BOOK NO.
1081

RECORDS

of the

INDIAN MUSEUM

(A JOURNAL OF INDIAN ZOOLOGY)

Vol. VII, 1912.

EDITED BY

THE SUPERINTENDENT

OF THE

INDIAN MUSEUM.

Calcutta:

PUBLISHED BY ORDER OF THE TRUSTEES OF THE INDIAN MUSEUM.

BAPTIST MISSION PRESS.

1912.

ZOOLOGICAL SURVEY OF INDIA
Kolkata
700 027
ALI. ORE

Acc. no P697
Dt. 15/5/07

591.5(05)
Asia

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I. NOTES ON THE DEEP-SEA FISH OBTAINED BY THE R.I.M.S.S. "INVESTIGATOR," DURING THE SURVEY SEASON 1910-11.

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During the season 1910-11 opportunities occurred for only four deep-sea trawls. These were all taken off the S. W. coast of India, and the detailed positions are as follows :—

Station 388, 26-iv-11.
7° 44′ 10″ N.
76° 35′ 45″ E. } 670 fathoms.
drift during trawl N. 36° E. 4 miles.

Station 389, 27-iv-11.
9° 01′ 50″ N.
75° 55′ 50″ E. } 81 fathoms.
drift during trawl N. N. W. 1 mile.

Station 390, 27-iv-11.
9° 09′ 00″ N.
75° 46′ 00″ E. } 260 fathoms.
drift during trawl N. N. W. 4 miles.

Station 391, 27-iv-11.
9° 14′ 10″ N.
75° 45′ 00″ E. } 237 fathoms.
drift during trawl N. 36° E. 4 miles.

Although the material obtained was by no means plentiful, several interesting species were found, notably a fine example of *Trachichthys darwinii* and an egg-capsule and the contained embryo of a species of *Rhinochimaera*.

Unfortunately, owing to the presence of a large number of shells of *Xenophora pallidula* in trawl 391, the material obtained was, in several instances, badly damaged; while in trawl 390 the net caught on a rock and was much torn, the only fish obtained being the example of *Trachichthys* that had very fortunately become entangled by its opercular spines in the meshes of the net close to the mouth.

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ELASMOBRANCHII.

Plagiostomi.

SELACHII.

Family SPINACIDAE.

Centroscyllium ornatum, Alcock.

1899. Alcock, p. 14.
Ill. Zool. Invest., pl. viii, fig. 2 (young).
,, ,, ,, pl. xxxv, figs. 1—1 b.

A single specimen 15·5 cms. in length (including the caudal fin) was obtained at Station 391.

A careful comparison with Alcock's type specimens failed to reveal any discrepancies.

So far as I am aware, the only previous records of the occurrence of this species are at "Investigator" Station 1—21° 6′ 30″ N., 89° 30′ 00″ E.—in 405-285 fathoms, and "Investigator" Station 211—23° 00′ 00″ N., 66° 08′ 00″ E.—in 609-620 fms.

HOLOCEPHALI.

Rhinochimaera sp.

A single egg-capsule, in a fresh state and containing an embryo, was obtained at Station 391.

The capsule was black in colour and, as regards general appearance, closely agrees with the description of the capsules of *R. atlantica* obtained off the W. coast of Ireland (Holt and Byrne, 1910, p. 22, pl. iv, figs. 4-5).

There is in the Indian Museum an egg-capsule labelled *Rhinochimaera indica* that was obtained by Alcock in 1890 (*Ann. Mag. Nat. Hist.* (vi), vol. viii, p. 21) at St. 112—13° 47′ 30″ N., 92° 36′ 00″ E.—in 561 fathoms, and was attributed by him to a species of *Callorhynchus*, subsequently receiving the name of *C. indicus* from Garman in 1899 (*Mem. Mus. Comp. Zool. Harvard*, vol. xxiv, p. 21).

Bashford Dean, who had an opportunity of examining this specimen, has expressed the opinion that it is, in reality, a capsule belonging to a species of *Harriotta* (*Chimaeroid fishes and their Development*, B. Dean, 1906), a view with which I am in complete agreement.

A comparison of the present specimen and Alcock's example showed at once that they could not belong to the same species. In the following table I have given the measurements of both these capsules and, for purposes of comparison, the measurements of one of Holt and Byrne's examples of *Rhinochimaera atlantica*.

	Rhinochimaera atlantica, Holt and Byrne.	*Rhinochimaera* sp. (present specimen.)	*Harriotta* sp. Alcock.
Total length	204	168+	130+
Total length of body and style	158	138	120
Length of membrane in front of body.	20	21	10+
Length of body	94	77	64
Length of anterior narrow part of body.	25	20	17
Greatest total width ..	62+	50	38+
Dorsal surface.			
Width of anterior part of body	21	15	15
Width at neck ..	19	13	18
Greatest width of body ..	31 *ca.*	23·5	25
Width of style at origin ..	9	6	7·5
Width of style at its middle ..	5	3·5	4·7
Width of posterior end of style	10	8·5	6·5
Ventral surface.			
Width between (including) ridges at anterior end.	13	10·5	8
Width between (including) ridges in front of patch of byssus.	19	15·5	12
Width between (including) ridges at neck.	15	13	11
Greatest width of body between (including) ridges.	25	19	17
Width of gutter between ridges 8 in middle of style.	? (very narrow)	1·5 mm.	5·3
Colour ..	Black.	Black.	Pale bottle green.
Patch of byssus ..	19 mm. square	14 mm. square	7·5 mm. square

Unfortunately both ends of the capsule are somewhat torn, the lateral margins are, however, entire and are, as usual, ridged—presenting in all from 48—50 ridges. The lateral lips of the mouth are smooth and free from the "ruffle-like serrulae" present in *Harriotta*.

The neck is distinct and narrower than either the head or body, a point in which it differs from Alcock's example of *Harriotta*, in which the neck is much less marked and, as will be seen by a reference to the preceding table, wider than the head portion.

The style is narrow and widens out posteriorly into a spatulate tip which is produced in a lanceolate tag of delicate membrane. On either side of the style close to the line of origin of the lateral membrane is a distinct ridge, the posterior two-thirds of which is transversely ribbed by the caudal pores. In this respect the capsule closely resembles that of *R. pacifica* (Bashford Dean: "Notes on the long-snouted Chimaeroids of Japan," *Journ. Coll. Sci. Tokyo*, xix, Art. 4, p. 19, pl. ii, fig. 12a). The pores, however, are continued further forward along the style.

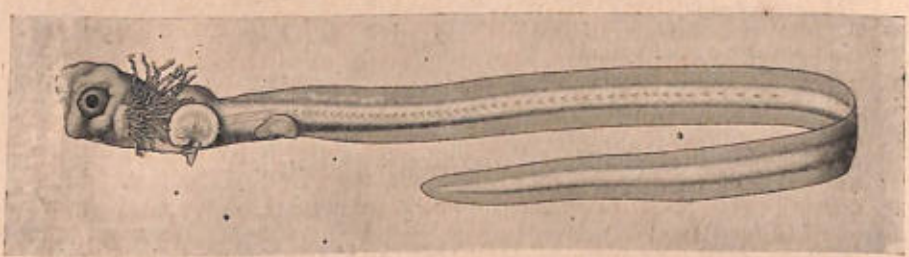
A point of difference between this specimen and other previously described examples of *Rhinochimaera* capsules is the presence,

on the posterior half of the rounded body, of a low but distinct median ridge on either side of which the body wall is pushed slightly inwards forming a shallow concavity.

The embryo when first obtained, was attached to a large yolk-sac, and the whole was floating in a creamy fluid caused in all probability by the fragmentation of the yolk as has been described by Dean (*l.c.*, p. 41) in the case of *Chimaera colliei*.

Unfortunately, it was impossible to examine the embryo in detail at the time of its capture and before an opportunity arose the embryo and yolk-sac had become separated, owing to the rupture of the yolk-duct.

The embryo had apparently reached very much the same stage as that shown in Bashford Dean's monograph (*l.c.*, plate viii, fig. 49). The first thing that strikes one is the extreme length of the tail. The total length of the embryo was 63·5 mm. and the distance between the anterior end and the anus 12 mm., hence the proportional lengths of body and tail are as 1 : 4·3. In this respect it presents a marked difference from the embryo of *Chimaera*



Embryo of *Rhinochimaera* sp., × 3.

colliei, in which, according to Dean's figure (he does not give any measurements), the proportions are 1 : 3·1.

The head. As in *Chimaera* the most anterior part of the head is not formed by the olfactory region and fore-brain, but by a large projection, circular in outline when viewed from the side but compressed somewhat laterally, which probably represents the rudiment of the elongated snout of the adult.

Just posterior to this on the dorsal surface is a second rounded and much smaller projection (corresponding to the mid-brain) which is apparently not represented in *Chimaera* embryos, and this again is succeeded by a large and very thin-walled, semi-transparent projection—the hind brain.

The olfactory region forms a well-marked rounded prominence on the ventral aspect, and the olfactory pits have already become separated from the mouth, although a faint surface groove can be made out connecting them. Between the olfactory pits in the middle line a bilobed projection can be distinguished probably corresponding to the underlying rostral cartilage.

The mouth is large and has broken through, and is bounded posteriorly by a complete lower jaw, the two mandibles having united in the middle line, and the point of union being marked by a rounded backwardly directed projection.

The eyes are large and bulge prominently on each side of the head; their maximum diameter is 1·5 mm. and the interocular diameter of the head 3 mm. Below the eye, between it and the mouth, is a small and not very distinct depression, corresponding in position almost exactly with the aperture described by Dean (*l.c.*, p. 104, pl. viii, fig. 49 d) in *Chimaera* as the rudimentary spiracle—a most unusual situation for it, if this view be correct.

Balfour in his classical work on the development of the Elasmobranchs (Humphry and Turner's *Journal of Anatomy and Physiology*, vol. x, pl. xxv, M and M′) has figured a young embryo of *Pristiurus*, which shows a well-marked triangular depression between the eye and the mouth in a situation precisely similar to Bashford Dean's "spiracle." (The true spiracle is shown to be present, much more posteriorly, between the eye and the 1st gill-cleft.) This depression, the morphological significance of which seems to have been erroneously interpreted by Bashford Dean, is apparently formed by the forward extension of the 1st visceral or mandibular arch on either side of the primitive mouth.

McIntosh and Prince (1890, p. 751) have shown that, in Teleosteans, the mandibular arch, though originally single, subsequently splits into two, an anterior palato-quadrate portion and a posterior true mandibular part. The former, apparently, at a somewhat later date extends forwards below the eye on either side of the mouth and finally unites with the olfactory region of the snout. Judging from Balfour's figures and description (*l.c.*, p. 563) a precisely similar process occurs in *Pristiurus*.

What happens in *Chimaera* (and in all probability in *Rhinochimaera* also) is, so far as one can tell, that this palato-quadrate portion of the mandibular arch grows forwards and, when it reaches the lateral part of the olfactory region, fuses with it, leaving, as Bashford Dean has shown, an aperture between the mouth and the exterior just below the eye, in a position exactly analogous to the lachrymal duct in higher vertebrates. This canal subsequently disappears, only a trace of it being visible, as a shallow depression, in embryos that have reached a stage of development corresponding to Balfour's stage M in the shark (Balfour, *l.c.*, vol. x, pl. xxv). It is obvious from Bashford Dean's figures that his so-called "spiracle" lies not only in front of the mandible but even anterior to the palato-quadrate or maxillary offshoot from this arch and hence cannot possibly be the true homologue of the spiracle, *i.e.*, a gill-cleft immediately anterior to the 1st gill-arch between it and the mandibular arch.

The Gills. Five gill-arches are present and project markedly at the side of the head; they are fringed with long external gill-filaments in which the vein and artery can be distinctly made out

coiling spirally around each other. These filaments are much longer, apparently, than in *Chimaera colliei*, being at least twice the length of the interocular diameter of the head. In the fresh state they were covered with small masses of yolk that appeared to be more or less adherent to their surface.

There are only four gill-clefts actually present, for the 5th although being represented by a deep groove has apparently not yet broken through.

Anterior to and covering over the upper part of the 1st gill-arch is a delicate crescentic fold of membrane—the rudimentary operculum. This bulges out somewhat prominently from the side of the head and lying just above and in front of it and between it and the eye is a slight angular depression. Judging from its situation I should have, without hesitation, considered it to be the spiracle, but under the present circumstances one can only await further researches before definitely deciding on this point.

The Fins are well established and—in the case of the paired fins—remarkable for the degree of development to which they have already attained. The pectoral and ventral fins are folded dorsally so as to lie flat against the sides of the body and radiating fin-rays can be easily made out. The first dorsal fin is completely separate but as yet no trace of a dorsal spine exists. The second dorsal has not yet separated off from the remainder of the long median dorsal fin and is continuous around the extreme tip of the tail with the median ventral fin which extends as far forward as the posterior border of the paired ventral fins.

No trace of claspers could be detected, but possibly the specimen is a female.

Between the ventral fins is a small but distinct anal papilla.

The lateral line could be traced back to a point a short distance behind the ventral fins and traces could be made out on the head of the cephalic system of mucous canals.

The pedicle by which the embryo had been attached to the yolk-sac was broken but appeared to have been very short and of narrow diameter: it arose from the body midway between the two pectoral fins.

The *yolk-sac* appeared to be completely enclosed in the blastoderm and was roughly trilobed in shape: its dimensions were 25 mm. × 18 mm.

The main features in which this embryo differs from those of *Chimaera colliei* are as follows:—

1. The much greater length of the tail region.
2. The projection of the mid-brain dorsally.
3. The greater length of the gill-filaments.

The occurrence of this egg-case and embryo is of extreme interest, as it is, so far as I am aware, the first occasion on which an embryo of *Rhinochimaera* has been obtained, and it affords undoubted evidence of the occurrence of this genus in Indian waters.

Teleostei.

ACANTHOPTERYGII.

Trachichthys darwinii, Johnson.

1895. Goode and Bean, p. 188, fig. 207.
1899. Alcock, p. 35.

A single specimen was obtained at Station 390. In the fresh state the colour was a uniform scarlet, fading to a pale silvery tint on the abdomen.

Family CYTTIDAE.

Antigonia capros, Lowe.

1887. Günther, p. 44.
1895. Goode and Bean, p. 229, fig. 235.
1899. Alcock, p. 44.

A single specimen was obtained at Station 389. The height of its body exactly equalled the length of body (without the caudal fin). Only three examples were known from previous "Investigator" researches, and in all four specimens slight differences existed from the figure given by Goode and Bean. The head, when viewed in profile, shows a well-marked convexity between the eyes, not a uniform concavity as they figure it, and the eye is distinctly larger.

In the two small specimens there is present a well-marked vertical black streak running upwards from the orbit.

Famliy ZOARCIDAE.

Neobythites macrops, Günther.

Three small specimens ranging from 86 to 135 mm. in total length (without caudal) and a single large example, 233 mm., were obtained at Station 391.

PEDICULATI.

Lophius lugubris, Alcock.

1899. Alcock, p. 55; and *Ill. Zool. Invest.*, Fishes, pl. xiv, fig. 1.
1908. Brauer, p. 314.

A single example, obtained at Station 391, is referred to this species. A careful comparison with Alcock's type specimens revealed a very close resemblance, the only appreciable difference being in the diameter of the eyes, which was considerably greater than in the type; but this may very possibly be due to shrinkage in Alcock's specimens caused by prolonged immersion in spirit.

