraceous with the apices of the second and third joints narrowly, and the apical halves of the fourth and fifth joints brownish-black.

Length 12 millim.; breadth between pronotal angles 7·5 millim.

Type No. 8369/H1 in the collection of the Zoological Survey of India.

Compastes bhutanicus (Dall.).

Four specimens from above Tura.
Recorded from Bhutan, Sikkim, Assam and Burma.

Priassus exemptus (Walk.).

One specimen from above Tura.
Known from the Naga Hills and Tenasserim.

Rhynchocoris humeralis (Thunb.).

One specimen from Tura, 1,400 ft., x.1917 and one specimen from above Tura.
Recorded from Sikkim, Assam and Burma.

Catacanthus incarnatus (Dru.).

One specimen from Tura, 1,200-1,500ft., 15.vi–15.vii.1917.
Almost universally distributed.

Nezara viridula (Linn.).

One specimen from above Tura.
Common all over India, Burma and Ceylon.

Menida varipennis (West.).

Three specimens from above Tura, 15.vii–31.viii and ix.1917; occurring in Sikkim, Khasi Hills and Tenasserim.

Menida histrio (Fabr.).

One specimen from above Tura.

At present recorded only from Calcutta, Bangalore and Burma.

Cecyrina platyrhinoides, Walk.

Three specimens from above Tura.

In these specimens the dark brown ochraceous colour given by Walker in his description of the species is replaced by shining black, the pale ochraceous and pale luteous markings on the various parts of the body are present but are less distinct; in one specimen, probably a male, the femora of all the legs and the intermediate and posterior tibiae are medially banded with red; the second and third joints of the rostrum are also red.

This species is apparently confined to Assam. It was not previously represented in the collection of the Zoological Survey of India.

Cazira verrucosa (Westw.).

Two specimens from above Tura, ix.17, and one from Tura, 1,400 ft., x.1917.

Found all over India and Burma.

Picromerus obtusus, Walk.

Four specimens from above Tura.

Recorded from Sikkim, Naga Hills, Assam and Burma.

Eusthenes rubefactus, Dist.

Two males and two females from Tura, 1,200-1,500 ft., 15.vi–15.vii.1917; also one specimen from above Tura.

The latter is dark brown above and pale ochraceous on the underside and legs. It is partly deformed, the lateral margins of the pronotum being asymmetrical. This is evidently an immature male.

A common Assamese species.

Pycanum ochraceum, Dist.

Two specimens from above Tura.

Recorded from Sikkim, Assam and Burma.

Dalcantha dilatata, Amy. and Serv.

Three specimens from above Tura.

Probably only known from Assam.

Cyclopelta siccifolia (Westw.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.

Found all over India, Burma and Ceylon.

Aspongopus chinensis, Dall.

Three specimens from above Tura.
Common in Sikkim and Assam.

Megymenum parallelum, Voll.

One specimen from above Tura.
Recorded from Sikkim, Assam and the Andamans.

Eumenotes obscura, West.

One specimen from above Tura.
Previously recorded from Sikkim and Burma.

Gonopsis coccinea (Walk.).

One specimen from above Tura, ix.1917.
Recorded from Sikkim, Assam and Burma.

Sastragala heterospila (Walk.).

One specimen from above Tura, ix.1917.
This species was not previously represented in the collection of the Zoological Survey of India.
Recorded from the Western Himalayas and the Nilgiris. Apparently very widely distributed.

Sastragala trilineata, sp. nov.

Pl. xxxiv, fig. 1.

Described from a single specimen from above Tura.
Head ochraceous with four longitudinal series of punctures, two discal and two marginal, two small, triangular, black spots on basal margin, antennae pale ochraceous with the fourth and fifth joints slightly fuscous ; rostrum luteous, its apex black ; pronotum ochraceous, coarsely but sparingly punctured, anterior area levigate a little behind the anterior margin, posterior lateral angles spinously produced, acute, the spines dark castaneous, between the posterior lateral angles a broad castaneous fascia occupies the basal portion of the pronotum, and on the middle of the fascia there are three pale ochraceous, longitudinal fasciae, giving the central area a paler appearance; sternum pale ochraceous ; scutellum light brownish on the basal area, the apical half luteous with a pale fuscous transverse band just before the apex ; extreme basal angles black, the basal area and the apical half sparingly but strongly punctured ; corium luteous, irregularly punctured with a few dark castaneous punctures which are most dense on the disk and at the apical angle ; connexivum ochraceous, marked with black at the segmental angles ; the apex of

the sixth abdominal segment broadly black; underside of abdomen and the legs pale ochraceous, the latter with the apices of the femora, tibiae and tarsi pale fuscous.

Length 7 millim., breadth between pronotal angles 4·5 millim.

Type No. 8370/H1 in the collection of the Zoological Survey of India.

Elasmostethus nebulosum, Dist.

Two specimens from above Tura.
Hitherto known only from the Naga Hills.

Elasmostethus truncatulum (Wa'k.).

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917, and two from above Tura.

This and the preceding species were not previously represented in the collection of the Zoological Survey of India.

Recorded from Darjiling and Sibsagar, Assam.

Family COREIDAE.

Helcomeria spinosa (Sign.).

One mature and one immature specimen from above Tura, 2,500 and 3,900 ft., respectively, 15.vii–31.viii.1917.

Recorded from Sikkim and Assam.

Elasmomia granulipes (Westw.).

One specimen from above Tura.
Recorded from Sikkim.

Mictis tenebrosa (Fabr.).

Two specimens from above Tura.
Occurring in Sikkim, the Khasi Hills, Assam and Burma.

Mictis gallina, Dall.

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Recorded from Burma.

Homoeocerus subjectus, Walk.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917 and one specimen from above Tura.

Within our limits, known only from Assam.

Homoeocerus simiolus, Dist.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Recorded from Sikkim, Assam and Burma.

Homoeocerus concisus, Walk., var. *a*.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Recorded from Sikkim and Burma.

Cloresmus antennatus, Dist.

One specimen from above Tura, 3,500–3,900 ft., ix.1917.
This specimen agrees in every respect with Distant's description of the species, but it is much larger, being 16 millim. in length.
Hitherto known only from Sikkim.

Colpura erebus, Dist.

Three specimens from above Tura
Recorded from Sikkim and the Naga Hills.

Colpura funebris, Dist.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Recorded from Sikkim and Assam.

Colpura sulcata, sp. nov.

Pl. xxxvi, fig. 1.

Described from one specimen from above Tura.
Black with ochraceous and reddish ochraceous markings, and some very fine, short, golden hairs above and beneath; extreme base of first joint and the apical joint of the antennae (excluding base), the ocelli, tubercles behind eyes, two lateral spots on basal margin of head, anterior, lateral and posterior margins of pronotum, two irregularly shaped marks on disk and a short longitudinal line on posterior margin of pronotum, apex of scutellum and costal margin of corium, reddish ochraceous; annulations to femora and tibiae of all the legs, those on the posterior femora very broad, veins on the basal area of membrane, transverse linear fasciae at incisures of connexivum, the apex of the first joint and the bases of the second, third and fourth joints of the rostrum ochraceous; some black spots on the pale areas of the femora; a lateral series of segmental spots and four spots at base of abdomen beneath dull black, those on the fifth, sixth and seventh segments larger and more distinct; membrane with a few irregular greyish marks; corium brownish ochraceous with a large dull black spot near inner angle followed by a small, indistinct ochraceous spot; pronotum with its margins slightly reflexed, two short, oblique pits or depressions on centre of anterior area and a shallow longitudinal discal sulcation which extends to the basal area; rostrum very long, extending to the apical margin of the fourth abdominal segment, first joint passing base of head,

shorter than any of the remaining joints, which are subequal, a somewhat deep, longitudinal sulcation on disk of abdomen beneath extending to the apical margin of the sixth segment.

Length 16·5 millim., breadth between pronotal angles 5 millim.

Type No. 8371/H1 in the collection of the Zoological Survey of India.

Hygia touchei (Dist.) var.

Three specimens from above Tura.

These specimens differ from the typical form in being black instead of piceous brown; the legs are entirely black with no ochraceous markings.

Recorded from Sikkim.

Dasynus relatus, sp. nov.

Described from three specimens from above Tura.

Brownish ochraceous, thickly and darkly punctate; corium purplish; membrane fuscous brown, its basal angle darker; antennae black, the apical joint ochraceous with the base narrowly black; legs and underside ochraceous; antennae with the first joint slightly incrassated towards apex, first and second joints equally long, longer than the third and fourth, which are subequal; head a little longer than breadth between eyes, with a few minute scattered black punctures, which are most dense in a central longitudinal groove situated between the ocelli; apex of head broad, pale ochraceous; rostrum ochraceous, its extreme apex black, extending to base of mesosternum; pronotum densely punctate, the lateral margins narrowly black, posterior pronotal angles prominent, obtusely angulate and slightly recurved, disk of pronotum with a pale, faint, central, longitudinal carina, posterior marginal area of pronotum with a somewhat deep, transverse sulcation; scutellum brownish ochraceous, its apex pale and impunctate, the anterior area deeply punctured, transversely rugulose; coriaceous portion of hemelytra blackly punctate, outer portion of corium purplish, remainder brownish ochraceous, costal margin of corium ochraceous; abdomen above reddish ochraceous, the lateral margins of the sixth and the greater part of the apical two segments dull black; connexivum ochraceous; a small black spot on the lateral areas of the meso- and metasterna and a similar spot near the middle of the lateral areas of the second, third, fourth and fifth abdominal segments below.

Length 17-21 millim., breadth between pronotal angles 6-8 millim.

Type No. 8372/H1 in the collection of the Zoological Survey of India.

Cletus punctulatus (Westw.).

One specimen from above Tura.

Recorded from Sikkim and the hills of Assam.

Cletus bipunctatus (West.).

One specimen from above Tura.
Common throughout India, Burma and Ceylon.

Cletus punctiger (Dall.).

One specimen from Tura, 1,200–1,500 ft., vii–viii.1917 and two from above Tura.
Recorded from Murree; Bengal and Burma.

Cletomorpha raja, Dist.

Two specimens from above Tura.
Recorded from Sikkim, Assam and Burma.

Riptortus linearis (Fab.).

Three specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Distributed throughout India, Burma and Ceylon.

Serinetha abdominalis (Fab.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Apparently a common Indian species.

Family LYGAEIDAE.

Graptostethus trisignatus, Dist.

Two specimens from Tura, 1,400 ft., x.1917 and five from above Tura.
Recorded from the Assam Hills and Burma.

Nysius ceylanicus (Motsch.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
A very common and widely distributed species.

Ninus turaensis, sp. nov.

Described from a single carded specimen from above Tura.

Head dark, clothed with fine white pubescence; eyes very dark purplish-red; antennae ochraceous, the basal and apical joints darker in hue, first joint stout, shortest, second longest, third and fourth joints much shorter than second, subequal, fourth incrassated; pronotum brownish, densely pubescent on anterior area, the brown colouration on the posterior area in the shape of the letter **M**; scutellum, clavus and base of corium clothed with white pubescence, a spot at the apex of clavus near the inner angle of corium, a small linear mark near outer margin of corium a

little beyond base and the apex dark castaneous, a small impunctate, hyaline depression near apical area of clavus and a larger similar depression on disk of corium near the inner angle; membrane hyaline; legs ochraceous, claws of tarsi black.

Length excluding membrane 2·5 millim.

Type No. 8375/H1 in the collection of the Zoological Survey of India.

Macropes excavatus, Dist.

Four specimens from above Tura.
Known only from Shillong, Assam.

Malcus scutellatus, Dist.

Three specimens from above Tura.
Recorded from Assam, Sikkim and Ceylon.

Nerthus kempi, sp. nov.

Pl. xxxvi, fig. 2.

Described from one carded specimen from above Tura.

Shining black, elongate. Base of first joint of antennae, basal margin of pronotum, central longitudinal fascia on apical area of scutellum not extending to base, basal marginal area of first and third segments of connexivum, basal third of intermediate and posterior femora, and a more or less distinct central annulation to posterior tibiae, yellowish ochraceous; clavus brownish ochraceous, with the scutellar margin black, and two longitudinal series of black punctures on marginal areas; basal half of corium semi-hyaline, its veins, costal margin and the apical area broadly black; membrane shining, bronzy; head, pronotum, scutellum and sternum densely punctured, the pale areas on the pronotum and scutellum almost impunctate, a small, foveate depression at the centre of the basal margin of scutellum; femora slightly incrassate, antennae with the first joint very short, second joint longest, third longer than fourth.

Length 11 millim., breadth between pronotal angles 3 millim.

The colour of the corium, connexivum and legs distinguishes this species from *N. dudgeoni*, Dist.

Type No. 8376/H1 in the collection of the Zoological Survey of India.

Vertomannus capitatus, Dist.

Four specimens from above Tura.

Recorded from Assam and Burma and represented in the collection of the Zoological Survey of India from the Darjiling district.

Paromius exiguus (Dist.).

One specimen from above Tura.
Apparently widely distributed.

Pamera pallicornis (Dall.).

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.viii.1917.
Recorded from Assam, Sikkim, Burma and Shillong.

Pamera vincta, Say.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.viii.1917.
Universally distributed.

Dieuches uniguttatus (Thunb.).

One specimen from Tura.
A very common and widely distributed species.

Family PYRRHOCORIDAE.

Lohita grandis (Gray).

Four specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917, and two from above Tura.
A fairly common species, also found in the plains.

Physopelta gutta (Burm.).

Four specimens from above Tura.
Common in the Darjiling district. Recorded from Assam, Burma and Ceylon.

Ectatops gelanor, Kirk. and Edw.

One specimen from Tura, 1400 ft., x.1917.
This species was not previously represented in the collection of the Zoological Survey of India.
Recorded only from Karenee, Burma.

Dindymus lanius, Stål.

Five specimens from above Tura.
Recorded from the Naga and Khasi Hills, Assam, and Burma.

Dindymus rubiginosus (Fabr.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
A common species in Assam. Occurring also in Malabar and Burma.

Pyrrhopeplus posthumus, Horv.

One specimen from above Tura,
Recorded from Sikkim, Assam and Burma.

Family ARADIDAE.

Mezira membranacea (Fabr.).

Three specimens from above Tura.
An abundant species.

Neuroctenus affinis, Dist.

Two specimens from above Tura.
Not previously known to occur in Assam.

Family HYDROMETRIDAE.

Rhagovelia nigricans (Burm.).

Two specimens in alcohol, one from Tura, 1,200–1,500 ft., vi–vii.17 and another from the Ganool R., Damalgiri, Garo Hills, viii.17.

Recorded from the Southern Palaearctic Region and the Mascarene Is.

Microvelia lineatipes, sp. nov.

Pl. xxxiv, fig. 2.

Described from four carded specimens from Damalgiri, Garo Hills, ix.1917.

Head and pronotum piceous; lateral margins of head and greater part of pronotum with silvery grey pubescence; a fine, central, longitudinal sulcation extending from near base of head to apex; antennae castaneous, second joint longest, remaining joints subequal; a short, pale reddish ochraceous fascia near anterior margin of pronotum medially interrupted with black, some long black hairs near anterior lateral pronotal margins, lateral angles prominent; hemelytra fuscous, a long streak sometimes broken near inner margin of clavus, another on basal area of corium, three spots inconstant in size placed transversely across the middle of membrane, a long streak, sometimes broken up into spots, near inner margin and a somewhat elongate spot at the middle of apical area of membrane greyish-white; legs ochraceous, apical half of claw joint of all the tarsi, apices of fore tibiae and a longitudinal streak on the anterior part of all the femora, inwardly black, femora and tibiae of the legs hairy; underside dull black, densely pubescent, a spot beneath lateral pronotal angles and the connexivum beneath dark reddish ochraceous.

Length 2·3 to 2·5 millim.

Type No. 8377/H1 in the collection of the Zoological Survey of India.

Microvelia atromaculata, sp. nov.

Pl. xxxiv, fig. 3.

Described from five carded specimens from Damalgiri, Garo Hills, ix.1917.

Head and pronotum dull black; apex of head, anterior margin and posterior portion of lateral angles of pronotum, reddish ochraceous; lateral margins of head and anterior area of pronotum greyishly pubescent; antennae ochraceous, apices of first and second joints and the whole of the fourth joint fuscous, second joint shortest, fourth longest, first and third subequal in length, third joint very slender; pronotum with a transverse patch produced narrowly backwards but not reaching basal margin, situated immediately behind the ochraceous fascia on anterior margin and two almost contiguous spots at basal angle jet black; hemelytra pale brownish, a longitudinal streak on clavus connected with a small spot at basal angle of corium, a large spot on disk of corium, a large, furcate mark near base of membrane, a rounded spot near apical angle of corium, a series of linear spots on inner margin and a large subrectangular spot on apical area of membrane greyish white; legs pale ochraceous, apices of tibiae and tarsi infuscate; underside black, greyishly pubescent.

Length 1·75 millim.

Type No. 8378/H1 in the collection of the Zoological Survey of India.

Perittopus maculatus, sp. nov.

Pl. xxxiv, fig. 4.

Described from six carded specimens from above Tura, Garo Hills, 3,500–3,900 ft., 15.vii–31.viii.1917. Also found in a well in dense jungle above Tura, 3,800 ft., 15.vii–31.viii.17.

Macropterous form —Bright reddish ochraceous, with a large patch on each antero-lateral margin of pronotum black; the entire insect covered with erect hairs, those on the disk of the pronotum very short; head globosely arched, almost perpendicularly deflected anteriorly, a short longitudinal sulcation between eyes; antennae shining black, inserted below the eyes on a level with the clypeus, first joint stout, curved outwards, longer than any of the remaining joints, second and fourth subequal, slightly longer than the third, first three joints with long black hairs on inner margins; pronotum about as long as broad, lateral margins strongly sinuate, lateral angles broadly prominent, basal angle subangulate, disk moderately raised, minutely punctured, anterior margin depressed behind head, the whole surface covered with hairs which are most conspicuous on the lateral areas; hemelytra reddish-brown, with the claval margins and the basal and apical margins of corium black, clothed with short greyish hairs; membrane dusky grey, body beneath bright ochraceous, an irregular lateral fascia extending from the metasternum to the sixth abdominal segment black; legs bronzy black, coxae, trochanters, anterior femora and the bases of the intermediate and posterior femora pale ochraceous.

Apterous form.—Similar in colour to the macropterous form; lateral and basal angles of pronotum rounded; a slight transverse impression between the anterior and posterior lobes of the pro-

notum; the black patch on the antero-lateral area more distinct and rounded; pronotum not so long as in the macropterous form; abdomen above black as far as the sixth visible segment, remaining segments bright reddish ochraceous, the entire surface very hairy.

Length 2 millim.

Type No. 8379/H1 in the collection of the Zoological Survey of India.

Gerris (Limnogonus) tristan, Kirk.

A single specimen from a stream in dense jungle above Tura, 3,800 ft., 15.vii–31.viii.1917.

A very common and widely distributed species.

Chimarrhometra orientalis (Distant).

1879. *Halobates? orientalis*, Distant, *Trans. Ent. Soc. Lond.*, p. 126.
1879. ,, ,, *Id.* (gen. ?) *Sec. Yark. Miss., Rhyn.*, p. 12, ff. 11, 12.
1896. *Chimarrhometra orientalis*, Bianchi, *Annuaire Mus. St. Pétersb.*, p. 71.
1904. ,, ,, Distant, *Fauna Brit. Ind. Rhy.*, II, p. 190.
1908. *Rheumatotrechus himalayanus*, Kirkaldy, *Canad. Ent.*, XL, p. 452.
1910. *Gerris monticola*, Distant, *Ann. Mag. Nat. Hist.* (8) V, p. 141.
1910. ,, ,, *Id., Fauna Brit. Ind. Rhy.*, V (Appendix), p. 142.
1910. *Rheumatotrechus himalayanus*, Kirk., Distant, *Fauna Brit. Ind. Rhy.*, V (Appendix), p. 151.

One winged and five apterous females from the same locality as the preceding species.

The generic position of this species is doubtful. It has evidently been described under various generic and specific names by different authors. Distant himself has described it under two different genera. He based his original description on the structural character of the basal joint of the anterior tarsi but there appears to be a misunderstanding on this point. The male genitalia form a very good character for distinguishing the genus. Distant's description of *Gerris monticola* was taken from a macropterous female, while that of *Halobates? orientalis* was taken from an apterous male. We have in the collection of the Zoological Survey of India the type of *Halobates? orientalis* as well as the co-types of *Gerris monticola*. There is no doubt that Kirkaldy's species is the same as *G. orientalis*. It is common in Himalayan streams.

Eotrechus kalidasa, Kirk.

One apterous specimen from above Tura.

This species was not hitherto represented in the collection of the Zoological Survey of India. I have no doubt that the specimen is specifically identical with the winged form described from Karenee, Burma, by Distant.

Ptilomera laticaudata (Hardw.).

Four apterous specimens from Tura, 1,200-1,500 ft., 15.vi—15.vii.1917.

Genus **Metrocoropsis**, nov.

Type: *Metrocoropsis femorata*, Paiva.

Distribution: Assam, Garo Hills.

Head subquadrate, as long as broad at base; lateral margins strongly concavely sinuate at junction of eyes, apical and basal margins convex; antennae four-jointed, first joint longest, almost as long as the remaining three together, third joint shortest; eyes large, posteriorly extending over the lateral angles of the pronotum; pronotum much longer than broad; hemelytra passing abdominal apex; anterior legs very robust in male, anterior femora much incrassated with two distinct teeth situated on the underside, one a little beyond middle and the other near apex, anterior tibiae almost as long as anterior femora, much stouter than the tibiae of the other legs, anterior tarsi with the basal joint much smaller than the second joint; intermediate and posterior legs very long; in the female the anterior femora are simple.

Allied to *Metrocoris*, but differing in the presence of the teeth on the anterior femora.

Metrocoropsis femorata, sp. nov.

Pl. xxxiv, fig. 5.

Described from five specimens from a stream in dense jungle, above Tura, 3,800 ft., 15.vii–31.viii.1917.

Head, pronotum, underside and legs ochraceous; antennae (excluding base of the first joint), a large patch on head between eyes, anterior and lateral margins of pronotum (excluding anterior angles), a central longitudinal fascia to pronotum extending from anterior margin to a little before basal angle, a broad curved fascia on each side of the central one, in some cases united anteriorly a little before middle, but not reaching basal angle, a few linear marks on intermediate and posterior acetabula, four longitudinal fasciae on anterior femora, the uppermost widest, the anterior tibiae and tarsi and two small rounded spots at the bases of the intermediate and posterior femora black; intermediate and posterior legs fuscous brown.

Length including membrane 8·5 millim.

This species resembles *Metrocoris nigrofasciatus* very closely, but is easily separated from it by the markings on the pronotum and the anterior femora, etc.

Type No. 8381/H1 in the collection of the Zoological Survey of India.

Family REDUVIIDAE.

Myiophanes greeni, Dist.

One specimen from Tura, 1,400 ft., x.1917.

Not previously represented in the collection of the Zoological Survey of India.

Recorded only from Ceylon.

Bagauda cavernicola, sp. nov.

Pl. xxxvi, fig. 3.

Six specimens in alcohol from the Siju Cave, Garo Hills, Assam, xi.1917 (*R. Friel*).

Castaneous brown; constricted area of pronotum extending to the anterior half of the posterior lobe, a large rounded spot on corium at base of membrane, bases of anterior coxae, apical halves of anterior femora, the anterior tibiae (excluding base and apex), prosternum, a spot on the disks of meso- and metasterna, intermediate and posterior coxae, apices of intermediate and posterior femora, bases of intermediate and posterior tibiae creamy white; abdomen beneath paler than above; membrane pale fuliginous; other structural characters as in *B. splendens*, Dist. Antennae mutilated in type specimen.

Length excluding membrane 16 millim.

Type No. 8547/H1 in the collection of the Zoological Survey of India.

Apocaucus laneus, Dist.

One specimen from above Tura.

Hitherto known only from Kurseong, Darjiling district, E. Himalayas.

Canthesancus gulo, Stål.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917 and two from above Tura.

Recorded from Sikkim, Assam and Burma.

Valentia apetala (de Vuill.).

Three specimens from Tura, 1,200–1,500 ft., 15 vi–15.vii.1917

Known only from Sylhet, Assam.

Valentia compressipes, Stål.

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.

Recorded from Burma.

Psophis erythraea, Stål.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917 and two from above Tura.

Not previously represented in the collection of the Zoological Survey of India. Recorded from North India.

Centrocnemis ståli, Reut.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917 and three found on a dead tree above Tura, 3,000 ft.
Recorded from Darjiling district, E. Himalayas and Assam.

Epirodera impexa, Dist.

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Not previously represented in the collection of the Zoological Survey of India.
Hitherto known only from Burma.

Acanthaspis helluo, Stål.

Three specimens from above Tura.
Apparently confined to Assam.

Scadra fuscicrus, Stål.

Three specimens from above Tura.
Recorded from Burma and Ceylon.

Scadra castanea, sp. nov.

Pl. xxxv, fig. 1.

Described from two specimens from above Tura.

Head light brown, collar, pronotum, scutellum and legs castaneous; antennae black, longly pilose, the base of the first joint pale ochraceous; pronotum shining, glabrous, constricted a little before the middle, a deep, central longitudinal furrow extending from the anterior margin to a little beyond the middle of the posterior lobe, a longitudinal depression on each lateral area of the posterior lobe extending from the impression at the constriction to the posterior basal margin, with the exception of the central longitudinal furrow, the other furrows on the pronotum are transversely impressed; scutellum strongly depressed on disk, the apical spines curved inwards; hemelytra dull black, the basal angle of the corium and a small triangular patch on its apical margin ochraceous, sometimes tinged with red; connexivum dilated, obliquely reflexed, marked alternately with orange yellow and black; sternum black; abdomen beneath black, centrally carinate, a pale ochraceous line on the middle of the apical margins of the first three basal segments, and a greenish-yellow patch on the basal lateral angles of the second, third, fourth and fifth segments; legs with the coxae, trochanters, apices of the femora broadly, bases and apices of the tibiae and the tarsi ochraceous.

Length 13·5 millim.

Type No. 8382/H1 in the collection of the Zoological Survey of India.

Genus **Paralibavius**, nov.

Type: *P. singularis*, Paiva.

Distribution: Assam, Garo Hills,

Head deflected in front of eyes, its apex acuminate, central lobe tuberculous, eyes large, postocular area tumid, distinctly narrowed behind, forming a short cylindrical collar; antennae 7-jointed, inserted nearer the eyes than the apex, first joint long, passing apex of head, about as long as head, its apex incrassated, second joint longer than first, the remainder smaller and slender; pronotum slightly, transversely constricted before middle, centrally, longitudinally impressed, the impression not reaching the basal margin, anterior lobe tumid, faintly sculptured on disk, minutely tuberculous on lateral areas, posterior lobe with a shallow impression on each lateral area, where it is transversely striate; scutellum with three spinous angulations, the outer ones curved inwards, the central about two-thirds as long as the outer, disk with a large depression; hemelytra about reaching apex of abdomen; abdomen a little broader than hemelytra; a strong, acute spine at the posterior angle of each segment of the connexivum; femora slightly incrassated towards apex, two rows of minute, tuberculous spines on the underside of the femora and tibiae of all the legs, anterior tibia with a short spongy furrow at apex.

Readily distinguished from the other genera of the Ectrichodiinae by the spinous projections of the connexivum.

Paralibavius singularis, sp. nov.

Pl. xxxv, fig. 2.

Described from a perfect specimen from above Tura.

Head, anterior lobe and lateral margins of posterior lobe of pronotum, base and lateral margin of corium and connexivum pale reddish ochraceous; antennae black, extreme base of first joint ochraceous; disk of posterior lobe of pronotum, scutellum and legs castaneous; membrane dull black;

Length 8 millim.

Type No. 8384/H1 in the collection of the Zoological Survey of India.

Ectrychotes relatus, sp. nov.

Pl. xxxv, fig. 3.

Three specimens from Tura, 1,200–1,500 ft. 15.vi–15.vii.1917 and three from above Tura.

Head, lateral margins of posterior pronotal lobe, scutellum, bases of clavus and corium, connexivum and legs reddish testa-

ceous; antennae longly pilose, black, first joint brown, its extreme base pale ochraceous; pronotum, excluding the posterior lateral margins, and base of scutellum cupreous; hemelytra black, a very deep black patch on clavus and disk of corium, the lateral margins and the apical area of corium reddish-black; connexivum marked with black on the third, fourth, fifth and sixth segments; sternum blackish; abdomen beneath reddish ochraceous, with the segmental sutures and large, lateral patches on each segment united to form a broad band, black; apices of the anterior and intermediate tibiae black; anterior and intermediate femora very faintly, and the posterior femora very distinctly, annulated with black at about middle; a narrow black annulation near base of posterior tibiae.

Length 13 millim.

Type No. 8385/H1 in the collection of the Zoological Survey of India.

Closely resembling *E. cupreus*.

Vilius melanopterus, Stål.

Two specimens from Tura, 1,200-1,500 ft., 15.vi–15.vii.1917.
Recorded from Assam and Burma.

Harpactor marginellus (Fabr.).

Two specimens from Tura, 1,200-1,500 ft., 15.vi–15.vii.1917 and two from above Tura.

Recorded from Assam, Burma and Aden.

Harpactor nigricollis (Dall.).

Four specimens from above Tura.
Found in Bhutan, Sikkim and Burma.

Sphedanolestes mendicus (Stål) var.

One specimen from Tura, 1,200-1,500 ft., 15.vi–15.vii.1917.
Recorded from Assam and Burma.

Sycanus ? dubius, sp. nov.

Described from a single specimen from above Tura, 2,500 ft., viii.1917.

Head, antennae, anterior lobe of pronotum, scutellum, membrane, body beneath, legs, and large rounded spots on the dilated connexivum shining black; antennae with the fourth joint very dark brown, the first joint longest, about as long as the anterior tibiae; head a little longer than pronotum; rostrum with the second joint longest; anterior lobe of pronotum small, centrally impressed near base, posterior lobe luteous, smooth, the lateral angles nodulosely subprominent; scutellum without a raised

tubercle or spine; clavus and corium dull black, margins of the dilated connexivum broadly brownish ochraceous, anterior tibiae outwardly spined before apex, coxae and trochanters of the anterior legs and the coxae of the intermediate and posterior legs dull reddish.

Length 28·5 millim.

Type No. 8386/H1 in the collection of the Zoological Survey of India.

I am not sure of the generic position of this species. It appears to belong to *Sycanus*, but the posterior lobe of the pronotum is not rugosely punctate and the anterior tibiae are outwardly spined before the apex.

Villanovanus dichrous (Stål.).

Two specimens from above Tura.
Known only from Assam.

Rihirbus trochantericus, Stål.

One male and one female from Tura, 1,500 ft., viii.1917.
A very variable species with a wide distribution.

Panthous excellens, Stål.

Six specimens from above Tura.
Recorded only from Assam.

Gorpis annulatus, sp. nov.

Pl. xxxvi, fig. 4.

Described from a single carded specimen from above Tura.

Head, pronotum, scutellum, and legs pale luteous; some light brown linear marks on vertex of head; antennae ochraceous, the apex of the second joint black; disk of anterior lobe of pronotum variegated with brown, its anterior and lateral margins and two indistinct patches on the posterior lobe brown, the latter rugosely punctured; scutellum with a black spot at centre of basal margin; hemelytra fuscous brown, the lateral margins of the clavus, the costal margin of the corium, medially interrupted, and all the veins luteous, a transverse patch a little beyond middle and the apex of the corium blackish, apical half of membrane hyaline; legs with two large black patches on the outerside of the anterior femora, two indistinct annulations to intermediate and posterior femora and a slight annulation to intermediate and posterior tibiae near base fuscous; membrane passing abdominal apex.

Length including membrane 10 millim.

Type No. 8387/H1 in the collection of the Zoological Survey of India.

Nabis assamensis, sp. nov.

Pl. xxxiv, fig. 6.

Described from one carded specimen from above Tura.

Head fuscous brown, a black V-shaped mark on disk extending from anterior margin of eyes to base of head; antennae black, extreme bases and apices of first and second joints, two annulations to second joint, third joint (excluding base) and fourth joint (excluding apex) ochraceous; pronotum with a greyish sericeous patch on disk of anterior lobe, widening posteriorly and extending from anterior margin to the transverse impression, the lateral margins and an elongate spot on the central area of the anterior lobe just before the transverse impression black; posterior lobe brownish mottled with ochraceous; scutellum black; hemelytra fuscous brown, thickly mottled with ochraceous; a large patch at apex of corium, and a linear mark at base of inner margin of membrane creamy white, a small black spot on disk of corium, some small spots on apical margin of membrane ochraceous; connexivum black with transverse ochraceous spots; legs brownish, mottled and annulated with ochraceous, some small, round, black spots on the femora; anterior and intermediate tibiae with a distinct row of small spines on the underside; tarsi brownish annulated with ochraceous; underside black; first joint of antennae longer than head, second joint longest, third slightly shorter than second, fourth shortest.

Length 9·25 millim.

Type No. 8388/H1 in the collection of the Zoological Survey of India.

Closely allied to *N. mussooriensis*, Dist.

Velocipeda aliena (Dist.).

Four specimens from above Tura.
Recorded only from Burma.

Family CAPSIDAE.

Owing to the war it has not been possible to consult descriptions of various new species. It is, therefore, not advisable to describe specimens which do not agree with any of the described forms in the Fauna volumes of Rhynchota. The remainder of this paper will therefore consist only of those species which have already been recorded by Distant.

Onomaus pompeus, Dist.

Two specimens from above Tura.
Recorded from Assam and Burma.

Lasiomiris albopilosus (Leth.) var.

Two specimens from above Tura.
Recorded from Burma and Ceylon.

Helopeltis cinchonae, Mann.

Three specimens from above Tura.
Recorded from the Darjiling district and British Bhutan.

Poeciloscytus longicornis (Reut.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
A widely distributed species.

Family PELOGONIDAE.

Pelogonus marginatus (Latr.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Found nearly all over India, Burma and Ceylon.

Mononyx indicus, Atkins.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917, and two specimens from above Tura.
A common E. Himalayan species.

Family CICADIDAE.

Tosena melanoptera (White).

Two specimens from above Tura.
Common in the Himalayas and U. Burma.

Cryptotympana corvus (Walk.).

One specimen from above Tura, "common with *Tosena melanoptera*. *S. W. K.*"
Recorded from the E. Himalayas and the Nilgiris.

Leptopsaltria samia (Walk.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917, and three from above Tura.
Recorded from N. India and Sikkim.

Platylomia similis (Dist.).

Two specimens from Tura, 1,400 ft., x.1917.
Recorded only from Sikkim and Assam.

Platylomia umbrata (Dist.).

Two specimens from Tura, 1,400 ft., x·1917.
Found in Sikkim, Assam and Burma,

Pomponia fusca (Oliv.).

Four specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917 and six from above Tura. " This species differs in note from very closely allied form from Tura, 1,300 ft. Its call is a harsh monotonous drone, whereas the species at 1,300 ft., though it begins in similar style, after a short period changes to an ear-splitting screech, 3,900 ft., vii.1917. *S. W. K.*"
Occurring in Assam and the Nilgiris.

Family FULGORIDAE.

Fulgora viridirostris (Westw.).

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.1917.
Recorded from Assam, Jumna Valley and Burma.

Fulgora spinolae (Westw.).

Three specimens from above Tura. " Not uncommon at 3,000 ft. with *F. clavata*, often found on the same tree. *S. W. K.*"
Recorded from Sikkim, Assam and Mysore.

Fulgora clavata, Westw.

Five specimens from above Tura. " Not uncommon at 3,000 ft. Several specimens sometimes found on single trees to which they return after disturbance. *S. W. K.*"
Fairly common in Sikkim and Assam.

Saiva gemmata (Westw.).

One specimen from Tura, 1,400 ft., x.1917.
Distributed throughout the E. Himalayas, extending to Assam.

Saiva cardinalis (Butl.).

Four specimens from above Tura, 2,500 ft., 1–10.viii.17. " On mossy tree-trunks, very inconspicuous. Only seen at 2,500 ft. *S. W. K.*"
Recorded from Nepal and the Darjiling district.

Aphana pulchella (Guer.).

Two specimens from Tura, 1,400 ft., x.17.
Recorded from Sikkim, Assam and the Andamans.

Aphana variegata (Guer.).

One specimen from above Tura, 2,500 ft., viii.17.
Very widely distributed, extending from the Darjiling district through Assam and Burma to Cochin China.

Lycorma punicea (Hope).

Two specimens from above Tura.
Apparently confined to Assam and China.

Euphria submaculata (Westw.).

One specimen from above Tura, ix.17.
Recorded only from the Darjiling district, E. Himalayas.

Loxocephala aeruginosa (Hope).

One specimen from above Tura.
Extending from Garhwal in the Kumaon Hills to the hills of Assam.

Centromeria simulata, Dist.

Two specimens from above Tura, ix.17.
Known only from Assam.

Borysthenes suknanicus, Dist.

Two specimens from Tura, 1,200–1,500 ft., vii–viii.17.
Recorded only from Sukna, 500 ft., E. Himalayas.

Melandeva ocellata, Dist.

One specimen from above Tura.
Recorded from the Khasi Hills in Assam and from Momeit, Burma.

Pochazia guttifera, Walk.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Extending from the Darjiling district through Assam to Burma and Tenasserim.

Euricania ocellus (Walk.).

Six specimens from above Tura.
Recorded from Sikkim and Assam; also found in China and Japan.

Family MEMBRACIDAE.

Hypsauchenia hardwicki (Kirby).

One specimen from above Tura.
A common East Himalayan species; recorded also from Nepal, Assam and Burma.

Nilautama typica, Dist.

Four specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Recorded from "India" and Tenasserim.

Centrotypus assamensis (Fairm.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Found in Sikkim, Assam, Burma and Tenasserim.

Darthula hardwicki (Gray).

Three specimens from above Tura. "On twigs, 3,900 ft. Each specimen found sitting on clutch of eggs. Tail raised to perpendicular position when irritated. *S. W. K.*"
Recorded from Nepal, Sikkim, Assam and Burma.

Family CERCOPIDAE.

Callitettix versicolor (Fab.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Extending from Kashmir to Sikkim and Assam as far as Burma.

Eoscarta semirosea (Walk.).

One specimen from above Tura.
Found in the E. Himalayas and Assam.