Brauer (*l.c.*) obtained a single small specimen, which he considers must belong to this species, off the N. W. coast of Sumatra: he states that there were only two spines, instead of

three as described by Alcock, on the superior margin of the orbit. In all four specimens in the Indian Museum three spines are present in this situation, but the most anterior is smaller than the others and may conceivably be occasionally absent altogether.

Chaunax pictus, Lowe.

1899. Alcock, p. 58.

Three specimens, ranging from 59 to 137 mm. in length, were obtained at Station 391. In the smallest example the body was covered on the upper surface with large and indistinct dark spots; the mouth was almost completely occupied by a free tongue and the ventral fins arose at the bottom of two small pits on the ventral surface.

Halicmetus ruber, Alcock.

1899. Alcock, p. 66.
Ill. Zool. Invest., Fishes, pl. xix, fig. 5.

Six specimens, ranging in length from 35·3 to 69·3 mm., were obtained at Station 391.

An examination of these and other specimens—thirteen in all—in the Indian Museum reveals the fact that there is a very considerable degree of variation in the species in the relative proportions of the disc. In the following table I have given the results obtained by measuring the greatest breadth of the disc between the prominent lateral spines and comparing this with the total length (without the caudal fin):—

No. of specimen	1	2	3	4	5	6	7	8	9	10	11	12	13
Total length ..	45·7	44·5	44·5	29	40	75	40·5	58	55·5	42·3	55·5	59	35·5
Maximum breadth of disc.	37·6	34·5	33	21	28	52	27	38	34·5	25	32	34	17
Ratio ..	1·22	1·3	1·35	1·38	1·42	1·44	1·5	1·5	1·6	1·69	1·73	1·74	2·09

Lloyd (1909, p. 171) has shown that a similar variation is present in the closely-allied genus *Malthopsis*.

Family GOBIIDAE.

Callionymus carebares, Alcock.

1899. Alcock, p. 73.
Ill. Zool. Invest., Fishes, pl. xx, fig. 4.

Two small specimens, obtained at Stations 388 and 389 respectively, are referred to this species.

Callionymus kaianus, Günther.

1887. Günther, p. 44, pl. xix, fig. B.
1899. Alcock, p. 74.
1907. Tate Regan, p. 248.

Two examples of this rare species, measuring respectively 93 and 96 mm. in length, were obtained at Station 389.

Tate Regan (*l.c.*) erroneously states that, previous to the Percy Sladen expedition, this species was known only from the type specimen; two examples, however, were obtained by the "Investigator" in Indian waters prior to the date of this expedition at Station 258, 23-iv-99—8° 23′ 00″ N., 76° 28′ 00″ E.—in 102 fathoms, and are recorded by Alcock (*l.c.*).

In the present specimens, as in the single example described by Tate Regan, the 1st dorsal fin ray is not prolonged as described by Günther in the type specimen: in all other respects, however, they agree both with the description and the two specimens already in the Indian Museum.

ANACANTHINI.

Macrurus nasutus, Günther.

M. nasutus, 1877, Günther, p. 440.
,, ,, 1887, Günther, p. 132, pl. xxx, fig. B.
M. brevirostris, 1889, Alcock, p. 393.
,, ,, *Ill. Zool. Invest.*, Fishes, pl. xiii, fig. 3.
M. nasutus, 1899, Alcock, p. 111.
M. brevirostris, 1908, Brauer, p. 263.

Two examples obtained at Station 391 are referred to this species. Though rare in Indian waters examples have been previously obtained and were described by Alcock under the name *M. brevirostris*. He subsequently, however, arrived at the conclusion that *M. brevirostris* was really only a synonym for *M. nasutus*, Günther.

Brauer has again tried to separate the two species and has pointed out several discrepancies between the two accounts. I have carefully compared all the specimens in the Indian Museum, which include one of the "Challenger" duplicates from Japan, and can find no difference between them.

As regards the points which Brauer mentions, I would point out that:—

1. The anus in the Challenger specimen is midway between the base of the ventral and the anal fins. In the Indian examples it may be either midway between or slightly nearer the ventrals.
2. The outer row of teeth in all the specimens is enlarged —as described by Alcock.
3. The number of scales between the 1st dorsal fin and lateral line is the same in all the specimens; between the 1st

dorsal ray and the lateral line, there are 7-8 rows, the lower five or six are large and resemble those found all over the body, the upper two rows are composed of small scales, about half the size of the others, and somewhat overlap the bases of the fin rays; between the last dorsal ray and the lateral line there are six rows of scales in all.

4. In all specimens the distance of the 2nd dorsal fin from the last spine of the 1st dorsal is approximately half the head length.
5. The 2nd spine of the 1st dorsal fin may vary somewhat in length and its extremity is very thin and easily broken. In all the specimens in which it was entire it is a trifle longer than the head length.

I have therefore come to the conclusion that all the specimens must be considered to belong to the same species, and that *M. nasutus* and *M. brevirostris* are mere synonyms.

Macrurus sp. and **Coelorhynchus** sp.

Several specimens belonging to these two genera were obtained at Station 391; unfortunately they were so badly damaged that specific determination was impossible.

Family PLEURONECTIDAE.

Boopsetta praelonga, Alcock.

Poecilopsetta praelonga, 1894, Alcock, p. 130, pl. vii, fig. 2.
Boopsetta praelonga, 1899, Alcock, p. 126.
Poecilopsetta maculosa, 1894, Alcock, p. 130, pl. vii, fig. 1.
Boopsetta maculosa, 1899, Alcock, p. 127.
Boopsetta praelonga, 1908, Brauer, p. 295.
Ill. Zool. Invest., Fishes, pl. xv, fig. 1; pl. xvii, fig. 5.

A single specimen, 12·5 cm. in length, was obtained at Station 391.

Brauer has expressed some doubt as to the distinction between this species and *B. maculosa*, Alcock. I have carefully examined all the specimens of both types in the Indian Museum and have come to the conclusion that there is no specific difference.

In the following table I have given the measurements of the only two examples of *B. maculosa* and for purposes of comparison have selected four examples of *B. praelonga* of as nearly as possible the same size.

	B. maculosa.		*B. praelonga.*			
Greatest length (without caudal) ..	8·65	7·4	8·37	8·1	7·25	7
Greatest breadth	4·25	3·95	4·0	?	3·45	3·5
Length of head	2·05	2·0	2·3	2·0	2·1	1·9
Diameter of eye	0·7	0·7	0·9	0·6	0·8	0·6
Length of snout	0·2	0·2	0·35	0·2	0·2	0·2
Length of right pectoral fin ..	0·5	0·4	1·25	0·8	1·0	0·9
Length of left pectoral fin ..	0·45	0·4	0·9	0·5	0·87	0·55
Length of ventral fin	0·85	0·7	0·8	0·6	0·6	0·7

From the above it is obvious that as regards the size of eye and the proportions of breadth to length it is quite impossible to draw any distinction between the two; the other characters, such as the length of pectoral fins, though fairly constant, are hardly reliable since in both examples of *B. maculosa* these fins have a ragged and somewhat damaged appearance, and in a large proportion of the smaller specimens of *B. praelonga* the coloration of the upper surface is identical with that of the two examples of *B. maculosa*.

Solea umbratilis, Alcock.

1899. Alcock, p. 129.
Ill. Zool. Invest., Fishes, pl. xv, fig. 4.

Six specimens of this species, the largest measuring 72 mm. in total length, were obtained at Station 389.

HAPLOMI.

Family SCOPELIDAE.

Chlorophthalmus corniger, Alcock.

1899. Alcock, p. 155.
1908. Brauer, p. 145.
Ill. Zool. Invest., Fishes, pl. xv, fig. 8.

A single specimen, measuring 11 cm. in total length (without the caudal fin), was obtained at Station 391 and was referred to this species.

Scopelus[1] **engraulis**, Günther.

1887. Günther, p. 197, pl. li, fig. c.
1899. Alcock, p. 161.

[1] An attempt has in recent years been made to change the generic name to *Myctophum*. For the purposes of this paper, however, I prefer to use the generally accepted and more widely known term *Scopelus*.

A large number of examples, the majority, unfortunately, in a badly damaged condition, were obtained at Station 391.

Brauer (1908, p. 217) has provisionally placed *S. engraulis* as a synonym of *S.* (*Myctophum*) *coeruleus*, Klunzinger.

Although agreeing very closely with the description of *S. coeruleus*, the specimens in the Indian Museum, which I refer to *S. engraulis*, differ in a few points, especially in—

(1) The greater number of rays in the pectoral fin: in all examples there are 12 present, whereas in *S. coeruleus* there are only 10.

(2) The greater relative length of the dorsal fin: this was invariably greater than the length of the anal fin, not *vice versa* as in *S. coeruleus*.

In the present state of our knowledge I consider that it is not advisable to unite the two species.

(I would remark in passing that the smaller of the two specimens referred by Alcock to *S. engraulis* and obtained at Station 115, 9-xii-90—11° 31′ 40″ N., 92° 46′ 40″ E.—188-220 fathoms, off the Andaman Islands, is undoubtedly an example of *S.* (*Myctophum*) *splendidus*, Brauer.)

APODES.

Family ANGUILLIDAE.

Coloconger raniceps, Alcock.

1899. Alcock, p. 196.
Ill. Zool. Invest., Fishes, pl. vii, fig. 4.

A single specimen measuring 19·1 cm. in total length was obtained at Station 391.

Uroconger lepturus (Richardson).

Congrus lepturus, 1844, Richardson, p. 106, pl. 56, fig. 1—6.
Uroconger lepturus, 1870, Günther, vol. 8, p. 44.
,, ,, 1908, Brauer, p. 124.
Uroconger vicinus, 1899, Alcock, p. 200.

A single example, measuring 55 cm. in total length (including caudal), was obtained at Station 388 and was referred to this species. Brauer (*l.c.*) considers that the specimens obtained by Alcock and described by him under the name *U. vicinus*, Vaillant, are in reality not members of that species.

As he points out, in *U. vicinus* the proportion of head length to total length is 1 : 11, whereas Alcock gives it 1 : 7-8 in his specimens—a fact which I have verified.

The points on which Alcock relies to separate his examples from *U. lepturus* are: (1) the reduced number and larger size of the vomerine teeth; (2) the widely separated gill-openings; and (3) the increased distance from gill-opening to dorsal fin. Brauer

has shown that as regards the vomerine teeth, the number present in *U. lepturus* may vary from 1—3. Alcock's specimens all possess two which vary very considerably both in size and position.

The gill-openings are also separated by a distance somewhat greater than their long diameter, in this respect closely resembling Brauer's specimens, and as regards item 3 I can find no other reference to it in the literature at my disposal.

I give below measurements of my example and the two larger of Alcock's specimens, and for purposes of reference have also given Brauer's measurements of his example of *U. lepturus*:—

	U. lepturus, Brauer.	*U. vicinus* (?), Alcock.		*U. lepturus*, Sewell.
Total length ..	70	63	61	55
Greatest height of body ..	6·1	?	?	5·6
Length of head ..	9·8	7·7+	8·3	8·5
Length of snout ..	2·7	2·25	2·25	2·3
Diameter of eye ..	1·4	1·25	1·25	1·15
Distance from snout to anus	26·5	22	22	24
Length of pectoral fin ..	3·9	3·4	3·4	3·15

One cannot help being struck by the very close agreement of these figures, the only marked difference being the head-length; this is in part due to a shorter snout length and also to a shrinkage of the soft parts in front of the gill-opening which causes these to gape somewhat. When it is considered that Brauer's and my measurements were taken on comparatively fresh specimens, whereas those obtained by Alcock have now been in spirit from 14—19 years, these slight differences lose any importance that might otherwise have been attributed to them.

I consider that all the specimens in the Indian Museum must be regarded as examples of *U. lepturus*.

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II. NOTES ON DECAPODA IN THE INDIAN MUSEUM.

III. The Species obtained by R.I.M.S.S. 'Investigator' during the Survey Season 1910-11.

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(Plate i.)

During the season 1910-11 it was unfortunately only possible to make four hauls of the trawl in deep water; but at one of the stations a large number of interesting Decapod Crustacea were obtained and, inasmuch as many of these species appear to be rare, we have thought it as well to draw up a few notes on the collection.

The only species hitherto undescribed is a Macruran of the genus *Merhippolyte*, the first representative of the family Hippolytidae which has yet been found in deep water off the coasts of India. A small crab, allied to the genus *Carcinoplax*, also seems to belong to a species as yet unknown; this specimen is being referred to Col. Alcock and is not included in the present account.

Of the others in the collection perhaps the most interesting is the male of *Aristeomorpha rostridentata* (Bate), a species previously known from females only. *Pentacheles hextii* of Alcock is identified with the Atlantic and Mediterranean *Polycheles typhlops* and our knowledge of the distribution of several other scarce forms has been considerably extended.

The stations at which the collection was made are all situated off the S.W. coast of India; they are—

St. 388. 26-iv-11. 7° 44′ 10″ N., 76° 35′ 45″ E. 670 fathoms.

St. 389. 27-iv-11. 9° 01′ 50″ N., 75° 55′ 50″ E. 81 ,,

A considerable number of corals (Caryophyllinae) were obtained at this station.

St. 390. 27-iv-11. 9° 09′ N., 75° 46′ E. 260 fathoms.

On this occasion the net caught on a rock and was badly torn. No Decapoda were taken.

St. 391. 27-iv-11. 9° 14′ 10″ N., 75° 45′ E. 237 fathoms.

This haul was remarkable for the large number of the Gastropod, *Xenophora pallidula*, which were obtained. The majority of the Decapoda which form the subject of the present paper were found at this station.

Only a few of the more important papers dealing with deep-sea Decapoda are cited. The date appended to an author's name affords reference to the short bibliography at the end of the paper.

DECAPODA NATANTIA.

Tribe **Penaeidea.**

Family *PENAEIDAE.*

Sub-family PENEINAE.

Peneopsis coniger var. **andamanensis** (Wood-Mason).

Metapeneus coniger var. *andamanensis*, Alcock, 1901, p. 17, and 1906, p. 27, pl. iv, fig. 13.

Peneopsis coniger var. *andamanensis*, de Man, 1911, p. 61.

Eleven males and nineteen females were obtained at St. 389.

The distinctions between the variety and the typical form which are afforded by the thelycum are well marked and apparently constant. The form found in the variety has been illustrated by Alcock and we take this opportunity of giving a similar figure of the thelycum of the typical *P. coniger* (pl. i, fig. 7).

In males we have been unable to detect the pair of spines which de Man mentions at the base of the second peraeopods.

Parapeneus rectacutus (Bate).

Peneus (*Parapeneus*) *rectacutus*, Alcock, 1901, p. 17, and *Ill. Zool. Invest.*, Crust., pl. xlix, fig. 5.

Parapeneus rectacutus, Alcock, 1906, p. 33, pl. vi, figs. 19, 19a-b, and de Man, 1911, pp. 78, 82.

A much damaged female from St. 391 may safely be referred to this species. The station represents the most westerly point at which *P. rectacutus* has been observed.

With reference to de Man's notes on this species (*loc. cit.*, p. 82) we would observe that the minute rudiments of exopods on the thoracic legs, mentioned by Wood-Mason and Alcock (1891, p. 274), can be detected in examples preserved in the Indian Museum. The ridge defining the anterior part of the cervical groove agrees precisely with Alcock's figure, but in some females the spine which is stated to occur on the basis of the second peraeopods appears to be missing. The last pair of legs fails to reach to, or slightly exceeds, the apex of the antennal scale. There is no sharp spine at the distal end of the lobes of the petasma.

Haliporus aequalis, Bate.

Haliporus aequalis, Alcock, 1901, p. 23, and de Man, 1911, p. 32.

Seven males and fourteen females were obtained at St. 391.

Aristaeus semidentatus, Bate.

Aristaeus semidentatus, Alcock, 1901, p. 31, and *Ill. Zool. Invest.*, Crust., pl. xlix, fig. 3.

? *Aristeus semidentatus*, de Man, 1911, p. 29.

Six males and eleven females were obtained at St 391. They agree precisely with Alcock's account and with other specimens in the Museum collection. The pleurobranchs in advance of somite xiv are the merest rudiments, minute papillae without trace of pinnae.

It would appear doubtful whether the specimens obtained by the 'Siboga' really belong to this species, for de Man states that the pleurobranchs above the base of the first four peraeopods are "distinct filaments, similar to those of *A. virilis*"; whereas the difference in this respect between the present specimens and the examples which Alcock referred to *A. virilis* is most marked.

Hemipeneus crassipes (Wood-Mason).

Hemipeneus crassipes, Wood-Mason and Alcock, 1891, p. 281, fig. 7; Alcock, 1901, p. 33, and *Ill. Zool. Invest.*, Crust., pl. xlix, figs. 1, 2.

A single male, 77 mm. in length, was found at St. 388.

Among the males of this species preserved in the Indian Museum, two different types of modification are observed in the ultimate and penultimate segments of the external maxillipeds. The differences are shown in pl. i, figs. 8 and 9. In one form (fig. 9), that which is shown in the 'Investigator' illustrations, the penultimate segment is cylindrical and swollen and the ultimate segment is dilated at the base with the distal part curved outwards and provided with a spatulate tip. In the other type (fig. 8) the penultimate segment is flatter and less swollen and is produced distally as a strong acuminate process in front of the insertion of the ultimate joint. The latter is curved as in the type figured by Alcock; but it is not dilated at the base.

It is with the second of these two types that the specimen from St. 388 corresponds, and it is possible that the form deserves recognition as a distinct variety. The material at our disposal is not, however, in good condition and we are content to leave the matter pending the acquisition of further specimens.

Aristaeomorpha rostridentata (Bate).

Aristaeus (*Aristaeomorpha*) *rostridentata*, Alcock, 1901, p. 39, and *Ill. Zool. Invest.*, Crust., pl. ii, fig. 1.

Two males, obtained at St. 391, unquestionably belong to the same species as the female example recorded by Alcock and Wood-Mason under the name of *A. rostridentata*, and there can be

little doubt that all are correctly referred to the species described in the 'Challenger' Report.

The resemblance of the species to the well-known Mediterranean form, *A. foliacea* (Risso), is very striking and Bouvier in his account of the Peneidae collected by the Prince of Monaco (1908, p. 56) was unable to determine the distinctions with any degree of precision. On comparing the two species, however, several characteristic differences may be observed.

The rostrum in both sexes is shorter in *A. rostridentata* than in specimens of *A. foliacea* of larger size. In the single female example of the former species, the rostrum trends more strongly upwards towards the apex than in specimens of *A. foliacea* of the same sex, while in male *A. rostridentata* it reaches only to the end of the basal joint of the antennular peduncle and its lateral carina is straight, or slightly concave ventrally, showing no trace of the sinuosity seen in male *A. foliacea*.

But perhaps the most important distinction is to be found in the areolation of the carapace. The pterygostomian region is much broader in proportion to its length in *A. rostridentata* than in *A. foliacea* and the same is true of the branchial region, though the differences in this case are not so well-marked. In *A. rostridentata* the length of the pterygostomian region (measured from the antero-lateral margin of the carapace to the postero-dorsal end of the hepatic groove) does not exceed 2·5 times its greatest breadth, while it is more than 3·5 times as long as broad in *A. foliacea* (*cf.* figs. 5 and 6, pl. i). The ridge defining the upper boundary of the branchial region is, moreover, slightly less sinuous in the Indo-Pacific species.

The specimens examined yield the following measurements (in mm.):—

	A. rostridentata (Bate).			*A. foliacea* (Risso).			
Sex	♀	♂	♂	♀	♀	♀	♂
Total length	149	*ca.*125	*ca.*119	*ca.*215	*ca.*215	170	137
Length of rostrum ..	29	11·5	10·5	45+	49+	41+	14
Length of carapace ..	43	40·5	37	57	55·5	41	38·5
Length of pterygostomian region	17·3	16·5	15·7	25·5	23·5	18·3	17
Breadth of pterygostomian region	7·3	7·2	7	6·5	6·5	4·5	4·5
Ratio of length to breadth of pterygostomian region..	2·4	2·3	2·2	3·9	3·6	4·0	3·8

In other respects there appears to be an extremely close resemblance between the two forms, but the dactyli of the last two pairs of peraeopods, which, in the specimens of *A. rostridentata*, are unfortunately broken off in all but two instances, appear to be longer than in *A. foliacea* and measure more than half the length of their respective propodites. The telson, also,

seems to be longer in *A. rostridentata* than in *A. foliacea*. In the former species it reaches exactly to the apex of the inner uropod, the slightly greater length shown in the 'Investigator' Illustrations being due in all probability to a perspective effect.

We have been unable to find any distinctions between the two species in regard to the form of the oral appendages or of the thelycum and petasma.

Bouvier (*loc. cit.*, p. 53) states that the branchial formula of *Aristaeomorpha* is the same as that of *Benthesicymus*; but Alcock notes the presence of two arthrobranchiae at the base of the penultimate pair of peraeopods, which, according to Bouvier's account (*l.c.*, p. 17), do not occur in the latter genus. Examination of the specimens in the Indian Museum shows that these branchiae occur both in the Indo-Pacific and in the Mediterranean species of *Aristaeomorpha*.

In the Indian Museum no specimen of *Aristaeomorpha* can be found bearing the name *A. giglioliana*, but the example figured by Wood-Mason under this name is undoubtedly that which is preserved in the collection with the label "'Washington,' St. xiv, 13-viii-81; 39° 01′ 28″ N., 9° 30′ 19″ E. 772 metres. Enrico H. Giglioli." It is evident that Wood-Mason figured this specimen from the Mediterranean for comparison with *A. rostridentata*, but his reasons for assigning it a new specific name remain obscure, for he never published any description. The measurements of the specimen, a female 170 mm. in length, are shown on p. 18; it is unquestionably an example of *A. foliacea*.

Family *SERGESTIDAE*.

Sergestes bisulcatus, Wood-Mason.

Sergestes bisulcatus, Alcock, 1901, p. 49; *Ill. Zool. Invest.*, Crust., pl. 1, figs. 1, 1a-b, and Stebbing, 1905, p. 87, pl. xxiv A.

A small female, about 46 mm. in length, is referred to this species. It was obtained at St. 388 and was almost certainly caught during the ascent of the trawl.

S. bisulcatus is very closely allied to the Atlantic *S. robustus*, Smith, but is readily distinguished by the sharply cut cervical groove, which is specially distinct on the dorsum of the carapace.

Tribe **Caridea.**

Family *PASIPHAEIDAE*.

Sympasiphaea annectens, Alcock.

Sympasiphaea annectens, Alcock, 1901, p. 63, and *Ill. Zool. Invest.*, Crust., pl. lii, fig. 7.

A large female, 91 mm. in length, was obtained at St. 388.

The rostrum is more strongly elevated at the apex than in the type and the epipod at the base of the second maxilliped,

though small, is well formed and could hardly be described as a mere papilla.

Hitherto this species was only known from a single specimen; but a third example is preserved in the Museum collection. This specimen measures 76 mm. in length and was obtained at St. 297. 13-iv-02. Gulf of Oman; 25° 11′ 30″ N., 57° 15′ E. 689—700 fathoms.

Family *HOPLOPHORIDAE.*

Hoplophorus gracilirostris, A. Milne-Edwards.

Hoplophorus gracilirostris, Alcock, 1901, p. 73.

A single male, about 55 mm. in length, was taken at St. 391.

Family *PANDALIDAE.*

Pandalus (Plesionika) martius, A. Milne-Edwards.

Pandalus (*Plesionika*) *martius,* Alcock, 1901, p. 95.

Three damaged specimens, one an ovigerous female, appear to belong to this species. They were obtained at St. 391.

Heterocarpus gibbosus, Bate.

Heterocarpus gibbosus, Alcock, 1901, p. 103.

Three small specimens were found at St. 391. In all these examples the rostrum is considerably longer than in adults and exceeds the median length of the carapace.

Family *HIPPOLYTIDAE.*

Merhippolyte calmani, sp. nov.

(Pl. i, figs. 1—4.)

The general form is slender and the surface of both carapace and abdomen is glabrous and without trace of punctation. The rostrum is twice, or rather more than twice, the length of the carapace, straight to the end of the second joint of the antennular peduncle and thence to the apex very strongly ascendant. The vertical height of the apex above the dorsal line of the carapace continued forwards is about equal to the carapace-length. At its base the rostrum is armed with three large and almost equidistant teeth; the median one is situated directly over the orbit, while the anterior one reaches about to the end of the eyes. At the extreme apex there is a small dorsal tooth but the upper margin between this point and the eyes is wholly unarmed. On the ventral edge there are ten teeth, large and closely set towards the base, smaller and more distant towards the apex. Between the proximal teeth of both margins there are a few setae. All the teeth are fixed. The rostral carina is continued backwards

on the carapace and disappears before reaching the posterior third. The antero-inferior angle of the carapace is rectangular—not spinous (fig. 4).

The abdominal terga are all smoothly rounded dorsally. The sixth somite is longer than the telson excluding its terminal setae and is more than twice the length of the fifth. The telson is a little shorter than the inner uropod; its apex is very narrow and is furnished with two pairs of spines the outer of which is more than twice the length of the inner. The upper surface of the telson is slightly flattened and is provided with two pairs of dorso-lateral spinules. There is no movable spine at the base of the uropods.

The cornea of the eye is greatly expanded; it is much wider than the stalk and its breadth is fully a quarter the median length of the carapace. In the entire absence of an ocellus the species differs markedly from *M. agulhasensis*.

The antennular peduncle reaches to about half the length of the antennal scale. The basal joint is long and bears a sharply-pointed lateral process which reaches nearly to its distal end; the second and third segments are very short and subequal. The antennal scale is distinctly shorter than the carapace. Its outer margin is slightly concave and terminates in a short spine which fails to reach the apex of the lamella.

The mandible is provided with a large incisor process and a three-jointed palp. The basal segment of the latter is distinctly longer than the second (fig. 3). The first and second maxillipeds each possess an exopod and an epipod and the second maxilliped in addition bears a large podobranch. The third maxilliped also possesses both an exopod and an epipod, the former reaching to about half the length of the antepenultimate segment.

The first peraeopod reaches almost to the end of the antennular peduncle; the carpus is about the same length as the chela and the fingers are less than half the length of the palm. On the internal surface of the carpus near its distal end is an excavated notch, margined with setae and having a stout spine at its proximal end. The apparatus resembles a comb and is perhaps used for cleaning the antennae or other appendages (fig. 2).

The second peraeopods reach beyond the end of the antennal scale by almost the whole length of the propodus. The carpus is composed of 14 or 15 segments, the ultimate of which is only a trifle shorter than the chela.

The third peraeopod reaches beyond the apex of the scale by the length of the dactylus. At the distal end of the merus are two stout spines. The fourth peraeopod reaches only to the end of the antennular peduncle and is shorter than the fifth which reaches to the tip of the spine at the distal end of the antennal scale—on the distal half of the merus of these two last pairs there are a few large spines the number of which seems subject to considerable variation. The dactyli of the last three pairs bear from four to six strong spines.

The branchial formula is as follows:—

	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Pleurobranchiae ..	..	..	..	1	1	1	1	1
Arthrobranchiae ..	..	..	2	1	1	1	1	..
Podobranchiae ..	..	1	..	..	..	..	..	..
Epipods ..	1	1	1	1	1	1	1	..

So far as we are aware only two species belonging with certainty to this genus have been described, *M. agulhasensis*, Bate, the type of the genus, and *M. orientalis*, Bate. Calman, in his valuable contribution to our knowledge of this family (1906), has pointed out that Hodgson's *M. australis* is in reality a species of *Nauticaris* and has also suggested that Milne-Edward's *Hippolyte spinifrons*, which G. M. Thomson referred to *Merhippolyte*, is in all probability a species of *Alope*. With this suggestion we were inclined to concur; but Chilton (1911, p. 547) has recently recorded four specimens of *M. spinifrons* from the Kermadec Is. and it is clear from his paper that the species is quite distinct from *Alope palpalis*. *M. spinifrons*, however, still stands in urgent need of redescription.

From both the species in the 'Challenger' Report and from *M. spinifrons* the present species is readily distinguished by the peculiar form of the rostrum and by many other less conspicuous characteristics. Though it agrees almost exactly with Miss Rathbun's account of *Spirontocaris kauaiensis* from the Hawaiian Islands (1906, p. 913) the resemblance must be entirely superficial. The carpus of the second peraeopods in *Spirontocaris* is composed of only six or seven segments and it is to be assumed that such a number occurs in *S. kavaiensis*—it is not mentioned in the description. Apart from this feature the two genera are readily distinguished by the gill-formula and by the number of segments in the mandibular palp.

Two specimens of *Merhippolyte calmani*, 50 and 56 mm. in length, were obtained at St. 391. Both examples are female and in the larger, which is ovigerous, the eggs measure ·46 × ·39 mm. in their longer and shorter diameters.

Family *CRANGONIDAE*.

Aegeon (Parapontocaris) bengalense, Wood-Mason.

Aegeon (*Parapontocaris*) *bengalense*, Alcock, 1901, p. 122, and *Ill. Zool. Invest.*, Crust., pl. ix, fig. 1.

Two male specimens, measuring 29 and 30·5 mm. in length, were obtained at St. 391.

Except for the customary sexual distinctions in the second pair of pleopods and in the outer ramus of the antennular peduncle, the specimens closely resemble the females described by Alcock: we would note, however, that in both sexes there are very frequently two or three spines on each carina of the sixth abdominal somite in addition to the terminal one.

Two other samples of this species, hitherto unrecorded, are preserved in the Indian Museum—

St. 136. 4-v-92. 15° 41′ N., 72° 43′ E. 444 fathoms. One female; about 41 mm. in length. Regd. No. $\frac{7056}{10}$.

St. 279. 18-iii-11. 11° 35″ 15″ N., 80° 02″ 15″ E. 300 fathoms. Two males, four females (one ovigerous); 30—48 mm. in length. Regd. Nos. $\frac{4080\cdot5}{10}$.

DECAPODA REPTANTIA.

Tribe **Eryonidea.**

Family *ERYONIDAE.*

Genus **POLYCHELES,** Heller.

The majority of recent authors have not followed Spence Bate in the recognition of distinct genera, *Polycheles* and *Pentacheles*, and there can be no doubt that, as many subsequent authors have shown, the distinctions employed in the 'Challenger' Report are untenable.

Alcock, however, in 1901 again recognized the two separate genera, distinguishing them by the characters afforded by the epipodites of the third maxillipeds and of the peraeopods. Unfortunately at the date when he was writing, little was known as regards these structures in the case of *Polycheles typhlops*, the type of the genus *Polycheles* and the first recent species of Eryonidea to be described.

By actual comparison of specimens we have been able to convince ourselves that Alcock's *Pentacheles hextii* must be regarded as a synonym of *Polycheles typhlops* and this, if two genera are to be recognized, necessitates the transposition of the names *Polycheles* and *Pentacheles* as applied by him. In *P. typhlops* the epipod at the base of the third maxilliped is small; but the distinction in this respect between the genera seems of little moment. More important by far is the condition of the epipods at the base of the peraeopods and in *P. typhlops* these structures agree precisely with those of specimens which Alcock referred to *Pentacheles* and with the account contained in his description of that genus.