Cosmoscarta egens (Walk.).

Twelve specimens from above Tura.
Common in the Darjiling district and Assam. Also recorded from Karenee, Burma.

Cosmoscarta dimidiata (Dallas).

Three specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Recorded from Sikkim, the Bhutan Duars and Assam.

Cosmoscarta dorsimacula (Walk.).

One specimen from Tura, 1,400 ft., x.17.
Widely distributed, extending from the Kangra Valley to Assam.

Cosmoscarta septempunctata (Walk.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17, and one from above Tura.
Not uncommon in the Darjiling district and Assam; also found in Burma.

Cosmoscarta funeralis, Butl.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Recorded from the Khasi Hills, Assam.

Leptataspis fulviceps (Dallas).

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.17. and three from above Tura.
Recorded from Sikkim, Bhutan, Assam and Burma.

Family JASSIDAE.

Tituria planata (Fab.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Recorded from Calcutta, Nepal, Darjiling district and Tenasserim.

Petalocephala latifrons (Walk.).

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Widely distributed. Recorded from the Bombay Presidency, the Darjiling district and Assam.

Ledra dorsalis (Walk.).

One specimen from above Tura.
Occurring in Sikkim and Assam.

Tettigoniella ferruginea (Fab.).

Two specimens from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
A very common and widely distributed species.

Tettigoniella leopardina, Dist.

One from Tura, at light, 1,200–1,500 ft., 15.vi–15.vii.17.
Recorded from Upper Assam and Tenasserim.

Tettigoniella inflammata, Dist.

One from above Tura.
Only known from Margherita, Assam.

Tettigoniella sikhimensis, Dist.

Two specimens from above Tura.
Recorded from Sikkim.

Hylica paradoxa, Stål.

One specimen from Tura, 1,200–1,500 ft., 15.vi–15.vii.17.
Recorded from the Darjiling district, Burma and Tenasserim.

Vangama steneosaura, Dist.

One specimen from Tura.

Recorded from Bhim Tal, Kumaon Hills, Dehra Dun and the Darjiling district.

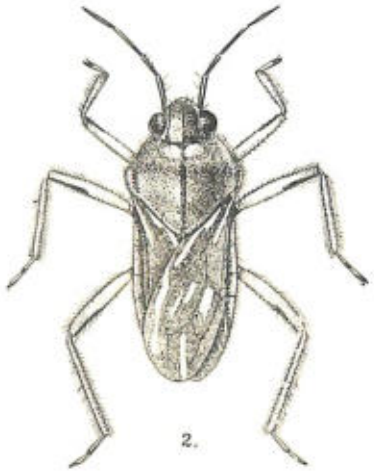
Krisna strigicollis (Spin.).

Two specimens from above Tura.

A very widely distributed species.

EXPLANATION OF PLATE XXXIV.

FIG. 1.—*Sastragala trilineata*, sp. nov.
,, 2.—*Microvelia lineatipes*, sp. nov.
,, 3.—,, *atromaculata*, sp. nov.
,, 4.—*Perittopus maculatus*, sp. nov.
,, 5.—*Metrocoropsis femorata*, gen. et sp. nov.
,, 6.—*Nabis assamensis*, sp. nov.



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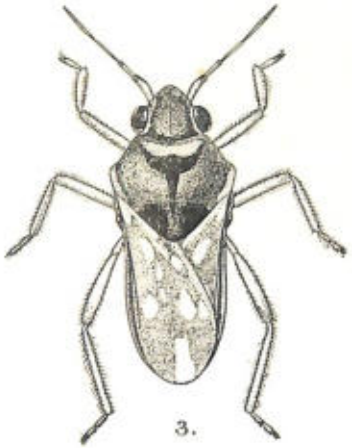

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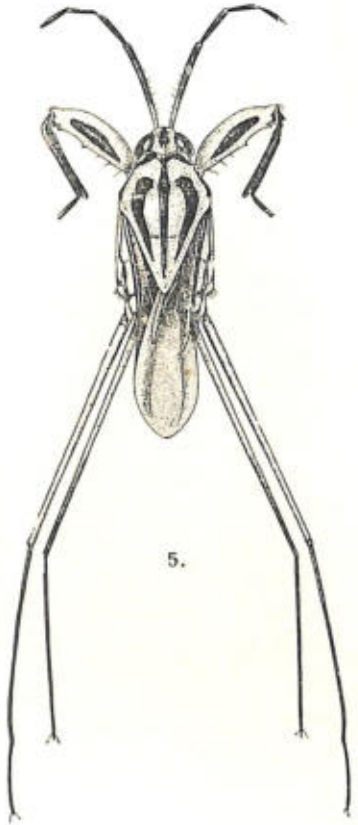

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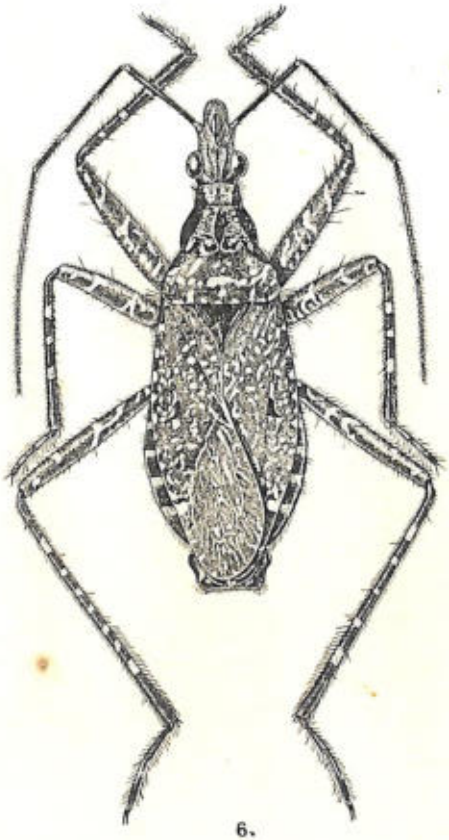

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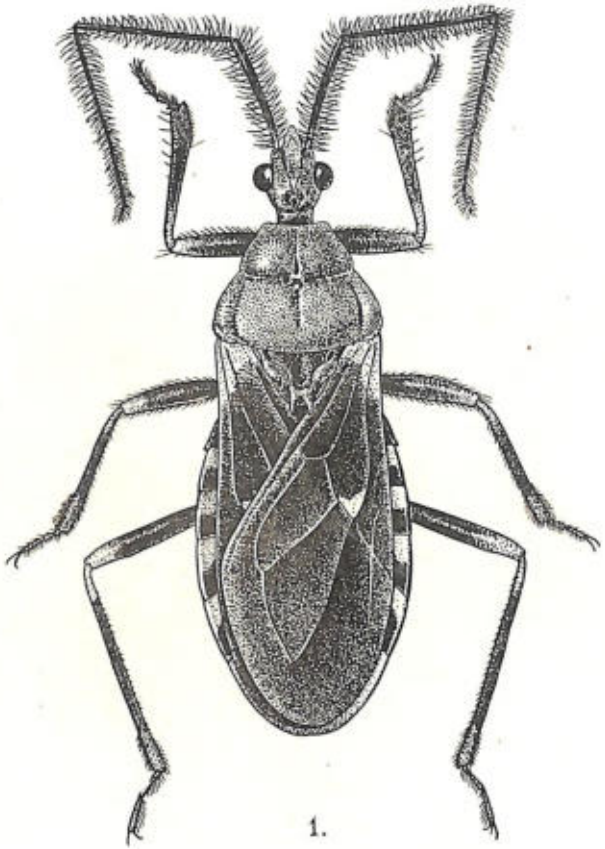
D. Bagchi del.

RHYNCHOTA OF THE GARO HILLS.

EXPLANATION OF PLATE XXXV.

FIG. 1.—*Scadra castanea*, sp. nov.
,, 2.—*Paralibavius singularis*, gen. et sp. nov.
,, 3.—*Ectrychotes relatus*, sp. nov.



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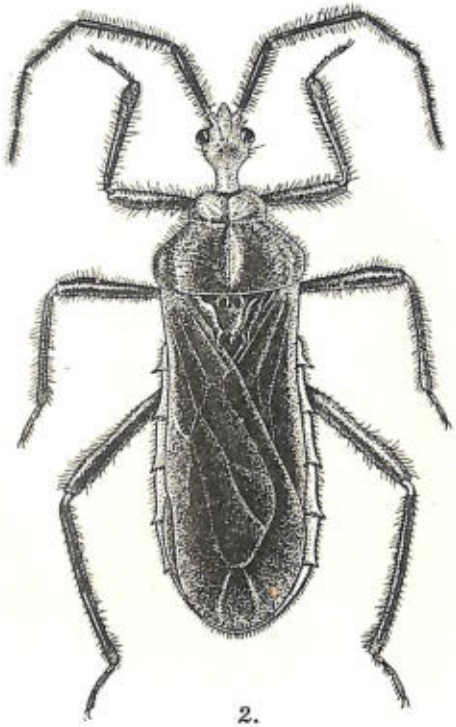

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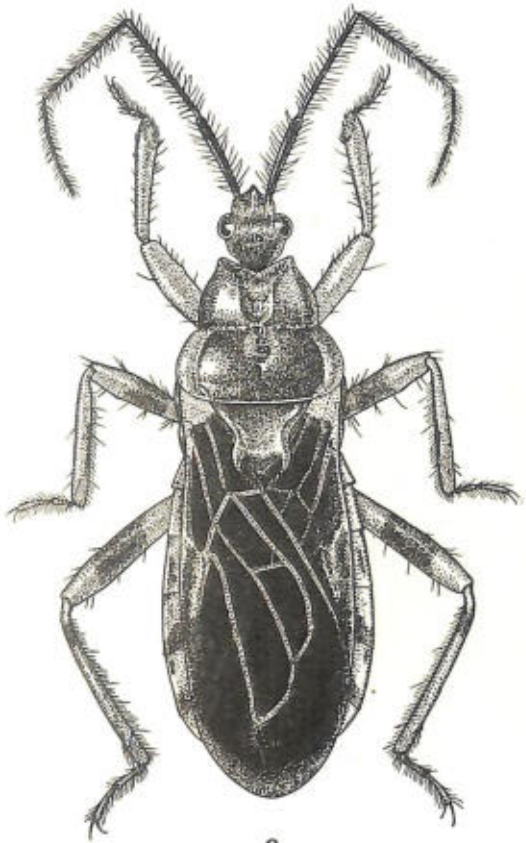

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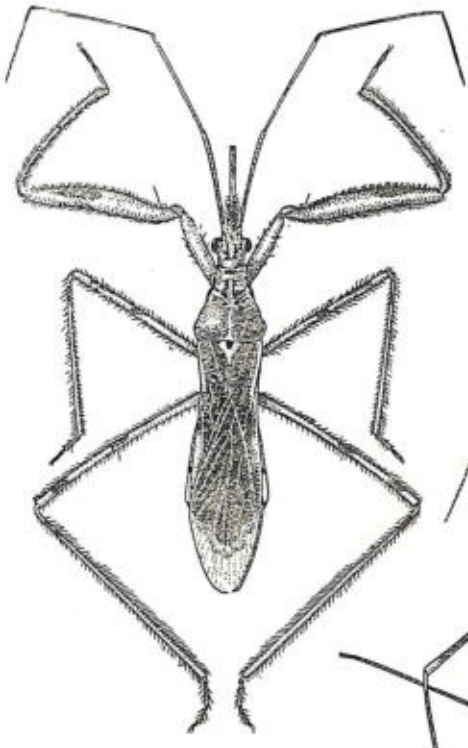
D. Bagchi del.

RHYNCHOTA OF THE GARO HILLS.

EXPLANATION OF PLATE XXXVI.

FIG. 1.—*Colpura sulcata*, sp. nov.
,, 2.—*Nerthus kempi*, sp. nov.
,, 3.—*Bagauda cavernicola*, sp. nov.
,, 4.—*Gorpis annulatus*, sp. nov.



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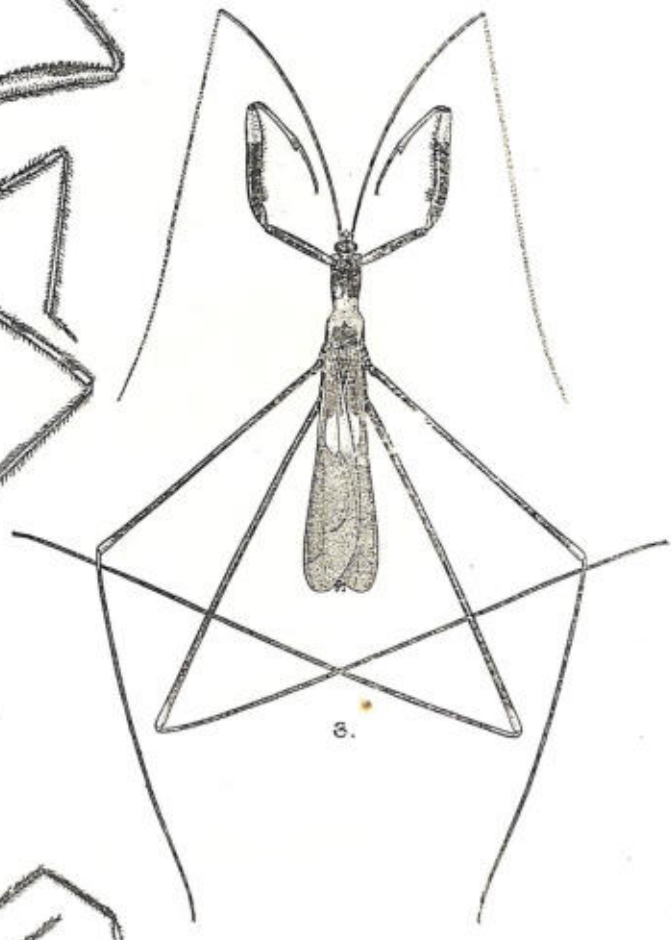

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RHYNCHOTA OF THE GARO HILLS.

XXIV. TWO NEW SCORPIONS FROM SOUTHERN INDIA.

By J. R. HENDERSON, *M.B., C.M., C.I.E., Formerly Superintendent, Madras Government Museum.*

Plate XXI.

The scorpions which form the subject of this note were exhibited at the meeting of the Indian Science Congress held at Madras in January, 1915, but have not been described till now.

Lychas albimanus, n. sp.

Plate XXI, figs. 1, 2.

Habitat.—Three specimens found under logs, at an elevation of about 1,500 feet in the Teak Forests, Cochin State, by Dr. F. H. Gravely and Mr. B. Sundara Raj, M.A., in September, 1914. The following description has been drawn up from only one of these specimens, an apparently adult female.

Colour black with brownish mottlings, the last three terga with yellowish spots and mottlings. Tail paler especially towards its distal end, the vesicle yellowish. Chela black with the exception of the band which is white (becoming yellow in spirit); the fingers black. Legs pale brownish, with the femora and patellae black.

Carapace finely granular, the granules being most strongly developed towards the anterior margin.

Terga finely granular, with a single median keel on each, which, however, is poorly developed on the last tergum and the latter carries two well-developed lateral keels in addition.

Sterna smooth, except the last which is faintly granular and carries two indistinct keels on either side of the middle line.

Tail about five times as long as the carapace, faintly granular; keels well-developed, granular; vesicle faintly granular below; spine beneath the aculeus triangular, pointed, and placed at the end of a median granulated ridge which traverses the undersurface of the vesicle.

Chelae practically smooth, but with granular crests on the humerus and brachium; hand smooth, about the same width as the brachium; digits in contact, not sinuate, the movable one slightly longer than the carapace; outer series of teeth on the movable finger 6, inner series 5.

Legs faintly granular ; the tibial spurs much longer than the neighbouring hairs.

Pectinal teeth 21.

Measurements.— ♀ Total length 41 mm., carapace 4·5 mm., tail 21 mm., underhand 3 mm., movable finger 5 mm., width of hand 2 mm.

Type-specimen : No. $\frac{2}{11}$ in the collection of the Zoological Survey of India.

This species, which is chiefly characterised by its white hand and the pronounced granulation of the anterior portion of the carapace, appears to be related to *L. tricarinatus*, Simon, and *L. hendersoni*, Pocock. From the former it is distinguished by the fact that all its terga except the last have only a single carina ; in the latter species the colouration is entirely different, the hand and fingers both being yellow.

Palamnaeus tristis, n. sp.

Plate XXI, figs. 3, 4.

Habitat.—Tirupati Hills, North Arcot District, two males.

Venkatagiri Hills, Nellore District, two females and one young male.

This species was discovered in September, 1904 by my former pupil and assistant at the Madras Christian College, Mr. S. K. Sundara Charlu, M.A., who made a large collection of scorpions from the Eastern Ghats and other parts of the Madras Presidency. The specimens recorded above were found at elevations of between 2,000 and 3,000 feet, inhabiting short burrows, the entrance to which were, as is usually the case in the species of *Palamnaeus*, covered by a large stone. Mr. Sundara Charlu informed me that in some cases the burrow also afforded shelter to a small frog—*Callula variegata*, Stol.

Colour greenish-black, the legs sometimes paler than the rest of the body ; vesicle reddish-yellow.

Carapace on the whole smooth and polished, slightly granular towards the sides.

Terga smooth and polished, slightly granular towards the sides.

Sterna smooth and polished, the last one without a crest.

Tail about three times as long as the carapace ; all the segments polished, particularly above, and slightly granulated ; keels of the first three segments smooth, of the fourth and fifth segments slightly denticulate.

Vesicle wider than high, about as wide as the fifth segment, with four tuberculate crests below ; a well-defined groove on each lateral surface.

Chelae with the humerus and brachium both slightly longer than the carapace ; humerus coarsely granular above and at the base below, with the anterior margin rather strongly denticulate ; brachium strongly ridged above and very slightly granulated ;

hand with the outer portion of its upper surface vertical and crested, the upper crest or finger-keel forming the outer border of the hand as seen from above and stopping opposite the articulation of the mobile finger; hand covered above with large smooth tubercles of varying size and shape, which are specially aggregated to form three well-defined hand ridges in addition to the finger-keel, *viz.* an inner and an outer ridge continued on to the immobile finger where the tubercles disappear, and a third intermediate shorter ridge which stops short of the immobile finger ; the three ridges all commence at the posterior margin of the hand; in addition to the keel of the underhand, which is smooth, there are three slightly tuberculate ridges on the undersurface of the hand, and this surface is rather coarsely tuberculate towards the inner margin ; the fingers are faintly granular particularly below.

Legs practically smooth.

Pectinal teeth 17-18.

Measurements.— ♂ Total length 116 mm., carapace 19 mm., tail 60 mm., humerus 21 mm., brachium 21·5 mm., underhand 18·5 mm., movable finger 21 mm., width of hand 13 mm.

Type-specimen: No. $\frac{2433}{17}$ in the collection of the Zoological Survey of India.

The above description is taken from an adult male. In the female the hand is much broader, more finely granulated, and the three ridges on the upper surface of the hand are much fainter. The length of the tail as compared with that of the carapace is practically the same in both sexes.

This species resembles *P. gravimanus*, Pocock, in the presence of longitudinal ridges or crests on the upper surface of the hand, but in other respects is very different. It appears to be most nearly related to *P. fulvipes*, Koch, and *P. wroughtoni*, Pocock, which both have the outer portion of the upper surface of the hand defined above by a distinct ridge. I had the opportunity some years ago of comparing specimens of the species just described with the types of *P. wroughtoni* from Belgaum, Bombay Presidency, preserved in the British Museum. This last species, which is of smaller size, has a much wider hand and the crest on the outer border of this joint is not so well-defined. The part external to this crest is flatter and more vertical in the new species, which is also characterised by the well-marked longitudinal ridges on the upper surface of its hand ; the underhand is granular in the new species, while it is smooth in *P. wroughtoni*.

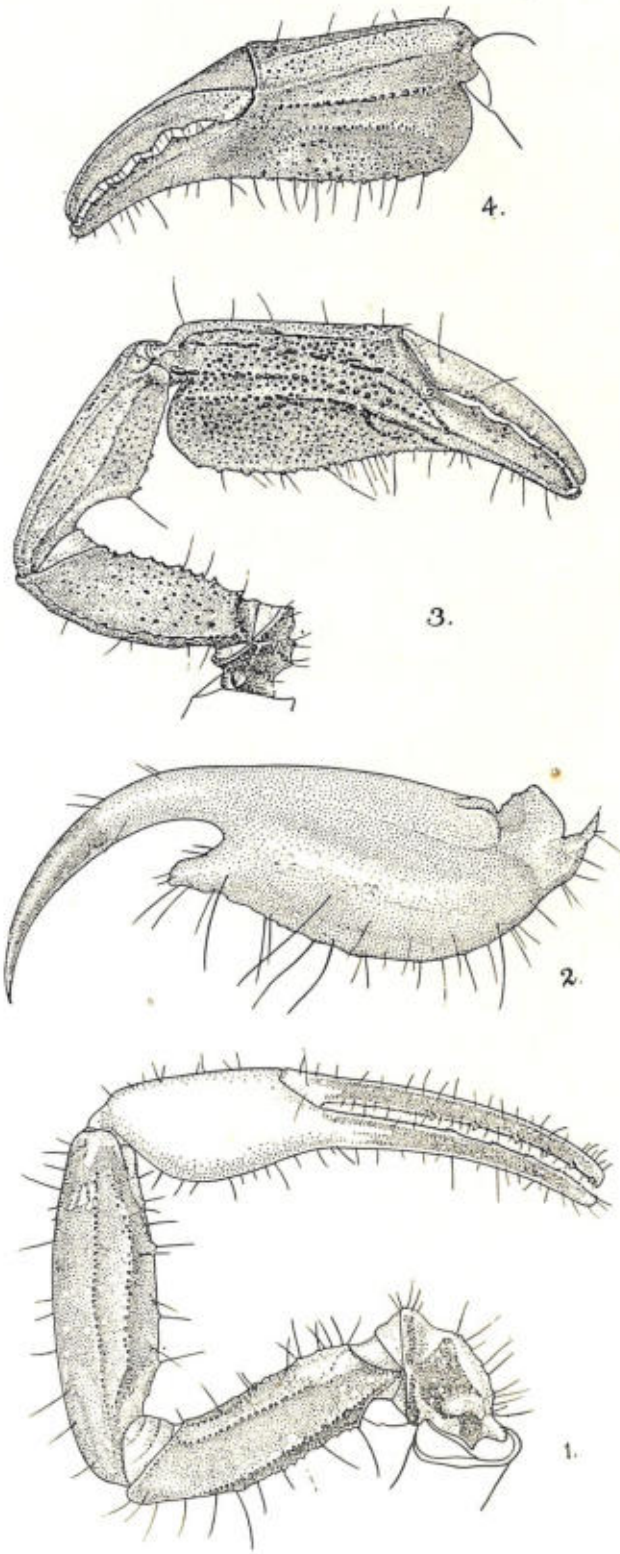
EXPLANATION OF PLATE XXI.

Lychas albimanus, n. sp.

FIG. 1.—Arm and hand from above.
,, 2.—Vesicle and aculeus from side.

Palamnaeus tristis, n. sp.

FIG. 3.—Arm and hand from above.
,, 4.—Hand and fingers from below.



D. Bagchi del.

SOUTH INDIAN SCORPIONS.

XXV. NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

XIII. The Indian species of *Macrophthalmus*.

By Stanley Kemp, *B.A., Superintendent, Zoological Survey of India.*

Plate XXIV.

Since Alcock published his account of the Indian species of *Macrophthalmus* in 1900[1] a considerable amount of additional material has been obtained from various sources. A number of species not hitherto known from Indian waters have been added to the list, while several which were known to Alcock only by name have been rediscovered.

In determining the species I have derived great assistance from Dr. Tesch's recent monograph of the genus.[2] This work contains a most valuable key to twenty-five species, critical notes on their characters and synonymy and a great number of figures. I have found myself in complete agreement with Tesch as regards the species recognised by him, but I differ from him, and from other recent authorities also, in my views on the position of the species usually termed *Euplax bosci*.

The genus *Euplax* was established by Milne-Edwards for the reception of certain species which he found to differ from typical *Macrophthalmus* in the squarer outline of their carapace, in their shorter eyestalks and in the shortness of the chelipeds in both sexes. During the sixty years that have intervened since Milne-Edwards wrote, numbers of additional species have been described, referred for the most part to *Macrophthalmus*, and nowadays it is no longer possible to form two distinct groups on the characters on which he based his generic distinction.

Tesch, in his account of the Grapsoid crabs collected by the 'Siboga' expedition[3], distinguishes *Euplax* from *Macrophthalmus* by other characters: by the extent of the gape between the external maxillipeds and by the proportions of the merus of those appendages. In these respects, however, the difference is sometimes so very slight that it is clear that they do not afford a basis for generic differentiation.

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1 Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 375 (1900).
2 Tesch, *Zool. Meded. Rijks Mus. Nat. Hist. Leiden*, I, pp. 149-204, pls. v-ix (1915).
3 Tesch, *Decap. Brachyur. 'Siboga' Exped.*, XXXIXc, p. 57 (1918).

Unfortunately it is not at present possible to include *Euplax* definitely in the synonymy of *Macrophthalmus*, for *E. leptophthalma* from Chili, the type species of the former genus, has never been re-examined since Milne-Edwards described it; there is thus a possibility that it may possess characters, hitherto overlooked, which entitle it to generic recognition. There is, however, very little doubt that *E. bosci* must be regarded as a species of *Macrophthalmus*, to which genus both Audouin and Krauss referred it. In his notes on the species Tesch remarks [1] that the proportional length of the merus of the outer maxillipeds in relation to the ischium is variable. This variation also extends to the relative length and breadth of the merus; the segment is sometimes nearly as long as broad, sometimes as much as one sixth broader than long. In this respect it is not possible to draw a distinction between *E. bosci* and such species as *Macrophthalmus erato* and *M. pacificus*.

E. bosci, moreover, as Tesch has noted [2], is so very closely related to *Macrophthalmus crinitus*, Rathbun, that the two forms can only with difficulty be distinguished from one another (see p. 391). There can be no possible doubt that the two species are congeneric, yet no one has suggested that *M. crinitus* should be referred to *Euplax*. In both species the gape of the outer maxillipeds is a little wider than in normal *Macrophthalmus* and the front proportionately broader. But the former distinction is a trivial one and the difference, on comparison with *M. pacificus*, is very small; in the latter the species merely takes a place at one end of an evenly graded series.

The position of the Australian species, described by Milne-Edwards as *Cleistostoma tridentatum* and recently referred to the genus *Euplax* by Miss Rathbun and Tesch, seems to require further investigation. On comparison with *Hemiplax hirtipes* from New Zealand I find many points of resemblance. The two species agree with one another and differ from all *normal* species of *Macrophthalmus* in three characters:—(i) the front is extremely broad, its breadth between the eyestalks being considerably more than one third that of the carapace, (ii) the sides of the front are strongly convergent anteriorly, and (iii) there are no enlarged teeth on the fingers of the male cheliped. It appears to me therefore that *C. tridentatum* should be referred to Heller's *Hemiplax*; but the distinctions between this genus and *Macrophthalmus* are by no means convincing and it will perhaps be better to regard the former merely as a subgenus of the latter.

At the present moment two broad-fronted Australian species of *Macrophthalmus*, *M. punctulatus*, Miers and *M. latifrons*, Haswell, are known to us only from the original descriptions. When these have been rediscovered we shall probably be better able to decide on the position of *C. tridentatum* and on the validity of *Hemiplax*.

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[1] Tesch, *loc. cit.*, 1918, p. 60.

[2] Tesch, *loc. cit.*, 1915, p. 192.

Excluding three species altogether unrecognisable from the published descriptions, Tesch recognised twenty-six species of *Macrophthalmus* in his monograph; to these may be added *M. bosci*, Sav. & Aud., *M. sandakani*, Rathbun, *M. gastrodes*, Kemp and *M. teschi* described in this paper. The total number of species, including the somewhat doubtful *M. latifrons*, Haswell and *M. punctulatus*, Miers, is consequently thirty.

Alcock in his account of the Indian Catometopes described seven species of the genus and mentioned the names of four others which were said to occur in Indian seas. The total number of Indian forms now stands at fifteen. The species are:—

SPECIES.	SYNONYMS.
M. pectinipes, Guérin.	*M. simplicipes*, Guérin.
M. transversus (Latreille).	
M. telescopicus (Owen).	*M. compressipes*, Randall. *M. podophthalmus*, Souleyet. *M. verrauxi*, Milne-Edwards.
M. latipes, Borradaile.	
M. sulcatus, Milne-Edwards.	
M. brevis (Herbst).	*M. carinimanus*, Milne-Edwards.
M. convexus, Stimpson.	*M. inermis*, A. Milne-Edwards.
M. erato, de Man.	
M. latreillei, Desmarest.	*M. desmaresti*, Lucas. *M. serratus*, Gray. *M. polleni*, Hofmann. *M. laniger*, Ortmann.
M. pacificus, Dana.	*M. bicarinatus*, Heller.
M. tomentosus, Souleyet.	
M. depressus, Rüppell.	*M. affinis*, Guérin.
M. teschi, sp. nov.	
M. gastrodes, Kemp.	
M. crinitus, Rathbun.	

Of these I have seen all but *M. latipes* and *M. latreillei*.

Macrophthalmus pectinipes, Guérin.

1900. *Macrophthalmus pectinipes*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX. p. 377.

1915. *Macrophthalmus pectinipes*, Tesch, *Zool. Meded. Mus. Leiden*, I. p. 156.

I agree with Tesch that Guérin's *M. simplicipes* is probably founded on a young varietal form of this species.

No additions have been made to the specimens examined by Alcock. The record from Orissa is based on a large male labelled "Cuttack. Dr. F. Stoliczka." This appears to be an error, for the original label, also found with the specimen, clearly reads "Kutch."

M. pectinipes is otherwise known only from Sind (Henderson), Karachi (Alcock), Bombay (Guérin) and Penang (Henderson).

Macrophthalmus transversus (Latreille).

(Plate xxiv, fig. 1.)

1915. *Macrophthalmus transversus*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 158, pl. v, fig. 1 (*ubi lit.*).

This species is not mentioned by Alcock in his account of the Indian species; it was, however, recorded from Pondicherry by Milne-Edwards and has recently been found in great abundance by Dr. F. H. Gravely on the coast of Orissa

The specimens agree well with the excellent figures published by Milne-Edwards in Cuvier's *Règne Animal*[1] and also, in most respects, with Tesch's figures and detailed description. The eyes are variable in length; sometimes they reach beyond the tip of the orbital tooth by only half the length of the cornea, sometimes by fully twice its length. In none of the specimens I have seen are they quite so long as shown in Tesch's figure. The differences noted by Tesch in the granulation of the carapace are undoubtedly sexual; in females the greater part of the surface is smooth and glossy, whereas in males it is closely covered with small granules.

In his description of the male cheliped Tesch notes that the lower surface of the palm is bordered by two parallel serrated crests, but only one is visible in the specimens I have seen. The palm as a whole (fig. 1) is more slender than in the figure and the fingers more strongly deflexed: when the claw is closed the dactylus is at right angles to the main axis of the palm. Tesch remarks that a part of the palm at the insertion of the movable finger "seems to be detached, so as to form a separate joint, but the suture separating this part from the rest of the palm is not continued on the inner surface." I think the appearance of a separate segment must be due to a partial fracture; I can find nothing resembling it in any of the specimens I have examined. The dactylus differs from the description in bearing a large molar tooth near the base[2], directed slightly backwards, and another which is much smaller in the distal third, fitting close behind the foremost tooth on the fixed finger. Between these larger teeth there is a series of denticles.

The specimens are smaller than those seen by Tesch. In the largest male the carapace is 9·4 mm. in length and 22 mm. in breadth, the length of the chela being 15 mm.

$\frac{9.5 \times 3 \cdot 9.6}{1.5}$ Chandipur, near Balasore, Orissa. F. H. Gravely. Many.

M. transversus has been recorded from Massouah (Cano), Pondicherry (Milne-Edwards) and Sumatra (de Man, Tesch).

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[1] Pl. xvi, figs. 2, 2*a-d*.

[2] Obscurely shown on the left-hand chela in Milne-Edwards' figure.

Macrophthalmus telescopicus (Owen).

(Plate xxiv, figs. 10, 11.)

1900. *Macrophthalmus verrauxi*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 377.

1915. *Macrophthalmus telescopicus*, Tesch, *Zool. Meded. Mus. Leiden*, I. p. 161, pl. v, fig. 2.

I accept Tesch's views on the synonymy of this species as a temporary measure, but further work is necessary before his conclusions can be accepted as final. The species, as understood by Tesch, is one of extremely wide distribution and it is quite possible that two or more allied forms may be confounded. Comparison of specimens from Australia, the Hawaiian Is. and the Red Sea is a necessary step to further progress.

The material at my disposal is very limited, but the three males in which the chelipeds are extant differ considerably from one another.

In a male from Port Blair in the Andamans (one of those examined by Alcock), with carapace 4·2 mm. in length and 6·7 mm. in breadth, the fine keel on the outer face of the palm (fig. 11) near its lower border is decidedly sinuous and the fingers, as in Miss Rathbun's figure[1], gape very widely at the base. There is a small molariform tooth at the proximal end of the dactylus and another, in the form of a crest truncated anteriorly, near the tip of the fixed finger. The teeth on the lateral margin of the carapace behind the orbital tooth are blunt.

In a larger male, also from Port Blair, with carapace 15 mm. in breadth and 9 mm. in length, the chela is of the same type, but the keel on the outer face of the palm is a little straighter. The lateral teeth of the carapace, behind the orbital angle, are sharp and the meral segments of the first walking legs (which have been lost in the smaller specimen) bear a dense patch of fur on the underside.

A male from the northern end of the Gulf of Manaar, with carapace 7·8 mm. in length and 12·4 mm. in breadth, has sharp lateral teeth on the carapace and no furry patch on the lower side of the merus of the first walking legs. The keel on the outer face of the palm is much less sinuous in this specimen (fig. 10), the fingers do not gape, the tooth on the fixed finger is longer and a little more remote from the apex, while the molariform tooth on the dactylus is longer and broader and situated more nearly in the middle of the finger length. In this individual the terminal segment of the abdomen is proportionately broader than in those from Port Blair.

From the material at my disposal I am not able to decide whether the differences in these males are specific or merely a matter of variation.

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[1] *K. Danske Vidensk. Selsk. Skrift.* (7), *naturvid. og math.*, V, p. 322, text-fig. 6 (1910).

In none of the specimens I have seen is the propodus of the last leg dilated as in Borradaile's *M. latipes*.[1]

Alcock recorded this species from the Andamans and Mergui; additional specimens are from the following localities:—

$\frac{98\,2\,0}{10}$	Tor, Sinaitic Peninsula, Red Sea.	R. B. S. Sewell.	One ♀.
$\frac{98\,2\,1}{10}$	Backwater at Pamban, Ramnad Dist., G. of Manaar. ...	S. Kemp.	One ♂.
$\frac{88\,1\,0}{10}$	Fisher Bay, Port Owen, Tavoy I.	'Investigator.'	Two ♀ (damaged).

Macrophthalmus sulcatus, Milne-Edwards.

(Plate xxiv, figs. 3-5).

1900. *Macrophthalmus sulcatas*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 379.

1915. *Macrophthalmus sulcatas*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 165.

The only specimens in the collection are the male and female examined by Alcock. They differ rather conspicuously in the form of the orbital and antero-lateral teeth. In the female the orbital tooth is shorter than in the male and is separated from the first lateral tooth by a comparatively wide gap (fig. 4). In the male the orbital tooth is curved backwards and upwards, slightly overlapping the margin of the first lateral tooth (fig. 5). The form of the male chela is shown in fig. 3.

I have compared these specimens with an example of the very closely allied *M. grandidieri*, A. Milne-Edwards, from the Red Sea. The differences between the two species have been tabulated by Lenz.[2]

Alcock by a *lapsus calami* states that the Indian examples of this species were obtained in the Andaman Is. They are in reality from Kutch. The species is otherwise only known from Mauritius (Milne-Edwards) and Australia (Ortmann); the latter locality is almost certainly erroneous.

Macrophthalmus brevis (Herbst).

Macrophthalmus carinimanus, auct.

1915. *Macrophthalmus brevis*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 169, pl. vi, fig. 5 (*ubi. lit.*).

Tesch has shown that the name *M. brevis* must be employed for the species hitherto known as *M. carinimanus*. It was recorded by Milne-Edwards under the latter name from Pondicherry, but it is only within the last few years that it has again been found in Indian waters.

$\frac{88\,2\,8}{10}$	Paway I., Mergui Archipelago.	'Investigator.'	Five.

The species is known from Mauritius (Milne-Edwards), Pondicherry (Milne-Edwards), Singapore (Gray), Halmaheira (de Man) and Celebes (de Man).

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1 *Faun. Geogr. Maldives Laccadives*, I, p. 433, fig. 114 (1903).

2 Lenz, *Abhandl. Senckenb. Ges. Frankfurt*, XXVII, p. 366 (1905).

Macrophthalmus convexus, Stimpson.

(Plate xxiv, fig. 2.)

1900. *Macrophthalmus convexus* Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 378.

1915. *Macrophthalmus convexus*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 175, pl. viii, fig. 8.

A large male from the upper end of the Gulf of Manaar is referred with considerable doubt to this species, for it differs widely from all other adult specimens of the same sex that I have seen in the form of the chelae (fig. 2).

In normal males from Indian waters the chela agrees exactly with the figure of *M. inermis* published by A. Milne-Edwards in 1873[1], *M. inermis* being regarded by most authorities as a synonym of *M. convexus*. In the abnormal male from the Gulf of Manaar the form is altogether different, resembling that of females and very young males.

The chela in this specimen is about 2½ times as long as the height at the base of the fingers and the dorsal edge of the palm bears a double row of small tubercles not seen in normal males. The outer surface is minutely granulate in its upper part; but lower down, above the strong serrate carina that runs from the base to the tip of the fixed finger, it is concave and perfectly smooth. In normal males the fingers and a small portion of the palm in the vicinity of the finger-cleft are clothed with hair internally, but in this specimen the hairy covering extends over practically the whole of the inner surface. The prehensile edges bear only rudiments of the large teeth found in normal males and the fixed finger is scarcely at all deflexed. The chela differs from that of the female in only two points,—in the possession of rudimentary teeth on the fingers and in the hairy covering of the inner surface.