Faxon, however, in 1895 (p. 118) remarks that "an examination of a large number of species discloses a gradual transition in the development of the epipods from large well-developted organs, through small, delicate thin ones, to merest rudiments

in the shape of small expansions at the base of the stem of the gill." While this is not the case with the Indian species—Alcock found that they fell readily into two groups—the passage quoted above, coming as it does from a high authority on crustacean morphology, seems to show that the two groups merge in the Eastern Pacific and we propose, therefore, to combine once more the genera *Polycheles* and *Pentacheles*.

Polycheles typhlops, Heller.

Polycheles typhlops, Heller, 1862, p. 389, pl. i, figs. 1—6, and Senna, 1903, p. 332, pl. xviii, figs. 1—11.

Pentacheles hextii, Alcock, 1894, p. 237; 1901, p. 172, and *Ill. Zool. Invest.*, Crust., pl. x, fig. 2.

One female, 70 mm. in length, was obtained at St. 391.

This specimen agrees in all its characters with examples described by Alcock under the name of *P. hextii*; but we are of the opinion that the form which has received this name is identical with the older *Polycheles typhlops* of Heller, a species hitherto known only from the Mediterranean and East Atlantic.

We have closely compared specimens of *P. hextii* with two examples of *P. typhlops* obtained by the 'Talisman' expedition off the Cape Verde Islands and with a large drawing of a specimen from the W. coast of Ireland. The only difference that we have been able to discover is that the epipod at the base of the outer maxillipeds is a trifle larger in the Atlantic specimens; but the spinulation and proportions of examples from the two localities and the peculiar character of the orbit correspond so precisely that the specific identity of the two forms cannot be doubted.

The species affords yet another illustration of the wide-spread distribution of many deep-sea Crustacea.

Polycheles phosphorus, Alcock.

Polycheles phosphorus, Alcock, 1901, p. 168, and *Ill. Zool. Invest.*, Crust., pl. viii, fig. 2.

A female, 74 mm. in length, was found at St. 388.

Anomura.

Tribe Galatheidea.

Family *GALATHEIDAE*.

Munida microps, Alcock.

Munida microps, Alcock, 1901, p. 240, and *Ill. Zool. Invest.*, Crust, pl. xiii, fig. 5.

A single male, 36 mm. in length when fully extended, was obtained at St. 388.

Munida andamanica, Alcock.

Munida andamanica, Alcock, 1901, p. 242, and *Ill. Zool. Invest.*, Crust., pl. xii, fig. 2.

Two females and one male were taken at St. 391. The length of the specimens, when fully extended, ranges from 38 to 52 mm.; the largest example is an ovigerous female. To the abdominal sterna of the two smaller individuals an interesting parasitic Isopod, belonging to the family Liriopsidae, is attached.

Family *UROPTYCHIDAE.*

Ptychogaster investigatoris, Alcock and Anderson.

Ptychogaster investigatoris, Alcock, 1901, p. 281, and *Ill. Zool. Invest.*, Crust., pl. xlv, fig. 1.

One female, slightly larger than the type and only other known specimen, was found at St. 391. The two individuals are in closest possible agreement.

Tribe **Paguridea.**

Family *PAGURIDAE.*

Sub-family PAGURINAE.

Paguristes puniceus, Henderson.

Paguristes puniceus, Alcock, 1905, p. 38, pl. iii, fig. 6, and *Ill. Zool. Invest.*, Crust., xxxii, fig. 1.

Fourteen specimens, three of which are ovigerous females, were obtained at St. 391. The majority inhabited shells of *Xenophora pallidula*; but one was found in *Ranella perca*, and one in a species of *Pleurotoma*.

Two females are parasitized by *Peltogaster*, a genus of Rhizocephala not hitherto recorded from Indian seas.

Sub-family EUPAGURINAE.

Parapagurus andersoni, Henderson, var. **brevimanus,** Alcock.

Parapagurus andersoni var. *brevimanus*, Alcock, 1905, p. 103.

Two males, inhabiting shells of *Solariella infundibulum*, were found at St. 388.

Tomopaguropsis lanata, Alcock.

Tomopaguropsis lanata, Alcock, 1905, p. 137, pl. xiii, fig. 4.

A single male was obtained at St. 391 in a shell belonging to the genus *Pleurotoma*.

Sympagurus arcuatus, Milne-Edwards and Bouvier, var. monstrosus, Alcock.

Sympagurus arcuatus var. *monstrosus*, Alcock, 1905, p. 104, pl. x, fig. 5.

Six specimens in *Cancellaria cretacea*, Smith, *Pleurotoma* sp. and in other gastropod molluscs, were taken at St. 391. The majority of the shells are encrusted by an anemone.

Nematopagurus indicus, Alcock.

Nematopagurus indicus Alcock, 1905, p. 109, pl. xii, fig. 4.

Two specimens, a male and an ovigerous female obtained at St. 391, are referred to this species.

They agree with Alcock's description and with the type specimens in every particular except the eyes. These extend only to the end of the proximal third of the ultimate segment of the peduncle and are slightly shorter and very distinctly stouter than in the type. We have been unable to find any other distinctions and we are convinced that the specimens are correctly referred to this species.

Bouvier (1900, pp. 194, 198, and 1894, p. 69, pl. xi, figs. 2—6) has shown that in *Sympagurus bicristatus*, Milne-Edwards, and *S. gracilipes*, Milne-Edwards, there is considerable variation in the size of the eye. In the case of the former species Bouvier notes that in examples from comparatively shallow water the cornea is as a rule more dilated than in those from greater depths; in *S. gracilipes*, however, he is of the opinion that no such correlation exists.

The present specimens were found in 237 fathoms and it is interesting to note that in these examples the eyes are more dilated than in the type specimens obtained at a depth of only 102 fathoms. The case, so far as the evidence goes, is therefore precisely the reverse of that found in *S. bicristatus*; but many instances of a parallel development in one direction or the other might be cited and it is no more difficult to believe that a shallow water species migrating to greater depths would find it more advantageous to increase its corneal area than that another species also migrating in a similar manner should in this respect, retrogress, finding that its other senses rendered ocular vision a secondary consideration.

The specimens were found in shells of *Nassaria coromandelica*, Smith.

Brachyura.

Tribe Dromiacea.

Family *HOMOLIDAE.*

Homola megalops, Alcock.

Homola megalops, Alcock, 1899, p. 9; 1901, p. 62, and *Ill. Zool. Invest.*, Crust., pl. xiv, figs. 1, 1a.

Nineteen males and ten females (five ovigerous), ranging in length of carapace from 12·5 to 54 mm., were obtained at St. 391.

Many of these specimens are of considerably greater size than those which afforded Alcock material for his original description and we notice that *large* males differ from his account in the following features:—

The chelipeds are both longer and stouter; the merus and carpus are distinctly broader than the meri of the ambulatory legs and the chela may reach to the end of the propodus of the next limb.

The whole under surface of the chela, except for the extreme tips of the fingers, is clad in a thick and deep, dark brown velvety pubescence which is not present in females.

The palm is very conspicuously longer than the dactylus and at the base of the latter, on the inner edge, there is a stout tooth which is not found in females or young males.

The spines on the anterior region of the carapace, though always distinct, are less prominent in large individuals.

Measurements of the carapace (including rostrum) and chelipeds of forty-two examples of this species, show that whereas in the female the growth of the cheliped is proportional to that of the carapace throughout the whole period of its existence, this, as in many other species of Brachyura, is by no means the case with the male. In young examples of the latter sex, in which the carapace does not exceed 30 mm. in length, the cheliped has the same proportions as in females; but, as growth continues, there is a relatively greater increase in the length of the chelate leg. In females and young males the proportion of cheliped-length to carapace-length is approximately 1·5, whereas in large males it may reach as much as 2·0.

This marked difference between the sexes is illustrated in the accompanying figure (p. 28).

Tribe Oxystomata.

Family *DORIPPIDAE.*

Ethusa andamanica, Alcock.

Ethusa andamanica, Alcock, 1899, p. 33, and *Ill. Zool. Invest.* Crust., pl. xiv, fig. 8.

It is with some doubt that a single ovigerous female from St. 391 is referred to this species.

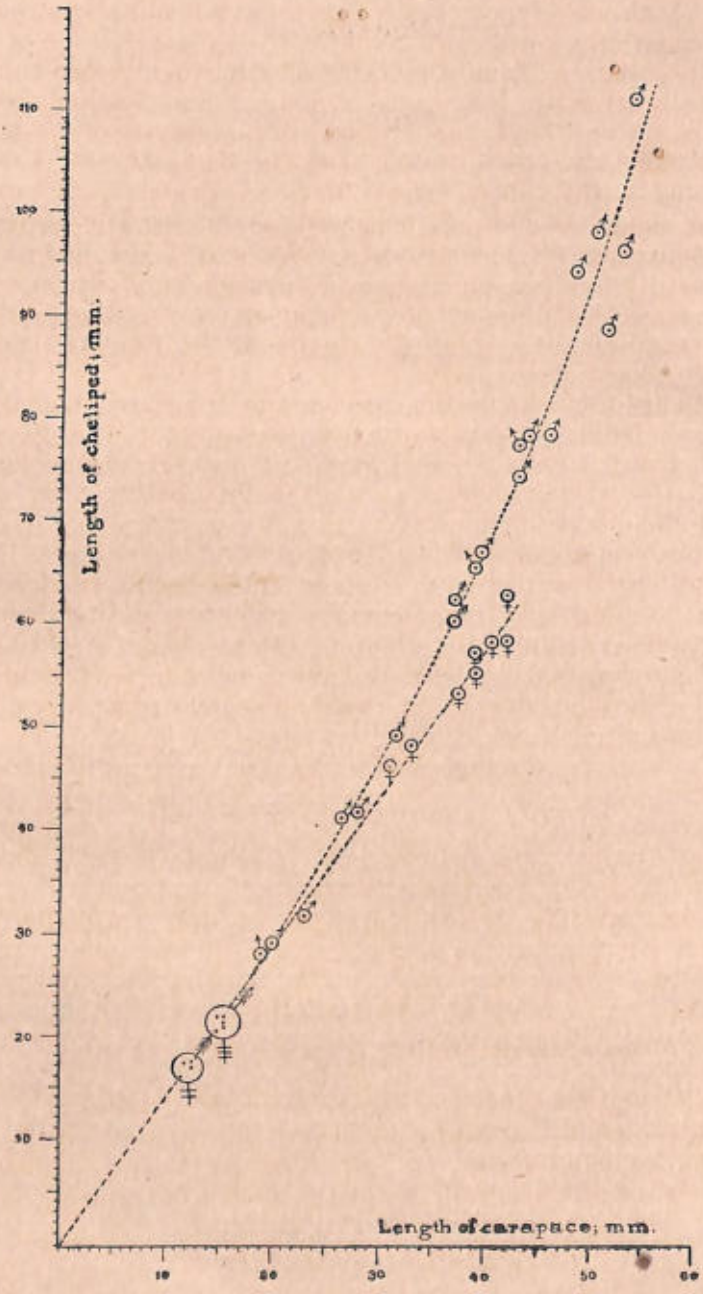

Diagram showing the relation between length of carapace and length of cheliped in forty-two examples of *Homola megalops*. The two large circles at the base of the curve represent respectively, the upper circle four males and three females, the lower four males and two females.

The carapace, which is 10 mm. in length, corresponds closely with that of Alcock's types; but it is perhaps not quite so strongly narrowed anteriorly.

The posterior parts of the carapace and the whole frontal border are beset with long setae and in the possession of such an investment on the former region the specimen approaches *E. hirsuta*, McArdle (1900, p. 474, and *Ill. Zool. Invest.*, Crust., pl. lxxii, fig. 1, 1a). In *E. hirsuta*, however, the external orbital spines are longer than in *E. andamanica* and have a different form, though they do not always reach beyond the tips of the frontal teeth as stated in McArdle's description. The external orbital angle is much broader in *E. andamanica* than in *E. hirsuta* and its internal margin is markedly sinuous in the former, straight or slightly concave in the latter.

Except for the hairs on the cardiac and branchial regions we are unable to differentiate our specimens from the types of *E. andamanica* and the possibility that such a character was originally present in the latter specimens, but was lost before they were examined, cannot be overlooked.

The species which Doflein (1904, p. 27, pl. xiii, figs. 7, 8) describes under the name of *E. andamanica* seems to differ in several material respects from the type specimens of that species. In the original examples the external orbital angle is decidedly broader than is shown in Doflein's figures and the dactyli of the second and third peraeopods are longer than their propodites.

Family *RANINIDAE*.

Lyreidus channeri, Wood-Mason.

Lyreidus channeri, Alcock, 1899, p. 38, and *Ill. Zool. Invest.*, Crust., pl. lxxiii, figs. 1, 1a.

A single specimen, with carapace 19 mm. in length, was obtained at St. 391.

Family *CALAPPIDAE*.

Mursia bicristimana, Alcock and Anderson.

Mursia bicristimana, Alcock, 1899, p. 23, pl. iii, fig. 3.

Eight specimens, ranging in length of carapace from 10·5 to 23 mm., were obtained at St. 391. Doflein (1904, p. 41) regards this form as merely a sub-species of De Haan's *M. armata*.

Family *LEUCOSIIDAE*.

Randallia lamellidentata, Wood-Mason.

Randallia lamellidentata, Alcock, 1899, p. 26, and *Ill. Zool. Invest.*, Crust., pl. v, figs. 5, 5a—b.

Nine males 13—23 mm. in length, and one huge ovigerous female, measuring 35 mm., were obtained at St. 391. The latter

specimen, the only known example of its sex, differs from the males in the following features:—

1. The spine on the carapace at the posterior end of the intestinal region is blunt—little more than a tubercle—and cannot be said to overhang the posterior margin.
2. The lamelliform teeth which fringe the lateral and posterior margins of the carapace are much less conspicuous.
3. The 4th—6th abdominal terga are fused and the sutures partially obliterated; but the telson is freely movable. All the segments are covered with vesiculous granules and at the distal end of the sixth there is a blunt tubercle comparable with that found in the male but by no means so evident.
4. The coxal joints of all the legs are elevated on either side of the abdomen and form a thin outstanding crest.

The close-set tubercles which cover both surfaces of the chelipeds and the upper portions of the merus, carpus and propodus of the ambulatory legs are in both sexes much more conspicuous than is shown in plate v of the "Investigator" Illustrations.

Tribe **Brachygnatha.**

Family *GONOPLACIDAE.*

Sub-family CARCINOPLACINAE.

Psopheticus stridulans, Wood-Mason.

Psopheticus stridulans, Alcock, 1899, p. 73; 1900, p. 309, and *Ill. Zool. Invest.*, Crust., pl. v, fig. 1.

One specimen, a female with carapace 11 mm. in length, was found at St. 391. *P. stridulans* has, hitherto, only been recorded from the Andaman Sea and S. W. of the Great Nicobar.

Family *MAIIDAE.*

Sub-family INACHINAE.

Physachaeus ctenurus, Alcock.

Physachaeus ctenurus, Alcock, 1899, p. 40; *Ill. Zool. Invest.*, Crust., pl. xviii, figs. 1—1b, and Doflein, 1904, p. 71, pl. xxiv, figs. 1—4, pl. xlii, figs. 1—7, pl. xlviii.

Two males and one ovigerous female were obtained at St. 391.

Sub-family PISINAE.

Sphenocarcinus aurorae, Alcock.

Sphenocarcinus aurorae, Alcock, 1899, p. 84.

Twelve males and fifteen females (ten ovigerous) were obtained at St. 391. A drawing of this species, which has not hitherto been figured, will be found on pl. i, fig. 10.

Sub-family MAIINAE.

Maia gibba, Alcock.

Maia gibba, Alcock, 1899, p. 56, and *Ill. Zool. Invest.*, Crust., pl. xxi, figs. 5, 5a.

Ten specimens, ranging from 18 to 40 mm. in the length of the carapace and rostrum, were found at St. 391.

In the smaller examples four spines in the median line of the carapace are decidedly longer than in larger individuals, in which they are scarcely distinguishable from the general tuberculation of the surface. In young specimens also five spines on the lateral margin of the carapace are more conspicuous than in the adult and thus resemble *M. miersi*, Walker (1890, p. 113, pl. vi, figs. 1—3), though the distinctions between the species still remain quite definite.

Maia gibba was hitherto known only from the three type specimens obtained in the Andaman Sea.

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EXPLANATION OF PLATE I.

Merhippolyte calmani, sp. nov.

FIG. 1.—Lateral view of one of the type specimens, × 2½.

,, 2.—Carpus of the first peraeopod showing the excavation on the internal margin.

,, 3.—Mandibular palp.

,, 4.—Antero-lateral margin of carapace.

Aristaeomorpha foliacea (Risso).

FIG. 5.—Carapace of a male in lateral view.

Aristaeomorpha rostridentata (Bate).

FIG. 6.—Carapace of a male in lateral view.

Peneopsis coniger (Wood-Mason).

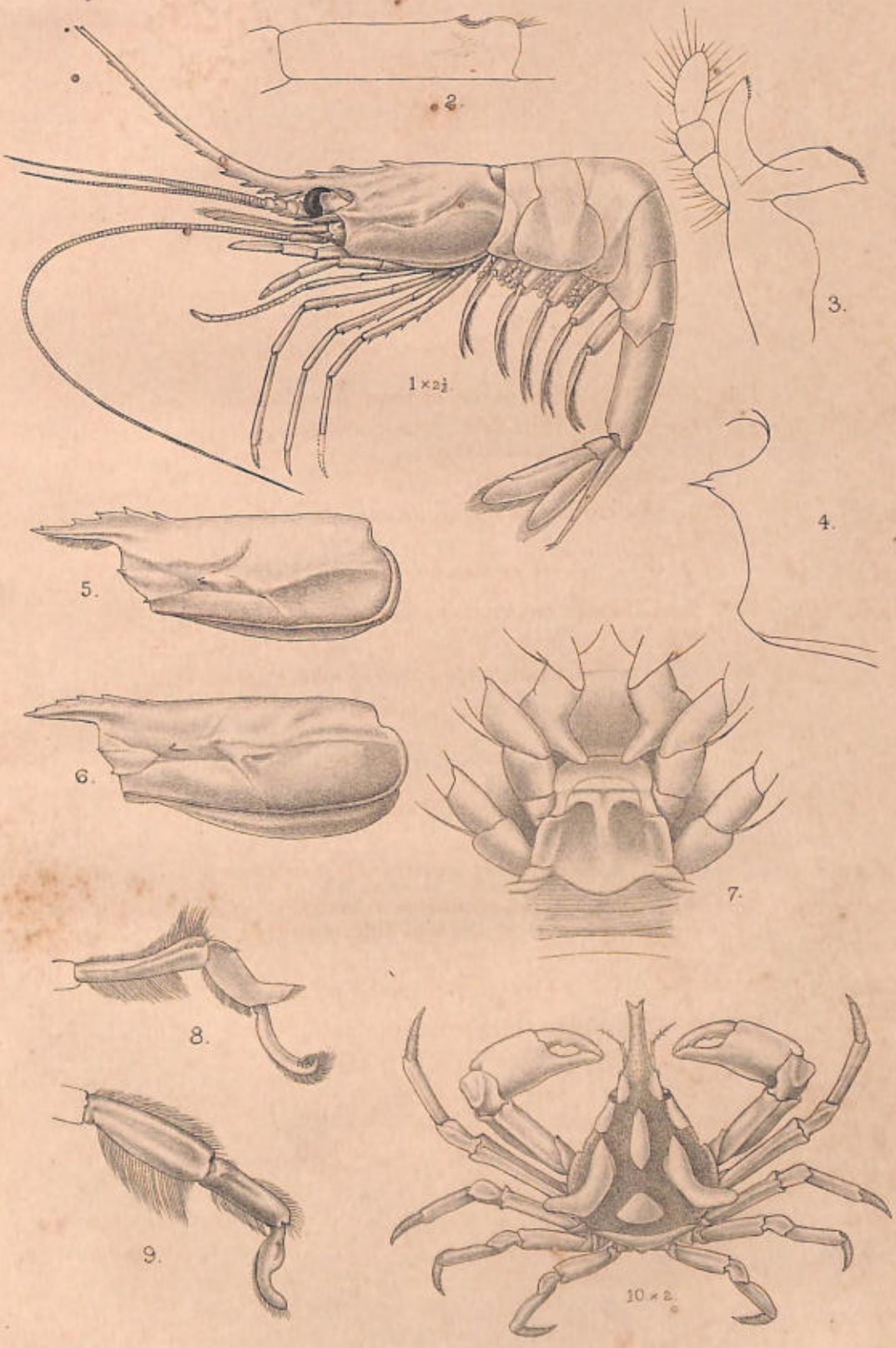
FIG. 7.—Thelycum of a typical specimen.

Hemipeneus crassipes (Wood-Mason).

FIGS. 8, 9.—Last three segments of external maxillipede of the male showing the two different types of structure.

Sphenocarcinus aurorae, Alcock.

FIG. 10.—Dorsal view of a male specimen, × 2.



A. C. Chowdhary, del. et lith.

DEEP-SEA DECAPODA.

III. NOTES ON THE FAUNA OF PARESNATH HILL, WESTERN BENGAL.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent, Indian Museum.*

Parésnath Hill, the highest mountain in Bengal apart from the Himalayas, is situated in the district of Hazaribagh (Chota Nagpur) and is separated from the foot-hills of Nepal by a distance of about 180 miles in which the whole width of the Ganges valley is included. Isolated to a considerable extent from the other, lower hills and ridges of the district, the mountain rises to a height of 4,800 feet above sea-level. Its flanks and crest are covered with dense jungle which periodical forest fires prevent from reaching any great height, and its atmosphere though damper (at any rate near the summit) than the atmosphere of the surrounding country owing to the clouds which it attracts, does not possess the humidity of that of the Eastern Himalayas, resembling rather that of the slopes below Naini Tal in Kumaon.

The fauna of Parésnath has hitherto received little attention, although Blanford and Stoliczka collected molluscs, crustacea and lizards upon it many years ago. The following notes are based mainly on collections made by Dr. J. Travis Jenkins and myself in April and May, 1909.

I.—A LIST OF SPECIES IDENTIFIED.

*(The names of the species as yet known only from Parésnath are marked with a *.)*

MOLLUSCS.

The land molluscs of Parésnath exhibit a tendency to form separate species and races such as usually occur in isolated areas of a mountainous nature.

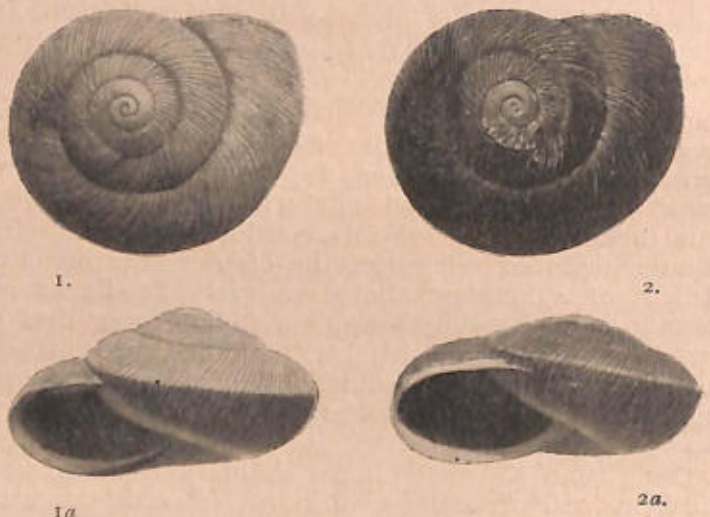
Family ZONITIDAE.

1. *Ariophanta interrupta* (Bs.) subsp. *sacra.*, nov.

Blanford and *Godwin-Austen, Fauna Brit. Ind.*—Moll., i, p. 31.

As is pointed out by the authors cited, Parésnath shells of this species represent a local race distinguished from the typical

form by its larger size (on an average) and greater depression (maximum breadth 34 mm., depth 17 mm.). I found several dead specimens of this shell on the northern slope of the hill at different altitudes and there are others in the Indian Museum from Stoliczka's collection. The typical form is widely distributed in Bengal, the northern part of the Madras Presidency and Central India.



Figs. 1, 2.—Shells of *Ariophanta interrupta*.

Figs. 1, 1a.—An unusually large (somewhat faded) specimen of the typical form from Calcutta.

,, 2, 2a.—Type of the race *sacra* from Parésnath.

(Both the figures are slightly magnified, to the same extent.)

2. *Macrochlamys sacrata*,* G. A.

Godwin-Austen, Land and Freshwater Moll. Ind., ii, p. 244, pl. cxxviii, fig. 3, pl. cxxix, fig. 4.

This snail, which was doubtfully attributed to *M. lecythis* (a species found on the Rajmahal Hills) by Stoliczka, is apparently endemic on Parésnath. I found numerous individuals, most of them immature, on the north side of the hill at altitudes of from 4,000 to 4,500 feet. They were aestivating under stones at the time of my visit (April, 1910) and had their shells closed by a wad of dried slime, but on being brought into the moister climate of Calcutta they resumed active life.

3. *Macrochlamys perplana*, G. A. (Nevill MS.).

Blanford and *Godwin-Austen, Fauna Brit. Ind.*—Moll., i, p. 99.

Numerous specimens of this snail were found together with those of *M. sacrata* in similar circumstances and condition. The

species is also known from Manbhum and Panchet Hill near Raniganj in Bengal.

4. *Microcyrtina cryptomphalus*,* G. A.

Blanford and *Godwin-Austen, op. cit.*, p. 257.

We did not take this shell, which was obtained on Parésnath at an altitude of 4,480 feet.

5. *Kaliella barrakporensis* (Pfr.).

Blanford and *Godwin-Austen, op. cit.*, p. 258.

Specimens of this widely distributed species were obtained on Parésnath by Stoliczka and also by myself. My specimens were taken on the north side at an altitude of 4,350 feet. *K. barrakporensis*, which occurs practically all over Peninsular India and also in Madagascar, is not uncommon in pine-woods round Simla at altitudes of 7,000—8000 feet.

Family HELICIDAE.

6. *Glessula praelustris* (Bs.).

Hanby and *Theobald, Conch. Ind.*, p. 9, pl. xvii, p. 6.

Some dead and partly incinerated shells of this species were found among the ashes of a jungle fire under a stone on one of the ridges of the hill (alt. 4,000—4,500 feet) and have been identified for me by Col. Godwin-Austen, to whom I am indebted also for confirmation of the other identifications of the land shells here recorded. *G. praelustris* is also known from Orissa.

Family CYRENIDAE.

7. *Pisidium* prox. *atkinsonianum*, Theob.

In a small spring situated on the north side of the hill at an altitude of about 4,000 feet I found numerous specimens of a minute *Pisidium* which my friend Mr. G. H. Tipper has examined. He informs me that they resemble specimens of *P. atkinsonianum* from Gangtok in Sikhim so closely that they should probably be regarded as representing a local race of that species. They differ considerably from *P. clarkianum*, Nevill, the common species of the plains of Bengal.

EARTHWORMS.

Dr. W. Michaelsen writes as regards the earthworms collected on Parésnath:—

"Unfortunately none of them is quite mature. In consequence I can only partially determine them, hardly being able to denominate the genus.

"The worms 'from a small stream' [Sita Nullah, on the lower slopes of the hill] belong to two species, the larger being a '*Glyphidrilus* sp.' (perhaps the same as that from the Himalaya, which was not determinable) and two specimens of an Ocnerodrilid with one gizzard, *viz.*, a *Gordiodrilus* or a *Kerria*. The worms 'from mud at the edge of small spring' [alt. *ca.* 4,000 feet] belong to *Perionyx* or *Perionychella* (probably *Perionyx excavatus*, E. Perr., which is so often found immature and so widely distributed)."

At the time Dr. Michaelsen wrote this note only one species of Microchaetinae had been recorded from India, namely an indeterminable young form of *Glyphidrilus* from the Simla Himalayas. More recently he has described the same or an allied species, from mature specimens taken in the plains of Travancore, under the name *G. annandalei*.[1]

CRUSTACEA.

Family POTAMONIDAE.

Paratelphusa (*Barytelphusa*) *jaquemontii*, Rthbn.

Alcock, Cat. Ind. Dec. Crust., i (fasc. ii)—Potamonidae, p. 79, pl. xii, fig. 55.

There are numerous specimens in our collection obtained on Parésnath by Stoliczka, and I found several myself in the small spring (alt. *ca.* 4,000 feet) to which allusion has already been made. They were unusually small although apparently adult. *P. jacquemontii* is widely distributed in Peninsular India but appears to be rather commoner in the western and the southern districts than in Bengal.

Family PALAEMONIDAE.

Palaemon (*Brachycarpus*), sp.

In a jungle stream running down the north slope of the hill and known as Sita Nullah I found, at an altitude of about 2,000 feet, numerous specimens of a small prawn belonging to the subgenus indicated. It is remarkable for its dark green, almost black colour and has the thick-set appearance often possessed by prawns of the genus from mountain streams. The species is probably undescribed as yet but, should this prove to be the case, will be described later by Mr. S. W. Kemp. It appears to differ considerably from the species common at similar altitudes in jungle streams in the Darjiling district, but may be identical with one that occurs in the R. Tista at Jalpaiguri.

A few terrestrial isopods were also obtained but have not been identified.

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[1] "Die Oligochätenfauna der vorderindisch-ceylonischen Region," *Abh. Naturwis. Verein Hamburg*, xix, Heft 5 (1910), p. 89.

MYRIAPODA and ARACHNIDA.

Family SCOLOPENDRIDAE.

Cormocephalus dentipes, Poc.

A specimen of this scarce species, which is only known from Bengal,[1] was taken at an altitude of about 4,300 feet under a stone. The only other specimen in our collection is from Calcutta.

Family GALEODIDAE.

Galeodes orientalis, Stoliczka.

Pocock, Fauna Brit. Ind.—Arachnida, p. 138, fig. 48.

A single specimen was taken under a stone at an altitude of between 4,000 and 4,500 feet. This species is perhaps the most widely distributed of the North Indian Solifugae. It was originally described from Central Bengal and Delhi and specimens in the collection of the Indian Museum prove that its range extends all over the drier parts of northern India from Cutch to the W. Himalayas and to Assam. A subspecies (*rufulus*, Poc.), distinguished chiefly by its darker coloration, occurs in Bombay. *G. orientalis* is common in a house situated near Giridih some miles from the base of Parésnath.

Several spiders and millipedes were also collected but have not yet been identified.

INSECTS.

ORTHOPTERA.