In all other respects the specimen agrees precisely with normal examples of the species. It is, however, unusually large, the breadth of the carapace being 32·5 mm. and the length 16·5 mm. An ovigerous female found with this male is 23·1 mm. in breadth and 12·2 mm. in length; it is as nearly as possible identical with other females taken in company with normal males.

It is difficult to come to any satisfactory conclusion regarding the identity of these two specimens; I believe, however, that they are to be referred to *M. convexus* (=*M. inermis*). The abnormal character of the chelae of the male is perhaps to be explained by regeneration; but, if so, the original chelipeds must both have been lost at the same time and at a very early age.

Tesch has followed de Man and Alcock in regarding *M. inermis* as a synonym of *M. convexus*. Miss Rathbun considers them distinct and has noted various points of difference, but I am not at all certain that the statements are derived from actual comparison of specimens. It appears probable that the informa-

[1] A. Milne-Edwards, *Nouv. Arch. Mus. Hist. Nat. Paris*, IX, p. 277, pl. xii, fig. 5 (1873).

tion regarding *M. convexus* was derived from the posthumous work of Stimpson, then unpublished. Perhaps Miss Rathbun has since changed her opinion on the subject, for if the two species are distinct the specimen from the Gulf of Siam recorded by her as *M. convexus* should have been referred to *M. inermis*.

Stimpson described *M. convexus* from a young specimen with carapace ·34 ins. in length and ·59 ins. in breadth. I have examined a still smaller individual from the Andamans in which the carapace is 6·5 mm. in length and 11·4 mm. in breadth. Except that the tooth on the merus of the last legs is absent, this specimen is in almost exact agreement with Stimpson's description and figures. I am convinced that it is an example of *M. convexus* and that this species is based on a young specimen of *M. inermis*.

Alcock recorded specimens from the Andamans; additional records are :—

$\frac{9\,5\,3\,2}{10}$	Jack and Una Is., Mergui Archipelago	'Investigator.'	One.
$\frac{9\,5\,3\,0}{10}$	Pamban, Ramnad dist., Gulf of Manaar.	S. Kemp.	Two.

The Gulf of Manaar is the most western locality from which the species has been recorded. Eastwards it extends to Australia, Samoa, the Loo Choo Is. and the Hawaiian Is.

Macrophthalmus erato, de Man.

1898. *Macrophthalmus erato*, Koelbel, *Wiss. Ergebn. Reise Grafen Béla Széchenyi in Ostasien*, II, p. 576, pl. i, figs. 13, 14.
1900. *Macrophthalmus erato*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 381.
1915. *Macrophthalmus erato*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 179, pl. viii, fig. 9.

This species was recorded by de Man and Alcock from the Mergui Archipelago and Akyab; it has since been found at the following localities :—

$\frac{9\,8\,3\,3\cdot4}{10}$	Chandipur, near Balasore, Orissa.	F. H. Gravely.	Many.
$\frac{3\,7\,1\,5}{10}$	Arakan coast.	'Investigator.'	One.
$\frac{9\,1\,8\,1}{10}$	Fisher Bay, Port Owen, Tavoy.	,,	Three.
$\frac{9\,8\,3\,1}{10}$	Jack and Una Is., Mergui Archipelago	,,	Eleven.
$\frac{9\,8\,3\,2}{10}$	Parker I., Mergui Archipelago	,,	Two.

The specimen from the Arakan coast is exceptionally large; the carapace is 17·4 mm. in breadth and 11·9 mm. in length.

Outside the Bay of Bengal *M. erato* is known from Malacca (de Man), the Gulf of Siam (Rathbun), Madoera near Java (Tesch) and Hongkong (Koelbel).

Macrophthalmus crinitus, Rathbun.

(Plate xxiv, fig. 7.)

1915. *Macrophthalmus crinitus*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 192.

Four small specimens from the Mergui Archipelago and Singapore belong to this species. The largest male is 6·9 mm. in length and 9·0 mm. in greatest breadth of carapace.

M. crinitus, as Tesch has observed, is much more nearly related to *M. bosci* than to *M. pacificus*, with which Miss Rathbun compared it. I have examined a good series of *M. bosci* from the Red Sea and find that the two species are to be distinguished by the following characters:—

M. crinitus, Rathbun (fig. 7).	*M. bosci*, Sav. & Aud. (fig. 6).
Carapace widest behind tip of first antero-lateral tooth, less strongly areolated.	Carapace widest between tips of orbital teeth, more strongly areolated.
Orbital teeth not very sharp, their outer margins parallel.	Orbital teeth very sharp, their outer margins posteriorly convergent.
Third tooth [1] of antero-lateral border of carapace distinct.	Third tooth [1] of antero-lateral border of carapace practically invisible.
Granulate crest on outer surface of palm of male conspicuous.	Granulate crest on outer surface of palm of male exceedingly faint.

Tesch is mistaken in supposing that the species differ in the form of the third maxillipeds.

$\frac{9838}{10}$	Paway I., Mergui Archipelago.	'Investigator.'	Three.
$\frac{9839}{10}$	Tanah Merah Besar, Singapore.	N. Annandale.	One.

M. crinitus has been recorded only from Halmaheira (de Man) and Amboina (Rathbun). *M. bosci*, though described from the Red Sea and since reported from the E. coast of Africa, Malaysia and Oceania, has not yet been discovered in Indian waters.

Macrophthalmus pacificus, Dana.

1915. *Macrophthalmus pacificus*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 190, pl. viii, fig. 11.

Thirteen specimens from Portuguese India belong to this species; in the largest, which is a female, the carapace is 12·8 mm. in length and 18·7 mm. in greatest breadth. I have compared these individuals with a rather larger male from Australia, obtained many years ago from the Queensland Museum, and am unable to find any difference between them.

Heller's *M. bicarinatus* from the Nicobars is almost certainly synonymous with this species.

$\frac{9840}{10}$	Nova Goa, Portuguese India.	S. Kemp.	Four.
$\frac{9862}{10}$	Rachol R., opposite Durbate, Portuguese India	S. Kemp.	Nine.
$\frac{8070}{9}$	Australia.	Queensland Mus.	One.

The specimens from Portuguese India were found in brackish water, under stones on the banks of the Mapusa and Rachol Rivers.

The species is known from the Nicobars (Heller), Penang and Pontianak (de Man), the Loo Choo Is. (Stimpson), Upolu and Samoa (Dana).

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[1] Including the orbital tooth.

Macrophthalmus tomentosus, Eydoux & Souleyet.

1915. *Macrophthalmus tomentosus*, Tesch, *Zool. Meded. Mus. Leiden*, I, p. 193, pl. ix, fig. 12.

The only recent example of this species that I have seen is that recorded by Alcock from the Mergui Archipelago. There are, however, ten fossil or subfossil specimens labelled 'Sandoway,' a locality on the Arakan coast of Burma.

The latter specimens have been preserved in mud and have evidently undergone considerable vertical pressure. The upper and lower surfaces of the carapace have been partially crushed together, frequently without causing any considerable distortion, and the eyestalks and terminal segments of the legs have been broken off. The tuberculation of the upper surface is exceedingly well preserved.

By softening the mud with water and by working at it with a stiff brush I have been able to develop out the specimens to some extent and to satisfy myself of their identity. They agree precisely with the spirit specimen from the Mergui Archipelago and though the chelae are invariably broken or absent, I have been able to find clear indications of the "musical crest" on the inner face of the merus.

M. tomentosus has not hitherto been found in the fossil state.

Macrophthalmus depressus, Rüppell.

1900. *Macrophthalmus depressus*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 830 (part only).

1915. *Macro hthalmus depressus*. Tesch, *Zool. Meded. Mus. Leiden.*, I, p. 196, pl. ix, fig. 13.

There appears to be some confusion about this species. Alcock records specimens from both Mergui and Aden, but in my opinion only those from the latter locality are true *M. depressus*. The Mergui specimens, which were also examined by de Man, and are labelled *M. depressus* in his handwriting, belong in reality to a closely allied undescribed form to which I have given the name *M. teschi*. The differences between the two species are explained overleaf.

$\frac{1871}{10}$	Suez.	H. J. Walton.	Two.
$\frac{1913}{4}$	Aden.	J. Wood-Mason.	Seven.
$\frac{1843\cdot4}{10}$	Pamban, Ramnad dist., Gulf of Manaar.	S. Kemp.	Many.

M. depressus has been recorded many times from the Red Sea and is also known from the Persian Gulf (Nobili), Bombay and Pondicherry (Guérin) and Rameswaram I. (Henderson). Haswell's record from Australia (under the name *M. affinis*) is almost certainly erroneous. The two specimens from Mergui examined by de Man belong to *M. teschi* and the single female recorded by the same author from Atjeh is probably also to be referred to that species.

Macrophthalmus teschi, sp. nov.

(Plate xxiv, figs. 8, 9.)

1888. *Macrophthalmus depressus*, de Man, *Journ. Linn. Soc. Zool.*, XXII, p. 124 (? all).
? 1895. *Macrophthalmus depressus*, de Man, *Zool. Jahrb. Syst.*, VIII, p. 578.
1900. *Macrophthalmus depressus*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 380 (in part).

This species is very closely allied to *M. depressus* ; males differ only in the following particulars :—

M. teschi, sp. nov.

Granulation of lateral parts of carapace sparse, the interspaces between the granules being much greater than the diameter of the granules.

The transverse row of granules extending inwards from the posterior antero-lateral tooth of the carapace is conspicuous.

Lateral and frontal edges of rostrum crenulate.

Upper border of palm of cheliped without large granules ; lower surface conspicuously granular proximally.

Fixed finger of chela strongly deflexed with a very large tooth on its prehensile edge not reaching beyond the middle of its length (fig. 8).

Sternum granular only near abdomen, quite smooth externally.

M. depressus, Rüppell.

Granulation of lateral parts of carapace close, the interspaces between the granules being little if at all greater than the diameter of the granules.

The transverse row of granules extending inwards from the posterior antero-lateral tooth of the carapace is inconspicuous, being lost in the close granulation of the adjacent parts.

Edges of rostrum not crenulate.

Upper border of palm of cheliped with a row of large granules ; lower surface quite smooth [1].

Fixed finger of chela very slightly deflexed with a low crest on its prehensile edge reaching beyond the middle of its length.

Sternum finely granular throughout.

From *M. japonicus*, de Haan, with which I have also compared it, *M. teschi* may be distinguished by the following characters,—(i) the orbital borders are less oblique, (ii) the upper orbital border is finely crenulate and the lower serrate (in *M. japonicus* both are finely serrate), (iii) the antero-lateral margins are finely crenulate (rather coarsely tuberculate in *M. japonicus*), (iv) the palm is smooth dorsally and does not possess the row of granules found in *M. japonicus* on the upper part of the inner surface, (v) the whole inner surface of the chela, including the fingers, is densely clothed with hair, (vi) there are no spinules on the upper border of the dactylus of the chela, (vii) the posterior borders of the meropodites of the walking legs are finely crenulate, without the blunt spinules seen in *M. japonicus*.

In *M. definitus*, Adams and White, which I have not seen, the carapace is proportionately broader, the length being three quarters the greatest breadth ; the central portions of the carapace are smoother and there is a granular line, anteriorly convex, on each epigastric lobe. Moreover, the upper border of the palm is coarsely granulate in this species and there is a transverse ridge on the third abdominal segment.

[1] Except for an exceedingly fine frosting only visible with a powerful lens the surface is quite smooth to the touch.

I have seen no females of *M. teschi*; four males yield the following measurements (in mm.):—

	Length of carapace.	Greatest breadth of carapace.
Port Canning ..	.. 13·9	.... 22·7
Arakan Coast ..	.. 14·1	.... 22·9
Mergui ..	.. 14·9	.... 22·7
	.. 14·2	.... 21·7

It will be noticed that in the specimens from Mergui the carapace is proportionately a little longer than in the others.

The specimens examined are from the northern and eastern sides of the Bay of Bengal. The geographical distribution of the species appears therefore to be different to that of *M. depressus* which extends from the Red Sea to the Gulf of Manaar.

$\frac{9842}{10}$	Port Canning, Gangetic delta.	Bengal Fishery Dept. (B. Prashad).	One. Type.
$\frac{3714}{10}$	Arakan coast.	'Investigator.'	One.
$\frac{8138}{6}$	Mergui.	Mus. Collr.	Two.

Macrophthalmus gastrodes, Kemp.

1915. *Macrophthalmus gastrodes*, Kemp, *Mem. Ind. Mus.*, V. p. 228, pl. xii, fig. 5.

This species, described contemporaneously with the publication of Tesch's monograph, differs widely from all other members of the genus in the great proportionate length of the carapace and its very strongly divergent lateral margins. It is known only from two specimens obtained in water of variable salinity near the mouth of the Chilka Lake in Orissa.

EXPLANATION OF PLATE XXIV.

Macrophthalmus transversus (Latreille).

FIG. 1.—Chela of male.

Macrophthalmus convexus, Stimpson.

FIG. 2.—Chela of abnormal male.

Macrophthalmus sulcatus, Milne-Edwards.

FIG. 3.—Chela of male.
,, 4.—Antero-lateral angle of carapace : female.
,, 5.—Antero-lateral angle of carapace : male.

Macrophthalmus bosci, Sav. & Aud.

FIG. 6.—Antero-lateral angle of carapace.

Macrophthalmus crinitus, Rathbun.

FIG. 7.—Antero-lateral angle of carapace.

Macrophthalmus teschi, sp. nov.

FIG. 8.—Chela of male.
,, 9.—Type male in dorsal view : carapace 22·7 mm. in breadth.

Macrophthalmus telescopicus (Owen).

FIG 10.—Chela of male from the Gulf of Manaar.
,, 11.—Chela of male from Port Blair.

MACROPHTHALMUS.

XXVI. A NOTE ON THE MARINE INVERTEBRATE FAUNA OF CHANDIPORE, ORISSA.

By F. H. GRAVELY, *D.Sc., Assistant Superintendent, Zoological Survey of India.*

With

NOTES ON ECHIUROIDS.

By B. PRASHAD, *D.Sc., Officiating Director of Fisheries, Bengal, Bihar and Orissa.*

The following notes are based on visits to Chandipore in or about May of the years 1915, 1916, 1917 and 1919. I have to thank Dr. N. Annandale and Mr. S. W. Kemp for many of the identifications.

Chandipore is situated on the Orissa coast, about ten miles from Balasore. A stretch of jungle interspersed with muddy pools and creeks of brackish water, where Calling Crabs (*Gelasimus*) of various colours abound, is separated from the shore by a narrow belt of sand-dunes. The shore slopes very gradually, and a mile or more of wet sand or mud is uncovered at low tide. The Burhabalang River empties itself into the sea two or three miles to the north east, and a smaller stream at a somewhat greater distance to the south-west. The nature of the shore between tide-marks varies considerably in different places and there are patches of sparse low grass or sedge towards the latter estuary, where the ground is particularly muddy. The fauna includes estuarine species, such as *Bimeria fluminalis* and *Meretrix meretrix* as well as species which are essentially marine; but the greater part probably belongs to the latter category.

At the mouth of the Burhabalang River the open sea has evidently encroached on an old mangrove swamp, and the tide comes up over banks of stiff clay, where roots and stumps of bushes are still to be seen, and Calling Crabs and other species characteristic of the jungle swamps behind the sandhills are still abundant. This clay was examined in 1917 and 1919 only. Where the mangrove roots had been washed away and the fauna was more of a marine type the following invertebrates were found:—

COELENTERATA.

Burrowing Actinians. A few small specimens.

LAMELLIBRANCHIATA.

Solen sp. Very minute; siphons normal, *i.e.* not as in the Chilka Lake species (*Mem. Ind. Mus.*, pp. 354-355, fig. 5). Few specimens found.

Fragile burrowing Lamellibranch with very long siphons. Abundant.

GEPHYREA.

Thalassema branchiorhychus, Annandale and Kemp. Abundant in 1917. One doubtful specimen (without proboscis) found in 1919.

Thalassema microrhynchus, Prashad. With very small proboscis. One specimen only of this interesting new species found in 1919.

CRUSTACEA.

Isopod (? *Sphaerona*) living in burrows and rolling into a ball like a woodlouse when disturbed. Common in 1919.

Upogebia sp. One specimen only (1919).

Alphaeus sp. The snapping of its claws could be heard in all directions as one's weight pressed on its burrows.

The invertebrates found between tide-marks on the shore generally were as follows:—

COELENERATA.

Clavactinia gallensis, Thornely (*Report on the Pearl Oyster Fisheries of the Gulf of Manaar*, II, pp. 110-111, pl. i, fig. 3). Abundant on *Nassa* and other shells, both living and inhabited by hermit crabs.

Clavactinia sp. Much denser and more luxuriant than the former, and of a deeper pink colour, but possibly the same species. Found only on the exposed ends of Chaetopterid tubes in 1919.

Bimeria fluminalis, Annandale. (*Mem. Ind. Mus.*, V, pp. 111-114, text-fig. 10, pl. ix, figs. 3-3*a*). On post driven into sand between tide-marks. This species has not hitherto been found in the open sea.

Obelia spinulosa, Bale—(see Annandale, *Mem. Ind. Mus.*, V, p. 106, fig. 9.) On exposed ends of Chaetopterid tubes.

Cavernularia sp. Common every year except 1919, when no specimens were seen.

Virgularia sp. Apparently fairly common, especially in 1919, near low-tide mark. Occasionally specimens are found lying on the sand when they can readily be collected; more often they are embedded in mud or sand to within an inch or two of the top. When touched or disturbed by pressure they shoot down out of sight and out of reach with extraordinary rapidity.

Actinians are sometimes found attached to shells inhabited by hermit crabs. One species attaches itself to Chaetopterid tubes below the surface of the ground, rising up to spread its tentacles at the surface. The largest form (? *Cerianthus* sp.), common every year, except 1919 when none were found, lives with its elongate column deeply embedded in the sand, and its tentacles expanded, usually at the bottom of a slight depression in the ground.

POLYCHAETA.

Syllidae. Small worms, some of them strobilizing, found among *Obelia* on Chaetopterid tubes.

Polynoidae. Sometimes found in large shells inhabited by hermit crabs.

Spionidae. Small worms living among debris at base of *Obelia* on Chaetopterid tubes.

Chaetopteridae (? n. gen.). A small Chaetopterid with a single pair of tentacles, 7 short chaetigerous segments (including the specialized fourth segment), 2 longer ones, 2 very long ones and then a number of short ones, forms slender and strongly anulated hyaline tubes (diameter about 1 mm.) in the sand near low-tide mark. About 60 mm. of the tube project above the ground and are often covered with hydroids on which small nudibranchs feed and among which small Syllids and Spionids live. Actinians sometimes attach themselves to these tubes below the surface of the ground, stretching up to spread their tentacles in the water.

Other worm tubes, including tubes of *Pectinaria* washed up by the tide, are common.

MOLLUSCA.

Nassa. A large species is the commonest gastropod between tide-marks. Its shell is often covered with *Clavactinia gallensis* which is found on living individuals as well as on shells inhabited by hermit crabs.

Nudibranchs, probably minute Aeolids, were found eating and laying eggs among hydroids on Chaetopterid tubes. A larger nudibranch without cerata was washed up by the tide in considerable numbers in 1916.

Lamellibranch shells washed up by the tide are both varied and numerous. *Meretrix meretrix* is sometimes found alive on the surface of the ground between tide-marks.

ECHINODERMATA.

Small Echinoid shells are sometimes washed up by the tide, and were specially abundant in 1919, when a few living specimens were found between tide-marks. Their tube-feet were very small, and appeared to be useless for walking, this function having been taken over by the somewhat long purplish spines.

Crustacea.

Ocypoda macrocera, Milne-Edwards (see Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, II, p. 347) is by far the most striking crab on the beach on account of its bright red colour, large numbers and considerable size.

Scopimera investigatoris, Alcock (see Kemp, *Rec. Ind. Mus.*, XVI, pp. 316, 317) burrows in the sand at about high tide-mark, arranging its moderately large pellets beside a broad and very definite straight pathway from its hole.

Dotilla intermedia, de Man (see Kemp, *Rec. Ind. Mus.*, XVI, pp. 331–333, fig. 10) occurs to some extent with *Scopimera* but also extends a great deal further out. Where it burrows in sand that is not too wet it brings up pellets, somewhat smaller than those of *Scopimera*, and arranges them in concentric arcs which may be completed to form either a spiral or a series of concentric circles, with less definite paths across them from the burrow to the outside. When burrowing in wet mud it builds a sort of rampart round its hole, which often closes over it as a small dome. Two forms of male occur at Chandipore in this species (see Kemp, *loc. cit.*, pp. 331–333, fig. 10).

Macrophthalmus transversus, Latreille (see Kemp, *Rec. Ind. Mus.*, XVI, p. 386) lives further out towards low water than does *Dotilla*. It is usually common, but was very scarce in 1916. Its burrows are markedly oblique, not vertical as are those of *Ocypoda*, *Scopimera* and *Dotilla*.

Arachnida.

Limulus molluccanus, Latreille (see Pocock, *Ann. Mag. Nat. Hist.*, 7, IX, pp. 260-266, pl. v-vi; and Annandale, *Rec. Ind. Mus*, III, pp. 294-295), is moderately abundant.

Insecta.

Cicindela biramosa, Fabricius, is very abundant.

Cicindela quadrilineata, Fabricius, is sometimes to be found where the ground is muddy. In 1919 it was comparatively abundant on muddy sand at the mouth of the Burhabalang River. Both species are common seashore insects, living near high-tide mark, but I am not aware that they have been found so closely associated before. In Annandale and Horn's Annotated List of Indian Museum Cicindelinae (Calcutta, 1909) *C. biramosa* is recorded from various places from N. Canara on the Malabar coast to Java, and *C. quadrilineata* from Burma and Bengal to south of Madras; and the known range of the latter species is extended in the "Fauna of British India" to Sind and Baluchistan. More recent observations both by Dr. Annandale and myself suggest that *C. biramosa* is the common seashore species of the east and south-west coasts of the Indian Peninsula, that *C. quadrilineata* holds this position on the

northern parts of the west coast. Mr. Kemp found both on the coast of Portuguese India.

NOTES ON ECHIUROIDS FROM CHANDIPORE, ORISSA.

By B. PRASHAD, *D.Sc.*

In May 1919, Dr. F. H. Gravely obtained two specimens of Echiuroids from the mud-flats at Chandipore on the coast of the Bay of Bengal. The two specimens belong to the genus *Thalassema*, Gaertner, and are referable to two distinct species. One of the specimens is without the proboscis and so it is impossible to assign it to its species with any great certainty, but it bears in general shape and anatomy a very close resemblance to *T. branchiorhynchus*, Annandale and Kemp,[1] which was collected previously by Dr. Gravely at the same locality in fairly large numbers. The other specimen cannot be assigned to any previously known species and is described as a new one. This species is very important from a biological point of view, and affords an interesting example of the occurrence under essentially similar biological conditions of animals with exactly opposite types of apparently adaptive characters.

Thalassema branchiorhynchus, Annandale and Kemp.

1915. *Thalassema branchiorhynchus*, Annandale and Kemp, *Mem. Ind. Mus.*, V, p. 61, figs, 2, 3.
1919. *Thalassema branchiorhynchus*, Prashad, *Mem. As. Soc. Bengal*, VI, p. 324.

I assign the specimen without the proboscis to this species with some hesitation, because the most characteristic feature of the species—the proboscis—is absent. In the position of the proboscis a semicircular scar is to be seen, and from this it appears that the proboscis must have been cast off long ago, for the scar is quite healed up, and there is no trace of the openings of the vascular sinuses.

The specimen is preserved in an expanded condition, and is an elongated sickle-shaped organism much more pointed at the posterior than at the anterior end. The length is 31 mm. and the maximum breadth only 5 mm. The arrangement of the integumentary papillae is very similar to that described for the type-specimen. The general anatomy also is identical.

Thalassema microrhynchus, sp. nov.

There is a single specimen of this species from the same locality as the preceding one. Preserved in an expanded condition,

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[1] *Mem. Ind. Mus.*, V, p. 61 (1915).

it measures 26·5 mm. in total length, of which 1·4 mm. is formed by the proboscis. The greatest breadth at a point just behind the middle is 7 mm., but this measurement is very unreliable as it varies greatly with the state of expansion or otherwise at the time of preservation. In general shape the animal is elongate, slightly curved near the middle and pointed at both ends.

The proboscis, the length of which is only one nineteenth of the entire length of the body, is a rudimentary structure. Its cross section a little behind the tip would be more or less of a semi-circle, while near the base where the two margins are united the structure becomes quite tubular. In appearance it resembles the proboscis of *T. sabinum* described by me in another paper,[1] except that the structure is at a much lower grade of development. The two species agree in the lateral margins of the proboscis being united ventrally at the base, but in other respects such as the absence of finger-shaped outgrowths in the Indian form they are

Thalassema microrhynchus, sp. nov.
Ventral view of the proboscis and setal region, × 8.

quite different from one another. The distal free end of the proboscis is truncated. No ciliated groove is to be made out on the ventral surface but the inner surface anteriorly shows longitudinal furrows. The dorsal surface is practically smooth.

The body wall is covered with papillae, which near the two ends of the body are arranged in definite rings; between the rings of large papillae rows of much smaller ones are also visible. On the ventral surface of the body about the middle there is a crescentic area on which the adjacent papillae are united together to form small elongated ridges, but the individuality of the papillae can still be distinguished. The circum-anal region also shows distinct papillae covering it.

The ventral hooks are situated very near the anterior end; they are, as shown in the figure, very well developed and have the free projecting portion of the hooks very broad and curved.

[1] *Mem. As. Soc. Bengal*, VI, p. 325 (1919).

The longitudinal muscles form a continuous sheath and are not divided into bundles.

There are two pairs of segmental organs with their external openings behind the level of the ventral hooks. The vesicle is an elongated bag-like structure with the free closed end pointing backwards, and has the mouth of the internal funnel drawn out into very long spiral lobes.

The anal vesicles are of a simple type, about half the length of the body, and each provided with two rows of ciliated funnels on their anterior half. There is nothing special to note with regard to the rest of the anatomy.

The animal preserved in spirit after fixation in formalin is of a pale yellow colour; the proboscis, however, is very much lighter in tint, being creamy white.

Type specimen:—W $\frac{21^{a}}{1}$ in the collection of the Zoological Survey of India (Indian Museum).

The species under consideration belongs to the group of *Thalassema* treated of in my paper referred to above. The general anatomy and form are very similar; the most important feature, however, in which it differs from the forms discussed in that paper is the low grade of development of the proboscis. In discussing the different grades of development of this structure in the various species I stated, that in *T. sabinum* we have a form which shows the origin of small processes from the ventral margins of the proboscis, that in the second species *T. dendrorhynchus* the processes are much better developed even becoming dendritic by division, while in *T. branchiorhynchus* the processes are still better developed forming regular gills. The condition in the present form is even more primitive than in *T. sabinum*, for there is only a proboscis of a rudimentary type without any processes. *T. microrhynchus* in this respect represents probably the most primitive member of this group of the genus *Thalassema*.

A point of great biological interest arises from the occurrence under similar conditions of two such diverse forms as *T. branchiorhynchus* and *T. microrhynchus*, which stand at two extremes as to the development of the proboscis and the branchial processes. Specimens of the two species have been collected from the same locality, living under apparently similar biological conditions. The lines of evolution of respiratory structures in the two forms, however, are as divergent as possible. Whereas in *T. branchiorhynchus* the respiratory surface has been very greatly increased by the development of a large proboscis and very long, branched branchial processes, in the other (*T. microrhynchus*) the proboscis is quite rudimentary. Similar cases of adaptive characters of exactly opposite type developed by two species living in similar biological surroundings are not unknown elsewhere, and reference may be made to the various examples amongst sponges cited by Annandale.[1] In all these cases the two species have developed or at

[1] *Journ. 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).

any rate possess special characters adapting them to a peculiar habitat, but the structural peculiarities are of an exactly opposite nature. In the present case it is impossible to say whether the special structures have a particular physiological function, or whether they are merely highly developed in the one case and rudimentary in the other. We do not know what are the effects of this type of diverse evolution on the two species.

XXVII. ON THE GENERIC POSITION OF SOME ASIATIC UNIONIDAE.

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

This paper deals with the anatomy, etc. of Unionids from countries as far apart as the Malay Archipelago and Burma on the one hand and Palestine on the other.

I. ON THE GENUS *MONODONTINA*, Conrad.

In a recent paper,[1] while describing the soft parts of an Indian form of the genus *Pseudodon*, Gould, I questioned the propriety of Simpson's grouping[2] of the various species of that genus. This observation was based on a study of the soft parts of the species *P. salvenianus*, Gould—the type-species of the genus. I felt myself justified in making the remark referred to, because my description of *P. salvenianus* differed very materially from that of the genus *Pseudodon* as compiled by Simpson (*loc. cit.*) from Deshayes and Jullien's figure of *P. moreleti*.[3] It was, however, impossible for me to go into the question in any greater detail as I had no material of the other species. Through the courtesy of Mr. Van der Doop of Sumatra, Dr. N. Annandale recently received a large consignment of molluscs from Sumatra for identification, and he very kindly passed on the entire collection of Unionids to me. This collection, though consisting of a single form, has proved very valuable in enabling me to clear up a number of doubtful points regarding the synonymy of some of the species; as also of the various groups assigned by Simpson to the genus *Pseudodon*. According to that author, the species to which the specimens must be assigned is *P. chaperi* (de Morgan). The question of the validity of this species is, however, discussed at length further on.

To understand properly the situation regarding the generic name of the group to which the species under consideration belongs, it is necessary to go into the history of the type-species of *Monodontina*, namely *M. vondembuschiana* (Lea). This species was originally described by Lea as *Margaritana vondembuschiana*,[4] though in a later work [5] he changed the name to *Margaron* (*Mono-*

[1] *Rec. Ind. Mus.*, XVI, pp. 289-297 (1919).
[2] *Proc. U.S. Nat. Mus.*, XXII, pp. 501-1075 (1900).
[3] *Nouv. Arch. du Mus.*, X, pl. v, figs. 1-3 (1874).
[4] *Proc. Amer. Phil. Soc.*, I, p. 288 (1840). [5] Lea, *Synopsis*, p. 45 (1852).

condylea) *vondembuschiana*. H. & A. Adams,[1] recognizing the validity of d'Orbigny's genus *Monocondylea*, assigned the species to that genus. Later Conrad[2] established a new genus *Monodontina* for the same species,[3] abbreviating the specific name also; but subsequently, considering his new genus to be a synonym of Gould's *Pseudodon*, he again described the species as *P. vondembuschiana*. Simpson (*loc. cit.*), following Conrad, has included the form in the genus *Pseudodon*, making it however the type of a distinct group, which included a number of other species. This grouping on the whole is artificial, since widely different species such as *P. salvenianus* have been included in the group of *P. vondembuschiana*. A few other unimportant changes affecting the name of this species are given by Simpson.

The material from Sumatra has made it possible for me to examine the animal of a form of *P. vondemhuschiana*, and as a result of this examination I have found it necessary to revive Conrad's genus *Monodontina*—because the animal of the Sumatran species—a form of the type-species of *Monodontina*—is very different from that of the type-species of *Pseudodon*, namely *P. salvenianus*. I have also added a few notes on the synonymy of the other species, based on an examination of the collection of the Zoological Survey of India (Indian Museum) and a critical study of the excellent figures in Haas' incomplete monograph[4] and other available literature.

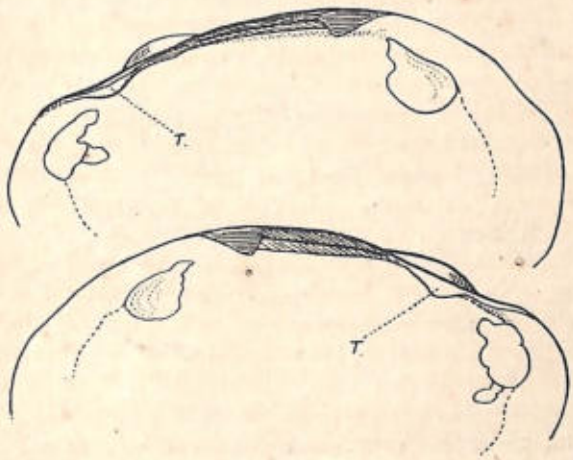
Of the species included by Simpson in this group *P. ellipticum*, *P. zollingeri*, *P. cumingii*, *P. aeneolus* and *P. tumidus* seem to be related to *M. vondembuschiana*, and will probably have to be assigned to Conrad's genus *Monodontina*. It is, however, impossible for me to go further into this question as no specimens of these forms are available. It is also impossible to express any opinion as to *P. thomsoni*, *P. cambodjensis* and *P. nicobaricus* owing to incomplete information, while *P. moreleti* cannot be included in the genus, for, as is shown in the rather poor figure of the soft parts by Deshayes and Julien (*loc. cit.*), the animal appears to be very different from that of *M. vondembuschiana*. Specimens of *P. inoscularis* identified as such by Mr. H. B. Preston, and now in the collection of the Zoological Survey of India, are undoubtedly no more than a variety of *M. vondembuschiana*, while specimens of *P. chaperi* also merge very gradually into this species. *P. zollingeri*, as stated above, is undoubtedly a distinct species, but I do not think that Mousson[5] was right in including in it shells which he described as var. *angulosa*, for this latter is probably nothing more than what I describe below as var. *chaperi*

[1] *Gen. Rec. Moll.*, p. 501 (1858).
[2] *Proc. Acad. Nat. Sci. Philadelphia*, VI, pp. 266-449 (1853).
[3] *Amer. Journ. Conchology*, I, p. 233 (1865).
[4] Martini und Chemnitz, *Conch. Cab.* (*ed.* Kuster), *Unio*. Owing to the war no further instalments of this work were received in the Calcutta libraries after page 256 and plate 59 (1910).
[5] *Moll. Java*, Zurich, p. 96, pl. xvii (1849).

of *M. vondembuschiana*. Simpson considers Mousson's species *Alasimodonta crispata* synonymous with *M. vondembuschiana*, but in my opinion it is a distinct species, as it was also considered to be by von Martens.[1]

Monodontina, Conrad.

As already stated, the genus was established by Conrad for Lea's species *Margaritana vondembuschiana*, with the following description: "Hinge with an obtuse rounded tooth immediately below the beak." It may be redescribed as follows:—Shell rather thin, rhomboid ovate, rounded in front, truncated posteriorly, with the result that the posterior margin is nearly straight; with a narrow wing and a feebly developed posterior ridge; in young specimens a second ridge also visible above the posterior ridge;



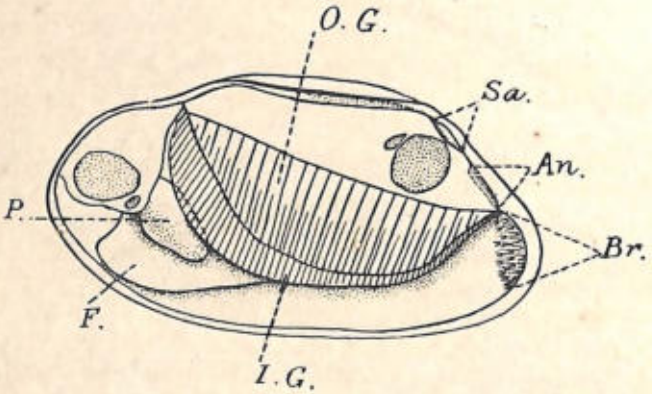
TEXT-FIG. 1.—*Monodontina vondembuschiana*, var. *chaperi*, hinge and muscle-scars.

umbo compressed, beak sculpture consisting of concentric zig-zag lines; shell practically smooth except for lines of growth; hinge-line straight (fig. 1); a single smooth cardinal tooth (T) in each valve, that of the right valve situated just in front of the umbo and fitting in front of that of the left valve; lateral tooth represented by a feebly developed ridge in each valve, its posterior limit having a triangular brownish scar containing a prolongation of the hinge-ligament; the two anterior muscle-scars prominent, uniting with one another and having very irregular outlines; posterior muscle-scars very faint and separate; nacre bluish, somewhat iridescent with a brownish marginal line running parallel to the border at a little distance from the edge.

The animal of the Sumatran form (fig. 2) has the inner pair of gills very much wider than the outer throughout their entire length.

[1] *Malakol. Blätter*, XIV, p. 13 (1867).

The inner lamellae of the inner pair of gills are attached to the abdominal sac only along one-third of their anterior length, while the posterior two-thirds is quite free until the lamellae of the opposite sides meet each other a little behind the posterior margin of the abdominal sac and unite to form the diaphragm. The outer lamellae of the outer pair of gills are united with the mantle all along. The diaphragm is complete and is formed only by the gills, there being no mantle connection between the branchial and the anal apertures, though the mantle-wall of the opposite sides is slightly drawn in. The palpi are well developed, rather ellipsoid in outline, with a narrow base of attachment to the abdominal mass and further attached along one half of their posterior margin to the mantle. The anterior margin of the gills is separated from the palps by a small gap. The branchial aperture is large with two to three rows of elongated papillae ; the anal is a little more



Text-fig. 2.—Animal of *M. vondembuschiana*, var. *chaperi*. *An.*=anal aperture ; *Br.*= branchial aperture ; *F.*=foot ; *I.G.*= inner gill ; *O.G.* outer gill ; *P.* palp ; *Sa.* supra-anal.

than two-thirds the size of the branchial and is quite smooth ; the supra-anal is much smaller than either and is separated from the anal by a small mantle connection. The foot is fairly large.

A comparison of the above description of a form of the genus *Monodontina* with that of *Pseudodon* described in my former paper (*loc. cit.*, p. 295) shows that the two genera differ from each other in the following respects :—

1. The inner lamellae of the inner pair of gills of *Monodontina* are free from the abdominal sac along two-thirds of their length, while in *Pseudodon* they are attached all along.

2. There is a distinct supra-anal in *Monodontina*, but owing to the absence of a mantle connection in the position between the anal and supra-anal of other genera there is no distinction between the anal and the supra-anal in *Pseudodon*.