Small Acridiids, mantises and cockroaches are common on Parésnath, but the only Orthopteron identified with certainty is the large and powerful grasshopper *Mecopoda elongata* (Linn.), a species found throughout the Oriental region and also in Japan and Australia. In India it is common among brushwood on hillsides whereon the jungle is dense. The elytra of the two forms, a green form and brown one, closely resemble leaves in different stages of decay. Both were found in April on Parésnath.

HYMENOPTERA.

Only the Aculeate specimens in the collection have as yet been examined. Of these Mr. C. A. Paiva has identified those that represent species described in the late Col. Bingham's volumes in the "Fauna," but there are also a considerable number which represent forms not described in these volumes and probably new to science. The following have been identified:—

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[1] Gravely, *Rec. Ind. Mus.*, v. p. 171.

Family Scoliidae.

1. *Myzine petiolata*, Smith.

One specimen taken at an altitude of between 4,000 and 4,400 feet (15-iv-09). A rare species recorded by Bingham from Barrackpore near Calcutta.

Family Pompilidae.

2. *Pseudogenia tincta* (Smith).

Two specimens (10 and 15-iv-09) taken at an altitude of between 4,300 and 4,400 feet. A rare species in the plains of Bengal but also recorded from the "North-West Provinces," Sikhim and Burma.

3. *Pseudogenia alaris* (Sauss.).

One specimen from an altitude of between 4,000 and 4,400 feet (12-iv-09). There is a specimen in our collection from the environs of Calcutta (24-viii-04) and the species has been recorded from Sikhim, Burma and Ceylon.

4. *Salius madraspatanus.*

One specimen (4,000 to 4,400 feet, 13-iv-09). The species is common all over the Indian Empire and in Ceylon.

Family Sphegidae.

5. *Sceliphron violaceum* (Fabr.).

Parésnath, 4,400 feet (11-iv-09). Another common species, its range extending from S. Europe to Australia.

6. *Sphex umbrosus*, Christ.

Parésnath, 3,000 feet (15-iv-09). Also a common species, ranging all over the Oriental region and to Japan, Australia and Africa.

7. *Sphex aurulentus* var. *ferrugineus*, Lepel.

Parésnath, 4,000 feet (9-iv-09). Another common form; widely distributed in the Oriental region and found in China and N. Australia.

8. *Cerceris unifasciata*, Smith.

A specimen from Parésnath differs somewhat in colour from specimens from Assam and may represent a distinct variety or a local race. The species occurs in Sikhim, Assam, Upper Burma and China and also in Calcutta. It appears to be found chiefly in mountainous regions but probably not at great or even considerable altitudes.

Family EUMENIDAE.

9. *Eumenes flavopicta*, Blanch.

Parésnath, 4,000—4,400 feet (12-iv-09). A common species throughout Peninsular India, Burma, Ceylon and the Malay Archipelago, but not a mountain species.

10. *Rhynchium brunneum* (Fabr.).

Parésnath, 4,300 feet (10-iv-09). Also a common and widely distributed species; found on the lower slopes of the Himalayas but apparently not at great altitudes.

11. *Rhynchium metallicum*, Sauss.

Parésnath, 4,000—4,400 feet. Widely distributed in India and Burma. The Indian Museum possesses specimens from Karachi, Sind; Lucknow; Oncha Gaon, base of W. Himalayas; Siliguri, base of E. Himalayas; Dalsingh Serai, N. Bengal; Ranchi, Chota Nagpur; Margherita and Sibsagar, Assam; Sikhim; Bangalore, Mysore State, S. India; Maymyo Road, Upper Burma; Mergui, Lower Burma, and Perak, Malay Peninsula. Apparently not a mountain species.

12. *Odynerus bipustulatus*, Sauss.

Parésnath, 4,000—4,400 feet (13-iv-09). Widely distributed in N. India, Assam and Burma. The Indian Museum possesses specimens from Calcutta and Manipur.

Family VESPIDAE.

13. *Icaria ferruginea* (Fabr.).

Parésnath, 4,000—4,400 feet (10—14-iv-09). A common species in Sind, Bombay, the United Provinces, Bengal, Mysore, Madras, Burma and the Malay Peninsula. In the Himalayas only found at low altitudes.

Family COLLETIDAE.

14. *Prosopis mixta*, Smith.

Parésnath, 4,000—4,400 feet (13-iv-09). Bingham gives the habitat as "India" but there is in the Indian Museum a specimen collected by him at Shwegyin in Tenasserim.

15. *Prosopis strenua*, Cam.

Parésnath, 4,000—4,400 feet (10-iv-09). Only recorded hitherto from Barrackpore near Calcutta.

Family Apidae.

16. *Normia westwoodi*, Grib.

Two specimens from Parésnath, 4,000—4,400 feet (15-iv-09). Only known from Bengal. There are specimens in the Indian Museum from Calcutta.

17. *Anthophora zonata*, Linn.

Parésnath, 4,300—4,400 feet (15-iv-09). "Throughout India, Burma, Tenasserim and Ceylon, extending through the Malay regions to Australia" (Bingham).

18. *Xylocopa amethystina*, Fabr.

Parésnath, 4,000—4,400 feet (12-iv-09). Although this species occurs in Calcutta and other places in the plains of Bengal, it penetrates further into the Himalayas than any other of the genus. The Indian Museum possesses specimens from Gilgit and Srinagar (Kashmir) and from the hills of Chota Nagpur and Upper Tenasserim; it also occurs in Bombay, Malabar and Ceylon. In May, 1911, I saw a *Xylocopa* which probably belonged to this species in a Simla garden situated at an altitude of slightly over 7,000 feet.

19. *Apis dorsata*, Fabr.

Parésnath; common in April. One of the commonest Indian bees; northwards its range extends into Tibet, eastwards to China and the Malay Archipelago; southwards to Tenasserim and the Malay Peninsula.

Family Chrysididae.

20. *Stilbum cyanurum*, Först.

Parésnath (12-iv-09). A cosmopolitan species.

21. *Chrysis oculata*, Fabr.

Parésnath, 4,300—4,400 feet (15-iv-09). Widely distributed in the plains of India and in Assam.

DIPTERA.

I am indebted to Mr. E. Brunetti for the identification of most of the following Diptera. The Trypetinae, which were unusually well represented, are now being worked out by Prof. Bezzi, who has found no less than five new species in the Parésnath collection.

Family PSYCHODIDAE.

1. *Phlebotomus major*, Annandale.

Annandale, Rec. Ind. Mus., iv, pp. 46 and 320.

A single male was taken in a bungalow situated at an altitude of 4,500 feet on Parésnath (April). The species is otherwise only known from the Himalayas and the Nepal terai. It is common both in the Simla and the Darjiling districts, especially at the end of June and in July, at altitudes of from 4,500 to 9,000 feet.

Family TIPULIDAE.

2. *Geranomyia semistriata*,* Brunetti.

Brunetti, Rec. Ind. Mus., vi, p. 277 (1911).

Several specimens of this species were obtained in herbage round a well situated at an altitude of about 4,300 feet. Three other Indian species are represented in the collection of the Indian Museum and have been described, together with the one from Parésnath, by Mr. Brunetti. The genus is widely distributed both in the Oriental Region and elsewhere.

Family LEPTIDAE.

3. *Atherix intermedia*,* Brunetti.

Brunetti, Rec. Ind. Mus., iii, p. 211 (1909).

Numerous specimens of this species were seen on rocks at the edge of the stream Sita Nullah (alt. 2,000 feet) on April 4th. In India the Leptidae appear to be confined to mountainous regions, and *A. intermedia* is the only species I have seen in numbers. The genus *Atherix* occurs both in the Himalayas and in Ceylon, and is widely distributed both in the Oriental Region and in other parts of the world.

Family BOMBYLIDAE.

4. *Exoprosopa niveiventris*,* Brunetti.

Brunetti, ibid., p. 214.

Two females and a male, apparently of the same species, were taken near the base of the hill (alt. *ca.* 1,000 feet). *E. niveiventris* has not been taken elsewhere.

5. *Argyramoeba distigma* (Wied.).

Brunetti, ibid., p. 221.

Common all over the hill, hovering a short distance above the ground. This is one of the least scarce of the Indian Bombylidae, occurring chiefly in the plains. It has also been recorded from several of the islands of Malaysia.

ACALYPTERATA, subfamily SEPSINAE.

6. *Sepsis cynipsea* (Linn.).

A pair were taken on Parésnath in April at an altitude of 4,350 feet. This common Palaearctic species occurs all along the Himalayas and is also found in the hills of Assam, but does not occur in the plains except just at the base of the Himalayas.

Numerous other Diptera were taken but have not yet been identified.

COLEOPTERA.

Although a considerable collection of beetles was made on Parésnath, it has been only possible to get a few species identified as yet. The most striking form was *Thysia wallichii*, Hope, a large Longicorn rendered conspicuous by its barred elytra and tufted antennae. This species was common at an altitude of 4,400 feet on the hill and was often observed on the wing. It is equally abundant at about the same altitude in the E. Himalayas, and its range extends eastwards through Assam and Upper Burma into China. Other conspicuous forms were the Cetoniinae *Clintesia klugii* (Hope) and *C. hearsiana*, Westw., which were found together in very large numbers, devouring the flowers of certain shrubs that grew near the top of the hill. *C. klugii* appears to be restricted to western and central India, while *C. hearsiana* has not been recorded from any other definite locality but Parésnath.

RHYNCHOTA.

The commoner and more conspicuous species of the Heteroptera from our Parésnath collection have been identified by Mr. C. Paiva, while Mr. W. L. Distant has recently described a number of new species. Only the larger Homoptera have yet been named, with the exception of one or two common Jassidae, but a large number of species will, I hope, be dealt with in the appendix to Mr. Distant's account of the Rhynchota in the *Fauna of British India*. Of those that have been identified the most interesting from a geographical point of view are two species of Cicada, both diurnal in habit and each common on the occasion of one visit, *viz.*, *Haphsa nicomache* (Walk.), which was abundant in April, and a new species of *Terpnosia*,[1] which replaced it in May. The range of *H. nicomache*, so far as it is known, extends (apart from Parésnath) from Mussoorie in the W. Himalayas through Sikhim into Assam.

The Heteroptera of Parésnath appear to fall for the most part into one of two categories—either they are common and widely distributed species or else they have not yet been found except on the hill. This, however, is the case as regards most newly explored localities in India, and it would appear to be a fact that species of this suborder are as a rule either very widely distributed or else quite local in their distribution. The number

[1] *T. jenkinsi*, Dist., *Ann. Mag. Nat. Hist.*, 1912.

of hitherto undescribed forms found on Parésnath was considerable. It seems unnecessary to give a list of those that have been identified; several of the new species are described by Mr. Distant in *Ann. Soc. Ent. Belgique*, liii (1909), pp. 361, 362, etc.

LEPIDOPTERA.

We were not able to pay much attention to the Lepidoptera and only a few species were collected. Mr. Meyrick has recorded two species of Microlepidoptera from Parésnath, namely *Oligophlebia amalleuta** from an altitude of 4,000 feet and *Acrocercops convoluta*. The latter is also known from Kurseong in the E. Himalayas and is fairly common, as Mr. Meyrick informs me, at Maskeliya in Ceylon.

For the following note on the butterflies of Parésnath I am indebted to Capt. G. H. I. Graham, who has visited the hill on more than one occasion in order to collect Rhopalocera :—

List of butterflies caught on Parésnath Hill by Capt. G. H. I. Graham and a native catcher, during the months of April and October, 1908-09.

"NYMPHALIDAE.

Subfamily I.

Danais plexippus	..	Common.
,, chrysippus	..	,,
,, limniace	..	,,
Euploea core	..	,,
,, mulciber	..	A few seen on the wing.

Subfamily II.

Mycalesis perseus	..	Common.
,, mineus	..	,,
,, visala	..	,,
Orsotrioena meda	..	Uncommon.
Lethe europa	..	,,
,, nilgiriensis	..	Common from 2,000 feet to top of hill.
Ypthima baldus	..	Uncommon.
,, inica	..	,,
Melanitis ismene	..	Very common.

Subfamily IV.

Charaxes imna	..	♀ ♀ more common than ♂ ♂.
,, marmax	..	Seen but not caught.
,, fabius	..	Very scarce.
Eulepis athamas	..	Fairly common.

Euthalia lubentina	..	Very scarce.
,, garuda	..	Fairly common.
,, nais	..	Very ,,
Moduza procris	..	Scarce.
Athyma perius	..	Very common.
Neptis eurynome	..	,, ,,
,, columella	..	Scarce.
Junonia iphita	..	,,
,, lemonias	..	Common.
,, orithya	..	Very common.
,, atlites	..	Scarce.
,, hierta	..	Very common.
,, almana	..	,, ,,
Vanessa cardui	..	Very scarce.
Hypolimnas bolina	..	Very common.
,, misippus	..	♂ scarce, only 2 ♀♀ caught.
Kallima inachus	..	Above 2,000 feet; very common at about 3,000 feet at small stream over which there is a foot-bridge—the only spot on the whole hill I ever saw them. All the specimens taken were quite as large as those from Assam and of a much deeper blue.
Atella phalantha	..	Very common.
Argynnis hyperbius	..	Scarce.
Ergolis ariadne	..	Uncommon.

Subfamily V.

Telchinia violae	..	Very common.

NEMEOBIDAE.

Abisara echerius	..	Very common.

PAPILIONIDAE.

Papilio aristolochiae	..	Common.
,, demoleus	..	....
,, polymnestor	..	Fairly common at bridge described above.
,, polytes	..	Common.
,, clytia	..	Scarce.
,, dissimilis	..	,,
,, nomius	..	Fairly common but difficult to capture; only seen in April.

PIERIDAE.

Leptosia xiphia	..	.. Fairly common.
Delias eucharis	..	.. Common.
Huphina nerissa	..	.. ,,
Ixias pyrene	..	.. Very common.
Catopsillia crocale	..	.. Uncommon.
,, pyranthe	..	.. ,,
,, florella	..	.. ,,
Terias libythea	..	.. Scarce.
,, hecabe	..	.. Very common.

Some skippers and blues were taken, but I have not yet started on these families, so know little or nothing about them.

G. H. I. GRAHAM."

FISH.

A small collection of fish from a little stream (Sita Nullah) on the north face of Parésnath has been described by Dr. Jenkins in *Rec. Ind. Mus.*, v (1910), p. 128. Only five species were obtained, *viz.*, *Glyptosternum saisii*,* *Nemachilus savona*, *Discognathus lamta*, *Danio dangila*, *Ophiocephalus gachua*. Two of these species (*O. gachua* and *D. lamta*) have a wide distribution in India and even beyond its borders, while two (*D. dangila* and *N. savona*) are common in rocky streams throughout Western Bengal. *G. saisii* has only been found as yet on Parésnath. It belongs to a genus found in the mountains of both northern and southern India, and is allied to *G. pectinopterum*, a species common in the Himalayas from Kangra to Darjiling and also in the hills of the Punjab.

REPTILES and BATRACHIA.

The only frog obtained was *Rana limnocharis*, Wiegm., of which several small specimens were taken at the edge of a spring situated on the north face of the hill at an altitude of about 4,000 feet. This species is abundant all over the plains of India and ascends the Himalayas to an altitude of between 5,000 and 6,000 feet.

The following lizards were collected by Dr. Jenkins and myself or subsequently sent to the Indian Museum from Parésnath by Dr. Walter Saise :—

Hemidactylus brookii, Gray.

Hemidactylus gleadovii, *Boulenger, Fauna Brit. Ind.*—Rept., p. 86, fig. 27.

Hemidactylus brookii, *id.*, *Ann. Mag. Nat. Hist.* (vii), i, p. 123 (1898).

Several specimens were taken on the walls of a bungalow situated at 4,500 feet. This lizard is common all over the plains

of India both in houses and in open country, sheltering under stones in the latter situation. It rarely occurs, however, in the Himalayan hill stations.

Calotes versicolor (Daud.).

Common all over Parésnath. The specimens obtained were to some extent intermediate between the form *gigas* of Blyth, which is the common race all over S. India and Ceylon and also in Orissa, and the smaller form with less strongly marked sexual characters which is characteristic of the Himalayas, Lower Bengal and the countries to east of the Bay of Bengal. *C. versicolor* is common in both the East and the West Himalayas up to an altitude of at least 5,000 feet, but Dr. J. R. Henderson tells me that he does not think that it ascends so high in the hills of the Madras Presidency, in which it is replaced at comparatively low altitudes by peculiar mountain species.

Charasia blanfordiana, Stoliczka.

The genus *Charasia* is peculiar to the Indian Peninsula, in which it takes the place of the Ethiopian and Palaearctic genus *Agama* found in the Himalayas as far east as the Little Nepal Valley. Three species of *Charasia* are known, namely, *Ch. ornata*, the range of which extends from Central India to the Ganges Valley in the United Provinces and to Kutch in Sind; *Ch. dorsalis*, which appears to be confined to the hills and tablelands of S. India; and *Ch. blanfordiana*, which is common in the hills of W. Bengal (including the whole of Parésnath), at low altitudes among the hills of S. India and in Travancore along the base of the W. Ghats. It also occurs among low hills in Central India, but I have been unable to find any record of its occurrence in the Bombay Presidency. In S. India it is apparently rare above about 2,500 feet, its place being taken at higher altitudes by *Ch. dorsalis*, which is common in the neighbourhood of Bangalore at an altitude of about 3,000 feet. Dr. J. R. Henderson tells me that he has only seen *Ch. blanfordiana* from low hills in the Chingleput district south of Madras, and he thinks from similar hills in the Nellore and North Arcot districts.

Mabuia carinata (Schneid.).

This common lizard is abundant on the lower slopes of Parésnath. Several specimens from the base of the hill and its vicinity show a tendency for the frontal to split longitudinally.

Lygosoma sikkimense (Blyth.).

Mocoa sacra, *Stoliczka, Journ. As. Soc. Bengal*, xli, p. 128, pl. iv, fig. 4 (1872).

Lygosoma sikkimense, *Boulenger, Fauna Brit. Ind.*—Rept., pp. 199-200.

Stoliczka many years ago obtained a single specimen of this species (which he described as the type of a new species, *Mocoa sacra*) from one of the little shrines on the ridge of Parésnath. I was so fortunate as to obtain a second near the summit. Both specimens are in the collection of the Indian Museum and I have compared them very carefully with a large series from Sikhim, Darjiling and Nepal. I can find no constant difference. My specimen has the fourth toe shorter than is usually the case, but one of the supposed specific characters of *M. sacra* was that this toe was longer than in *L. sikkimense*, and in Stoliczka's specimen, although it is not actually longer than in many Himalayan individuals, it is much longer than in mine. There can be no doubt that Boulenger was right in relegating *M. sacra* to the synonymy of *L. sikkimense*.

L. sikkimense is a species otherwise peculiar to the E. Himalayas. We have no evidence that its range extends west of the Nepal Valley, and in the Little Nepal Valley it actually occurs side by side with *L. himalayanum*, a closely allied species that takes its place in the W. Himalayas. Moreover, there is no evidence that *L. sikkimense* descends the Himalayas to altitudes of less than 3,000 feet. It is a damp-loving species and, unlike most skinks, is oviparous, laying its eggs in wet moss on tree-trunks during the rains. The eggs have comparatively soft, leathery skins, which shrivel up if they become dry. In these circumstances the embryo perishes.

II.—SUMMARY AND CONCLUSIONS.

The data set forth above must be regarded as extremely imperfect, but, imperfect as they are, they afford evidence of one remarkable fact, namely, that whereas a large proportion of the fauna of Parésnath is identical with that of the Ganges valley and a smaller proportion apparently endemic on the hill, a Himalayan element can also be detected which is totally absent from the surrounding plains. Representatives of this element are *Phlebotomus major* and *Sepsis cynipsea* among the Diptera (both representing families that have been more thoroughly investigated than most in India), *Haphsa nicomache* among the Rhynchota, *Thysia wallichii* among the beetles, and above all *Lygosoma sikkimense* among the lizards. Although winged insects might be blown with comparative ease across the Ganges valley from the Nepal foot-hills to Parésnath, it is quite impossible that a lizard could be carried in this way. It is impossible, moreover, that the eggs of *L. sikkimense* could be transported in a living condition by birds, for they perish within a short period of being removed from the damp moss in which they are laid. We must therefore seek for a geographical explanation of the occurrence of this lizard on an isolated hill-top two hundred miles from its present abode.

It is of course no new discovery that the fauna of hill-tops south of the Ganges valley includes a Himalayan element, and a great deal has been written about this fact with reference to the mountains of the Madras Presidency. A summary of all the more important writings on the subject will be found in the late Dr. W. T. Blanford's classical memoir on the distribution of the Indian vertebrates in the *Phil. Trans. Roy. Soc.*, vol. 194 (B), 1901 (p. 422, etc.).

The generally accepted explanation of distributional phenomena of the kind is that it is due partly to the transport of winged animals or the eggs of non-winged organisms by aërial currents and perhaps occasionally by birds, and partly to changes in the distribution and extent of the glaciers of the higher mountain ranges. Much evidence has been adduced by geologists in support of the belief that the glaciers of the Himalayas, at a period not very remote, extended considerably further south than they do at present. La Touche,[1] however, has recently shown that they cannot have extended as far as the Ganges valley, except possibly at an ancient geological period. It can, I think, hardly be maintained that any of the species common to the Himalayas and Parésnath existed in their present form at this ancient period, and it seems unnecessary to go far back in geological time to search for an explanation of their present geographical distribution. There is no reason whatsoever to think that the individuals living on Parésnath were ever isolated by a ring of ice or driven to the summit by glaciers sufficiently extensive to submerge the base of the hill: but it must be remembered that the secular movements of glaciers are accompanied by profound modifications not only in temperature but also in humidity, and humidity is perhaps an even more important factor in the distribution of reptiles and insects than actual temperature. We must suppose that *Lygosoma sikkimense* once lived in the plains as well as or instead of in the hills, but that a fall in the atmospheric humidity of the former, perhaps due in part to movements of glaciers in the Himalayas, drove it up into the E. Himalayas on the one hand and the summit of Parésnath on the other, or confined it to comparatively high altitudes.

It is perhaps worth noting that the Himalayan element in the fauna of Parésnath appears to be allied to that of the E. Himalayas, whereas that in the flora rather shows affinities with the flora of Kumaon. The climate is, however, very similar to that of the lower slopes of the hills below Naini Tal and we may suppose that seeds brought by winds or birds from that part of the Himalayan ranges would have a better chance of germinating and propagating their species than those from the damper forests of Nepal or Sikhim, which are actually nearer in space. Hooker says of the flora of Parésnath, which

[1] *Geological Magazine* (v), vii, p. 193 (1910).

he visited in 1848: "Of plants eminently typical of a moister atmosphere, I may mention the genera *Bolbophyllum*, *Begonia*, *Aeginetia*, *Disporum*, *Roxburghia*, *Panax*, *Eugenia*, *Myrsine*, *Shorea*, *Millettia*, ferns, mosses and foliaceous lichens; which appeared in strange association with such dry-climate genera as *Kalanchoe*, *Pterospermum*, and the dwarf-palm, *Phoenix*. Add to this list the *Berberis asiatica*, *Clematis nutans*, *Thalictrum glyphocarpum*, 27 grasses, *Cardamine*, etc., and the mountain-top presents a mixture of the plants of a damp hot, a dry hot, and of a temperate climate, in fairly balanced proportions. The prime elements of a tropical flora were however wholly wanting on Paras-nath, where are neither peppers, *Pothos*, *Arum*, tall or climbing palms, tree-ferns, *Guttiferae*, vines, or laurels."—*Himalayan Journals*, vol. i, pp. 23-24, footnote.

IV. OBSERVATIONS ON THE SHALLOW-WATER FAUNA OF THE BAY OF BENGAL MADE ON THE BENGAL FISHERIES STEAM-TRAWLER "GOLDEN CROWN," 1908-1909.

By J. T. JENKINS, *D.Sc.* (*Wales*), *Superintendent, Lancashire and Western Sea Fisheries.*

(Plate iv.)

The investigations carried on by the trawler "Golden Crown" during 1908 and 1909 have thrown some light on the fauna of the upper portions of the Bay of Bengal between the 15- and 30-fathom lines. A few hauls were made in greater and lesser depths, but trawling was mainly carried on within the limits mentioned. The trawl of the "Golden Crown" was of the ordinary commercial type and well calculated to capture any fish or invertebrate living on the bottom or swimming about within seven or eight feet thereof. Occasionally portions of a shoal of pelagic (*i.e.*, non-demersal) fish would be enmeshed when the trawl was being hauled inboard. To this category belong the pomfrets (*Stromateus cinereus, niger* and *sinensis*), large hauls of which were made off the Eastern Channel at the entrance to the River Hughli, and the flying gurnard *Dactylopterus orientalis*. The only pelagic fish taken in anything like large quantities was the Silver Pomfret (*Stromateus cinereus*). This species was most abundant in the months from December to April and was met with anywhere between the Mutlah light ship (off the entrance to the Mutlah River) and Puri on the coast of Orissa. It is not infrequently taken in the nets of the local fishermen at the latter place. So far as the "Golden Crown" records show, the pomfret is most abundant in the northern parts of the Bay during the months of January and February, at this time the writer occasionally observed vast shoals of them swimming leisurely past the "Golden Crown" whilst she was going ahead slow with her trawl down. The best catch was made during the voyage which lasted from the 9th to the 15th February, 1909, throughout which period trawling was prosecuted to the south of the Eastern Channel light vessel, the pilot ship of the Bengal Pilot Service being within sight the whole of the time.

A curious feature was that the pomfrets were only caught by daylight. It was customary on the "Golden Crown" to make four hauls *per diem*. The net was shot at 6 a.m., midday, 6 p.m. and midnight and hauled half an hour before those times, so that two hauls were made during darkness (6 p.m. to midnight

and midnight to 5-30 a.m.) and two by day. During the voyage from the 9th to the 15th February, 1909, twenty hauls were made, ten during daylight and an equal number at night. The total weight of pomfrets caught was 2,775 lb., of which only 68 lb. were caught at night. Moreover during the second daylight haul on the 10th February the net was badly torn, and a large proportion of the catch, consisting of pomfrets, escaped.

Dactylopterus orientalis was never captured in sufficiently large numbers to be weighed separately as a constituent of the "Golden Crown's" catch. It will be understood that a complete record of the different species of fish captured on each voyage was an impossibility and doubtless many records of this and other species are thus unobtainable. My impression is that *Dactylopterus* was obtained principally off the Madras coast (Ganjam). It is specially recorded in the voyage March 5—16th, 1909, from that locality.

On the whole the explorations of the "Golden Crown" showed that there were four more or less distinct trawling areas or fishing grounds in the northern portion of the Bay. These areas naturally passed gradually into one another, but there are quite distinctive features in each case. These areas (see plate iv) are—

(1) Extending from the Mutlah light vessel down past the entrance to the Eastern Channel to Pilot's Ridge.
(2) Off the Arakan Coast from the South Patches light vessel (entrance to the channel leading to Chittagong) to Oyster Island in the neighbourhood of Akyab.
(3) The coast of Orissa from the mouth of the Devi river to the entrance to Lake Chilka.
(4) The coast of the Ganjam district of the Madras Presidency from Ganjam to Santapilli light-house in the district of Vizagapatam.

The principal characteristics of these areas and the more noteworthy representatives of the fauna are dealt with below:—

Area I. Mutlah light vessel to mouth of Dhumra River.

The bottom in this area consisted entirely of a very fine and soft mud, the product of land denudation brought down by the Ganges and its affluents. So soft is this mud that it was always necessary to keep the trawler going at a good speed when the net was out as otherwise the latter would have sunk in the mud and have been lost. The speed was too high to allow of the use of the ordinary surface tow-net.

The principal feature of this mud was the presence of a large number of empty (dead) shells of *Dentalium eburneum*, Linn.

Peculiar rounded balls of mud were frequently brought up in the trawl and these when opened were found to contain a living Lamellibranch, a species of mussel, *viz.*, *Modiola rhomboidea*. On

the whole the Molluscan fauna of this area was not abundant, though specimens of *Murex tenuispina* were not infrequently met with.

Of the Echinoderms, the Holothurian *Aphalodactyla molpadoides* may be regarded as typical.

Of the Crustacea the two commonest inedible forms were *Thenus orientalis* and *Egeria arachnoides*. Two species of prawn of economic importance were found in this region, as well as an edible crab (*Scylla serrata*).

The prawns consisted mainly of *Peneus semisulcatus* and *Peneus indicus*, but they were not nearly so abundant in this area as off the sandy shores of Orissa (Area III), where large hauls were frequently made.

As a general statement it may be said that the invertebrate fauna of this region was scanty.

The fish-fauna of this muddy area off the Sunderbans is quite distinctive. Although the trawl was not adapted to catch surface-swimming forms, still *Carcharias menisorrah* and *Chiloscyllium indicum* were commonly taken. Of the Batoidei, *Trygon uarnak* and *Trygon bleekeri* were possibly more characteristic of this region than any other species. The former is a large species of "sting-ray" and individuals measuring 5 feet or more across the back were common. On one occasion (Voyage No. 14, December, 1908) nearly 23 per cent. of the total catch of fish in this area consisted of these gigantic Batoids. Nine specimens of *Trygon uarnak* taken near the Mutlah light vessel on this occasion aggregated 1,360 lb., the average weight being 151 lb. and the extremes 118 and 180 lb. respectively. This species seems to prefer a depth of from 24 to 25 fathoms, and in fact our general experience in this muddy area was that the fish-fauna was more abundant at this depth than on deeper or shallower areas.

Two hauls taken close together on the same day in the same locality bring this contrast out very well:—

December 20th, 1908. *Near Mutlah light vessel.*

Haul I,—in 14 fathoms of water: from 11-20 a.m. to 3 p.m.

	Wt.
One *Psettodes erumei*	3 lb.
A few "soles" (*Cynoglossus macrolepidotus*)	5 ,,
Prawns (*Peneus* spp.)	7 ,,
Arius spp., chiefly *dussumieri* ..	30 ,,
Total weight of catch	45 lb.

Haul II,—in depth of 24 fathoms: from 4-15 p.m. to 11 p.m.

Although the net was torn the catch consisted of—

	Wt.
Psettodes erumei	15 lb.
Otolithus maculatus	2 ,,
Stromateus cinereus	20 ,,
Prawns (*Peneus* spp.)	30 ,,
Sciaenoids, chiefly *S. vogleri* ..	80 ,,
Muraenesox cinereus	70 ,,
Arius spp., chiefly *A. dussumieri* ..	60 ,,
"Soles" (*Cynoglossus macrolepidotus*)	20 ,,
Trygon uarnak, 4 specimens weighing respectively	122 ,,
	160 ,,
	170 ,,
	180 ,,
Total weight of catch	929 lb.

The weights give one a very good idea of the relative abundance of the different species of fish.