3. The anal is quite smooth in *Monodontina*, whereas its lower part is papillose in *Pseudodon*.

4. The foot in the genus *Monodontina* is a much better developed structure than in *Pseudodon*.

Relationships.—Frierson [1] in discussing the relationship of *Pseudodon resuspinatus*, von Martens, says that the outline and sculpture are very like that of the genus *Virgus*, while specimens of *Nodularia* (probably *brandtii* from Japan) show a very close kinship to *Pseudodon* in the teeth and general facies. I do not, however, think that the comparison is quite correct for the sculpture of *Virgus* (vide Simpson, *loc. cit.*, p. 852) is quite different from that of any of the species of *Pseudodon* that I have seen, and also from that of the species that I now assign to the genus *Monodontina*. The hinge also is quite different in the two genera. The above remarks apply with equal force to the comparison made by the same author between *Nodularia* (probably *brandtii*) and *Pseudodon*, for the hinge and teeth in the group of *Nodularia japanensis*, to which *N. brandtii* belongs, are very different from those of *Pseudodon* and *Monodontina*. *Monodontina*, on the other hand, seems to have a rather close relationship with the group of *Nodularia contradens*, which Haas (*loc. cit.*, p. 173) has recently separated into a distinct genus *Contradens*.

Monodontina vondembuschiana (Lea).

1900. *Pseudodon vondembuschiana*, Simpson, *op. cit.*, p. 836.
1910. *Pseudodon vondembuschiana*, Haas, *op. cit.*, pl. xliv, figs. 4, 5.

A number of specimens of the typical form are present in the collection of the Zoological Survey, from Sarawak, and one specimen from the Philippine Islands (presented by the late Mr. W. Theobald). Mr. H. B. Preston also identified some shells (No. M$\frac{1905.1}{1}$) from Pegu as *P. vondembuschiana*, although he does not mention this species in his volume in the 'Fauna of British India.' These last-mentioned specimens, however, do not even belong to the genus *Monodontina*; they are rather specimens of *Pseudodon crebristriatus* and *P. peguensis*.

Var. chaperi (de Morgan).

1885. *Pseudodons chaperi*, de Morgan, *Bull. Soc. Zool. France*, X, p. 423, pl. ix, fig. 1.
1900. *Pseudodon chaperi*, Simpson, *Proc. U.S. Nat. Mus.*, XXII, p. 838.

Both de Morgan and Simpson considered this a distinct species. The large number of specimens of different ages received from Sumatra, however, show beyond doubt that it is no more than a variety of *M. vondembuschiana*. *P. zollingeri*, var. *angulosa* of Mousson (*loc. cit.*) also seems to me to be no more than a variety of that species. Indeed, it is probably identical with the var. *chaperi*, but it is impossible to express a definite opinion on this point without further material.

The record of the occurrence of this variety in Sumatra greatly extends its range, for it was previously known from

[1] *Nautilus*, XXIV, p. 97 (1911).

Cambodia and Siam only. It probably occurs also in the Malay Peninsula, the freshwater molluscs of which are little known.

Var. **inoscularis** (Gould).

1844. *Anodon inoscularis*, Gould, *Proc. Boston Nat. Hist. Soc.*, I, p. 160.
1900. *Pseudodon inoscularis*, Simpson, *Proc. U.S. Nat. Mus.*, XXII, p. 837.

There are two specimens of this form in the collection, one labelled "Tenasserim" and another "Tenasserim river."

It differs from the typical form in the shell being much smaller and more depressed, the posterior wing rather broader, the surface smoother and the cardinal tooth better developed.

Monodontina cumingii (Lea).

1850. *Anodonta cumingii*, Lea, *Proc. Zool. Soc. London*, p. 199.
1900. *Pseudodon cumingii*, Simpson, *op. cit.*, XXII, p. 837.

A single specimen from Cambodia in the collection belongs to this species.

A point worth noting about *M. cumingii* is that the origin of the cardinal tooth is exactly in line with the upper margin of the shell.

II. Sub-genera of *Unio* from the near East.

The specimens on which this part of the paper is based were collected by Dr. Annandale in 1912 in the Lake of Tiberias.[1] The entire collection of molluscs from this area was reported on by Preston,[2] but nothing was said by him about the anatomy of the various forms; further, the identifications of the two forms treated of in this paper are not correct in view of later work. One of the species belongs to Germain's recently proposed subgenus *Rhombunio*,[3] while I have found it necessary to give a new subgeneric name to the other species. Annandale[4] also has pointed out the great confusion that exists regarding the nomenclature of the various species of the genus *Unio* from Palestine, but I am unable to go into the question further owing to insufficient material of the related forms. I have, however, adopted Germain's plan of dividing the genus *Unio* into subgenera instead of groups as Simpson[5] had done, because Germain's idea conduces to a clearer understanding of the relationships.

Rhombunio, Germain.

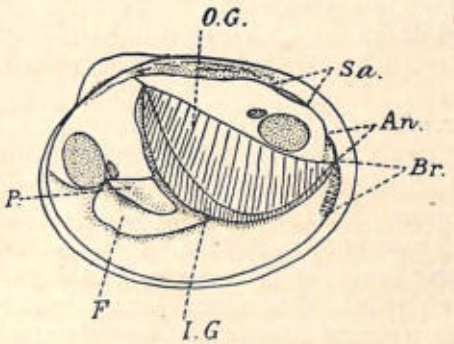
Germain proposed this subgenus in 1911 (*loc. cit.*) for a group superficially resembling that of *Unio littoralis* group. According

[1] For further details about locality, etc., reference may be made to *Journ. As. Soc. Bengal*, IX, p. 17 onwards (1913).
[2] *Ibid.*, pp. 465-476, pl. xxvii (1913).
[3] *Bull. Mus. D'Hist. Nat. Paris*, XVII, p. 67 (1911).
[4] *Journ. As. Soc. Bengal*, XI, p. 459 (1915).
[5] *Proc. U.S. Nat. Mus.* XXII, p. 679 onwards (1900).

to him this subgenus differs from *Unio, s.s.* in both shell characters and the soft parts. He stated in his paper that the account of the subgenus would be published later, but so far no such account has appeared.

In Dr. Annandale's collection there are three specimens of *Unio* (*Rhombunio*) *semirugatus* preserved in spirit; these were identified as *Unio simonis* by Preston. One of the three specimens is a gravid female. The following description of the soft parts of the sub-genus is based on this material.

Corresponding to the shape of the shell the gills (fig. 3) are fairly broad but rather short; the inner pair being much broader than the outer, particularly in the anterior half. There is only a very small gap between the anterior margin of the gills and the posterior margin of the palpi. The outer lamellae of the outer pair of the outer gills are attached to the mantle all along their length. The inner lamellae of the inner pair of gills are free from the abdom-



TEXT-FIG. 3.—Animal of *Unio* (*Rhombunio*) *semirugatus*, reference lettering same as in fig. 2.

inal sac except for a very short distance near the extreme anterior end; posteriorly the lamellae of opposite sides unite to form the diaphragm. The diaphragm is formed entirely by the gills, the mantle taking no part in its formation. The outer pair of gills alone are marsupial, but in these also a very small anterior and a much smaller posterior portion of each is not modified for a marsupial function. The margins of the marsupial gills are quite sharp even when the gills are charged with glochidia. The water-tubes in the gills are simple but well developed. The septa in the outer pair of gills are very crowded in the female, but in the male the arrangement is practically the same as in the inner pair of gills. The palpi are ellipsoid, attached to the abdominal sac along their base, and along nearly half of their posterior margin to the mantle. The branchial, anal and supra-anal openings are as is usual; the mantle connection between the anal and the supra-anal being nearly equal in length to the supra-anal and slightly larger than the anal, while the branchial is much larger. The branchial bears

three to four rows of elongated papillae at its edge, while the mantle covering also in this region is crenulate. The anal is smooth and so is the margin of the mantle below the branchial.

The glochidia (fig. 4) are very like those of *Physunio ferrugineus* [1] in outline, but have the hooks much better developed. They measure ·23 mm. × ·19 mm.

Text-fig. 4.—Glochidium of *Unio* (*Rhombunio*) *semirugatus*, × 75.

The animal of this sub-genus differs from that of *Unio, s.s.*, as described by Ortmann,[2] in having the whole organism of a much more compact type, the gills much shorter and broader, in the different shape of the palpi, the extent of the marsupial region and the very different shape of the glochidium.

Eolymnium, sub-gen. nov.

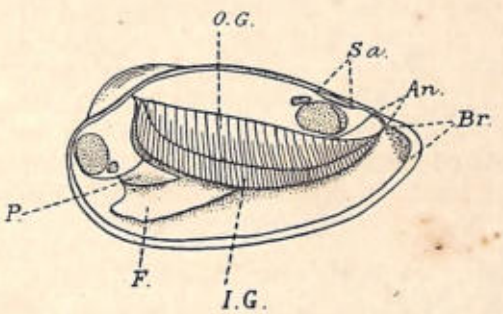
This new sub-genus is proposed for the species *Unio terminalis*, Bourguignat, and its allies. A large number of specimens of this species were collected by Dr. Annandale from the Lake of Tiberias in October, 1912.

Simpson (*loc. cit.*, p. 689) includes this species in his group of *Unio pictorum* (Linn.), the type of the section *Lymnium*, and Germain has followed him in calling the species *Unio* (*Lymnium*) *terminalis*. The soft parts of *Unio terminalis*, however, are very different from those of *U. pictorum* as described by Ortmann (*loc. cit.*, pp. 274-275). I have, therefore, found it necessary to separate *U. terminalis* into a distinct sub-genus. Reference here might also be made to the interesting controversy started by Thiele [3] regarding the validity of the generic name *Unio*. Haas [4] took objection to his statement and expressed the opinion that the name *Unio* could not be replaced by *Lymnium*, because Bruguière's name had priority over that of Oken. Ortmann,[5] who has recently summed up the whole situation very well, has come to the conclusion that *Lymnium* is nothing more than a synonym of *Unio* as restricted by Bruguière.

The animal (fig. 5) of the sub-genus *Eolymnium* may be described as follows:—The gills are elongate but relatively shorter than in *Unio pictorum*. The inner pair of gills is much broader than the outer throughout their length and the free region of the inner lamellae of the inner pair of gills is also much larger than in *U. pictorum*; the other attachments of the gills are similar to those described for *Rhombunio*. The outer pair of gills, except at the extreme anterior end, is marsupial, as was ascertained by cutting sections. The palpi are similar to those of *U. pictorum* except that they are more pointed

[1] *Rec. Ind. Mus.*, XIV, p. 184, pl. xxii, fig. 10 (1918).
[2] *Ann. Carnegie Mus.*, VIII, pp. 273-275 (1911-12).
[3] *Nachr. Bl. deutsch. Malakozool.*, XLII, p. 29 (1909).
[4] *Ibid.* pp. 68-72 (1909).
[5] *Nautilus*, XXV, pp. 88-91 (1911).

at the tip. The branchial aperture occupies nearly the whole of the curved posterior end of the shell and hence the anal is placed higher above; it is separated from the anal by a distinct notch and has three rows of elongated papillae on its margin. The anal is about half the size of the branchial and is smooth; it is separated from the supra-anal by a mantle connection a little more than half



TEXT-FIG. 5.—Animal of *Unio* (*Eolymnium*) *terminalis*, reference lettering same as in fig. 2.

the size of the anal and very much smaller than the supra-anal. The foot is rather poorly developed.

The glochidia are unknown, as none of the specimens are gravid.

This sub-genus comes near the group of *U. pictorum*, but differs in the general shape of the animal, the shape and size of the gills, the relations of the branchial, anal and supra-anal apertures, and in the poorer development of the foot.

XXVIII. CONTRIBUTIONS TO THE FAUNA OF YUNNAN BASED ON COLLECTIONS MADE BY J. COGGIN BROWN, B.Sc., 1909–1910.[1]

PART IX. TWO REMARKABLE GENERA OF FRESHWATER GASTROPOD MOLLUSCS FROM THE LAKE ERH-HAI.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India, and* B. PRASHAD, *D.Sc., Offg. Director of Fisheries, Bengal, Bihar and Orissa.*

Numerous fossil shells from the Miocene beds of Eastern Europe have been assigned (somewhat doubtfully we agree with Fischer[2]) to the family Pleuroceratidae or Pleuroceridae, but this family is usually believed to be confined in a living condition to North America. In the collection of molluscs made by Mr. J. Coggin Brown of the Geological Survery of India in Yunnan some years ago, we find numerous specimens of two species which we think may find a place at least provisionally among the Pleuroceratidae more conveniently than elsewhere. One of these species has already been described more than once, and has been placed by three different authors in three different genera of Hydrobiidae. Its proper name is *Fenouilia kreitneri* (Neumayr). The other species has not, so far as we can discover, been as yet described. It is impossible to separate it generically from the living and fossil Burmese and Chinese genus recently described by one of us under the name *Paraprososthenia*. It has, however, such marked conchological differences that we propose for its reception a new subgenus. We have named it *Paraprososthenia* (*Parapyrgula*) *coggini* in allusion to the name of its discoverer and to the *Pyrgula*-like appearance of the shell.

The precise locality at which both species were found is Shankuan at the north end of Erh-Hai. They were living on stones at the edge of the lake at a spot liable to strong wave-action.

The shells of *Paraprososthenia coggini* and *Fenouilia kreitneri* are very different in shape, that of the former being elongate and strictly conical, while that of the latter is trochiform. They resemble one another, however, in the structure of the mouth, which is pyriform with a continuous peristome and a thin, slightly everted outer lip, and is slightly produced posteriorly but broadly rounded anteriorly. Neumayr in 1880 placed *F. kreitneri*, on

[1] Former papers in this series were published in Vols. V-VII of the *Records of the Indian Museum* (1910–1912).

[2] *Man. Conchyl.*, p. 705 (1887).

shell-characters, in the genus *Lithoglyphus*. He was acquainted with the peculiarities of the radula to which we will refer later, but did not consider them of generic importance. In 1889 Heude erected a new genus (*Fenouilia*) for what we believe to be the same species. He was apparently ignorant of Neumayr's description and called the form *F. bicingulata*. This species was described for the third time in 1904 by Fulton under the name *Jullienia carinata*. The shell is very like that of *Lithoglyphus* but differs in the shape of the mouth (which is not shown quite correctly in Neumayr's figures); from *Jullienia* it differs in its thin outer lip.

The genus *Paraprososthenia*, or rather the only known recent species, was identified by Neumayr with the fossil genus *Prososthenia*. The latter is only known from the Miocene beds of Eastern Europe, while the living species inhabits Lake Tali Fu, in which *P. coggini* was also found. The fossil shells differ, however, in their thick outer lip and the resemblance is probably convergent. The subgenus *Parapyrgula* resembles the recent and fossil genus *Pyrgula* of Central Europe and the eastern Mediterranean basin in shell-characters, but has not quite the same type of sculpture and again differs in the distinctly pyriform shape of the mouth. Except in its very small size and delicacy of structure it closely resembles the shell of the N. American *Goniobasis*, the most prolific in species of the Pleuroceratid genera and the only one of which the geographical range extends to the Pacific coast of North America.

This resemblance in the outward form of the shell between *Parapyrgula* and *Goniobasis* would not be sufficient in itself to establish family identity, and in *Fenouilia* evidence of the kind is weak, depending as it does on a much less marked resemblance between the shell and that of *Anculosa*. The operculum of the two Chinese genera might equally well belong to the Hydrobiidae, to the Melaniidae or to the Pleuroceratidae. It is only when we examine the radulae that definite affinities begin to manifest themselves. According to Troschel's[1] figures the radulae of the Pleuroceratidae resemble those of the Melaniidae rather than those of the Hydrobiidae. The central tooth is small and transverse and its disc is without latero-basal denticulations or other projections. The tooth on either side of the central tooth differs greatly from the two outermost teeth and the dental formula would seem to be 2. 1. 1. 1. 2. The lateral tooth is characterized by the large size of the central denticulation. According to Stimpson[2] this feature is characteristic of the family as a whole, but Walker[3] in his recent synopsis of the N. American freshwater molluscs lays stress on the absence of basal denticulations on the central tooth.

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[1] *Das Gebiss der Schnecken* I, p. 109, pl. viii, figs. 7-9 (Berlin: 1856-63).

[2] For an account of certain features of the anatomy of the Pleuroceratidae see Stimpson, *Amer. Journ. Sci.* (1) XXXIII, pp. 41-63 (1864).

[3] In Ward and Whipple's *Fresh-water Biology*, p. 991 (New York: 1918).

The radulae of *Fenouilia* and *Parapyrgula* are very similar in general structure. They differ from those of all Melaniidae, Pleuroceratidae, Rissoidae or Hydrobiidae we have examined or seen figured (except the (?) Hydrobiid *Delavaya*, Heude[1]) in that the cusp of the central tooth is a simple elongate plate. This tooth is otherwise like that of the Hydrobiidae and Rissoidae, with latero-basal denticulations as in many genera of these families. The lateral and marginal teeth, however, resemble those of the American Pleuroceratidae, especially in the great enlargement of one of the denticulations of the laterals. As a whole the radula of these two Chinese genera is, therefore, intermediate in structure between that of the Hydrobiidae or Rissoidae and that of the American Pleuroceratidae, but it is no more different from the latter than the radulae of some genera of Hydrobiidae are from one another. Fischer[2] regards the presence or absence of latero-basal denticulations on the central tooth as a subfamily character, but this distinction is not accepted by all malacologists.

When the soft parts of *Fenouilia* are examined its real divergence from the Hydrobiid type becomes apparent. From this type it differs in the shape of its head, in the position of its eyes and above all in the complete absence of a copulatory organ in the male. The distal part of the genital system, especially in the male, is also simpler, the intestine is more capacious and the gill-filaments are longer, extending almost completely across the dorsal wall of the branchial chamber. Unfortunately the anatomy of the Pleuroceratidae is imperfectly known, but the absence of a copulatory organ is well established in all the genera that have been examined. We have satisfied ourselves that this organ is also absent in males of *Fenouilia* diagnosed by a microscopic examination of the gonad. Stimpson's figure of the living *Anculosa dissimilis* shows clearly that the eyes are situated just behind the cleft between the tentacles and the head, and this is precisely their position in *Fenouilia*. The latter also differs from all the Hydrobiidae of which we have particulars in that the head is spindle-shaped, with a distinct neck. Whether this is the case in the Pleuroceratidae we have no information. Stimpson states that the only visible difference between the sexes in *Anculosa* (= *Mudalia*) is the presence of a groove on the right side of the body of the female between the tentacle and the base of the operculiferous lobe of the foot. We think that we have detected a similar groove in female specimens of *Fenouilia*, but they are too much contracted to permit a dogmatic statement.

Of *Paraprososthenia* we have examined only dried specimens of *P.* (*Parapyrgula*) *coggini*. So far as we can say, they resemble those of *Fenouilia* preserved in spirit, but we rely in placing the

[1] Heude, *Mém. Hist. Nat. Emp. Chinois*, 1, p. 172, pl. xxxiii, figs. 8, 9, 10, 10*a*. See also Bavay and Dautzenberg (*Journ. de Conchyl.*, LX, p. 37 : 1912), who regard *Delavaya* as a subgenus of *Pachydrobia* and ascribe to it several species from the Mekong.

[2] *Man. Conchyl.*, p. 724 (1887).

two genera together rather on the resemblance between the radulae than on other anatomical grounds.

The conclusion we derive from the above observations is that the genera *Fenouilia* and *Paraprososthenia* are not Hydrobiidae but resemble the Pleuroceratidae, within the limits of which they may be included provisionally, rather than any other family.

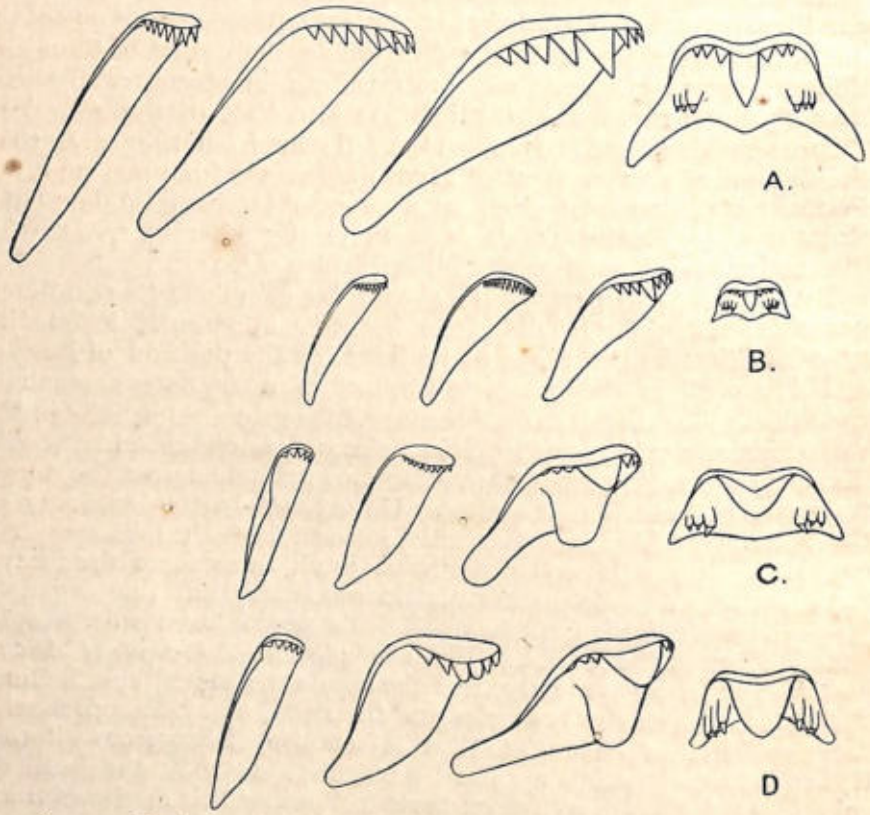

FIG. 1.—Radulae of Hydrobiidae and (?) Pleuroceratidae from China and Europe.
A. *Lithoglyphus fuscus*, Zieg. from E. Europe.
B. *Lithoglyphus liliputanus*, Gredler, from the Tong-Ting Lake, China.
C. *Fenouilia kreitneri* (Neumayr) from Erh-Hai Lake, China.
D. *Paraprososthenia coggini*, sp. nov. from the same lake.

Their possible relationship to the Rissoidae cannot be discussed in a satisfactory manner owing to lack of anatomical information about that family. Some relationship to forms like those included in the genus *Iravadia*, Blanford, is not impossible, but the position of that genus is also doubtful. It is found in brackish water, chiefly in the estuaries of the Ganges and Irrawaddi and also in the backwaters of the West Coast of India.

Neumayr[1] in describing *F. kreitneri* alluded, as we have already stated, to the peculiar form of the central tooth, but did not regard this character as of generic importance and placed the species in the genus *Lithoglyphus*. This genus is made the type of a subfamily by Fischer,[2] who describes the Lithoglyphinae thus: "Pied simple; plusieurs denticulations basales; verge simple ou fourchue; opercule corné, spiral ou subspiral." The only other species from China ascribed to *Lithoglyphus* is *L. liliputanus*, Gredler, of which there are specimens (apparently cotypes or paratypes) in the Museum collection. We have extracted the radula from one of these and find it differs little from that of the European *L. fuscus*. The radular teeth of *L. fuscus* have been figured by Troschel.[3] Our preparation differs from his figure only in having the chief denticulation of the lateral tooth relatively larger. We figure the teeth of *L. liliputanus* and *L. fuscus* for comparison with those of *F. kreitneri*.

Genus **Fenouilia**, Heude.

1880. *Lithoglyphus*, Neumayr, *Wiss. Ergebn. Reise B. Szechenyi* II, p. 655.
1889. *Fenouilia*, Heude, *Journ. de Conchyl.* XXXVIII, p. 46.
1890. *Fenouilia, id., Mém. Hist. Nat. Emp. Chinois* I, p. 172.

The only known species has experienced some vicissitude of nomenclature at the hands of three authors who have described it under as many generic and specific names. Heude described it as *Fenouilia bicingulata*, gen. et sp. nov., while Fulton called it *Jullienia carinata*. We have been able to compare specimens named by Fulton with topotypes of Neumayr's species.

Heude's original description of the genus (1889) ran as follows:—*Testâ trochoideâ, imperforatâ; operculo corneo, paucispirali, nucleo basali. Animali probabiliter rissoino.* Later (1890) he added, *radulâ 3. 1. 3., laminâ mediâ integrâ, laterali paucidentatâ.* So far as it goes, this is a correct description of the shell, operculum and radula, except that we read the dental formula 2. 1. 1. 1. 2. Heude, moreover, published in 1890 some good figures of the soft parts drawn by Rathouis, and most of these we have been able to substantiate by dissecting specimens from Mr. Coggin Brown's collection. Our examination of specimens diagnosed as male by a microscopic examination of the gonad shows that the vas deferens ends in a simple pore the margin of which is not even invaginated. The peculiarities of the head and branchial chamber to which we have alluded are also clear.

Fenouilia kreitneri (Neumayr).

1880. *Lithoglyphus kreitneri* (with varr.), Neumayr, *op. cit.*, p. 655, pl. iv, figs. 7-8.
1889. *Fenouillia bicingulata*, Heude, *op. cit.*, p. 46.

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[1] *Wiss. Ergeben. Reise B Szechenyi* II, p. 655.
[2] *Op. cit.*, p. 724. [3] *Op. cit.*, I, p. 105, pl. vii, figs. 12, 12*a*.

1890. *Fenouillia bicingulata*, *id.*, *op. cit.*, p. 172, pl. xxxiii, fig. 11.
1904. *Jullienia carinata*, Fulton, *Journ. Malac.* XI, p. 52, pl. iv.

The species has been described from three different lakes in Yunnan, as *Lithoglyphus kreitneri* from Erh-Hai (Tali Fu Lake), as *Fenouilia bicingulata* from Lake Hai Si in the same district and as *Jullienia carinata* from Yunnan Fu Lake (K'un-Yang Hai) some distance further east. The specimens we have examined are from the first and the last of these lakes. The shells from Erh-Hai are smaller and apparently thinner than the types of the species from the same lake and also than those named by Fulton *Jullienia carinata* and there is less variation among them than was the case in Neumayr's specimens. Several of them, however, possess a varix across the body-whorl as in Heude's type-specimens of *F. bicingulata*. We see no reason to think that specimens from the three lakes represent more than one species. It is unnecessary for us to redescribe the shell, but for convenience's sake we give a translation of Neumayr's description.

"Shell small, blunt, conico-ovoid, stout, dextral, non-umbilicate, consisting of four whorls sharply separated by an impressed suture; upper whorls convex, but the last flattened. Shell sculptured with stout growth-lines and with 1–2 spiral keels; base flattened. Mouth shortly ovoid, pointed and strongly contracted above, strongly recurved below; peristome continuous; inner lip swollen, outer lip quite sharp. Shell covered with an olive-green epidermis."

Neumayr also describes in the same place two varieties, *carinata* and *bicarinata*, the names of which practically explain themselves. Our specimens belong to the form *carinata*.

We have examined a number of specimens in spirit. They are fairly well preserved, but brittle and contracted. The operculum is relatively large, very thin, horny, of a pale yellow colour, regularly ovoid, broadly rounded anteriorly and bluntly pointed posteriorly. It has an extremely delicate narrow colourless inner border Its sculpture is obscure, but it is possible to detect the nucleus situated near the inner anterior border and surrounded by a spiral of two or three whorls, above which curved lines radiate onwards to the base of the membranous inner margin. The external surface of the operculum is thickly covered with diatoms in all the specimens examined.

The foot appears to have been broad in proportion to its length, bluntly pointed behind and truncate in front, with a broad lobular antero-lateral process on either side. The operculiferous lobe was relatively large. There is a sharply-defined narrow transverse groove running across the sole a short distance behind the anterior margin In a contracted specimen diagnosed by microscopic examination of the gonad as female, a distinct longitudinal groove runs along the right side of the body from just behind the tentacle to the base of the operculiferous lobe. When the animal was expanded this groove may have had a vertical or nearly vertical direction.

The head is distinctly spindle-shaped, bluntly pointed in front and tapering to a short contracted neck behind. The snout is of moderate length. The mouth is a longitudinal slit, entirely ventral in position except when the head is much contracted, with tumid, corrugated lips The tentacles are rather stout but taper to their apex. They are situated rather far back on the head. The eyes are very large and prominent, though sessile. They seem to have a peculiar construction, being covered with integument except for a minute pinhole in the centre. The retinal cup is relatively large, deeply pigmented and of an oval shape. The situation of the eyes is peculiar, for they are situated one at the base of each tentacle just behind the point at which it diverges from the head.

The edge of the mantle is smooth and pale, the remainder being deeply stained with black pigment. The mantle is ample and its margin is free all along the outer end of the branchial chamber, which is relatively large. The gill consists of numerous narrow but rather deep ridges, which run almost completely across the roof of the chamber and are not differentiated at either extremity. The osphradium is well developed and ridge-like.

The mouth opens into a short conical muscular pharynx, which is rather shorter than the buccal mass. The muscles of this mass are large and powerful, forming a well developed bulb. The horny lateral jaws are situated inside these muscles, forming in contraction a thin longitudinal plate at either side of the radula. They are merely cornified and pigmented patches on the sides of the alimentary canal, with ill-defined outlines and with an obscurely squamous structure. The radula is narrow and of moderate length. The central tooth is relatively large and of transverse form. Its lower margin is sinuous and its lower lateral angles are pointed. The cusp is broadly rounded at the tip, considerably narrower and shorter than the disk. There are three latero-basal denticulations on each side, each pedunculate. The lateral tooth is hardly at all bent but consists of a relatively narrow slanting basal part and a broad upper part bearing a broad, downwardly directed lobe on its disk. The main denticulation is triangular, but rather bluntly pointed. It occupies rather less than a third of the free margin and has two or three small denticulations on either side. The inner marginal tooth is not much broader than the outer and has its denticulation, of which there are a considerable number, smaller and sharper. Neither marginal is much narrower below than above, both begin to taper a short distance above the base. The outer marginal has an elongate triangular membrane on its outer margin. The oesophagous is rather long, narrow, cylindrical and sinuate. The salivary glands, situated at the posterior end of the buccal mass, are small and their ducts short. We have not been able to trace the alimentary canal further inwards. The intestine is a relatively capacious tube which opens by a simple pore on the edge of the mantle on the right side, running along the outer edge of the branchial cavity. The faecal pellets it

contains are of large size, very compact and somewhat spindle-shaped.

The most remarkable feature of the anatomy lies in the fact that there is no intromittent organ in the male. The lower part of the oviduct and of the vas deferens is alike a simple tube opening near the anus on the right side of the body. We have satisfied ourselves of this fact by dissecting a considerable number of specimens, of which we have also examined the gonads microscopically. Unfortunately the condition of our material renders it impossible to investigate the genitalia further.

Heude (*op cit.*, 1890, pl. xxxiii, fig. 11*e*) reproduces a figure of the central nervous system drawn by Rathouis. It shows the whole structure as being compact with rather short commissures. The optic nerves are, however, long. The otocysts are situated just in front of the supraœsophageal ganglia. Each otocyst, as we have satisfied ourselves, contains a single circular otocyst.

Imperfect as is this description of the anatomy of *Fenouilia*, it is sufficient to prove its wide divergence from the Hydrobiid type.

Genus **Paraprososthenia**, Annandale.

1919. *Paraprososthenia*, Annandale, *Rec. Geol. Surv. Ind.* L (3), pp. 209-240.

This genus, although it closely resembles *Prososthenia*, Neumayr, from the Miocene beds of Eastern Europe in form of shell differs in sculpture and in the structure of the lip, which is thin and somewhat expanded instead of thickened and contracted. Nothing is known of the soft parts, radula or operculum, but the shape of the shell and the structure of its mouth are so close to those of the new species here described that we think they must be united, notwithstanding certain obvious differences, as subgenera of a single genus. For the new subgenus we propose the name *Parapyrgula* in allusion to the resemblance, probably quite superficial, between the shell and that of *Pyrgula* from central Europe and the eastern parts of the Mediterranean basin.

Parapyrgula, subgen. nov.

The shell is elongate, narrow, strictly conical, with the base rounded and somewhat produced. Its substance is delicate and fragile but not very thin. There is a very delicate periostracum. The suture, which is sometimes almost obsolete externally, has a peculiar involute structure owing to each whorl growing over and pressing closely round the base of the one preceding it. The shell is imperforate. Its mouth, which is not very oblique, is of moderate size and of distinctly pyriform outline, slightly produced posteriorly. The peristome is continuous and there is a rather thick columellar callus, but the outer lip is thin. The only prominent sculpture is a single smooth spiral ridge on the body-whorl.

The operculum resembles that of *Fenouilia*.

The radula is also similar to that of that genus, but the denticulations of the teeth are for the most part longer and more

pointed. The cusp of the median tooth is simple and it bears several large latero-basal denticulations at each side. This tooth is not so high as in *Fenouilia* and has the base emarginate. The inner lateral tooth is relatively broad.

Type-species. *Paraprososthenia coggini*, sp. nov.

Distribution. Only known from the lake Erh-Hai, Yunnan.

In outline and general structure the shell of this subgenus resembles, as we have already noted, the North American Pleuroceratid genus *Goniobasis*. The size is, however, much reduced and the structure of the shell more delicate. The structure of the suture resembles that of *Pleurocera clevatum*, Say, shells of which we have examined.

Paraprososthenia (Parapyrgula) coggini, sp. nov.

The shell is narrow and elongate, sharply pointed at the apex and not at all expanded at the base. It is about twice as long as

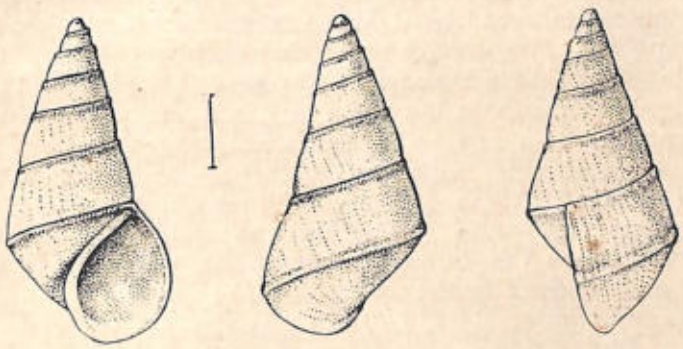

FIG. 2.—Shell of *Paraprososthenia (Parapyrgula) coggini*, sp. nov.

broad. The shell-substance is translucent bluish white like opal-glass, the periostracum pale yellow; but all the specimens examined are covered with a dense growth of diatoms which gives them an almost furry appearance. There are $7\frac{1}{2}$ or 8 whorls, but the terminal whorl or half-whorl is minute and slightly depressed. The other whorls increase gradually and evenly. The suture is oblique and linear when not obliterated externally. It is sometimes accompanied by a low flattened spiral ridge, which runs above it. The spiral ridge on the body-whorl is narrow but slightly flattened and not very prominent. The minute sculpture of the shell consists of numerous longitudinal and transverse striae. On the body-whorl fine longitudinal grooves are also sometimes disposed at fairly regular intervals, but they are often obsolete. The mouth of the shell is large, $1\frac{2}{3}$–$1\frac{3}{5}$ times as long as broad and a little more than $\frac{1}{3}$ as long as the whole shell. Anteriorly it is rounded and a little produced, while posteriorly it has a subcanaliculate structure. The callus is moderately developed, the outer lip strongly arched

and the columella curved. The main axis of the aperture forms an acute angle with that of the shell.

Measurements of shells (in millimetres).

	A (*type*)	B	C	D
Length of shell ..	10·3	9·5	8·5	8·8
Maximum diameter of shell	5	4·5	3·7	3·6
Length of spire (dorsal view)	6	5·3	4·5	4·8
Length of aperture ..	3·4	3·5	2·4	2·4
Breadth of aperture ..	2·2	2·2	1·7	1·7

We have extracted the dried animal from a shell. It seems to resemble that of *Fenouilia* but is much shrivelled. The operculum is ovoid, thin, horny, of a dark brown colour and resembles that of *F. kreitneri* in sculpture.

We have already pointed out certain characters in which the radula differs from that of *Fenouilia*. The following is a more precise account of the differences. The central tooth is low in proportion to its breadth, its base is produced at either side and sharply pointed but broadly and rather deeply concave. The cusp is very large, extending downwards far beyond the base of the tooth. The lateral tooth is bent in such a way that the narrow basal part makes an obtuse angle with the broad upper part. The main denticulation of this tooth is very large, occupying nearly half the free margin. The inner marginal tooth is much broader than the outer marginal and its denticulations are blunt. The triangular membrane on the outer margin of the outer marginal tooth is short and confined to the upper third.

Type specimen: M 11598/2 in the collection of the Zoological Survey of India.

Locality. Erh-Hai (Tali Fu Lake), Yunnan, W. China, alt. 6,700 ft.

The shape and structure of the shell are so like those of *Paraprososthenia gredleri* (Neumayr) from the same lake that we do not consider a complete generic separation possible in the present state of our knowledge. It must be remembered, however, that we know as yet nothing but the shell of *P. gredleri*. The resemblance in the shell to that of *Pyrgula*, Cristofora & Jan (of which the anatomy seems to be equally unknown) is probably quite superficial. If we are right in thinking that the anatomy resembles that of *Fenouilia*, as the radula undoubtedly does, there can be no relationship to *Oncomelania*, Gredler (= *Hypsobia*, Heude), the soft parts of which, according to Heude,[1] are of the Hydrobiid type. In considering the value of the radula as a guide to affinities, however, it must be remembered that the same author (*op. cit.*, pl. xxxiii, fig. 8) figures the teeth of *Delavaya* (which also appears to be of the Hydrobiid type and is regarded by Bavay and Dautzenberg on shell-characters as no more than a subgenus

[1] Heude, *Mem. Hist. Nat. Emp. Chinois* I. pl. xxxiii, figs. 1-7 (1890).

of the undoubted Hydrobiid genus *Pachydrobia*, Crosse & Fischer) as being not unlike those of *Fenouilia* in certain respects.

ADDENDUM.

Just as this paper was going to the press to be printed off, I received through the courtesy of the Rev. Father Courtois, S.J., a small but valuable collection of Chinese shells from the Zi-Ka-Wei College. It includes specimens of *Delavaya rupicola*, Heude, apparently cotypes. These shells could not be separated generically from *Paraprososthenia coggini* on conchological grounds, but they seem to be specifically distinct. If Heude's figures are correct, there are considerable differences in the radula and possibly the anatomy, and should our species prove to be so closely related to *D. rupicola* as it appears to be on shell-characters, the subgeneric name *Parapyrgula* will have to give place to *Delavaya*, of which *Paraprososthenia* will become a subgenus. The relationship between *Fenouilia* and these forms may therefore be less close than we thought, for no great reliance can be placed on apparent resemblances in the soft parts of dried specimens. I doubt in any case that *Delavaya* is really congeneric with *Pachydrobia*.

20th September, 1919. *N. Annandale.*

XXIX. THE POSSIBLE OCCURRENCE OF *SCHISTOSOMA JAPONICUM*, KATSURADA IN INDIA.

By R. B. SEYMOUR SEWELL, *F.A.S.B., Capt. I.M.S., Surgeon-Naturalist to the Marine Survey of India and Offg. Superintendent, Zoological Survey of India.*

(With Plate XXV).

During the past few months I have been engaged in investigations directly or indirectly connected with the introduction into India of the African and Mesopotamian forms of the human-infecting Schistosomes. These investigations are a continuation and elaboration of those begun by Mr. S. W. Kemp;[1] in the course of them I have undertaken the systematic examination of large numbers of freshwater molluscs in various parts of India and have discovered numerous cercariae hitherto unknown. Most of these belong to groups that have little interest to others than zoologists, but quite recently I have discovered in one of the tanks in the Calcutta area a cercaria that is a true Schistosome and that seems likely to have considerable practical importance from a medical point of view. I have therefore decided, having found it possible to give a full description, not to delay publication of my results in this respect.

The cercaria is, as far as it is possible to judge from the very detailed description and clear figures published by Cort,[2] and the further particulars given by Faust[3], morphologically indistinguishable from that of *Schistosoma japonicum*, Katsurada, a very important parasite of man in China and Japan.

Cercariae Indicae XXX.

This type appears to be a true Schistosome and is almost identical, if not absolutely so, with *Sch. japonicum*. The cercaria is a small one and is a feeble swimmer, as viewed in a watch glass. It appears to move tail first, dragging the body behind it, by vigor-

[1] Kemp and Gravely, *Ind. Journ. Med. Res.* (in the press).

[2] Cort, W. W. "The cercaria of the Japanese blood-fluke, *Schistosoma japonicum*, Katsurada." *Univ. Californ. Publ. Zool.*, Vol. XVIII, No. 17, pp. 485-507, 3 figures in text: Berkeley, 1919.

[3] Faust, E. C. "Notes on South African cercariae. *Journ. of Parasitology*, Vol. V, No. 4, p. 164: Urbana, 1919.

ous lashing of the tail. Under a cover slip it only makes feeble progress owing to the fact that its anterior end appears to be not a true sucker but an organ devised for penetrating the host tissues. The body is frequently bent from side to side and is capable of a very great degree of extension and retraction. Furthermore, the anterior end forms a protrusible snout which is sometimes thrust out to form a round papilla and from time to time is retracted within the anterior end of the animal, thus forming a depression which at first sight might be thought to be the cavity of an anterior sucker. The animal has a marked tendency to shed its tail while under observation.

Owing to the extreme degree of extension and retraction of the animal it is difficult to get the exact measurements in the live state. So far as my observations go the measurements of the cercaria are as follows :—

When the body is extended it measures 0·196 mm. in length × 0·025 mm. in breadth and when contracted 0·090 mm. × 0·050 mm. The tail seems to be capable of a certain degree of extension and varies in length in different specimens from 0·186 to 0·221 mm. The furcal rami are short and are capable of extension and contraction, having in a contracted condition a wrinkled appearance. They vary in length from 0·071 to 0·096 mm. The body is comparatively transparent and in consequence it is very easy to make out the details of the structure. The whole of its surface is covered by minute spines which extend as far forward as the limit where the body-wall joins the sides of the anterior sucker-like structure. The tail is rather more sparsely covered with spines that appear to be slightly hooked and are comparatively large and both furcal rami are armed with spines along the margins. The anterior sucker-like structure is pyriform in shape and measures 0·043 mm. by 0·032 mm. when the animal is in the state of retraction but during the extension of the body this pyriform mass becomes considerably longer and narrower. Behind the point where the body-wall joins the anterior "sucker" the wall of this latter organ is thick and is provided with a strong layer of circular muscle-fibres. Internally the great bulk of the organ is filled with a granular mass, the head gland, while laterally and posteriorly are a number of small parenchymatous cells, also granular in appearance: the ducts from the cephalic glands, of which there are five on each side, enter this pyriform structure on its ventro-lateral aspect and pass forwards to open at the tip of the protrusible snout. Each duct is tipped at its orifice by a hollow conical spine of which there are ten in all. The acetabulum is small and is situated about $\frac{1}{4}$ the distance from the posterior end of the body, its external opening is Y-shaped, the two limbs of the Y pointing forwards and one limb backwards: it measures in diameter 0·014 mm. Its external surface is covered with a number of fine spines and it is capable of some degree of protrusion and retraction but normally forms only a small projection on the ventral aspect.

The most obvious feature in the body is the large group of five pairs of cephalic glands that occupy the posterior ½ to ⅔ of the body. These glands are pyriform in shape and each cell has a wide and conspicuous duct that runs forward to enter the head gland as noted above. These cells appear to be of two kinds. The anterior two pairs are coarsely granular while the posterior three pairs are finely granular, and each possesses a large and conspicuous nucleus. Cort (*l.c.*, p. 501) makes no mention of any such differentiation in the cephalic gland cells of *Sch. japonicum.* He states that all five pairs of cells possess acidophilic cytoplasm, as is also the case in the present species. The ducts belonging to the two groups of cephalic gland cells can also be distinguished; those from the three posterior pairs are large and lie ventrally in a U-shape, while those from the anterior two pairs are small and are situated side by side in the opening of the U on the dorsal side.

The alimentary canal is extremely reduced. The mouth opens ventrally by a small orifice situated far forward just in front of the junction of the body-wall with the head-gland. A narrow intestine passes backwards as far as the anterior two pairs of cephalic glands and there is no trace whatever of any pharynx.

The excretory system is of the typical Schistosome type and agrees exactly with Cort's description of the excretory system in *Schistosoma japonicum.* Three pairs of flame cells are situated in the body. Of these the anterior pair is situated laterally, external to the ducts of the mucin-gland canals about midway between the head-gland and the anterior pair of cephalic gland cells. The second pair of flame cells is situated in the interval between the coarsely granular and finely granular cephalic gland cells, rather to the lateral side; while the posterior pair of flame cells is situated opposite the last pair of cephalic glands. A small excretory bladder is situated at the extreme posterior end of the body and from this two wide canals pass forwards and outwards, reaching as far forward as the anterior margin of the acetabulum; they then curve backwards and divide into anterior and posterior branches. The main canal is in two places somewhat dilated and each dilation contains a vibratile flagellum of the same type as the flagella of the flame cells but longer and narrower. The presence of these extra vibratile structures is important as one is very liable at first sight to confuse them with true flame cells and thus to consider the number of flame cells to be five pairs instead of three. The anterior and posterior "collecting tubules" each divide into two branches running to the flame cells. The second branch from the posterior "collecting tubule" leaves the body and passes into the tail to the fourth pair of flame cells that is situated on either side of the caudal excretory tube close to the root of the tail. The caudal tube enters the posterior end of the bladder by a typical "islet" opening: at the posterior end of the tail the tube bifurcates, a branch passing along each fork to open to the exterior in a cup-like depression situated at the extreme tip of the ramus.

The genital gland forms a mass of small round cells situated ventrally and immediately behind the posterior margin of the acetabulum. In addition to this group of cells there is along the posterior and lateral border a series of five or six large round cells with clear protoplasm and a small granular nucleus. It would seem probable that these large cells represent the rudiments of the testes, while the central mass of small cells represents the rudiments of the ovary.

The cercariae develop in elongate sausage-shaped sporocysts. In some cases, however, the sporocysts appear to be more or less oval or pyriform. Each sporocyst contains two or three mature cercariae; occasionally some of the cercariae appear to become encysted either in the sporocyst or in the substance of the liver outside. In these cases the cyst is of an elongate oval shape and has a thin clear wall, the cercaria lying within the cyst in a partially extended state and not, as is the case in most encysted forms, curled up into a spherical ball. The cercariae appear to reach the full development within the sporocyst before leaving it to enter the host's liver tissue. The liver of an infected snail is of a yellowish brown colour and has a mottled appearance owing to the sporocysts appearing on the surface.

The host. The cercariae develop in either *Planorbis exustus*, Desh. or in a form of *Limnaea amygdalum*, Troschel, in a tank in Russa Road South, Tollygunge, Calcutta.

	Present species.	*Sch. japonicum.*
Size.		
Body.	90 — 196 μ × 50 μ.	100 — 210 × 66 μ.
Tail trunk.	186 — 221 μ × 25 μ.	150 μ × 20 μ.
Furca.	71 — 96 μ.	75 μ.
Oval sucker.	32 μ × in transverse diam. × 43 μ in length.	33 μ in transverse diam. × 54 μ in length.
Mucin glands.	5 pairs of pyriform cells with large nuclei and with granular acidophilic cytoplasm; the anterior two pairs coarsely granular and the posterior three pairs finely granular.	5 pairs of pyriform cells with large nuclei and granular acidophilic cytoplasm. Cort makes no mention of any difference in the various cells.
Mucin ducts.	Very thick.	Very thick.
Duct openings.	At anterior end of protrusible snout; capped by five pairs of hollow, piercing spines.	At anterior end of protrusible snout; capped by five pairs of hollow, piercing spines.
Germ cells.	Clustered mass of cells just behind antabulum along the postero-lateral margin 5-6 large round cells with granular nuclei.	Clustered mass of cells just behind antabulum.
Parthenita.	Sporocyst.	Sporocyst.

In the accompanying table, adapted from Faust (*l.c.*, p. 167), I have given the main characters of the present type and of the cercaria of *Schistosoma japonicum* in parallel columns. The present form appears to be very slightly smaller as regards the body and a trifle longer in the tail, but owing to the degree of contractility

possessed by the animal these differences are of so slight a character as to be negligible and the difference in shape between my examples and the figure given by Cort of *Sch. japonicum* is of no importance in so protean an animal; the differentiation of the cephalic gland cells in the Indian form into coarsely-granular and finely-granular cells is a physiological rather than a morphological difference.

The occurrence of animal-infecting forms of Schistosome in India has been known since the researches of Montgomery [1]—and the finding of a cercaria, stated to be that of *Schistosoma spindalis*, Montgomery, has been recorded by Glen Liston and Soparkar,[2] but as no details of structure are given by these authors it is impossible to compare their specimens with the present form.

The final test of the identity of this form with that of *Schistosoma japonicum* lies in the similarity or otherwise of the adults and experiments are now being carried out to obtain the fully-grown sexual stage of this parasite.

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[1] Montgomery. "Observations on Bilharziosis among animals in India." *Journ. of Trop. Vet Sci.*, Vol. I, p. 16, 1906.

[2] Glen Liston and Soparkar. "Bilharziosis among animals in India. The life-cycle of *Schistosomun spindalis*." *Ind. Journ. of Med. Res.*, Vol. V, p. 567, 1918.

EXPLANATION OF PLATE XXV.

FIG. 1.—Cercariae Indicae xxx; the whole animal, ventral view.

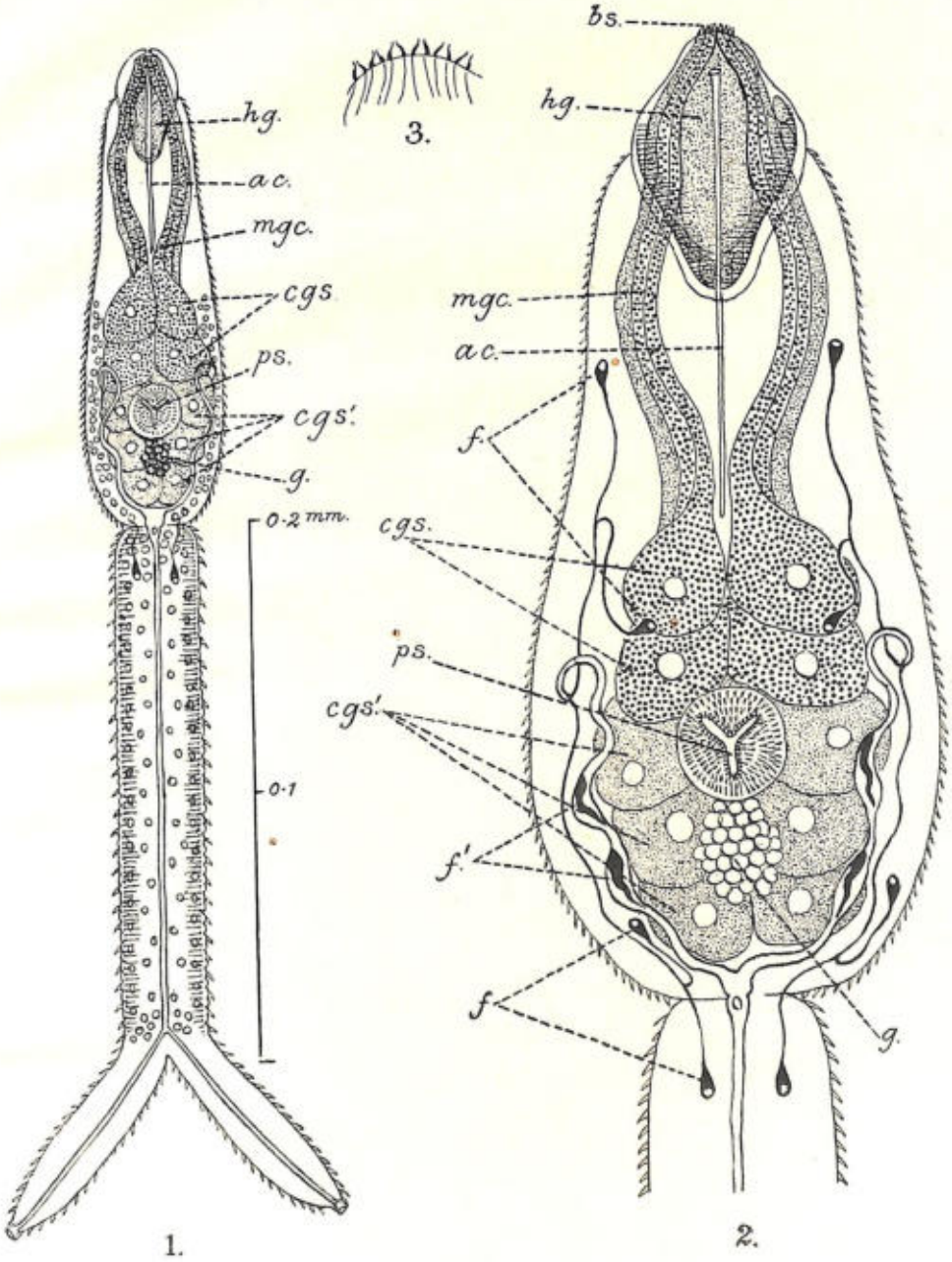
,, 2.—Cercariae Indicae xxx; the body enlarged, ventral view hollow.

,, 3.—Cercariae Indicae xxx; the hollow boring spines capping each mucin duct.

EXPLANATION OF LETTERING.

ac = intestine: *bs* = boring spines: *cgs* = coarsely granular cephalic-gland cells: *cgs'* = finely granular cephalic-gland cells: *f* = flame cells: *f'* = flagellae working in the main excretory tubes *: *g* = gonad (ovary): *hg.* = head-gland: *mgc* = mucin gland canals: *ps* = posterior sucker.

* These are shown much larger than is actually the case for purposes of clearness. They are actually much smaller than the flame cells.



R. B. S. S. del.

CERCARIAE INDICAE : TYPE XXX

MISCELLANEA.

MOLLUSCA.

On the Genus *Mysoria*, Godwin-Austen.

This was described in the *Records of the Indian Museum*, Vol. XVI, pt. iii, April 1919; type *Bithynia costigera*, Küster. I find the name is preoccupied, Mr. G. K. Gude has kindly pointed this out to me. It has been used for a genus of the Insecta, *Zoological Record*, 1893, p. 248. I have therefore to propose in lieu the title *Mysorella*. In connection with this genus Dr. Annandale in a recent letter dated 4th June alludes to species of *Valvata* from the intertrappean beds of Nagpur. It is interesting we had come independently to the same opinion. When looking at Plate XIV, *Geology of India* by Medlicott and Blanford my attention was called to the figure of the species *multicarinata* placed in *Valvata*, and which appeared much more likely to be a *Mysoria* or rather a *Mysorella*. *Valvata minima*[1] it would be necessary to see in its fossil state, it is so small, and only one view of it is given

The generic position of many species on this plate appear to me very doubtful, particularly those of *Lymnea subulata*, *telankhediensis* and *spina*, those assigned to *Paludina* and even *Physa prinsepii*. It would be most interesting to examine the fossils; this I hope to do, should they be represented in the Natural History Museum. They certainly require critical examination. They belong to a very distinct molluscan fauna and further close search in beds of this age would no doubt yield many more species. It is apparent very much has to be done in these intertrappean beds, with their distinct, widely separated vertical horizons. Very recently I met Capt. B. G. Gillett who was employed before the war constructing a reservoir near Khandala and was returning to Bombay. He told me he had noticed fossil shells in the sections excavated and promised to look them up and collect specimens.

H. H. Godwin-Austen, Lt.-Col.

Nore, 9th *July*, 1919.

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[1] I have recently examined specimens of "*Valvata*" *minima* and believe them to belong to *Gyraulus*.—*N. Annandale.*

XXX. NOTES ON INDIAN COCCIDAE OF THE SUB-FAMILY DIASPIDINAE, WITH DESCRIPTIONS OF NEW SPECIES.

By E. Ernest Green, *F.E.S.*, *F.Z.S.*

(Plates XXVI—XXXI).

Since the publication of my last enumeration of Coccidae from the Continent of India ('*Mem. Dep. Ag. Ind.*' Ent. Ser., II, No. 2, Ap. 1908), many fresh records have accumulated, including a considerable number of undescribed species. The present paper deals with those belonging to the sub-family Diaspidinae, describing the new species and listing others that have not previously been recorded from India. Of the fifty species now added to the Indian list, twenty are here described for the first time. It is only to be expected that, in such a vast and (in this respect) unexplored region, we can have touched no more than the fringe of the subject. Every fresh parcel that I receive discloses one or more novelties.

I am indebted to T. V. Ramakrishna Aiyar, of the Agricultural College, Coimbatore, for repeated consignments of valuable and interesting material. I have also had the privilege of examining collections from the Indian Museum, from the Agricultural Research Institute (Pusa), from the Forest Zoologist (Dehra Dun) and from the Poona Agricultural College.

Diaspis cinnamomi-mangiferae, Newst.

(Pl. XXVI, fig. 1*a*).

Female puparium thin, semitranslucent, whitish, circular. Dried insect pallid: probably yellowish in life. Form similar to that of *D. rosae*: the thoracic area broad, the abdominal area constricted. Pygidium with median lobes smaller, narrower, and less divergent than in *rosae*.

On *Mangifera indica*: Bangalore (*Ramakrishna*, No. 114).

Diaspis loranthi, Green.

(Pl. XXVI, fig. 1*g*).

On *Loranthus cordifolius*: Paresnath, Bihar, 4000 ft. (*Ind. Mus.* No. 71). Differs from *rosae* in the larger, more prominent and more rounded median lobes, which extend far beyond the lateral lobes. Dr. Annandale writes of this species, "It has perhaps

some economic importance, for it was strictly confined to the Loranthus upon which it was found in some abundance, and species of Loranthus have been known to do serious damage to forest timber in the Himalayas. I could find no trace of the Coccid on the tree on which the Loranthus was growing."

Diaspis rosae (Bouche).

(Pl. XXVI, fig. 1*b–f*).

On *Loranthus* sp.: Ootacamund (coll. E.E.G.). On *Hemigyrosa*: Courtallum, Tinnevelli District (*Ramakrishna*, No. 141).

D. rosae varies considerably in the size of the median lobes; but they are always more or less pointed at the outer extremity, and scarcely project beyond the lateral lobes. Figs. *b* to *f* represent examples of *rosae* from different localities, showing a gradual increase in the size of the median lobes.

Chionaspis annandalei, n. sp.

(Pl. XXVI, fig. 2*a–c*).

Puparium of female sordid white, pellicles castaneous. Form elongate, straight or slightly curved, very narrow; underside with a ventral scale enclosing the insect and ova, except for a narrow median slit which remains open—as in *Mytilaspis gloveri*. Length 2 to 2·5 mm. Greatest breadth 0·3 mm.

Male puparium pure white, with a rather indistinct median carina: pellicle castaneous. Length 1·25 mm.

Adult female (fig. 2*a*) elongate, linear; the cepalo-thoracic area occupying more than half the length of the body. Pygidium (fig. 2*b*) with six prominent lanceolate lobes, of which the median are slightly the largest: the two lateral lobes are situated close together on each side, but are separated by a considerable interval from the median lobes. All the lobes have radices extending far back into the pygidium. There is a conspicuous marginal pore between the median lobes, one in the space between the median and lateral lobes, and others at intervals on each side beyond the lobes. Squames spiniform. Anal and genital orifices near the base of the pygidium. There are no circumgenital pores. The oval dorsal pores are numerous and conspicuous, and are arranged as shown in the figure. Length 1 to 1·5 mm.

Nymphal pellicle (fig. 2*c*) with a well defined division between the thoracic and abdominal areas.

On stems of *Dendrocalamus strictus*. Paresnath Hill, 2500 ft., Bihar (*N. Annandale*, 10-iv-1909).

Chionaspis caroli, n. sp.

(Pl. XXVI, fig. 3*a–b*).

Puparium of female snowy white; smooth; pellicles fulvous. Form elongate, moderately dilated behind. Owing to the position

taken up by the insect (on the extreme margins of the leaves), the sides of the puparium are turned down, clasping the edge of the leaf (see fig. 3*a*). Average length 2 mm.

Male puparium (see also fig. 3*a*) white; narrow elongate; transverse section lenticular; without any trace of carinae; attached by the anterior extremity only, the rest of the scale tilted up from the leaf. Average length 1·5 mm.

Adult female narrow in front, widest across the abdomen, increasing in width up to the segment immediately preceding the pygidium. Lateral margins of abdominal segments moderately produced. Pygidium (fig. 3*b*) rounded. Median lobes very small, inconspicuously dentate on free edge: first lateral lobes duplex, the inner lobule large and conspicuous, with rounded entire margin, the outer lobule small and bluntly pointed, other lobes obsolete. Squames spiniform, tubular, unusually long and slender. Circumgenital glands in five groups: median group with from 10 to 12 pores, upper laterals 15 to 17, lower laterals 14 to 16. Oval dorsal pores in short diagonal series on the pygidium and on the preceding two segments; other similar pores on margins of remaining abdominal segments, and—occasionally—on the margins of the thorax. Length 1 to 1·25 mm.

On leaves of tea plant: Darjiling (*C. B. Antram*). The female insects disposed along the recurved edge of the leaf; male puparia in small groups on the undersurface of the leaves.

The species is well characterized by the exceptionally small median lobes.

Although the male puparia are not carinated, I consider that the insect bears closer relationship to the genus *Chionaspis* than to *Lepidosaphes*, in which it might otherwise be included.

Chionaspis chir, n. sp.

(Pl. XXVI, fig. 4*a–e*; Pl. XXVII, fig. 5*f*).

Puparium of female snowy white; smooth and shining; pellicles reddish, often partially obscured by a layer of white secretion: long-ovate or pyriform, rather strongly convex in transverse section. Average length 2·75 mm. Breadth 1·4 mm.

Male puparium not observed.

Adult female (fig. 4*a*) oblong ovate, narrower in front, broadly rounded behind. Anterior spiracles with a small group of parastigmatic pores. Lateral area of meso-thoracic and of the first three abdominal segments with numerous minute circular pores. Pygidium (fig. 5*f*) with evenly rounded margin, broken by four conspicuous pore-bearing prominences on each side: the extremity (between the innermost pair of marginal pores) varying—often asymmetrically—in almost every individual examined. In the most symmetrical form (fig. 4*d*), there is a small median conical point followed, successively, on each side, by a prominent lanceolate process, a broad tridentate process and an irregularly falcate

process. The tridentate processes are probably homologous with the usual median lobes. The lateral lobes are possibly represented by a minute process immediately caudad of the second marginal pore. In one example (fig. 4*c*) all of the median processes have been suppressed, leaving the margin—at this part—irregularly sinuate. Squames represented (if at all) by a few minute projections towards the base of the pygidium. Circumgenital glands in four groups: the upper lateral group with from 13 to 17 pores, the lower laterals with from 34 to 41 pores. Dorsal oval pores numerous, large and conspicuous: in regular series following the contour of the suppressed segments. Anal orifice near the base of the pygidium. Length 1·5 to 2 mm.

On 'Chir Pine' (*Pinus* sp.): Almora, Kumaon, U.P. (coll. Forest Zoologist, Dehra Dun.)

It is with considerable hesitation that I have assigned this insect to the genus *Chionaspis*. The characters of the covering scale, and most of those of the insect itself, suggest its affinity to Maskell's genus *Poliaspis*. But that genus was founded especially to contain species possessing more than five groups of circumgenital pores, of which this insect has four only—an unusual number in any Diaspidine genus, except *Parlatoria* and *Aspidiotus*, with neither of which can this species be associated.

Chionaspis (Phenacaspis) gudalura, n. sp.

(Pl. XXVII, fig. 6*a*, *b*).

Puparium of female (fig. 6*a*) circular, the larval pellicle projecting beyond the margin; slightly convex above. Colour clear white, the pellicles castaneous. Average diameter 2 mm.

Male puparium white: strongly tricarinate. Length approximately 1 mm.

Adult female ovate; length approximately equal to twice the breadth. Pygidium (fig. 6*b*) broadly rounded. Median lobes occupying a slight median depression; their bases united, their distal edges divergent, without serrations or indentations. Lateral lobes duplex, prominent; the first laterals distinct, the two lobules of approximately equal size; the second laterals in the form of thickened marginal prominences, the inner lobule with an oval dorsal pore at its base. Squames spiniform. Marginal spines inconspicuous. Anal orifice central. Circumgenital glands in five groups, with numerous pores; median group 16 to 25; upper laterals 30 to 42, lower laterals 29 to 28. Oval dorsal pores conspicuous, in broken longitudinal curved series. Length 1·5 mm. Breadth approximately 0·75 mm.

Massed on the stems of a large species of Bamboo. Gudalura, Nilgiris (coll. E. E. Green).

This is one of those species which reveal the close affinity between the *Phenacaspis* section of the genus *Chionaspis* and the *Aulacaspis* section of *Diaspis*, the chief distinction between which

appears to be that in the former the larval pellicle is ultra-marginal, while in the latter it is intra-marginal in position.

Chionaspis spiculata, n. sp.

(Pl. XXVII, fig. *7a–d*, *8e*, *f*).

Puparium of female (fig. *7a*) elongate and very slender; straight, parallel-sided, posterior extremity tapering abruptly to a point, exuviae fulvous, secretionary appendix white, sides sloping upwards to a median ridge which extends the whole length of the puparium. Length 2·25 to 3 mm; breadth approximately 0·25 mm.

Male puparium not observed.

Adult female (fig. *7d*) long and narrow, more than half the length occupied by the thoracic area. Pygidium (fig. *8e*, *f*) without the usual chitinous lobes; but with a terminal series of longish acuminate processes (7 or 8 on each side) of which the median two are longer and stouter than the others. These processes are possibly homologous with the tubular squames of other species, but do not appear to be associated with any glandular ducts. Circumgenital glands in five groups, the upper three forming a more or less continuous arch: average number of pores,—median 2, upper laterals 4, lower laterals 7 to 8. Dorsal pores large and conspicuous (see fig. *8f*), sausage-shaped, placed transversely. Diagonal series of similar pores on each side of the abdominal segments. Anterior spiracles with 3 or 4 parastigmatic pores. Length 1 to 1·25 mm.

Nymphal pellicle (fig. *7b*) narrow, acuminate behind: the posterior extremity (fig. *7c*) with six prominent, slender, acuminate processes.

On foliage of *Bambusa* sp. Peria Ghat, N. Malabar, 2000 ft. (*Ramakrishna*, No. 126–part).

This is a very distinct insect, quite unlike any other known species. It is placed provisionally in the genus *Chionaspis*, pending the discovery of the male puparium.

Chionaspis (Phenacaspis) varicosa, Green.

(Pl. XXVIII, fig. 9).

Green, "*Cocc. Ceylon*," II, p. 146, pl. L (1899).

On *Loranthus*, Dodabetta, Nilgiris (*Ramakrishna*, No. 74), and on *Piper* sp. Coorg, Sidapur (*Ramakrishna*, No. 62).

The Indian form (fig. 9) has the median lobes rather more strongly divaricate than in typical examples from Ceylon, and shows a single spiniform squame on the margin of the fourth space, in place of the group of three or four that occur in the same position in typical examples. The female puparium, also, is longer and narrower than in the type, and does not exhibit the conspicuous raised lines that characterize examples from Ceylon.

Chionaspis acuminata, Green.

On *Evodia*. Peria Ghat, North Malabar, 2,000 ft. (*Ramakrishna*, No. 127–part).

Chionaspis acuminata var **atricolor**, Green.

On *Tamarindus* and *Carissa*. Coimbatore (*Ramakrishna*, Nos. 124 and 147).

Chionaspis elongata, Green.

On *Bambusa* sp. Ootacamund (coll. E. E. Green).

Chionaspis litseae, Green.

On 'Ghumti.' Darjiling District. (Ex coll. Ind. Mus.).

Chionaspis megaloba, Green.

On *Zizyphus jujuba*. Pusa (*T. B. Fletcher*, No. 44).

Hemichionaspis chionaspiformis, Newst.

On 'Wild Indigo.' Coimbatore (*Ramakrishna*, No. 122).

Dinaspis permutans (Green).

On Evodia. Peria Ghat, 2,000 ft., N. Malabar (*Ramakrishna*, No. 127–part).

Aspidiotus (Hemiberlesia) pseudocamelliae, n. sp.

(Pl. XXVIII, fig. 10).

Puparium of adult female ochraceous (when on the twigs or the upper surface of the foliage), whitish (on undersurface of foliage): pellicles darker ochreous, occupying the greater part of the area of the scale. Form irregularly circular, slightly convex above. Diameter 0·75 to 1 mm.

Male puparium slightly paler in colour: ovate. Length 0·75 mm.

Adult female broadly ovate: bluntly pointed behind. Pygidium (fig. 10) with a single median pair of large prominent lobes, their inner edges converging and rather closely approximated, their free edges sloping steeply and indented at one or two points. Squames very slender and inconspicuous, spiniform, obscurely pectinate outwardly: the three or four outermost squames each on a slight prominence. Marginal spines long and conspicuous. A well-marked claviform paraphysis running inwards from the outer edge of each median lobe. Anal orifice ovate; distant from the posterior extremity by about a quarter the length of the pygidium. No circumgenital pores. Oval dorsal pores conspicuous: in two irregular series on each side. Length 0·5 to 0·75 mm.

Thickly clustered on the smaller twigs and on both surfaces of the leaves of *Capparis stylosa*. Ittige, Bellary District (*Ramakrishna*. No. 64).

The species differs from *camelliae* in the nature of the squames, which are not broadly pectinate, as in that species, and in the greater number and size of the oval dorsal pores. The puparia, also, are quite distinctive.

Aspidiotus tamarindi, n. sp.

(Pl. XXVIII, fig. 11*a*, *b*).

Female puparium irregularly oval or subcircular, flattish. Colour stramineous, ochreous, or pale castaneous, the darker examples being situated on the upper surface of the leaves. Diameter 2 mm.

Male puparium small; oblong oval, slightly narrower behind. Colour rather paler than that of the female scale, occasionally whitish. Length 0·75 mm.

Adult female (fig. 11*a*) evenly turbinate, without any indications of abdominal segmentation. Pygidium somewhat produced: the margin (fig. 11*b*) with six prominent, somewhat narrow lobes; all the lobes with a translucent band across the base; the median lobes are markedly indented on each side; the lateral lobes indented on the outer side only. Squames very thin and delicate, the distal extremity of each deeply fringed; those in the interlobular spaces ligulate; the ultra-lobular squames (of which there are six or seven on each side) broader, and acutely pointed at the inner edge. Anal orifice small, circular, approximately central. Circumgenital glands in four groups; the upper groups with 7 or 8, and the lower with 3 or 4 pores. Numerous slender filiform ducts communicate with inconspicuous marginal (and ? dorsal) pores. Length 1 to 1·25 mm.

On *Tamarindus*. Coimbatore (*Ramakrishna*, No. 26–part).

Crowded on both surfaces of the leaflets Male puparia intermingled with those of the females.

Aspidiotus cyanophylli, Sign.

On 'Ceara Rubber.' Nilgiris, 2,000 ft. (*Ramakrishna*, No. 53–part).

Aspidiotus hartii, Ckll.

On *Curcuma*. Poona (*H. H. Mann*, No. 34).

Aspidiotus rossi, Mask.

On *Carissa carandas*. Coimbatore (*Ramakrishna*, No. 36).
On 'Pomegranate.' Bilaspore, C.P. (*T.B. Fletcher*, No. 38).

Odonaspis penicillata, Green.

On *Bambusa*. Coimbatore (*Ramakrishna*, No. 134–part).

Odonaspis simplex? (Green).

On *Bambusa*. Coimbatore (*Ramakrishna*, No. 134-part).

Aonidia indica, n. sp.

(Pl. XXVIII, fig. 12*a*, *b*).

Puparium of female circular, moderately convex, the median area usually depressed or slightly concave; secretionary margin very narrow, the centre of the scale usually bare. Colour pale castaneous, the secretionary margin grayish brown. Diameter approximately 0·5 mm.

Male puparium larger; broadly ovate; the larval pellicle nearer one extremity. Colour dull grayish brown. Length 0·75 mm.

Adult female circular, the pygidium slightly prominent. Posterior extremity of pygidium (fig. 12*a*) somewhat truncate; with eight small rounded or slightly indented lobes, the median pair largest, the others decreasing in size to the outermost. Between the lobes are some delicate fimbriate or truncate squames, and there are three or four similar squames beyond the outermost lobe, on each side. Anal orifice relatively large, near the posterior extremity. Length approximately 0·5 mm.

Posterior margin of nymph (fig. 12*b*) with six prominent lanceolate lobes, the median pair slightly indented on each side. There are also six large and conspicuous semilunar marginal pores.

On undetermined plant. Museum Compound, Calcutta (*N. Annandale*).

Aonidia tentaculata, n. sp.

(Pl. XXIX, fig. 13*a–d*).

Female puparium flattish, dull castaneous, consisting of the large, naked nymphal pellicle upon which is superimposed the smaller larval pellicle—of a darker shade of brown. The nymphal pellicle is of the peculiar form shown at fig. 13*a*, the thoracic area widely expanded, subcircular, the narrow parallel-sided abdominal area projecting posteriorly. The substance of the pellicle is densely chitinous, with a markedly granular structure, and with concentric series of irregularly oval clearer spaces. There is a sharply defined narrow marginal border. The posterior extremity of the pellicle (fig. 13*b*) exhibits six well defined lobes, of which the median pair is very small and slender, the others broader and hastate in form. The intervals between the lobes are occupied by broad ligulate squames, and there are three obscurely dentate squames immediately exterior to the outermost lobe. The margin beyond the lobes is deeply incised at seven or eight points, and there are seven conspicuous lunate pores on each side. Length 1 mm. Width of thoracic area 1 mm., of abdominal area 0·3 mm.

Adult female (fig. 13*c*) with thoracic area broadly crescentic; the projecting pygidium tapering to a sharp point, its distal

extremity with a marginal series of sixteen long and slender spathulate processes (fig. 13*d*), beyond which is a single strong marginal spine on each side. Three small blunt projections on each side probably represent rudimentary pygidial lobes. Length 0·75 mm. Breadth 0·75 mm.

On *Vateria indica*. Quilon, Travancore (*Ramakrishna*, No. 146–part). Associated with *Websteriella vateriae*.

The species is well characterized by the remarkable spathulate tentacle-like processes on the pygidium.

Aonidia crenulata, Green.

On *Vatica lanceifolia*. "Makum Forest, Assam" (*Lindinger*).

Aonidia dentata, Lindinger.

On *Walsura piscidia*. "Kamlekum Hill, India" (*Lindinger*).

Aonidia spinosissima, Lindinger.

On *Mimusops hexandra*. "Central-India" (*Lindinger*).

Aonidia targioniopsis, Lindinger.

On *Miliusa velutina*. "Burma" (*Lindinger*).

Aonidia viridis, Lindinger.

On *Aglaia minutiflora*. Travancore (*Lindinger*).

Gymnaspis ficus, n. sp.

(Pl. XXIX, fig. 14*a*, *b*).

Puparium of female consisting of the swollen nymphal pellicle, sometimes with a superimposed larval pellicle: very broadly ovoid, strongly convex. Colour ochreous yellow, the centre with a dark patch where the colour of the dried insect shows through the semitranslucent scale. Length 0·6 mm. Breadth 0·5 mm.

Male puparium oblong: consisting of the yellowish larval pellicle at the anterior extremity, and a white secretionary appendix. Strongly convex on the anterior half, depressed behind. Length 0·75 mm. Breadth 0·5 mm.

Posterior margin of nymphal pellicle (fig. 14*a*) with six narrow lanceolate, prominent lobes: the median pair strongly indented on each side, the lateral lobes indented weakly on the inner but more strongly on the outer side.[1] Two large and conspicuous lunate pores on each side, situated in the interlobular spaces, and two or three similar but smaller pores beyond the lobes. Squames broad and deeply fringed.

[1] The lithographic artist has not reproduced quite correctly the outline of these marginal lobes.

Adult female subcircular or broadly oval. Rostral apparatus very large and conspicuous. Pygidium (fig. 14*b*) rounded, the margin serratulate at the extremity. A denser chitinous area surrounds the anal orifice and extends to the genital region.

On *Ficus retusa*. Kollegal, Coimbatore (*Ramakrishna*, No. 22).

Gymnaspis ramakrishnae, n. sp.

(Pl. XXIX, fig. 15*a–f*).

Female puparium consisting of the enlarged nymphal pellicle alone, the larval pellicle almost invariably becoming detached during the later growth of the nymph. The nymphal pellicle (fig. 15*c*, *d*) is broadly oval in outline, with a sharply defined pygidial area, in front of which the disc of the dorsum rises abruptly into a rounded dome-like protuberance. A lateral view (see fig. 15*d*) is suggestive of the shape of one of the shrapnel helmets used by our troops during the recent war. Length approximately 0·5 mm.

The early nymph (fig. 15*e*) is of the same contour, but shows no sign of the dorsal elevation. The pygidial area is strongly demarked, and recessed into the abdominal segments. The pygidial fringe (fig. 15*f*) is like that of a typical *Parlatoria*, with six small but prominent lobes and broad fimbriate squames.

Adult female (fig. 15*a*) subspherical; the pygidial area slightly projecting, weakly chitinized and with its inner boundary ill defined. Rostral apparatus large and conspicuous. Pygidium (fig. 15*b*) with two very small tricuspid lobes which are recessed into the margin. Between the lobes is a single prominent median process, and there are two similar processes (? modified squames) immediately exterior to each lobe. Anal orifice comparatively large, approximately central. Length 0·25 to 0·3 mm.

On undersurface of leaves of *Hemigyrosa*, disposed –principally—along the prominent veins. Courtallum, Tinnevelli (*Ramakrishna*, No. 140).

Parlatoria artocarpi, n. sp.

(Pl. XXIX, fig. 16).

Puparium of female castaneous, with a blackish medio-longitudinal vitta; broadly ovate; consisting of the nymphal exuviae alone, without any secretionary appendix. Nymphal pellicle unusually large. Length 0·8 to 0·9 mm.

Male puparium narrower and slightly longer; larval pellicle dull greenish-olivaceous; appendix white. Length 1 mm.

Adult female entirely concealed beneath the large nymphal pellicle. Of normal form; broader across the metathoracic area. Pygidium (fig. 16) with six prominent tricuspid lobes. A large and densely chitinous lunate marginal pore in each inter-lobular space, and smaller lunate pores at intervals along the margin beyond the lobes. The paired squames that occupy the inter-lobular spaces

are ligulate, irregularly serrate distally, the outer edges of each pair markedly longer than the inner edges, so that the distal margins of the two squames slope in opposite directions. The squames that lie outside the lobes are of irregular form; those nearest the lobes being comparatively broad, the remainder decreasing in width till, towards the base of the pydidium, they become long and slender. There are three tooth-like marginal prominences on each side, situated respectively after the 3rd, 7th and 11th squames, the last sometimes obsolescent. On the margins of the abdominal and post-thoracic segments the fimbriate squames are replaced by narrow, tapering, tentacle-like processes, similar to those at the extreme base of the pygidium. Anal orifice approximately central, surrounded by a narrow denser chitinous border. Circumgenital glands in four groups, each containing from 7 to 8 pores. A few small oval (or obscurely crescentic) dorsal pores, in pairs, near the margin of the pygidium. Length 0·5 to 0·75 mm.

On upper surface of foliage of 'jak' (*Artocarpus integrifolia*). Peria Ghat, North Malabar (*Ramakrishna*, No. 128).

Characterized by the large nymphal pellicle, absence of secretionary appendix, and the tentacular marginal processes.

Parlatoria (Websteriella) papillosa, n. sp.

(Pl. XXX, fig. 17*a–g*).

Puparium of female (fig. 17*b*, *c*) minute; oval; consisting of the nymphal pellicle without any secretionary appendix, the disc rising abruptly into a hemispherical boss. Colour bright yellow or ochreous, the median elevation jet black. Length 0·5 mm.

Male puparium (fig. 17*a*) creamy white or very pale ochreous, the larval pellicle dusky olivaceous; elongate ovate, broader in front, appendix moderately convex, with a broad medio-longitudinal depressed groove. Length 0·7 mm.

Adult female (fig. 17*d*) broadest across the anterior thoracic area, tapering behind. Mouth parts large and conspicuous. Margin of meso-thorax with a series of from 10 to 12 minute rounded papillae (see fig. 17*e*). Margins of metathorax and abdomen with a rather distant series of truncate conical papillae. Pygidium (fig. 17*f*) with median and lateral lobes represented by densely chitinous deltoid marginal prominences. The space between the median lobes is occupied by a single prominent broadly spathulate process; two similar but smaller processes occupy the space between the median and first lateral lobes, followed by three similar processes in the next interval. These processes apparently take the place of the deeply fimbriate squames that occur in the same positions in typical members of the genus. There are five conspicuous lunate pores situated immediately above the spaces occupied by the spathulate processes, and usually—but not invariably—a similar pore further up the margin on each side. Circumgenital glands in four groups, the upper lateral groups with six pores, the

lower laterals with from three to four pores. Anal orifice approximately central. Length 0·4 mm.

Posterior extremity of nymphal pellicle (fig. 17*g*) with six conical lobes, each placed on a sharp marginal prominence. There are six large and conspicuous lunate marginal pores in the deeply incised spaces between the lobes. Squames broad and deeply fimbriate at their extremities.

On *Artocarpus integrifolia*. Palghat (*Ramakrishna*, No. 137).

The insect has anomalous characters,—notably, the single median process on the pygidium of the adult female,—which might justify the erection of a separate sub-genus for its reception. But, until other allied species have been discovered, it may remain in the present genus. It most nearly approaches Leonardi's sub-genus *Websteriella*.

Parlatoria vateriae, n. sp.

(Pl. XXX, fig. 18*a–e*).

Female puparium irregularly ovate, flattish; consisting of the larval and nymphal exuviae, without any secretionary appendix. Larval pellicle slightly projecting beyond the anterior margin of the nymphal pellicle; subcircular; very pale stramineous, the centre slightly greenish. Nymphal pellicle (fig. 18*a*) stramineous or pale fulvous, translucent, marginal area darker; elongate ovate, narrower behind. Posterior extremity (fig. 18*b*) with rather small and narrow tricuspid lobes; lunate marginal pores strongly developed; squames either entire or obscurely dentate, broad. There is a sharply defined cleft between the median pair of squames, extending inwards as far as the anal orifice. Length of nymphal pellicle 0·85 to 0·9 mm. Total length of puparium 1 mm.

Adult female (fig. 18*c*) minute, entirely covered by the nymphal pellicle. Thoracic area and pygidium rigid and indurated, the former with a small translucent oval space on each side of the rostrum; abdominal segments soft and flexible. Anterior margin broadly rounded; body widest across the base of the abdomen; thence narrowed abruptly. Rudimentary antennae (fig. 18*e*) in the form of a ring with a radiating series of stout but short setae. Pygidial area sharply defined; base rounded, the extremity (fig. 18*d*) rather pointed; with six small obscurely tricuspid lobes; two small and inconspicuous lunate marginal pores on each side, squames long and narrow, projecting far beyond the lobes, sharply pointed, some of them obscurely dentate or fimbriate on their lateral margins: circumgenital glands in four groups, the upper laterals with 7 or 8 pores, lower laterals with 4 or 5. Length approximately 0·5 mm.

On *Vateria indica*. Quilon, Travancore (*Ramakrishna*, No. 146–part).

This insect, with its long sharply pointed squames and reduced semilunar pores, is very distinct from any other known species of *Parlatoria*; but may—for the present—be included in Leonardi's sub-genus *Websteriella*.

Parlatoria calianthina, Berl. and Leon.

(Pl. XXX, fig. 19).

On *Mangifera.* Rajputana Provinces (*T. Bainbrigge Fletcher*); and on *Nerium* and *Michelia.* Madras (*Ramakrishna*).

Typical examples of the species are distinguished from *pergandei* by the presence of a fifth (median) group of circumgenital glands, containing from 1 to 3 pores; by the broader and more densely chitinous pygidial lobes; and by the smaller and less pectinated marginal squames. I find, however, after examination of much material, from various localities and host plants, that the presence of the median group of pores is by no means constant and—in some gatherings—is actually exceptional. Fig. 19 shows the pygidium of an example from *Michelia champaca,* in which the median group is absent.

Parlatoria pergandei, Comst.

On *Garcinia cowa.* "Singbhum, India" (*Lindinger*).

Parlatoria (Websteriella) atalantiae, Green.

On *Miliusa indica.* Courtallum (*Lindinger*).

Lepidosaphes meliae, n. sp.

(Pl. XXX, fig. 20*a–c*).

Puparium of female clear ochreous brown, but usually appearing dark brown from the inclusion of fragments of the cortex of the plant. Mytiliform; straight or variously curved; moderately convex in transverse section. Larval pellicle reddish ochreous. Nymphal pellicle concealed. Total length averaging 2·5 mm.

Nymphal pellicle with two series of irregular translucent lacunae on each side of the cephalic area, the outermost series sometimes partially double. Length averaging 0·75 mm.

Male puparium dark brown; posterior extremity whitish; larval pellicle reddish ochreous. Narrow; margin somewhat sinuous. Length 1·25 mm.

Adult female broadest across base of abdomen. Median area of abdomen somewhat heavily but irregularly chitinized. Lateral area of second segment of abdomen with a transverse patch (fig. 20*a*) of stout conical spiniform spinnerets, each of which has a short tubular extension at its apex (fig. 20*b*). Pygidium (fig. 20*c*) considerably broader than long; the median lobes broad and prominent, adjacent, the apices towards the median line: lateral lobes duplex, the inner lobe large, sloping away from the inner edge, the outer lobule minute: long chitinous paraphyses extend inwards from each lobe. Beyond the lobes, on each side, are three marginal prominences, the inner two moderately cristate and rather heavily chitinized. Squames spiniform. Circumgenital

glands in five groups; the median group with from 8 to 11 pores, upper laterals with an average of 20, lower laterals averaging 14. Dorsal pores minute, circular. Length averaging 1·15 mm.

On 'Nim tree' (*Melia azedarach*). Coimbatore (*Ramakrishna*, No 149).

Lepidosaphes retrusus, n. sp.

(Pl. XXXI, fig. 21).

Puparium of adult female dull ochreous brown to reddish brown; occasionally with an incomplete superficial layer of whitish secretion; usually overlaid with hairs and extraneous matter from the leaf upon which it rests. Rather strongly but irregularly convex; often distorted; usually broadest across the middle, but sometimes wider behind. Length 1·25 to 1·5 mm.

Male puparium brighter ochreous brown; moderately convex; narrow. Length 1 mm.

Adult female broadly ovate. Pygidium obtuse; median area more densely chitinous. Median lobes large and prominent, the free edges strongly but irregularly dentate—with from 6 to 8 denticles. First lateral lobes usually duplex, the inner lobule largest and obscurely bi-dentate, the two lobules occasionally coalescing to form a single tri-dentate process. Second lateral lobes smaller, obscurely tri-dentate. Squames spiniform, stout, a pair in each of the spaces between the median and the lateral lobes, and a third pair shortly beyond the outermost lobe. Anal orifice oblate, close to the base of the pygidium. Circumgenital glands in five groups, the median group with from 6 to 12 pores, the upper laterals with from 8 to 18, and the lower laterals with 11 to 18. Oval dorsal pores of two sizes; three very large pores on each side near the margin, and numerous smaller pores, in irregular scattered series. Length 0·5 to 0·75 mm.

On the undersurface of leaves of *Litsea whiteana*, arranged along the mid-rib and principal veins. Dodabetta, 8,000 ft., Nilgiris (*Ramakrishna*, No. 73).

Lepidosaphes auriculatus, Green.

On *Codiaeum*. Calcutta (*H. M. Lefroy*).

Lepidosaphes pallidus, Green.

On *Psidium*. Ramchandrapur, Godaveri District (*Ramakrishna*, No. 105).

Lepidosaphes travancoriensis, Lindinger.

On *Aglaia minutiflora*. Travancore (*Lindinger*).

Ischnaspis spathulata, Lindinger.

On *Vatica obscura*. "W. Palukananda, Jumpalai" (*Lindinger*).

Fiorinia frontecontracta, n. sp.

(Pl. XXXI, fig. 22*a–d*).

Puparium of female pale castaneous, usually with a darker medio-longitudinal stripe running through both larval and nymphal pellicles. Little or no secretionary appendix. Elongate; narrow; with a distinct medio-longitudinal ridge. Length 2 to 2·25 mm. Breadth across middle 0·5 mm.

Nymphal pellicle (fig. 22*c*) elongate; narrow; anterior extremity with a sharply defined depressed area where it is overlapped by the larval pellicle. Margin of abdominal area with two (sometimes three) prominent thorn-like spines on each side. Margin of posterior extremity (fig. 22*d*) with well-developed median and lateral lobes; the former sunk in a median excision, wide apart and divergent, their free margins minutely serrate; the lateral lobes duplex, the inner lobule larger and more prominent. Length of pellicle 1·75 mm.

Male puparium white; larval pellicle pale stramineous. The white secretionary appendix wider towards the posterior extremity; flattish, with a single (often obscure) medio-longitudinal carina. Length 1 to 1·25 mm.

Adult female (fig. 22*a*) with the anterior extremity contracted and transversely wrinkled. Rudimentary antennae conspicuous; each with a stout curved seta. No inter-antennal tubercle. Mouth-parts large and conspicuous. Form narrow at anterior extremity, gradually widening behind; broadest immediately above the pygidium; abdominal segments retracted. Pygidium (fig 22*b*) with circumgenital glands forming an almost continuous arch; the upper and lower lateral groups confluent, together containing from 35 to 40 crowded pores, connected above by a loose series of 5 or 6 pores representing the median group. Median lobes well developed; recessed; rather widely separated; of irregular form, broadest across the base, the free edge coarsely and irregularly dentate. Lateral lobes minute, inconspicuous. Three conspicuous conical marginal prominences project on each side of the pygidium —one immediately exterior to the median lobes, a second exterior to the lateral lobes, and the third about half way between the last and the base of the pygidium. Closely following upon each of the second and third prominences is a shallow recess with its margin conspicuously thickened. Length approximately 0·75 mm.

On foliage of *Garcinia indica*. Bombay (*H. H. Mann*, No. 41).

Fiorinia plana, n. sp.

(Pl. XXXI, fig. 23*a*, *b*).

Puparium of female pale stramineous, translucent; elongate-ovate, flattish or slightly convex above; consisting of the larval and nymphal pellicles, with little or no secretionary appendix. Larval pellicle small. Nymphal pellicle enlarged, the pygidial area depressed; posterior margin (fig. 23*b*) with prominent median

and lateral lobes, all of which are narrow at the base and broadly expanded distally, the extremities squarely truncate. Length of puparium 1·75 to 2 mm.

Male puparium not observed.

Adult female with the abdominal segments strongly retracted. I have been unable to detect any trace of either antennae or inter-antennal tubercle. Lateral margins of thorax and abdomen with scattered tuberculate spines. Spiracles without parastigmatic pores. Pygidium (fig. 23*a*) with five groups of circumgenital glands; the median group with four widely separated pores, the upper laterals averaging 11 and the lower laterals 15 pores. Posterior margin with the median lobes rather widely separate, their distal extremities sharply and irregularly dentate; lateral lobes duplex, both lobules unusually broad, contiguous or more or less confluent, their free margins strongly dentate. Length of extended example 1 mm. Retracted examples 0·5 to 0·75 mm.

On upper surface of leaves of *Elaeodendron glaucum*. Coimbatore (*Ramakrishna* No. 139).

Fiorinia sapindi, n. sp.

(Pl. XXXI, fig. 24*a–d*).

Female puparium covered almost completely by the nymphal pellicle, with sometimes a very narrow colourless secretionary margin. Pellicles dark castaneous, lighter towards the margins. Length 1 to 1·35 mm.

Nymphal pellicle (fig. 24*a*) rather narrow; the posterior abdominal segments with lateral margin produced into small but acute points. Posterior extremity (fig. 24*b*) with a very large pair of median lobes which are widely divaricate and recessed into the margin, first lateral lobes duplex, the inner lobule longer than the other: second lateral lobes tridentate. Length 1 to 1·25 mm.

Adult female minute, with very thin and delicate derm. Antennae (fig. 24*c*) consisting of a pair of obscurely dentate tubercles, each with a longish curved bristle on the outer side, a slight fold between the antennae. Posterior extremity (fig. 24*d*) with small but prominent median lobes, set rather wide apart, with a lunate chitinous plate between them. Lateral lobes represented by a small conical prominence on each side. There is a pair of long slender spines between the median lobes, and other similar spines are set at intervals along the margin. Circumgenital glands consisting of a practically continuous arch containing about 50 pores. Length 0·5 mm.

On *Sapindus trifoliatus*. Poona (*H. H. Mann*, No. 20).

Fiorinia odinae, Leonardi, var. **multipora**, Lindg.

On *Taxus wallichiana*. "Khasia, India" (*Lindinger*).

Fiorinia saprosmae, var. **geloniae**, Green.

On *Gelonium*. Ootacamund (coll. E.E.G.)

Leucaspis indica, Marlatt.

On *Mangifera indica.* Poona (*H. H. Mann*, No. 35).

Leucaspis japonica, Ckll.

On *Ficus religiosa.* Calcutta. (Ex coll. Ind. Mus., Nos. 60 and 93).

Leucaspis salicis, Green.

On *Salix* sp. Baluchistan (*V. Iyer*).

EXPLANATION OF PLATE XXVI.

FIG. 1*a*.—*Diaspis cinnamomi-mangiferae*, Newst. Posterior extremity of adult ♀, × 280.

,, 1*b*.—*Diaspis rosae* (Bouche). Posterior extremity of adult ♀, from *Loranthus*, Ootacamund, × 280.

,, 1*c*.—*Diaspis rosae* (Bouche). Posterior extremity of adult ♀, from Rose, England, × 280.

,, 1*d*.—*Diaspis rosae* (Bouche). Posterior extremity of adult ♀, from Rose, Bohemia, × 280.

,, 1*e*.—*Diaspis rosae* (Bouche). Posterior extremity of adult ♀, from Rose, Singapore, × 280.

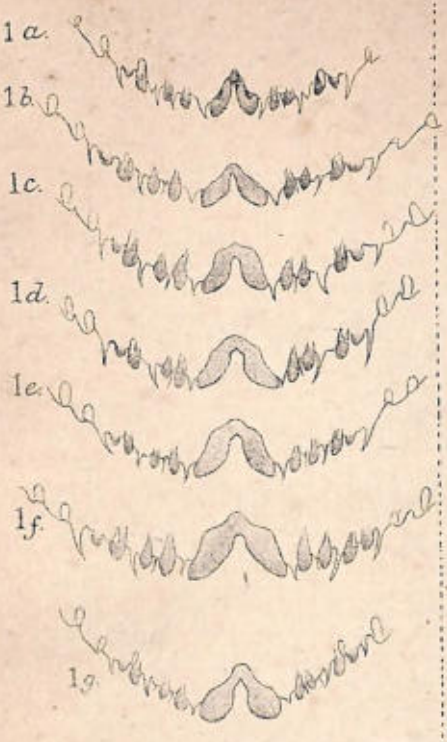
,, 1*f*.—*Diaspis rosae* (Bouche). Posterior extremity of adult ♀, from Rose, New Zealand, × 280.

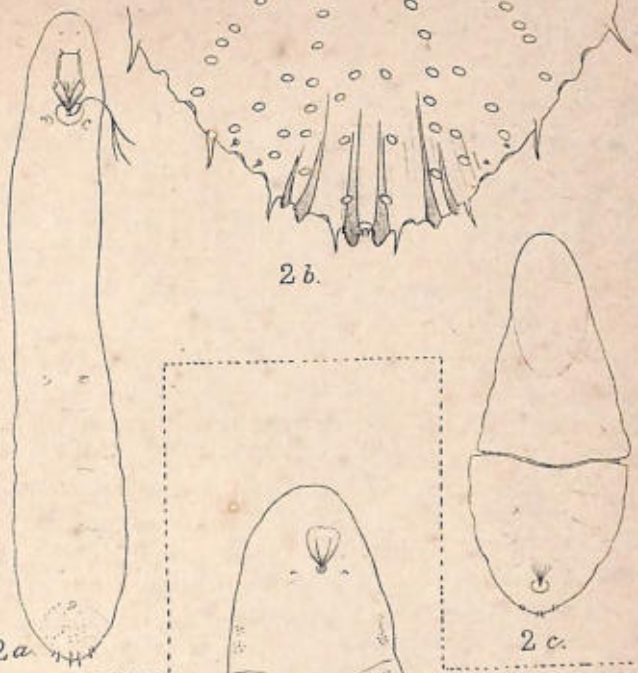
,, 1*g*.—*Diaspis loranthi*, Green. Posterior extremity of adult ♀, × 280.

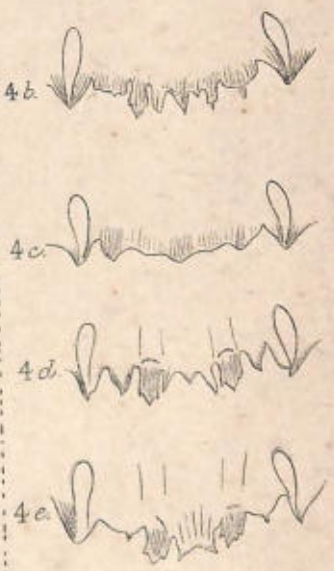
,, 2.—*Chionaspis annandalei*, n. sp. *a*. Adult ♀, × 30. *b*. Pygidium of adult ♀, × 280. *c*. Nymphal pellicle, × 30.

,, 3.—*Chionaspis caroli*, n. sp. *a*. Puparia, ♂ and ♀, × about 6. *b*. Pygidium of adult ♀, × 280.

,, 4.—*Chionaspis chir*, n. sp. *a*. Adult ♀, × 30. *b*, *c*, *d*, *e*. Various forms of extremity of pygidium, × 450.







E. E. Green *del.*

A. Chowdhary lith.

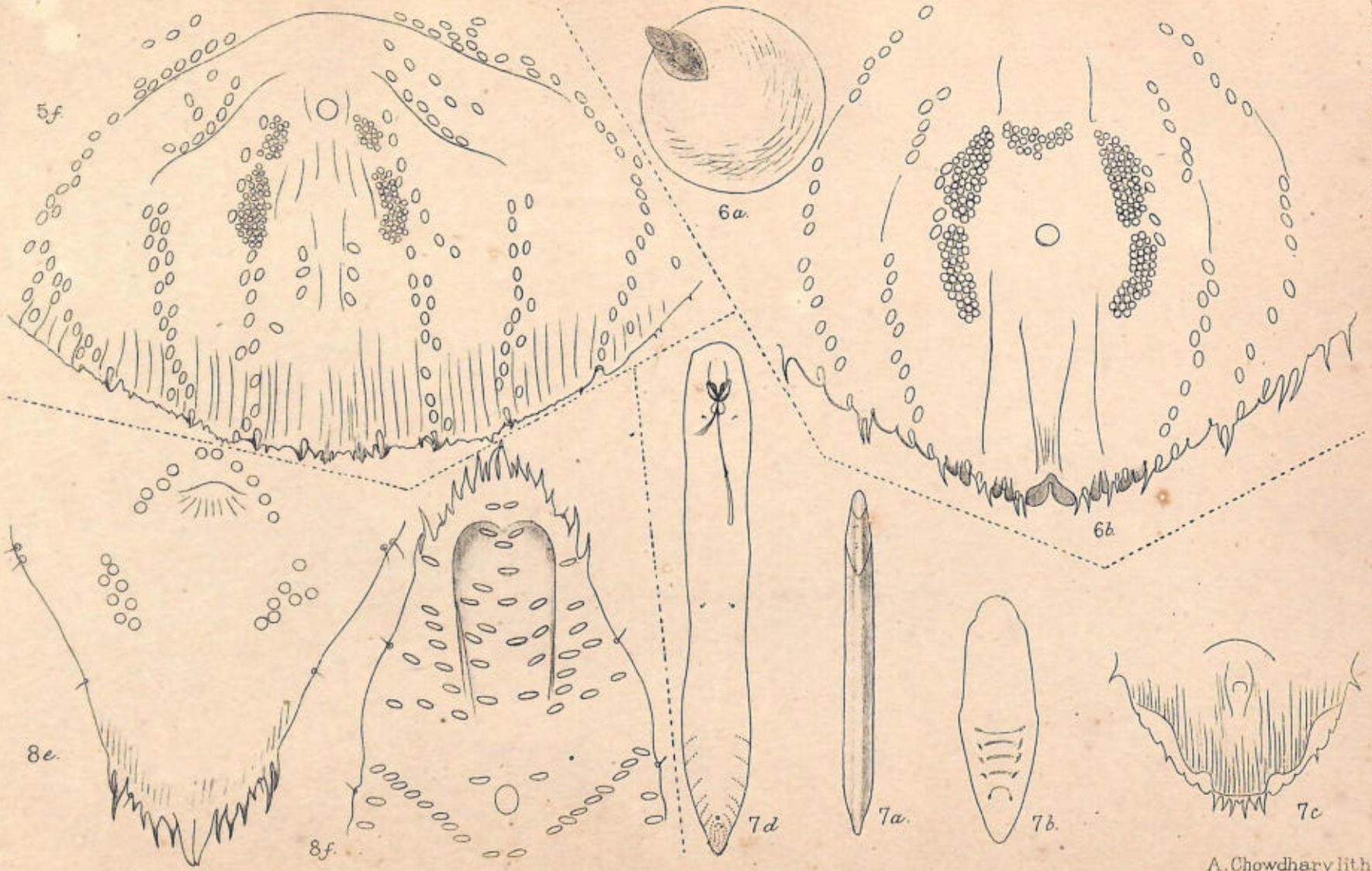
EXPLANATION OF PLATE XXVII.

FIG. 5.—*Chionaspis chir*, n. sp. *f*. Pygidium of adult ♀, × 220.

„ 6.—*Chionaspis* (*Phenacaspis*) *gudalura*, n. sp. *a*. Female puparium, × 10. *b*. Pygidium of adult ♀, × 280.

„ 7.—*Chionaspis spiculata*, n. sp. *a*. Puparium of adult ♀, × 30. *b*. Nymphal pellicle, × 65. *c*. Posterior margin of nymphal pellicle, × 450. *d*. Adult ♀, × 65.

„ 8.—*Chionaspis spiculata*, n. sp. *e*. Pygidium of adult ♀, ventral view, × 450. *f*. Pygidium of adult ♀, dorsal view, × 450.



E.E. Green *del.*

A. Chowdhary lith.

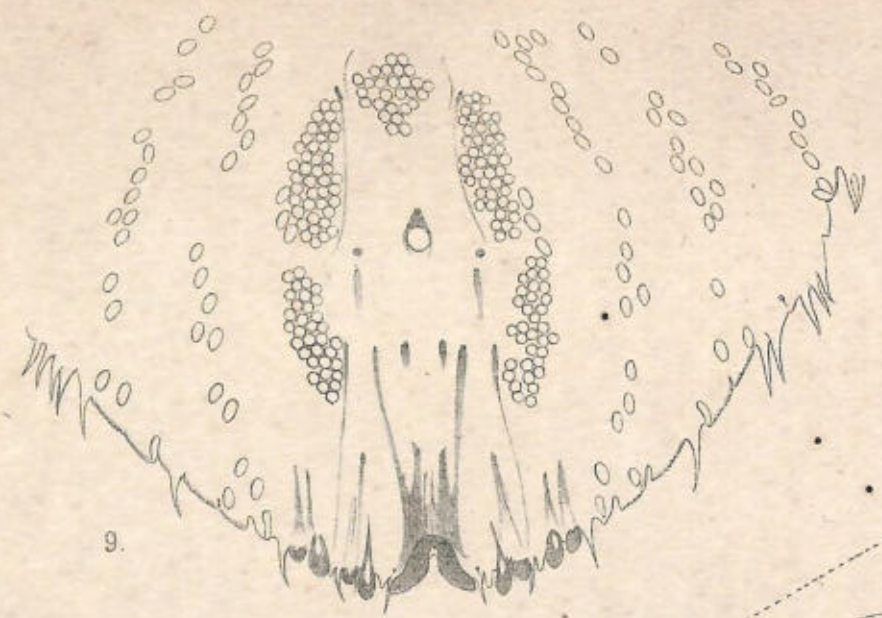
EXPLANATION OF PLATE XXVIII.

FIG. 9.—*Chionaspis* (*Phenacaspis*) *varicosa*, Green. Pygidium of adult ♀, × 280.

„ 10.—*Aspidiotus* (*Hemiberlesia*) *pseudocamelliae*, n. sp. Pygidium of adult ♀, × 450.

„ 11.—*Aspidiotus tamarindi*, n. sp. *a*. Outline of adult ♀, × 30. *b*. Pygidium of ♀, × 280.

„ 12.—*Aonidia indica*, n. sp. *a*. Posterior margin of nymph, × 280. *b*. Pygidium of adult ♀, × 280.



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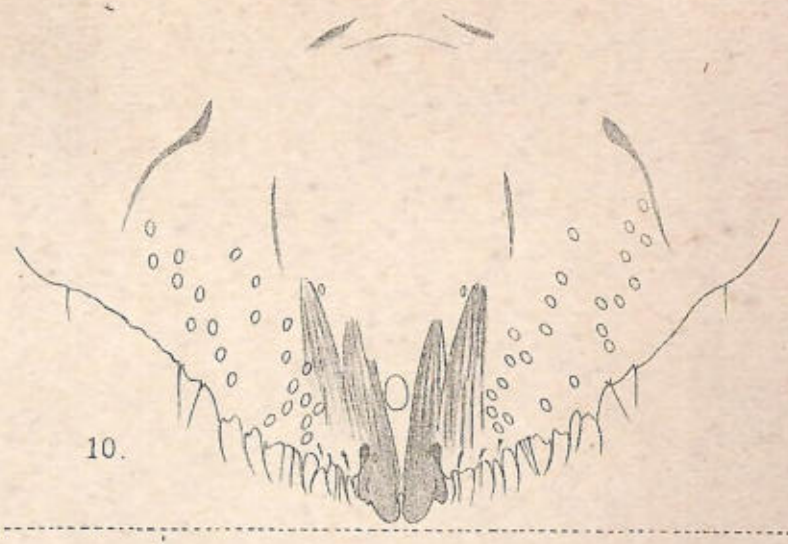

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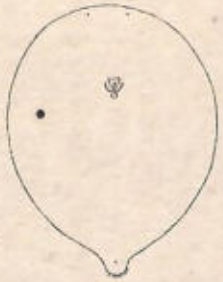
12 *a*.



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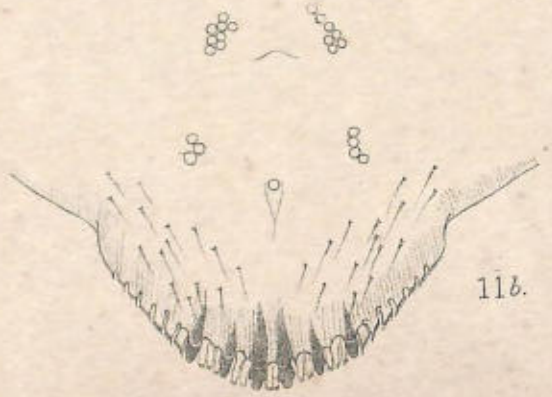
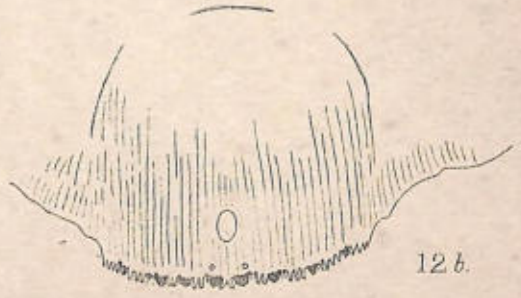


11 *b*.



12 *b*.

E. E. Green *del*.

A. Chowdhary lith.

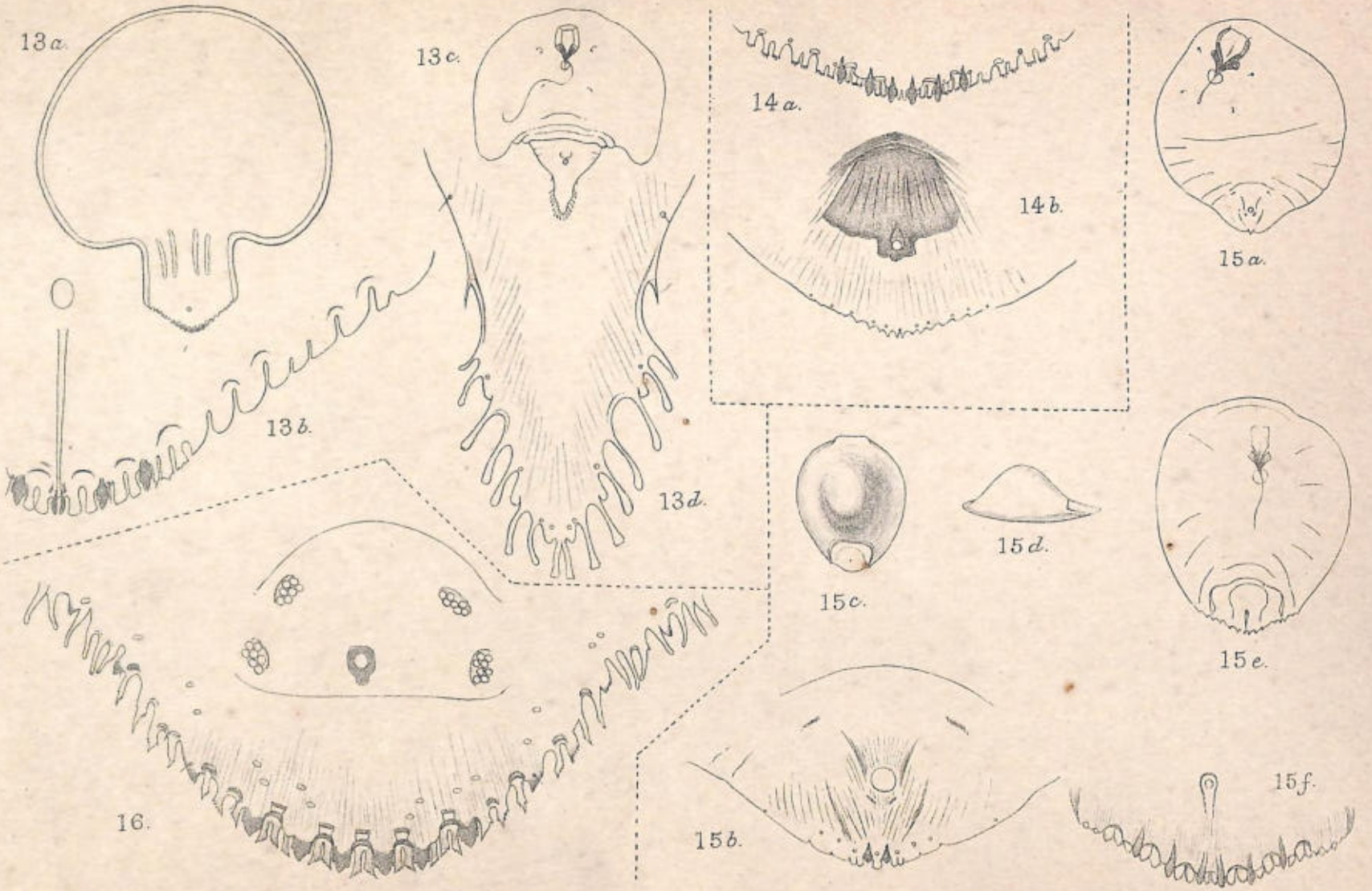
EXPLANATION OF PLATE XXIX.

FIG. 13.—*Aonidia tentaculata*, n. sp. *a*. Nymphal pellicle, × 50. *b*. Margin of posterior extremity of nymph, × 450. *c*. Adult female, × 50. *d*. Posterior extremity of adult ♀, × 450.

,, 14.—*Gymnaspis ficus*, n. sp. *a*. Posterior margin of nymphal pellicle, × 280. *b*. Pygidium of adult ♀, × 280.

,, 15.—*Gymnaspis ramakrishnae*, n. sp. *a*. Adult ♀, × 100. *b*. Pygidium of adult ♀, × 450. *c*. Nymphal pellicle, from above, × 50. *d*. Nymphal pellicle in profile, × 50. *e*. Nymph, × 100. *f*. Nymph, posterior extremity, × 450.

,, 16.—*Parlatoria artocarpi*, n. sp. Pygidium of adult ♀, × 280.



E. E. Green *del.*

A. Chowdhary lith.

EXPLANATION OF PLATE XXX.

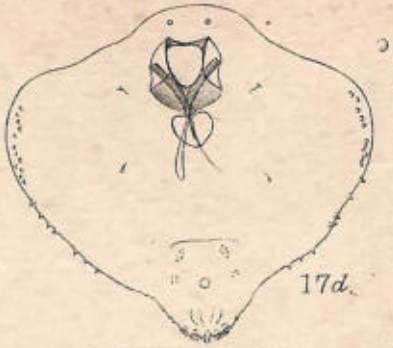
FIG. 17.—*Parlatoria* (*Websteriella*) *papillosa*, n. sp. *a*. ♂ puparium, × 30. *b*. ♀ puparium, × 30. *c*. ♀ puparium, side view, × 30. *d*. Adult ♀, × 130. *e*. Thoracic margin of adult ♀, × 450. *f*. Pygidium of adult ♀, × 450. *g*. Posterior extremity of nymphal pellicle, × 450.

,, 18.—*Parlatoria vateriae*, n. sp. *a*. Nymphal pellicle, × 50, *b*. Nymphal pellicle, posterior extremity, × 450. *c*. Adult ♀, × 50. *d*. Adult ♀, posterior extremity, × 450. *e*. Adult ♀, antenna, × 450.

,, 19.—*Parlatoria calianthina*, Berl. and Leon. Pygidium of adult ♀, × 280.

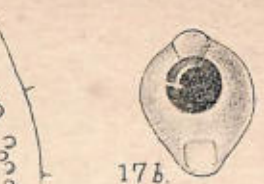
,, 20.—*Lepidosaphes meliae*, n. sp. *a*. Marginal area of second and third abdominal segments, × 220. *b*. Secretory spines from 2nd segment, × 450. *c*. Pygidium of adult ♀ (opt. sect.), × 220.

17a.



17d.

17c.



17b.

EXPLANATION OF PLATE XXXI.

FIG. 21.—*Lepidosaphes retrusus*, n. sp. Pygidium of adult ♀, × 450.

,, 22.—*Fiorinia frontecontracta*, n. sp. *a*. Adult ♀, × 80. *b*. Pygidium of adult ♀, × 450. *c*. Nymphal pellicle, × 30. *d*. Posterior extremity of nymphal pellicle, × 450.

,, 23.—*Fiorinia plana*, n. sp. *a*. Pygidium of adult ♀, × 450. *b*. Posterior extremity of nymyhal pellicle, × 450.

,, 24.—*Fiorinia sapindi*, n. sp. *a*. Nymphal pellicle, × 30. *b*. Posterior extremity of nymph, × 450. *c*. Frons of adult ♀, × 450. *d*. Posterior extremity of adult ♀, × 450.

21

22 c.

24 a.

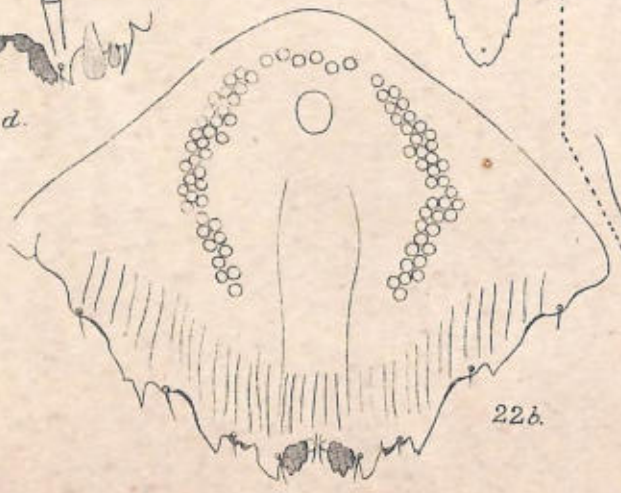
24 b.

24 c.

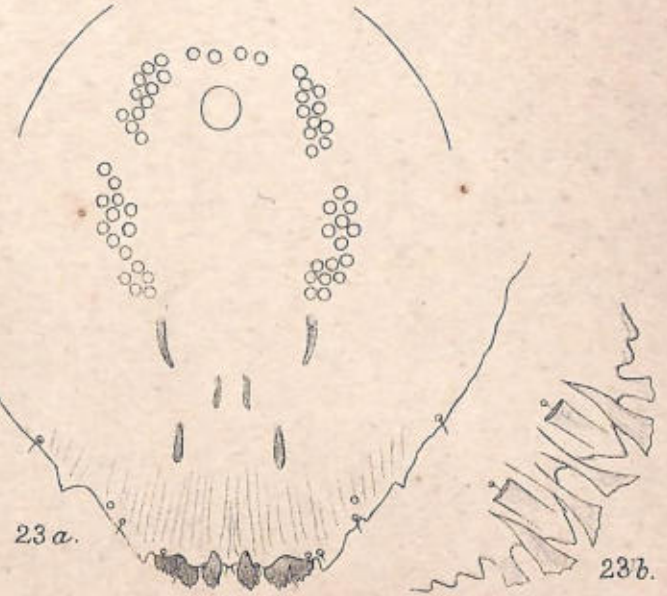
24 d.

22 a.

22 d.



22 b.



23 a.

23 b.

E. E. Green *del.*

A. Chowdhary lith.

XXXI. DESCRIPTIONS OF FOUR NEW INDIAN ODONATA.

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

All four of the new species belong to the subfamily Agrioninae, two belonging to the tribe Argiini and two to the tribe Agrionini. Species of the former tribe are easily distinguished from the latter by the relatively shorter petiolation of the wings.

Genus **Argiocnemis.**

Argiocnemis gravelyi, sp. nov.

1 ♀, Saugor, Central Provinces, India, 19—30-3-19 (*F. H. Gravely*), 1326/H2.

Female.

Head.—Eyes olive green above, greenish yellow beneath; labium and clypeus flesh coloured, the former with a small, triangular, black mark at its base and the latter with three black spots about its middle; remainder of head black, with no markings.

Prothorax black, with a sky-blue collar anteriorly and two similar coloured spots on each side, the anterior of which is much the largest.

Thorax black on the dorsum; a broad, humeral, black line, enclosing between it and the black of the dorsum, a greenish fascia, which is itself traversed by an irregular, black line, incomplete anteriorly. Below the humeral line, the sides pale sky-blue with a minute dot and black streak posteriorly. Tergum spotted with blue.

Legs creamy white, streaked with black on the extensor surfaces.

Wings very shortly petiolated; *ac* falls on to *ab* nearer the first antenodal nervure than the 2nd and *ab* meets the border of the wing opposite the 1st antenodal. Postnodals 7 and 6 respectively in the two wings. Stigma olive brown.

Abdomen sky-blue, paler anteriorly and deepening markedly in the last three segments. A broad, black fascia runs the whole length of the dorsum as far as segment 8, where it is continued on to the dorsum of segment 9 as a tongue-like process which does not attain to the apical border; tenth segment entirely blue, as also are the anal appendages.

Length of abdomen 22 mm. Length of hind-wing 15 mm.

Argiocnemis dyeri, sp. nov.

1 ♂, old bed of Nerbudda, North of Babai, Hooshangabad Dist., Central Provinces, India, 15-3-19 (*F. H. Gravely*). (A

single male of this insect was also taken by myself at Poona, 1-4-19, in Mr. Thistleton Dyer's compound, near the Moolah River. I have named it after Mr. Thistleton Dyer, who is a son of the eminent Kew botanist.) 1325/H2.

Head black; labium and clypeus sky-blue; two pyriform, blue, postocular spots; eyes deep sea-blue above, greenish beneath. (In Mr. Gravely's specimen the postocular spot is enclosed on one side only, but in my own specimen the spots are present on both sides.)

Prothorax blue marked with black in a somewhat elaborate pattern. The black, which is bordered all round with blue, narrowly at the sides and posteriorly, encloses a small, blue geminate spot at its middle, and a larger, subdorsal spot each side.

Thorax sky-blue, with narrow, dorsal and humeral, black lines.

Legs pale blue, streaked with black on the extensor surfaces.

Wings as in the first mentioned species; the petiolation of the wings is extremely short; *ac* falls on to *ab* opposite the 1st antenodal nervure. Postnodals 8 and 7 respectively in the two wings. Stigma pale sepia or cinereous. Apex of wing closely reticulated.

Abdomen blue marked with black, as follows:—a black spot on the basal half of segment I and a transversely linear, triangular spot on its apical border, followed distally by a blue annule. A broad, black, dorsal fascia on the 2nd segment, extending from the apical to the basal border, connecting up at the former with a black annule. Segments 3 to 7 with a black, dorsal streak expanding apically and pointed basally, where it fails to attain the basal border of segment. Apically these streaks are connected with black annules; eighth and ninth segments all blue but with an apical row of fine, black spines; tenth segment blue, with a small, hour-glass shaped, black spot on the dorsum.

Anal appendages very minute and simple, the inferior scarcely visible. Length of abdomen 23 mm. Length of hind-wing 16-17 mm.

It is possible that these two insects are the sexes of a common species of *Argiocnemis*, but after a careful comparison of the two I do not think that this is so.

Genus **Himalagrion**, gen. nov.

The genus has some of the features of *Agriocnemis* but differs chiefly in its large size, in the large number of postnodals and in the position of the arc, which is opposite the 2nd antenodal nervure.

Node placed at the junction of the middle and basal thirds of the wing, quadrilateral irregular, its distal angle sharply acute, no intercalated sectors, stigma short, rhomboidal, *ac* midway between the two antenodals, *ab* present, commencing just proximal to *ac*, arc opposite the second antenodal, *Cu*2 normal, postnodals numerous, reticulation moderately close.

The venation is identical with *Zoniagrion*, Kennedy, but there the resemblance begins and ends, there being no bifid, dorsal elevation on the 10th abdominal segment of the male, nor spine on the ventral surface of segment 8 in the female.

Himalagrion exclamationis, sp. nov.

4 ♂♂, 4 ♀♀, Sitong, *ca.* 4,000 ft., near Manghphu, Darjiling Dist., 6-7-18 (*S. Kemp*). 1314H2.

Male.

Head black, marked with wedge-wood blue as follows:—large, subtriangular, postero-internal ocular spots; a blue fascia across the vertex and clypeus in front of the anterior ocellus; the whole of the labium except for a black, basal border which extends on to the anteclypeus. Eyes dark brown above, pale olivaceous beneath, the two colours being sharply contrasted at the equator of the eyes.

Prothorax black marked with wedge-wood blue of which there is a fine, blue collar anteriorly and an irregular patch laterally.

Thorax matt black marked with the same coloured blue as sharply defined streaks and spots as follows:—a blue, humeral stripe, broadest anteriorly and constricted at the junction of its middle and posterior thirds, the sides broadly blue and traversed low down by an irregular, black stripe which begins at the base of the posterior trochanter. Tergum and bases of wings spotted with blue.

Legs pale blue, the femora streaked with black on the extensor surfaces and the tibiae similarly on the flexor surfaces.

Abdomen: 1st segment blue marked with an irregular, black streak, which runs obliquely backwards from the dorsum to the ventrum, a black annule incomplete on the dorsum, apically; 2nd segment blue with an irregular, oblong, black marking on the side, which fuses with a black, apical annule. A triangular, black mark on the posterior part of the dorsum, somewhat like a blunt arrow-head, looking forward; 3rd segment blue with a broad, black annule just in front of the apex and a narrow one at the apical border, lower part of sides and ventrum black; 4th segment similar but the apical annules have fused, enclosing a mere speck of blue laterally; 5th segment similar but the blue spot is absent and the annules have extended forward, especially on the dorsum, where there is a triangular projection into the blue, basally the apical, black annule of the 4th segment has extended slightly on to the dorsum of the 5th; 6th segment entirely black save for a fine blue, basal annule, incomplete on the dorsum; 7th segment black, its dorsum marked for the posterior three fourths with blue, this marking narrowing from behind forward and with a lateral indentation at the apical end; 8th and 9th segments entirely blue, but in some specimens the 8th has a finely stippled, black, lateral line; 10th segment black marked laterally with a small, blue spot

and presenting a narrow, shallow notch on the dorsum, posteriorly, which is blue.

Anal appendages. Superior shorter than the 10th segment and also than the inferior, slightly bifurcate in profile; inferior nearly as long as the 10th segment, broad at the base and narrowing rapidly to form a robust hook which is curved strongly down and inwards.

Female.

Very similar to the male, but the blue markings on the abdomen much less extensive. Head, prothorax and thorax scarcely differing from that of the male.

Abdomen. The oblique, black marking on the 1st segment covers the basal half of the dorsum; the triangular, black marking on the dorsum of the 2nd segment extends forwards as far as the base and encloses between itself and the lateral marking a blue, hook-shaped marking; the 3rd to 6th segments are black and each has a sharply-defined streak and dot on the sides, resembling a note of exclamation; the 7th may or may not have a faint indication of a similar marking; 8th segment black, with an apical, blue annule, confluent laterally with a largish, blue spot; 9th blue, marked basally with a black spot shaped like a coronet, and in some with a fine, dorsal, triangular, apical, black spot; 10th segment entirely blue.

Anal appendages very small, black.

Wings as for genus; postnodals 14; stigma black, covering one cell; length of hind-wing 22 mm. Length of abdomen 32 mm.

The position of the arc and the shape of the anal appendages suggest *Ceriagrion* but there is no ridge on the frons and the colour scheme is totally unlike anything seen in that genus, in fact I know of no parallel to the clear-cut, cameo-like effect of the markings in this beautiful insect, at least not in the subfamily Agrioninae.

Genus **Agriocnemis.**

Agriocnemis d'abreui, sp. nov.

1 ♀, Lamta, Balaghat Dist., Central Provinces, India, 1,300 ft., 23-3-18. (*E. A. D'Abreu.*)

Head black, marked with sky-blue, post-ocular spots and a blue streak across the vertex in front of the anterior ocellus; labium blue, the base narrowly black; anteclypeus blue, traversed by a fine, black line with a pointed projection at its middle, directed forward; eyes deep olive green above, paler beneath.

Prothorax black, with two small, blue, subdorsal spots in front.

Thorax sky-blue, the dorsum and a broad, black, humeral fascia black; the tergum spotted with blue.

Legs pale blue, streaked with black on the extensor surfaces.

Abdomen blue, marked with black as follows:—the dorsum broadly black throughout its whole length, the black on each segment from 2 to 7 expanding at the apical end and then contracting again to join an apical black ring; black, lateral streaks

on the same segments, broadest apically and becoming obsolete basally. On the 2nd segment this streak joins up with the black on the dorsum basally, and on the 7th similary but apically. Blue annules follow the 1st, 7th, 8th and 9th segments. No spine on the ventral surface of segment 8.

Wings: postnodals 6; arc distal to the 2nd antenodal; *ac* falls on to *ab* about midway between the two antenodals; stigma light brown, covers half a cell.

Length of abdomen 15 mm. Length of hind-wing 10 mm.

The specimen bears a slight resemblance to *A. splendidissima*, Laidlaw, but the insect is a more robust species. The lateral abdominal spots are not connected up with the dorsal black, except on the 7th segment, and lastly the head markings are quite different.

XXXII. NOTES ON FRESHWATER SPONGES.

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

No. XVII.—A NEW RACE OF *TROCHOSPONGILLA LATOUCHIANA* FROM CHINA.

In my recent account of the freshwater sponges of China I assigned specimens of *Trochospongilla* from Soochow to *T. latouchiana*, mihi, but pointed out that there were differences in the proportions of the gemmule-spicules. Mr. Gee has since sent me a large number of additional specimens, in which the differences are so constant and so marked that I now think they are worthy of nominal distinction.

Trochospongilla latouchiana subsp. sinensis, nov.

1918. *Trochospongilla latouchiana*, Annandale, *Mem. As. Soc. Bengal* IV, p. 203.

The sponge appears to have formed small cushions of a greyish colour on sticks or water-plants, but is imperfect in all the specimens examined. The skeleton is compact and contains a considerable amount of horny material by means of which the spicules in the vertical spicule-fibres are fastened together tightly. These fibres are well defined and vary considerably in thickness. As a rule, however, they are not very thick. They are connected transversely by an irregular network of single spicules and bundles of spicules joined together at the nodes by horny substance. The sponge is frequently so intermixed with that of *Spongilla geei*[1] that it is impossible to separate the two species, and confusion is liable to occur unless the spicules are carefully sorted out.

The skeleton spicules are very like those of *T. latouchiana*[2] (s.s.) but are rather more slender and more subject to the slight irregularities of outline. They vary considerably in size and proportions but are always quite smooth. The gemmule-spicules are minute. As a rule the outer rotule is slightly smaller than the inner one. The former is rather deeply concave and its margin is very slightly sinuous. The upper end of the shaft is conspicuous as seen from above but the surface of the rotule is not sculptured. The different rotules do not overlap on the surface of the gemmule. The shafts of these spicules are relatively slender and at least as long as

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[1] Annandale, *op. cit.*, p. 202 (1918).
[2] Annandale, *Faun. Brit. Ind., Freshw. Sponges*, etc., p. 114, fig. 23A.

the diameter of the upper rotule. The gemmules are small, subspherical but somewhat produced round the single foraminal aperture.

Measurements :—

Diameter of gemmule	.. 0·26 × 0·28	mm.
Length of skeleton spicule	.. 0·22 – 0·31	,,
Diameter of skeleton spicule	.. 0·01 – 0·012	,,
Length of gemmule-spicule	.. 0·012 – 0·015	,,
Diameter of lower rotule	.. 0·012 – 0·015	,,

Type-specimen.—No. P $\frac{28}{1}$ Zool. Survey of India (*Ind. Mus.*) dry.

The race differs from the *forma typica* mainly in the longer shaft of the gemmule-spicules and the greater concavity of their upper rotules.

XXXIII. DESCRIPTIONS OF NEW INDIAN ODONATE LARVAE AND EXUVIAE.

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

(With Plates XXXII—XXXVII).

The following descriptions of Odonate larvae have been made from specimens sent to me through the kindness of Dr. N. Annandale and from others collected by myself. The former were mostly collected by Messrs. S. Kemp and F. H. Gravely. The latter were collected around Poona and the types or paratypes have now been sent to the Indian Museum.

Only two specimens of *Epophthalmia* were collected and one of these has since been partly destroyed, the perfect specimen going to the Museum.

Very little has been written on individual Odonate larvae and not more than 10 per cent of the Indian forms have hitherto been described. Still less is known of their habits. As more descriptions become available, they may be expected to throw considerable light on the phylogeny of the race, and if only for this reason, are valuable. That this is so, is aptly illustrated by the descriptions of the three species of *Cyclogomphus* and by noting the close similarity of two of them,—*C. verticalis* and *heterostylus*,—to *Macrogomphus annulatus*. This similarity is much greater than that between the two species and a third,—*C. minusculus*, and raises doubts as to whether they are placed correctly. The curving and cupping of the antlered lobes of *Epophthalmia* foretells the evolution of the cupped mask of the Libellulines. One has only to web in the spaces between the elongated teeth to obtain such a mask. This bears out the theory that the Libellulinae are an offshoot of a Corduline stem. Other suggestive structures are the triquetral caudal gills of *Chloroneura quadrimaculata* and the cleft middle lobe of *Protosticta gravelyi*.

SYSTEMATIC.

Suborder ANISOPTERA.

Subfamily *CORDULIINAE*.

1. **Epophthalmia frontalis**, Selys.

(Pl. xxxii, fig. 1; pl. xxxiv, fig. 2.)

Poona, 7. 4. 19, 1512/H2.

Length 33 mm. Length of hind femora 16 mm. Length of abdomen 24 mm. Mask deeply cupped and curved to cover the

face as in Libellulinae. The cup formed by the interlocking of the long, spinous jaws of the lateral lobes, in a way similar to the interlocked fingers of two hands. Base of mask extending as far back as the mid pair of coxae. Lateral lobes long and curved, antler-like, furnished with 6-7 long, spinous teeth, the proximal 3 or 4 of which are half the length of the distal and the most distad furnished with a small, moveable hook on its inner side (pl. xxxiv, fig. 2).

Antennae long and filiform, 7 segments. Eyes stalked, crab-like in appearance but not retractile, moderately small in comparison to the size of the head. Synthorax saddle-shaped and bulky. Abdomen tumid, strongly carinated dorsally, the carina consisting of a row of backwardly imbricated spines, one on each of segments 5 to 9; spinous prolongations to the sides of segments 8 and 9. Legs very long and spidery, naked.

Hab.—Running streams amidst curtains or masses of water-weed.

Subfamily *LIBELLULINAE.*

2. **Tholymis tillarga,** Hagen.

(Pl. xxxii, fig. 2; pl. xxxiv, fig. 1.)

Poona, 9. 5. 18, 1513/H2.

Length 26 mm. Length of hind femora 13 mm., of the hind leg 22 mm. Length of abdomen 15 mm.

Mask typically Libelluline, the lateral lobes meeting flush, by the close interlocking of bordering rows of small saw-like teeth to the number of 11. Mask deeply cupped (pl. xxxiv, fig. 1).

Antennae long and filiform. Eyes bluntly conical, the functionating part comparatively large. Posterior to the eyes, the head bears some coarse hairs.

Synthorax stout, abdomen tumid, not carinated on the dorsum, the sides of the segments finely spined and ending posteriorly in stout spines, these being very long and robust on the last three segments. Internally the terminal spines are finely fringed with longish hairs. Apical border of all segments finely fringed with short, even hairs.

Anterior and middle pairs of coxae clothed with long, coarse hairs. Femora with 3 rows of minute, widely-spaced spines.

Hab.—Conceals itself amongst masses of coarse water-weed. Usually breeding in small tanks, disused granite quarries which have filled with water being favourite spots.

3. **Tramea limbata,** Kirby.

(Pl. xxxii, fig. 3; pl. xxxiv, fig. 3.)

Poona, 4. 5. 18, 1514/H2.

Length of body 26 mm. Length of hind femora 13 mm., of hind leg 32 mm. Length of abdomen 17 to 18 mm.

Similiar to the last in most respects but of heavier build.

Mask typically Libelluline, very deeply cupped, lateral lobes with interlocking teeth to the number of 16. These teeth pigmented at the tips and turned sharply in so that the apposition of the lobes is not so flush as in *tillarga*. Mid lobe moderately straight, slightly crenate along the border and fringed with coarse hairs (pl. xxxiv, fig. 3).

Antennae long and filiform, 7 segments.

Eyes small and shaped as horn-like processes which project markedly out from the sides of the head. Two or three coarse hairs posterior to the eyes and a largish, horn-like process at the posterior, outer angle of the head.

Trunk stout, abdomen tumid, markedly carinated, the carination made up of a row of stout, backwardly directed spines, one on each segment, to the number of 6 and each overlapping the ensuing segment. The last four segments with stout spines on the postero-lateral corners and segments 7, 8 and 9 with smaller, but robust spines situated mesially on the borders.

Legs very long and spidery, naked.

Hab.—Similar situations to the last.

Subfamily *GOMPHINAE.*

4. **Macrogomphus annulatus,** Selys.

(Pl. xxxiii, fig. 3; pl. xxxiv, figs. 4, 4*a*.)

Poona, 1. 8. 19, 1515/H2.

Length 49 mm. Length of hind femora 7·5 mm. Length of abdomen 39 mm. Mask typically Gomphine, very flat, oblong, the basal half constricted, mentum square, lateral lobes kukri-shaped, jaws armed with five robust teeth on the inner border and a long, moveable hook on the outer. No setae. Mid lobe straight, not projecting, minutely crenate along its border (pl. xxxiv, figs. 4 and 4*a*).

Eyes globular, comparatively large. Head small. Antennae short, club-shaped, 4 segments, coated with coarse, short hairs.

Synthorax narrow, wing-cases very narrow, triquetral, abdomen tapering towards the anal end, cylindrical, not carinated, greatly elongated, especially the last two segments, the 9th being furnished with a robust, backwardly directed spine on the mid-dorsum.

Legs very short and robust, adapted for digging, the femora and tibiae strongly curved and the former furnished with a long fringe of hairs on the extensor surface.

Hab.—Burrows in mud, in running streams. The fringe of hairs on the femora serve to collect flocculent debris which further conceals the insect.

The syphon-like end of the abdomen projects from the mud and thus permits the easy inspiration of clear water for purposes of respiration.

They emerge from the water about the 2nd week in August, often in great numbers and then fly inland for long distances. Finally the imago comes to rest in low growing trees, on the terminals of branches on the leeward side of the trees. Babul trees seem to be their special selection in the Deccan and about the end of August very few of these trees can be found that have not one or two occupants.

5. **Cyclogomphus heterostylus**, Selys.

(Pl. xxxiii, fig. 1 ; pl. xxxiv, figs. 5, 5*a*.)

Poona, 10. 9. 17, 1516/H2.

Length 21 mm. Length of hind femora 4·5 mm. Length of abdomen 15 mm.

Mask very broad, almost square, the base constricted, very flat, the outer surface coated sparsely with short hairs. Mid lobe straight, not projecting, fringed with longish, fine bristles, the lateral lobes somewhat similar to those of *annulatus* but without a marked, kukri-like bend at the tip, the inner border furnished with blunt, molar-like teeth, the outer with a long, robust, moveable hook (pl. xxxiv, fig. 5 and 5*a*).

Antennae clubbed, four segments, the last minute. Head comparatively larger than in *annulatus*.

Abdomen tapering slightly, more torpedo-shaped and the end segments not prolonged as in *annulatus*. The 8th and 9th segments with a robust, mid-dorsal spine projecting back from the apical border, the 10th segment very short, unspined, the 7th to 9th segments with short spines laterally.

Legs moderately short (rather shorter than shown in pl. xxxiii), the femora bearing the same fringe of hairs as seen in *annulatus*.

Hab.—Found in running streams crawling on the surface of muddy bottoms or rocks.

6. **Cyclogomphus verticalis**, Selys.

Poona, 17. 8. 19, 1517/H2.

Length 21 mm. Length of hind femora 4·5 mm. Length of abdomen 15 mm.

Almost exactly similar to the last. Differs by having blunt, mid-dorsal spines on all abdominal segments except the 9th and 10th, the latter segment is more than twice the length of the same segment in *heterostylus*. This segment also hollowed on the upper surface. Mask scarcely differing from that of *heterostylus*.

7. **Cyclogomphus minusculus**, Selys.

(Pl. xxxiii, fig. 2; pl. xxxiv, figs. 6, 6*a*.)

Poona, 9. 8. 19, 1518/H2.

Length of body 15 mm. Length of hind femora 5 mm. Length of abdomen 10 mm.

Mask very flat, the mentum slightly rounded, the base furnished laterally with a projecting, robust spine and 4 spinous hairs posteriorly, its sides bearing 7 short spines and the antero-lateral corner bearing a single, stout spine, lateral lobes without any armature whatever save for a short, moveable hook. The inner border finely crenulate, the outer bearing two small spines at its base, the mid lobe projecting somewhat like that of an Agrionid, its border finely crenulate and fringed with short, stiff hairs. The outer surface of the mask coated sparsely with short hairs (pl. xxxiv, figs. 6 and 6*a*).

Head triangular, the fore part projecting well in front of the eyes which are rounded and somewhat large.

Synthorax small, wing-cases short, flat and broad. Abdomen very broad and greatly depressed as in fact is the whole body of the larva. Dorsal spines on all segments except the last. The three last segments spined laterally.

Legs robust, femora short, tibiae comparatively long, naked except for a few scattered hairs.

Hab.—Lies buried in the mud near the borders of running streams. Emerges in considerable numbers about the end of August.

8. **Onychogomphus lineatus**, Selys.

Poona, 9.3.18.

Length of body 25 mm. Length of hind femora 5 mm. Length of abdomen 17 mm.

Almost exactly similar to *verticalis*. Differs only in its larger size, the short 10th abdominal segment, which is not hollowed out above and is similar in size to that of *heterostylus*. Differs from the latter in having mid-dorsal spines on the same segments as in *verticalis*.

Hab.—As for *C. verticalis* and *C. heterostylus*.

Suborder ZYGOPTERA.

Subfamily *CALOPTERYGINAE*.

9. **Matrona basilaris**, Selys.

(Pl. xxxv, fig. 1; pl. xxxvii, fig. 1.)

Shillong, 4,500-5,000 ft., in streams, Khasi Hills, Assam, 16-20.4.18, N. Annandale, 1320/H2, 1321/H2.

Length 36 mm. Length of mask 6 mm. Length of caudal appendages 11 mm.

Head small, eyes globular, antennae typically Calopterygine, the 2nd segment greatly elongated and pigmented on the outer side. This band of brownish pigment is continued across the head and synthorax on to the wing sheaths. Ocelli visible in the last stage.

Synthorax long and narrow. Wing-cases flat, leaf-like, venation well marked. Abdomen very long and narrow, tapering very

slightly. Caudal appendages triquetral, very long, the middle one considerably shorter than the lateral and lying in a vertical plane.

Legs long and slim, spidery, no armature.

Mask typically Calcpterygine ; middle lobe very deeply cleft, the terminal halves minutely crenate on the outer borders, where they engage with the outer lobes, the ends with a small spine at the tip and the extreme edge curling over, the edge of the curled part furnished with minute teeth, 2 setae on the inner surface ; lateral lobes with a long moveable hook, 2 setae situated just below it and 3 long robust spines of which the middle is the smallest, inner border minutely crenate where it engages the border of the middle lobe. Mask extends back as far as the hind coxae (pl. xxxvii, fig. 1).

Hab.—Generally concealed amongst debris, dead twigs, etc., or lying under cover of rocks. Movements sluggish. The insect is apt to be mistaken for a *Ranatra* to which it bears a close resemblance.

Subfamily *LESTINAE.*

10. **Lestes** sp.

(Pl. xxxv, fig. 2 ; pl. xxxvii, fig. 2, 2*a*.)

Jor Pokhri, Darjiling Dist., E. Himalayas, 6.8.18, S. Kemp, 1316/H2, 3 larvae.

Mask typically Lestine, very much elongated, very narrow, mid lobe projecting very slightly, 6 setae on either side of the middle line of the inner surface, lateral lobes foliate and branched, a moveable hook supported on one of the branches, from which spring 3 setae (pl. xxxvii, figs. 2 and 2*a*).

Head relatively large, eyes globular, antennae filiform, wing-case long and narrow, flattened, abdomen elongated, cylindrical, each segment bearing a lateral spine.

Caudal appendages 9 mm. long, spatulate, oar-shaped, of even width, flattened, crossed by broad bands of pigment. Tracheal vessels branching at right angles to the main vessel.

Legs long, armature 4 rows of fine spines on the femora.

Hab.—Running streams. Found on water-weeds or clinging to roots.

Subfamily *PLATYCNEMINAE.*

11. **Copera marginipes**, Ramb.

(Pl. xxxv, fig. 3 ; pl. xxxvii, fig. 6.)

Poona, 6.4.18, F. C. Fraser, 1519/H2.

Length 14 mm. Length of caudal appendages 5·5 mm. Length of abdomen 7 mm.

Mask pyriform, tapering sharply to the mentum, sides spined to the number of 11 or 12 ; mid lobe projecting sharply, armed with 4 setae, whose bases are in line at right angles to the middle line of the mask, the biting edge minutely dentate ; lateral lobes finely spined on the outer border, minutely dentate on the inner,

5 long setae on the inner surface, a robust, moveable hook and a shorter, robust, terminal spine (pl. xxxvii, fig. 6).

Head large, eyes globular, projecting laterally, prothorax small, thorax angular, its shoulders projecting, its dorsum triangular, wing sheaths flat and elongated.

Abdomen short, each segment spined laterally.

Caudal appendages highly differentiated, 3 in number, all lying in the vertical plane, petiolated and nodate, the petioles spined laterally, terminal part expanding like a leaf, its edges deeply dentate. Peppered with brownish pigment.

Legs long and slim, barred with pigment, minutely spined.

Hab.—Found in shallow brooks, in dense, darkened jungle, clinging to pieces of dead twig or tree roots. When not disturbed, they stand well out from the resting place, with the abdomen curled well over the back and the large, caudal appendages waving freely in the current. When disturbed they swiftly crouch flush with the root or twig on which they happen to be. The abdomen and caudal appendages are lowered and if the insect be approached, it will continually manoeuvre so as to place the root or twig between itself and the point of danger.

12. **Calicnemis miniata**, Selys.

(Pl. xxxvi, fig. 4; pl. xxxvii, fig. 5.)

Jor Pokhri, Darjiling District, E. Himalayas, 6. 8. 18, S. Kemp, 3 larvae, 1316/H2.

Length 17 mm.

Mask typically Agrionine in shape, somewhat similar to the last but the base not tapering so markedly and there are only 9 spines on the outer border. On the inner surface, a row of setae, 4 in number, placed rather far back on each side of the middle line; mid lobe similar to the last; lateral lobe with 7 setae, no spines on the outer surface, moveable hook robust. Biting edges of lobes finely crenulate (pl. xxxvii, fig. 5).

Legs long and slim, bearing 4 rows of fine spines.

Abdomen cylindrical, strongly spined laterally.

Caudal appendages 3 in number, broadly sagittate, subnodate, the position of node only indicated by extent of a row of spines bordering the outer side of the petiole, tracheae branching, root-like from the main stem.

Appendages banded with 4 rows of pigment.

Hab.—Running streams.

Subfamily *PROTONEURINAE.*

13. **Protosticta gravelyi**, Laidlaw.

(Pl. xxxv, fig. 4; pl. xxxvii, fig. 7.)

Between Nierolay and Mettupalaiyam, Bhavani River, base of Nilgiris, *ca.* 1,500 ft., 2 exuviae, 24. 8. 18, N. Annandale, 1360/H2.

Mask very flat, ovate, resembling in some measure that of a Gomphine, the inner surface finely striated with rows of minute, transverse grooves; mid lobe with a well-marked cleft, the mouth of which is contracted so that the edges approximate and enclose a small fenestrum. The free biting edge of this lobe armed with a row of slightly irregular, fine teeth. Lateral lobes massive and short, ending in a blunt, molar-like tooth and furnished with a robust, moveable hook. No setae on the mask (pl. xxxvii, fig. 7).

Head moderately large, eyes globular, synthorax small. Abdomen not spined laterally. Caudal appendages in a very poor, shrivelled condition. They appear to be lanceolate and triquetral in shape and without node or spines. Legs long and slim.

Hab.—Found "breeding in a small, rocky stream," N. Annandale.

[Adults flitting about in mottled shadow and light in rather deep jungle at edge of rocky stream. Rendered extremely inconspicuous by the broken colouration of the body. Exuviae on rocks in stream.—*N. A.*]

14. **Chloroneura quadrimaculata**, Ramb.

(Pl. xxxvi, fig. 3; pl. xxxvii, fig. 4.)

Bagra, Hooshangabad Dist., C.P., 3. 19, F. H. Gravely, 1 exuvia, 1333/H2.

Mask broadly pyriform in shape, its borders bearing about 18 spines, the foremost of which are the most robust; on the inner surface and immediately behind the middle lobe and on either side of the middle line is an oblique row of 4 setae; the mid lobe narrow and projecting sharply, entire, its edge finely crenulate; lateral lobes placed well away from the lateral border of the mask, reduplicated, the inner part ending in a blunt spine and furnished with 6 setae and a moveable hook, the outer part ending in a long and a short spine (pl. xxxvii, fig. 4).

Head moderately large, pentagonal, 4 small spines on the posterior border immediately posterior to the eyes. The eyes globular. Wing-cases long, flat and narrow.

Abdomen of moderate length, the last 3 segments with 2 or 3 spines laterally and the 10th with a row of dorsal spines on the apical border.

Caudal appendages 3 in number, triquetral, the broadest, flattened surface of the lateral ones, looking downwards, whilst the broadest surface of the middle appendage is uppermost, so that this appendage fits neatly between the lateral ones. Long, narrow and spined along their borders.

Legs longish, banded with pigment.

Hab.—Running streams.

Subfamily *AGRIONINAE.*

15. **Pseudagrion microcephalum,** Ramb.

(Pl. xxxvi, fig. 2.)

Hooshangabad, C.P., 12. 3. 19, F. H. Gravely, 1458/H2., and 16. 3. 19, 1456/H2. Pachmarhi, Satpuri Hills, C.P., 3,500 ft., F. H. Gravely, 1457/H2, 1461/H2, 1464/H2.

There are a large number of these larvae, which have been previously described by Dr. Laidlaw in the *Memoirs of the Indian Museum*, Vol. V, 1915, p. 179.

In regard to the caudal appendages, autotomy is a noticeable feature and what is of even greater interest, the power of replacing the lost appendages is aptly illustrated in several specimens. The replacement occurs at ecdysis, but even at the final instar the new appendage is never nearly as large as the originals.

The specimens differ considerably in the amount of pigmentation, this probably depending largely on environment.

The mask, which has been figured by Dr. Laidlaw (*loc. cit.*), has some inconspicuous teeth on the accessory lobe of the lateral lobe.

16. **Pseudagrion hypermelas,** Selys.

(Pl. xxxvi, fig. 1; pl. xxxvii, fig. 3.)

Hooshangabad, C.P., 3. 19, F. H. Gravely, 1438/H2, and at Burhanpur, C.P., 4. 3. 19, F. H. Gravely, 1466/H2.

Length 18 to 20 mm. Caudal appendages 4 mm.

Body usually darkly pigmented, rather stout and short.

Mask scarcely differing from that of *microcephalum*, but the accessory lobe of the lateral lobe absent and the setae numbering 5 (pl. xxxvii, fig. 3).

Abdomen much shorter than the former, the sides spined.

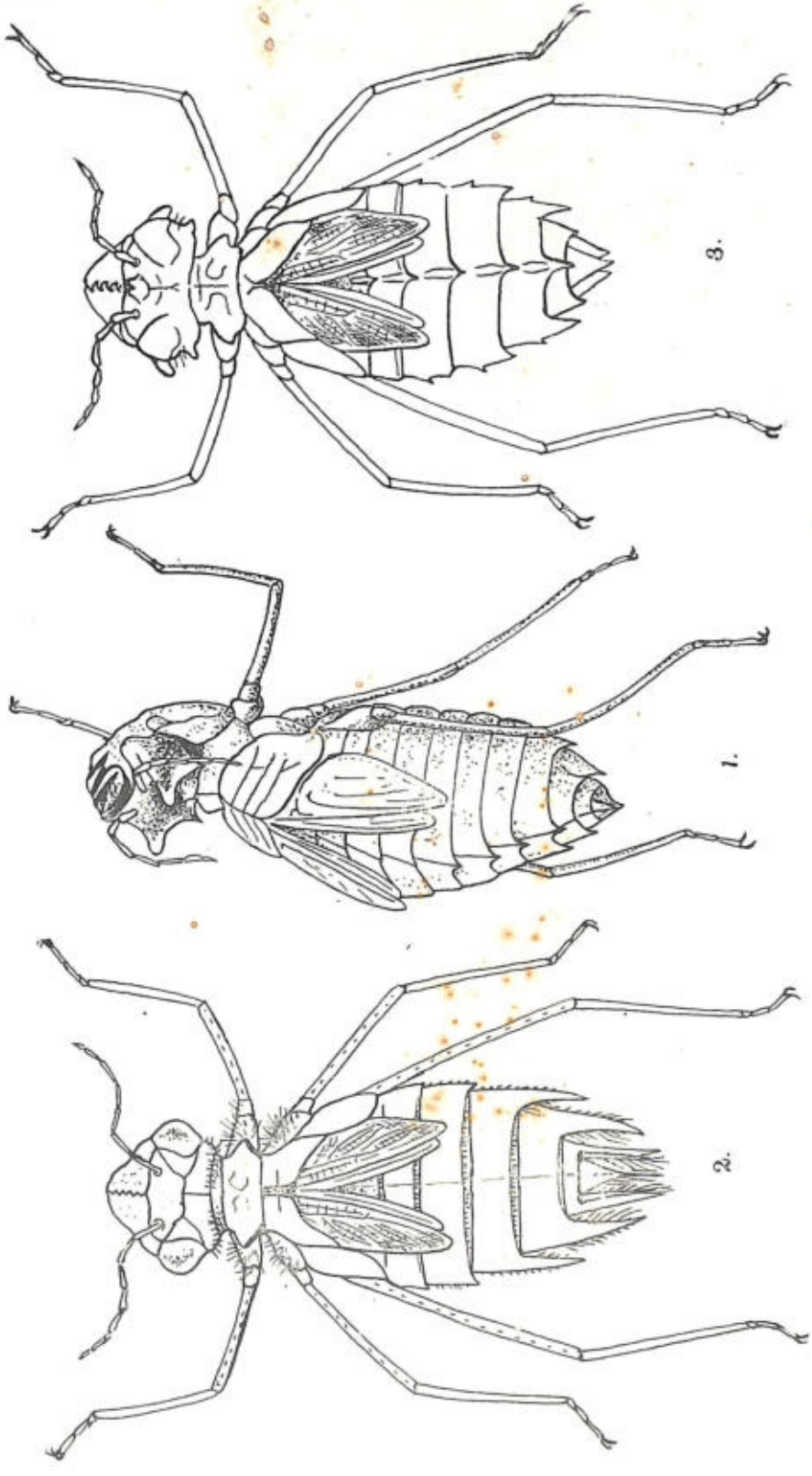
Caudal appendages pyriform in shape, blunt at the ends, subnodate, the proximal part spined laterally. Tracheae branching, root-like. A row of black, pigmented spots round the borders and some mottling elsewhere.

Legs long and slender, barred with pigment.

Hab.—Quiet running streams or large tanks, amongst weed.

EXPLANATION OF PLATE XXXII.

FIG. 1.—*Epophthalmia frontalis*, Selys.
,, 2.—*Tholymis tillarga*, Hagen.
,, 3.—*Tramea limbata*, Kirby.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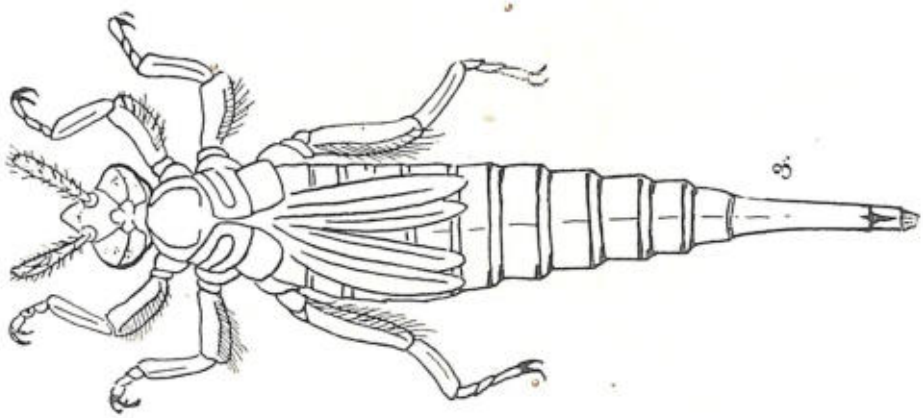
EXPLANATION OF PLATE XXXIII

FIG. 1.—*Cyclogomphus heterostylus*, Selys.
,, 2.—*Cyclogomphus minusculus*, Selys.
,, 3.—*Macrogomphus annulatus*, Selys.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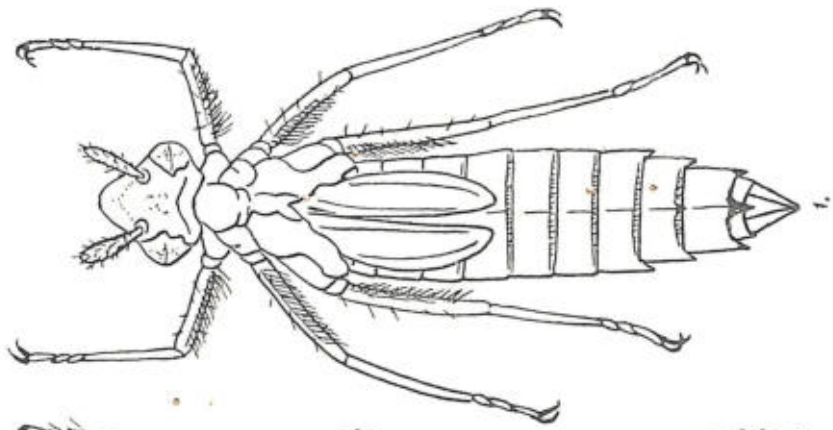
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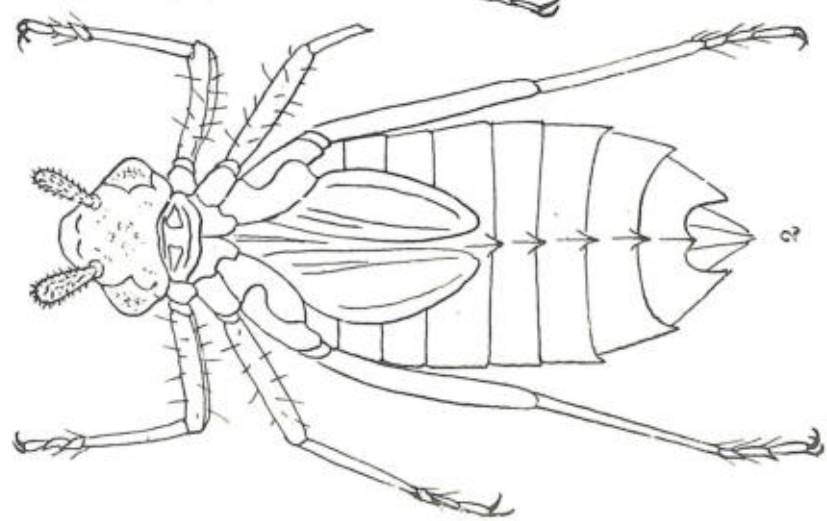
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EXPLANATION OF PLATE XXXIV.

FIG. 1.—Mask of *T. tillarga*, Hagen. The dotted outline represents the head, the heavy outline, the mask. Seen from the side.

,, 2.—Mask of *Epophthalmia frontalis*, Selys.

,, 3.—Mask of *T. limbata*, Kirby. Seen from the front.

,, 4.—Mask of *M. annulatus*, Selys.

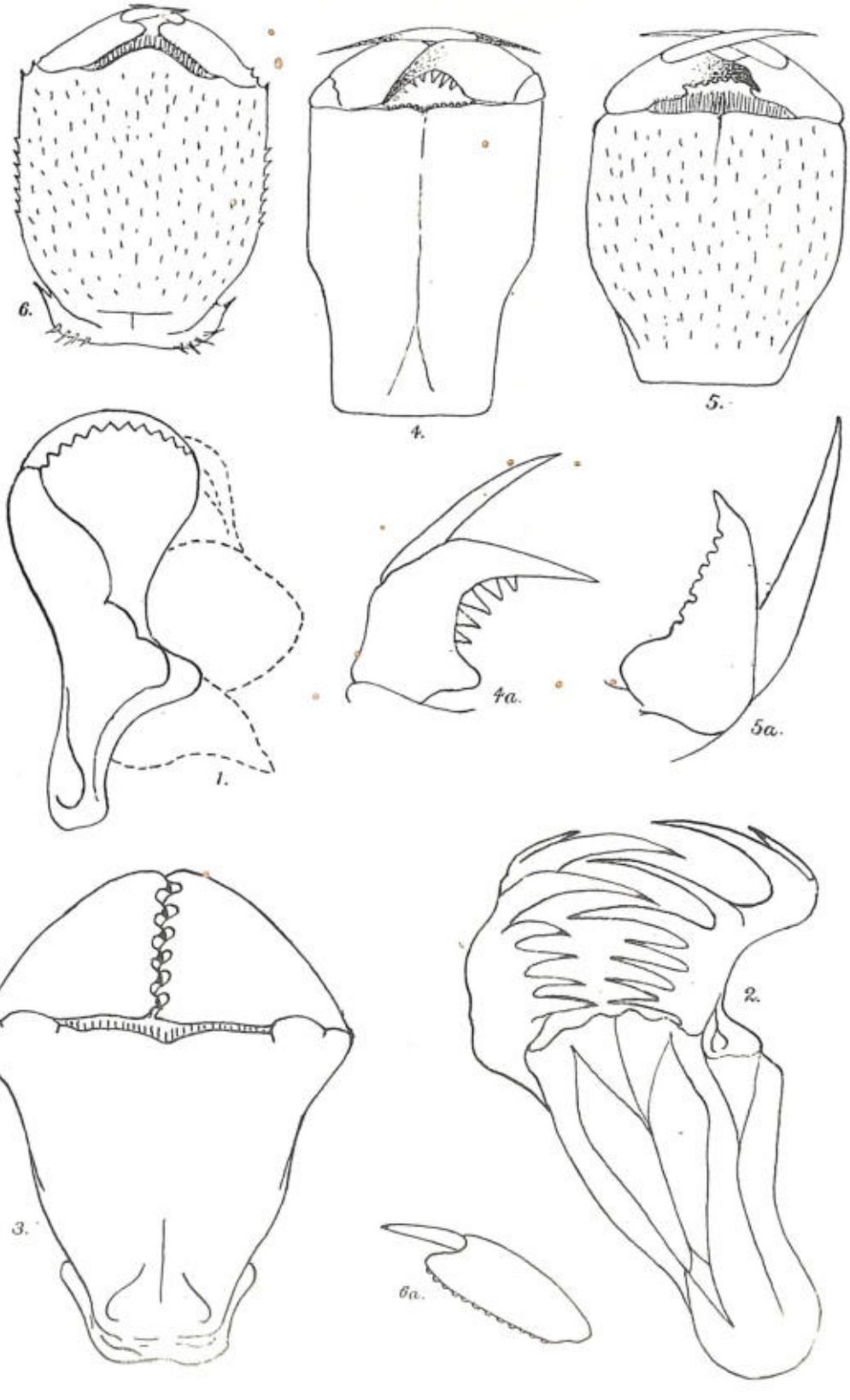
,, 4*a*.—Lateral lobe of same.

,, 5.—Mask of *C. heterostylus*, Selys.

,, 5*a*.—Lateral lobe of same.

,, 6.—Mask of *C. minusculus*, Selys.

,, 6*a*.—Lateral lobe of same.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EXPLANATION OF PLATE XXXIV.

FIG. 1.—Mask of *T. tillarga*, Hagen. The dotted outline represents the head, the heavy outline, the mask. Seen from the side.

,, 2.—Mask of *Epophthalmia frontalis*, Selys.

,, 3.—Mask of *T. limbata*, Kirby. Seen from the front.

,, 4.—Mask of *M. annulatus*, Selys.

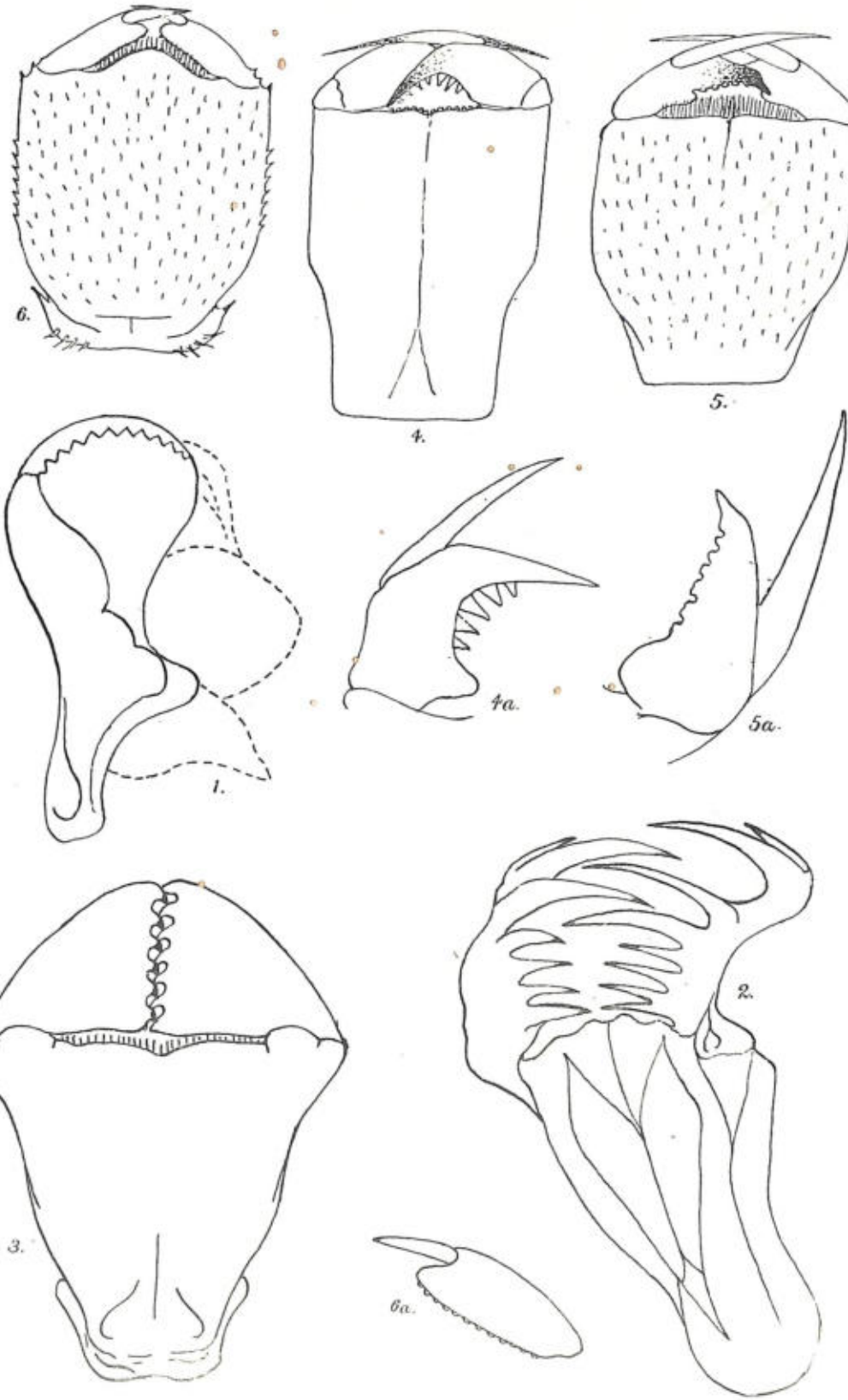
,, 4*a*.—Lateral lobe of same.

,, 5.—Mask of *C. heterostylus*, Selys.

,, 5*a*.—Lateral lobe of same.

,, 6.—Mask of *C. minusculus*, Selys.

,, 6*a*.—Lateral lobe of same.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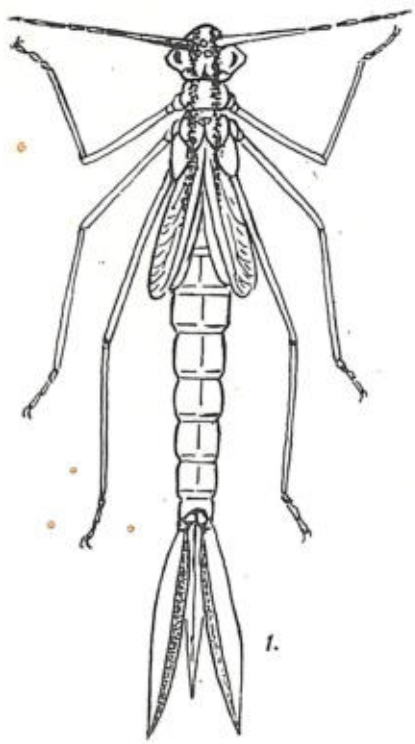
EXPLANATION OF PLATE XXXV.

FIG. 1.—*Matrona basilaris*, Selys.
,, 2.—*Lestes* sp.
,, 3.—*Copera marginipes*, Ramb.
,, 4.—*Protosticta gravelyi*, Laidlaw.



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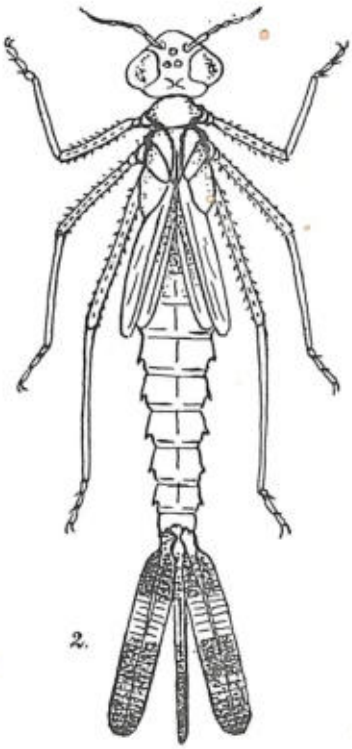

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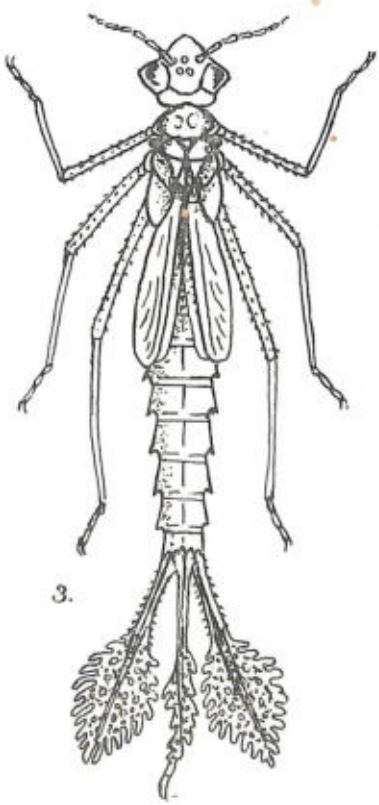

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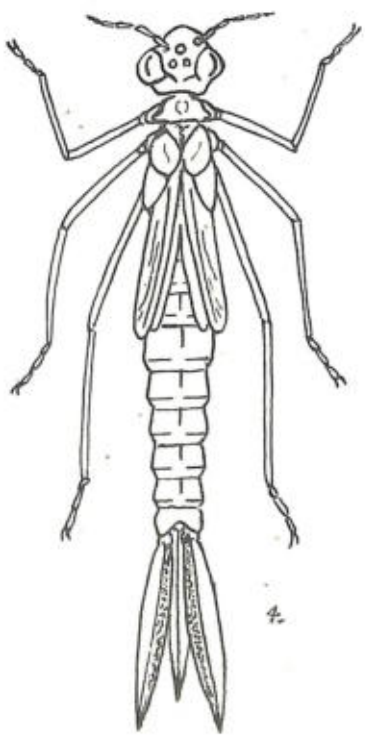
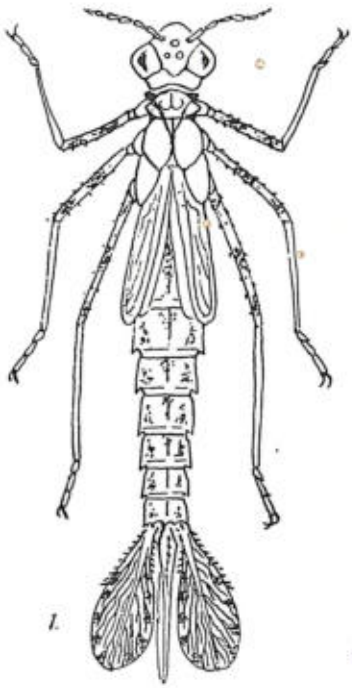


4.

EXPLANATION OF PLATE XXXVI.

FIG. 1.—*Pseudagrion hypermelas*, Selys.
,, 2.—*Pseudagrion microcephalum*, Ramb.
,, 3.—*Chloroneura quadrimaculata*, Ramb.
,, 4.—*Calicnemis miniata*, Selys.



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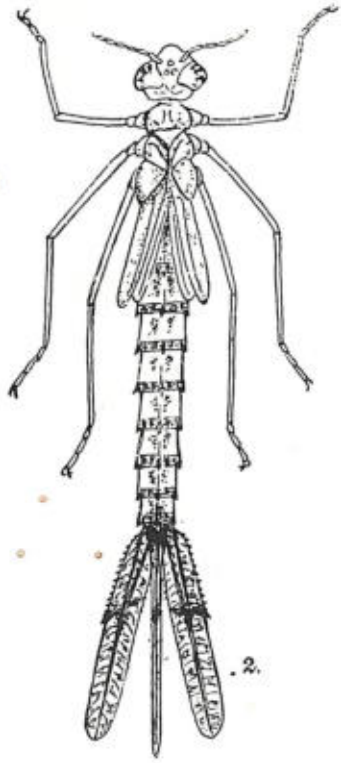

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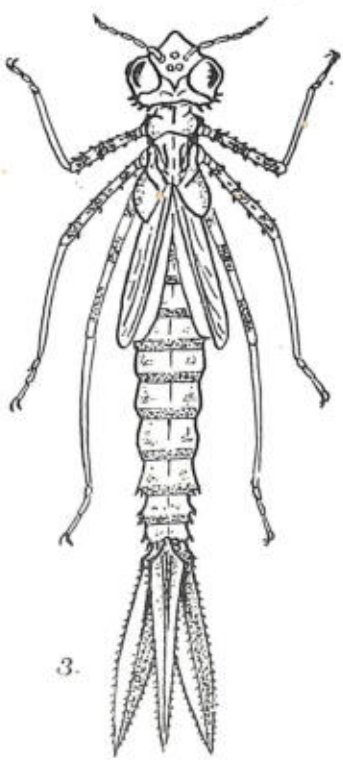

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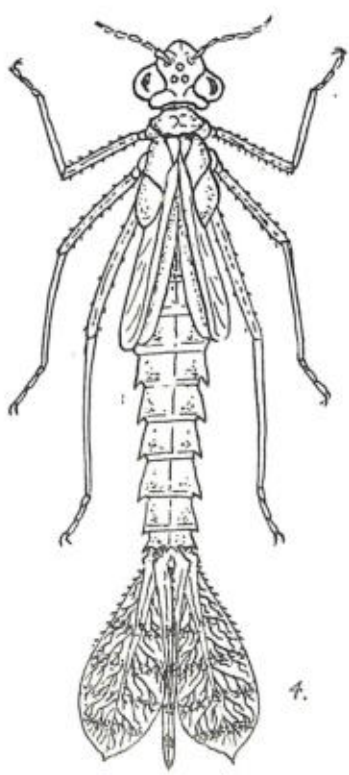
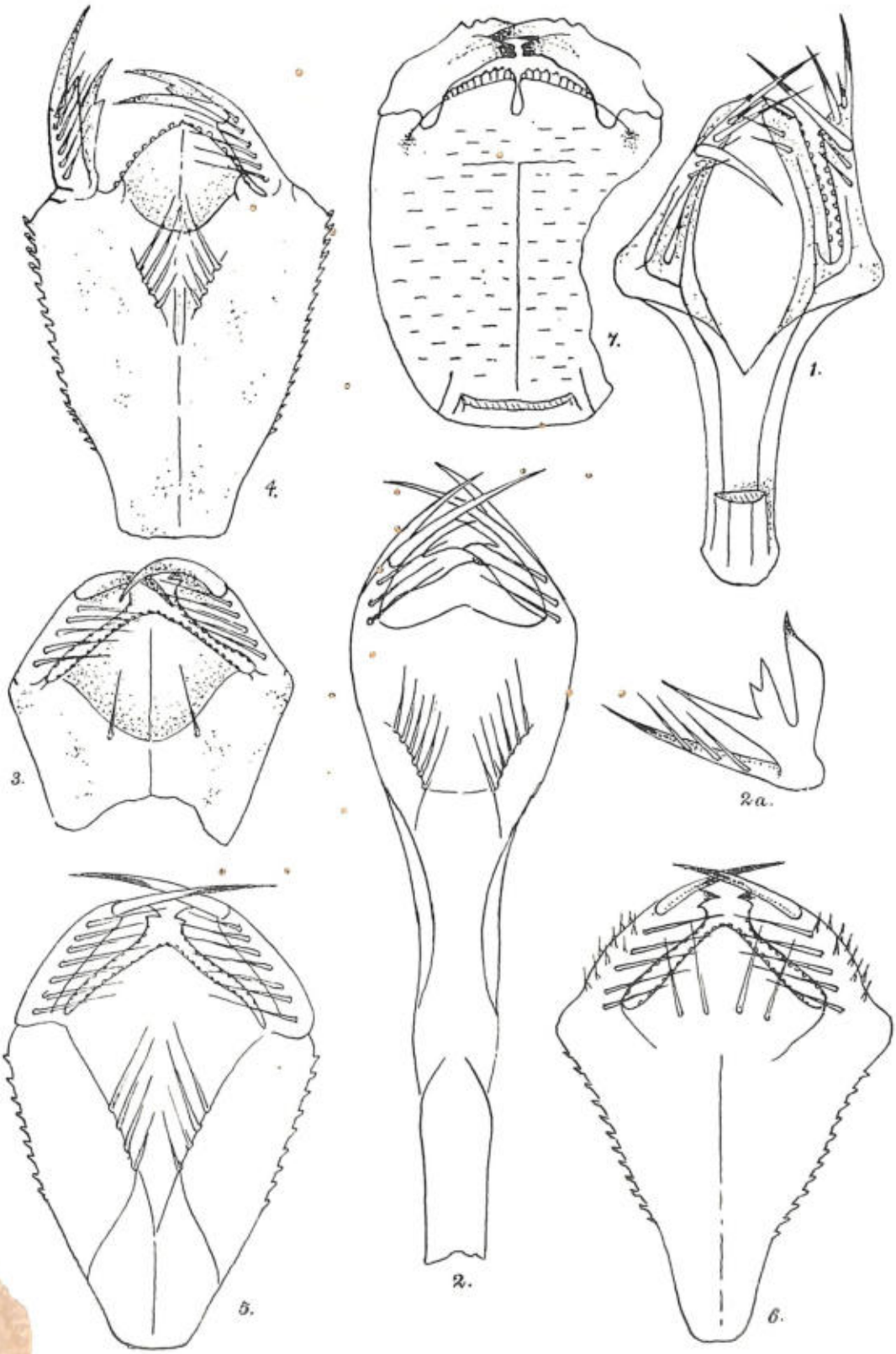


4.

EXPLANATION OF PLATE XXXVII.

FIG. 1.—Mask of *M. basilaris*, Selys.
,, 2.—Mask of *Lestes* sp.
,, 2*a*.—Lateral lobe of same.
,, 3.—Mask of *P. hypermelas*, Selys.
,, 4.—Mask of *C. quadrimaculata*, Ramb.
,, 5.—Mask of *C. miniata*, Selys.
,, 6.—Mask of *C. marginipes*, Ramb.
,, 7.—Mask of *P. gravelyi*, Laidlaw.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XXXIV. ON *AELUROPHRYNE MAMMATA*, GTHR., AN ADDITION TO THE BATRACHIAN FAUNA OF KASHMIR.

By G. A. BOULENGER, *LL.D., F.R.S., Hony. Foreign Correspondent, Zoological Survey of India.*

When in the Ladakh Valley, Kashmir, in August 1917, my son Captain C. L. Boulenger found, at an altitude of 12,000 feet, under a stone, a single young toad, measuring 25 mm. from snout to vent and still bearing a stumpy vestige of the tail. This toad was at first a puzzle to me. Its vertical pupil, combined with the absence of teeth, suggested the curious forms, annectant to the Bufonidae and the Pelobatidae, which I have described under the names of *Cophophryne*[1] and *Ophryophryne*.[2] I am now convinced that it is the young of the toad described by Günther[3] as *Bufo mammatus*, from the Kham Mountains in the Chinese province of Sze Chuen.

Günther's specimens were, as he admitted, in a poor state of preservation, and the shape of the pupil could not have been recognized. But an examination of the vertebral column and of the pectoral arch, which I have been able to make on one of the type specimens in the British Museum, shows the sacral vertebra to have unusually strongly dilated transverse processes and to articulate with the coccyx by a single condyle, as in *Pelobates* and *Megalophrys*, with both of which it agrees also in the structure of the pectoral arch (precoracoid strongly curved, sternum with a long bony style), thus confirming my first impression as to the affinities of the Kashmir specimen. *Bufo mammatus*, for which I now propose the generic name *Aelurophryne*, in allusion to the cat-like pupil, is closely allied to *Cophophryne*, differing from it in the absence of a notch in the posterior border of the tongue, which is oval in shape; the tympanum is present, though hidden under the skin, and the eustachian tube moderately large.

We are therefore now acquainted with three closely related generic types filling the gap between the Pelobatidae and the Bufonidae, and it may appear a moot point as to which of the two families they should be referred. As I am more and more losing faith in the importance of the presence or absence of teeth as a family character,[4] I would suggest an alteration of the definition of

[1] *Ann. and Mag. N. H.* (5) XX, 1887, p. 406.
[2] *Op. cit.* (7) XII, 1903, p. 186.
[3] *Ann. Mus. Zool. St. Pétersb.*, 1896, p. 10.
[4] *Cf.* Boulenger, *Ann. and Mag. N. H.* (6) I, 1888, p. 188.

the Pelobatidae so as to include these toothless forms. Although the definition will then be very vague indeed, the group will at least be expressive of the natural affinities of its constituents, which may be described as lowly forms approaching the Discoglossidae and leading on the one hand to the Cystignathidae (through *Batrachopsis*, Blgr.), on the other to the Bufonidae.

ADDENDA.

Since this note was written, Dr. Annandale has submitted to me two specimens of a toad from high altitudes in Kashmir, sent to him quite recently by Mr. F. J. M. Mitchell, as representing the adult of the tadpole described by him in these *Records*, XIII, 1917, p. 417, figs. 1, 2, as that of *Rana pleskei*, Gthr. I have no doubt Mr. Mitchell's suggestion is correct, and as the toads belong to *Aelurophryne mammata*, the resemblance of the tadpole to that of *Pelobates*, with which I had been struck on reading Dr. Annandale's description, is accounted for, and affords a confirmation of the systematic position assigned to *Aelurophryne*.

[I have to thank Mr. F. J. Mitchell for sending me further specimens of the tadpole which I recently described as that of *Rana pleskii*, and also of the adult which he believed, on my identification of the larva, to belong to that species. It was quite clear from the most superficial examination of the adult that it was not *Rana pleskii*. Almost at the same time as I received these specimens from Kashmir I also received from Dr. Boulenger the manuscript of his paper on *Aelurophryne*. This coincidence led me to re-examine all the material in the Indian Museum referred to *Rana pleskii*, which includes specimens from Tibet named by Dr. Boulenger as well as those collected in that country by Capt. F. H. Stewart (*Rec. Ind. Mus.* II. p. 345) and the tadpoles from Kashmir described by me in *Rec. Ind. Mus.* XIII, p. 417.

The eye was concealed in most of the specimens, but I found that on dissecting off the lower eye-lid of some very young examples which had just lost their tails, the pupil appeared to be slightly vertical though it was contracted to so small a speck that its shape was hard to see, while in other young specimens it was certainly not vertical. I still had very great difficulty in distinguishing the two forms on any other external character, as the examples of neither were in good condition, but Mr. Mitchell's series of beautifully preserved tadpoles and young of the species common at high altitudes in Kashmir, leaves no possible doubt that I had confused the young of *Rana pleskii* with those of *Aelurophryne*, and that the tadpole which I ascribed to the former really belongs to the latter. *N. Annandale.*]

XXXV. RECORDS OF TRIGONALIDAE FROM SOUTH INDIA.

By T. V. RAMAKRISHNA AYYAR, *First Asst. to the Government Entomologist, Madras.*

The Trigonalidae form a very small family of parasitic Hymenoptera and very little is on record regarding these interesting insects. As far as is known of the few European and American forms, the members of the family appear to be parasites or hyperparasites on species of Vespidae. So far as I know there is only a solitary example of this group of insects that has till now been recorded from the Indian Continent, and that is *Pseudogonalos harmandi*, Schulz, collected in Darjiling before 1907. In the *Genera Insectorum* volume on this family the author Schulz records three others from Burma and none from any part of India except the one noted at Darjiling. As such the following records might be of some interest.

In 1917 two undoubted specimens of this family were collected from South India. But their presence as representatives of this rare group was found out only when I was recently sorting out our Hymenoptera collection. These two forms have certain general resemblances to the Burmese species described by Westwood in the *Transactions of the Entomological Society* for 1868, p. 327, under the name of *Poecilogonalos* (*Trigonalys*) *pulchella*, but both are different in certain features and as such are, I believe new forms. Their general features are as below:—

1. Poecilogonalos fulvoscutellata, n. sp.

Head large, subquadrate, distinctly broader than thorax, vertex and frontal region closely punctured. Eyes large and situated sufficiently apart from each other. Antennae long and filiform. Ocelli clear; clypeus slightly emarginate; mandibles large and each provided with three well-developed teeth.

Prothorax large, broader than long; punctured in the same way as head. The anterior lateral region is drawn out into a flattened raised structure in front of the wing tegulae. Scutellum prominent, more or less spherical and gibbous. Median segment convex with the punctures at the basal region running into fine longitudinal striae; there is a short tubercle at each lateral angle of the base of the metanotum. Legs well developed; two spurs on the hind tibiae.

The abdomen is ovoid in shape. The first segment is small and triangular, the second largest, the posterior segments smaller and

curved downwards, the second and third segments finely punctured.

General colour dark with brown and yellow markings.

Head. Ground colour dark; the mandibles except the teeth, one oval spot on each side of the clypeus, one small spot at base of each antenna, the inner and outer orbits of the eyes (the outer somewhat broadly), a minute spot in front of the anterior ocellus, and the lateral margins of the occiput yellow. Antennae ferruginous; the scape and distal end of the flagellum slightly darker. The face, front and occiput dark in colour but the latter has a V-shaped reddish-brown mark, the two limbs of the mark diverging towards the eyes on each side of the ocellar region. In addition there is also a fulvous red streak on each side of this V-mark, and there is a faint small reddish spot just behind and between the two posterior ocelli.

Thorax. Prothorax dark ferruginous, two somewhat conical spots at the base near the head one on each side of the mid-dorsal line, the anterior lateral flattened region, and one prominent mark on each pleura yellow. Scutellum completely fulvous yellow. Three transverse lines on the post-scutellum (all three in a line but not touching each other, the middle one being longer and broader), two large irregularly oval spots on median segment one on each side of the median line, one small spot at the mesopleural region under the wings, and two slightly larger spots at the meta-pleural region also yellow. The legs—coxae black with yellow mark, trochanters fulvous; femora, tibiae and tarsi reddish to ferruginous brown.

Abdomen. The abdomen is dark ferruginous brown. One small triangular spot on the first segment near its junction with the second, a transverse stripe on its ventral side, a broad transverse band at the distal region of the second segment and similar ones on the following segments yellow; those on the posterior segments are broadly interrupted at the median line. There is a tinge of reddish-brown on the second and third segments in front of the yellow band.

Wings fuscotransparent with a fuscous spot at the radial region. Tegulae yellowish.

Length 8 mm.

Pulney Hills, 3600 feet, Madura district. Collected by P. Susainathan; May 1917.

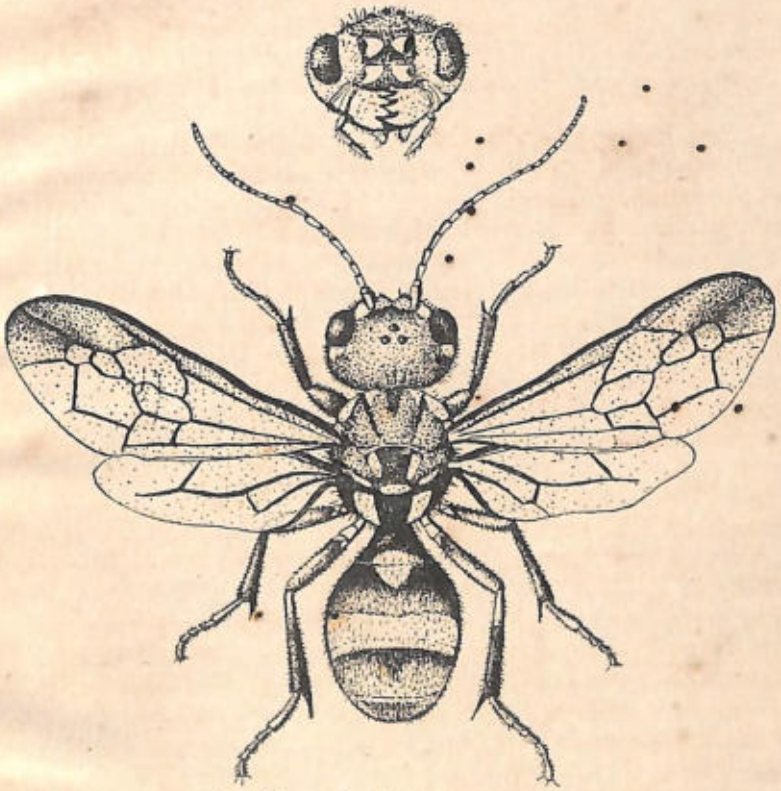
2. Poecilogonalos kerala, n. sp.

Though in some features this insect is similar to the above species from the Pulneys there are some marked differences which are as below.

It is quite different in general form and colour from *Poecilogonalos fulvoscutellata.* The head is very broad and appears shining and gibbous, although on closer examination it is found punctured very finely. The mandibles are prominent and show four big teeth. The dorsal grooves on the pronotum are some-

what more prominent. The tubercles in the median segment are less prominent. There are also colour differences. The general colour in this case is bright reddish-brown. The face and a narrow region of the front just above the antennae black; except the ocelli which are black the front and vertex are reddish-brown. The mandibles except the teeth, inner and outer orbits of eyes, one spot at the base of each antennae and a narrow portion along the posterior lateral region of occiput yellow; antennae reddish-brown.

Prothorax reddish-brown. One dark spot on the median line and one yellow spot on each side of the former, all three situ-



Poecilogonalos kerala, n. sp. × 6.

ated at the base close to the head. The anterior lateral flattened portion yellow. Scutellum black with a narrow yellow spot on each side of it. The three yellow lines on the post-scutellum and the other yellow marks more or less similar to the previous species. There is a reddish tinge predominant at the sides of the thorax in this species. Legs—coxae and trochanters brownish yellow, femora brown, tibiae ferruginous brown and slightly fulvous at the base, tarsi ferruginous.

Wings. Costal cell slightly narrower in this species. The second and third cubital cells shorter and broader than in the last species,

and the boundary veins of these and adjacent cells different in arrangement. Fuscus spot on wing clearer; tegulae ferruginous.

The face, cheeks, sides of thorax and abdomen clothed with more of whitish glistening pubescence.

Length 8 mm.

Santhanathode, Western Ghats, Malabar district. Collected by T. V. Ramakrishna Ayyar; 7-10-1917.

These insects are easily mistaken for small bees and likely to be overlooked. There is no doubt several other forms will be met with in South India in course of time, when it will be possible to get more information regarding this very little-known family of insects.