An extract from notes relating to a series of hauls on a purely muddy area, practically within a few miles of the Mutlah light ship, throws some light on the fish fauna of this area during the month of December.

The notes explanatory of the table on p. 55 are:—

Haul I.—Only one basketful of fish. (The baskets used for weighing the fish on the "Golden Crown" were real baskets, holding when full about 60 to 70 lb. weight of Sciaenoids or Siluroids.)

The chief fish this haul were *Cynoglossus* and *Platophrys*, *Stromateus* sp., *Sciaena* sp., *Ephippas orbis*, *Drepane punctata* and *Lynagris japonicus*. Depth of water 25 fathoms. Bottom "oozy." When the trawl was shot at midnight on the 17th December Mutlah light ship bore east about 4 miles.

Haul II.—The fish called "Begti" or "Bekti" by the natives on the "Golden Crown" is not *Lates calcarifer* but *Chrysophrys datnia*. This name was afterwards extended by the European crew to include any large Sparoid or Percoid fish. Other fish this haul were *Muraenesox cinereus*, *Pagrus spinifer* (few), *Cynoglossus macrolepidotus*, Siluroids of the genus *Arius*, various species of *Caranx*, a few *Pellona* and *Psettodes erumei*. Fish that were not sufficiently abundant to be classified and weighed separately were returned as "mixed." These included very different fish. This haul the mixed were almost entirely *Saurida tumbil*.

Inedible fish are not included in the weights in the table. This haul brought up two large *Rhynchobatus djeddensis* not included.

Same ground as in Haul I.

Haul III.—Same ground as before. Mixed fish again = *Saurida tumbil*.

Hauls near Mutlah light vessel. December 1908.

	Haul No.																
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Bekti' (*Chrysophrys datnia*)	No edible fish in any quantity.	189	65	93	..	..	174	.	..	..	..	..	..	..	..	..	..
Otolithus maculatus ..		7	..	25	9	..	102	..	18	25	3	..	2	..	..	..	..
Caranx (various) ..		50	48	32	..	..	..	82	3	3	8	..	..	..	3	62	..
Pomfrets		7	8	3	..	5	5	..	..	..	5	..	20	..	9	49	1
"Congers" (*Muraenesox*)		53	..	..	30	..	..	..	47	43	..	..	70	30	53	23	115
Psettodes		9	8	7	10	2	6	..	9	12	5	3	15	5	3	10	8
Prawns (Peneidae) ..		25	..	9	105	20	28	10	70	45	10	7	30	..	10	..	..
"Soles"		18	18	4	30	5	20	2	32	30	8	5	20	5	8	8	10
Sciaenoids		130	88	179	759	110	163	110	447	183	90	..	80	70	70	80	190
Siluroids		80	125	130	170	80	140	115	175	88	90	30	60	23	80	177	125
Trygon uarnak, etc. ..		130	..	..	505	180	..	62	..	118	..	..	632	.	9	330	..
Mixed		7	5	7	..	..	26	25	..	..	15	..	..	..	..	19	4

Haul IV.—Same ground as before. Mixed fish = *Trichiurus haumela.*

The fifth and sixth hauls were on the same ground and the catches similar to the above.

Haul VII.—One large *Pristis pectinatus* in net. Net torn. The cause of the net being occasionally torn on these soft grounds is either a large sawfish or a trunk of a tree brought down by the Ganges and waterlogged and sunken. The mixed fish consisted of 20 lb. weight of *Pellora* and 6 of *Saurida tumbil.*

Haul VIII.—The "skates" or "sting-rays" comprised a medium-sized specimen of *Trygon uarnak,* the balance (12 lb.) being *Myliobatis nieuhofii.* The mixed fish included several specimens of *Chirocentrus dorab.* One *Zygaena blochii* was captured but not included in the weights given in the table.

In both the eighth and ninth hauls five specimens of pomfret (*Stromateus cinereus*) were captured; the weights were not included in the table.

Haul X.—The net was badly torn during this haul. It took an hour and a half for all hands to repair it. One specimen of *Thalassochelys caretta* was captured in this haul. The Carangidae comprised during this and the preceding two hauls *Caranx malabaricus, C. atropus* and *C. gallus.*

There were also present (Haul XI) in the "mixed" fish:—*Minous monodactylus, Polynemus sextarius, Sebastichthys strongea, Platycephalus* sp., *Therapon jarbua* and *Mene maculata.* The Siluroid which predominated in all the hauls on this ground was *Arius dussumieri.* Day states that *Therapon jarbua* is not uncommon at Calcutta in the tidal Hughli. Hauls XII and XIII are quoted above (p. 55), the former was in from 14 to 15 fathoms of water, the latter back again in 24 fathoms. In Haul XV the small "skate" was *Myliobatis* sp.

Haul XVI was in deeper water, approximately 40 fathoms. The only remarkable fish not recorded in previous hauls was *Chorinemus lysan.*

Haul XVII was made in the direction of (*i.e.*, towards) the Eastern Channel light vessel. The "mixed" fish were *Elacate nigra.*

Area II. South Patches Light Vessel to Akyab.

The second area trawled over by the "Golden Crown" was that extending from the South Patches light vessel (off the entrance to Chittagong) down past Oyster Island to the vicinity of Akyab. This area is separated by the "Swatch of No Ground" from Area I. The bottom varied considerably. Near the light ship it was mud, further to the south this was replaced in depths from 8 to 17 fathoms by fine glittering sand, with patches of shells at intervals. Off St. Martin's Reef in from 10 to 13 fathoms the bottom consisted of shells and fine gravel. Between St. Martin's Reef and Oyster Island the trawl brought up fossiliferous rocks of

miocene age. The rocky nature of the ground and the consequent damage to the nets led to trawling being abandoned in this area.

The fifteenth voyage of the "Golden Crown" was partly devoted to trawling on this area and details of the hauls are appended.

The first haul was made in muddy grounds in depths varying from 13 to 18 fathoms not far from the South Patches light vessel.

The catch included one very large male *Pristis perottetii*, *Pteroplatea micrura*, *Echeneis naucrates*, *Arius dussumieri*, *Synaptura altipinnis*, *Psettodes erumei*, *Cynoglossus macrolepidotus*, *Pseudorhombus arsius*, *Pellona indica*, Sciaenoids (various), *Pagrus spinifer*, *Ephippus orbis*, *Scomber macrolepidotus*, *Stromateus cinereus*, *Pterois* sp., *Caranx atropus*, *Drepane punctata*, *Saurida tumbil*, *Chirocentrus dorab*, *Dactylopterus orientalis*, *Pristipoma maculatum* and *Diodon hystrix*.

Squilla raphidea was abundant on this ground.

Haul II.—On muddy grounds in same neighbourhood in slightly deeper water (average 18 fathoms). Catch included *Cynoglossus macrolepidotus*, *Arius dussumieri*, *Pteroplatea tentaculata*. Two large and one small *Trygon uarnak*, *Elacate nigra* and one *Limulus*.

Haul III.—Muddy grounds. Depth during haul 18, 19 and 20 fathoms. Fish much as before with one large *Rhynchobatus djeddensis*.

Haul IV.—From 20 to 12 fathoms. Mud to fine sand. *Sphyraena obtusata* in "mixed" fish.

Hauls V and VI were made further to the southward. Haul VII was made 15 miles off Elephant Point which bore E.N.E. when the net was shot. There were 21 *Carcharias menisorrah* in this haul.

Haul VIII was in the neighbourhood of St. Martin's Reef, which at 10 a.m. bore E.N.E. 6 miles away. The bottom varied considerably during this haul. At 8 a.m. the sounding gave 12¾ fathoms, shells. At 10 a.m. 10½ fathoms, shells and small stones, at 10-30 a.m. 9½ fathoms, shells and grit.

Haul IX.—The net caught some obstruction on the bottom and was badly torn, both the foot and head ropes being broken. The cause of the damage was the reef of miocene rocks referred to above. In this haul several specimens of *Callionymus longicaudatus* were taken. In the next haul (X), the net was again badly torn for the same reason and specimens of the rocks were again preserved. Antipatharians were also dredged up this haul, Gorgonids and Alcyonarians as well. Large Percoid and Sparoid fish similar to those found in corresponding localities on the other side of the Bay were taken. Of these the most abundant was *Lutjanus annularis*. In Haul XII there were no edible fish, but one large *Tetrodon stellatus* was present.

On a previous voyage to the Arakan coast somewhat similar results were obtained, except that the hauls were confined to the more northern portions of the area where no rocky ground is

encountered. Good catches of *Polynemus plebeius* and *Harpodon nehereus* (the "Bombay Duck") were a feature of this voyage (on 11th November 1908): also large *Pristis cuspidatus*, *Zygaena blochii* and *Pristis perottetii*. *P. cuspidatus* was very prevalent during this voyage.

Rhynchobatus djeddensis common, no less than six large specimens taken in one haul (Haul XIV, November 17th, 1908). Snakes were not infrequent, principally *Enhydrina valakadien*. The fish identified during these hauls were *Chatoessus chacunda*, *Raconda russelliana*, *Platophrys pantherina*, *Synaptura commersoniana*, *Sillago panijus*, *Narcine timlei*, *Hypolophus sephen*, several small *Carcharias laticaudus*, *Stromateus niger* and *Pellona filigera*.

This area was the only one in which large specimens of the estuarine "Sele" fish (*Polynemus plebeius*) were obtained. They were captured in considerable numbers on muddy grounds near the South Patches light vessel. On this ground the Pristidae were unusually abundant in November.

Two Pleuronectids previously described by Alcock from the "Investigator" collections were obtained from the southern portion of this area. These were:—

Rhomboidichthys azureus, previously recorded from Ganjam and Ceylon; and

Rhomboidichthys valde-rostratus, previously recorded from Ceylon only.

Incidentally it may be noted that this area was less explored than any of the other three.

AREA III. FROM THE MOUTH OF THE DEVI RIVER TO THE ENTRANCE TO LAKE CHILKA.

This area off the coast of Orissa was to a large extent explored by the "Investigator" previously to voyages of the "Golden Crown." Moreover a large number of the fish were known owing to the fact that there is a regular coastal fishery carried on by Telugu fishermen at Puri by means of drift- and seine-nets and also by baited hooks.

Most of the shallow-water trawling of the "Investigator" was in this area and there are a number of papers by Alcock[1] which afford us valuable information, more particularly as to the fish.

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1 *Vide*—Alcock, *A Naturalist in Indian Seas.*

" "On some undescribed shore-fishes from the Bay of Bengal," *Ann. Mag. Nat. Hist.*, December, 1890, pp. 425—443.

" "List of the Pleuronectidae obtained in the Bay of Bengal in 1888 and 1889, with description of new and rare species," *Journ. As. Soc. Bengal*, vol. lviii, pt. ii, No. 3, 1889, pp. 279—295.

" "Descriptions of some new and rare species of fishes from the Bay of Bengal, obtained during the season of 1888-9," *Journ. As. Soc. Bengal*, vol. lviii, pt. ii, No. 3, 1889, pp. 296—305.

The trawl of the "Investigator" was very much smaller than that of the "Golden Crown" and consequently the larger species of Elasmobranchs would not be captured by it. Apart from these gigantic rays and saw-fish there is a marked similarity in the catches of the two vessels. The predominant feature of the bottom in the area trawled over by the "Golden Crown" was sand and, owing to circumstances which need not be specified here, her trawling was carried out on a much more limited area than that of the "Investigator," which worked in this neighbourhood in depths from shoal water up to 100 fathoms. The latter depth may be taken as the limit in a discussion of shallow-water forms. Consequently the faunistic lists of the "Investigator" (apart from records of large species) are much more complete than those of the "Golden Crown." Not only was the latter vessel compelled to trawl in waters where fish might be expected in quantities sufficiently large to make out a case for commercial fishing, but the net used was designed only to catch fish sufficiently large to be marketable. Invertebrates of any kind (except prawns) were regarded as undesirable débris.

No account, however cursory. of this area can be considered complete which omits reference to the shallow-water forms captured by the catamarans and the masula boats of Puri. From the latter vessels, which fish during the period of the N.E. monsoon, a large seine-net of semicircular "sweep" is used. The catching part of the net is of very small mesh so that forms which would pass through the cod-end (tail-end) of the "Golden Crown's" trawl would be enmeshed by this "bara jāl" of the native fishermen at Puri. Consequently forms like *Clupea kunzei*, which are occasionally captured in immense quantities on the shore, are absent or represented only by isolated individuals in trawl net hauls made further out. Hauls made by the seine-net on Puri beach in December 1908 consisted mainly of this species with a few other forms such as *Scomber microlepidotus*, *Upeneoides vittatus* and *Tetrodon lunaris*. *Elacate nigra*, *Cybium guttatum* and a few "skates" (*Myliobatis nieuhofii*) may also be regarded as typical.

The following list, though not to be regarded as complete, gives one an idea of the species most prevalent at Puri at this time of the year (December):—

Elasmobranchii.

Torpedo marmorata.	Myliobatis nieuhofii.
Trygon walga.	,, ,, var. cornifera.
,, ,, var. imbricata.	

Alcock, "A supplementary list of the Marine Fishes of India, with descriptions of two new genera and eight new species," *Journ. As. Soc. Beng.*, vol. lxv, pt. ii, No. 3, 1896, pp. 301—338.

(The above is not a complete list of Dr. Alcock's papers on Indian marine fish but refers only to those which contain descriptions of or reports on shallow-water species.)

Teleostei.

Clupea kunzei.
Chatoessus nasus.
Engraulis commersonianus (young only).
Saurida tumbil.
Arius jatius.
Arius nella.
Pristipoma maculatum.
Therapon theraps.
Upeneoides vittatus.
Sciaena (species not yet determined).
Sciaena carutta.
Caranx kurra.
,, melampygus.
,, atropus.
,, hippos.
Equula ruconius.
Equula lineolata.
,, insidiatrix.
Chorinemus lysan.
Lactarius delicatulus.
Seriola nigrofasciata.
Scomber microlepidotus.
Cybium guttatum.
Elacate nigra.
Sillago sihama.
Sphyraena obtusuta (also a species not yet identified).
Mugil jerdoni.
Synaptura commersoniana.
Plagusia bilineata.
,, marmorata.
Triacanthus brevirostris.
Tetrodon lunaris.

This list was considerably extended as a result of further observations in March (1909) when fishing, both with the seine-nets in the masula boats and with the drift-nets of the catamarans, was carried on. The pomfrets (both *Stromateus cinereus* and *S. niger*) were present in large numbers. On this occasion these fish were captured in the drift-nets as the weather was too rough for the masula boats. In this net there were also present *Cybium guttatum*, *Trygon gerrardi* and *T. imbricata*, *Chiloxyllium griseum*, *Dussumieria acutus* and species of *Minous* and *Trichiurus*.

The sea-snake *Distira robusta* was represented by a specimen 174·5 cms. (68 inches) in length. *Trygon alcockii*, a new species of sting-ray, was captured in a seine-net at Puri at this time.

The "Golden Crown" rarely trawled in muddy ground in this area, though occasionally in deeper water mud was met with; but this mud was invariably of a harder consistency than that in Area I. Off the Black Pagoda (Konarak) there is a reef composed of a recent conglomerate of sand and decomposed shells, and the trawl net was on one occasion lost on this reef. Off the Devi river turtles were unusually abundant, no less than six being taken in one haul of the trawl. The forms represented were *Thalassochelys caretta* and *Chelone imbricata*.

Invertebrates were not uncommon; of the edible species the "prawns" (Peneidae) predominated. The largest hauls made by the "Golden Crown" were made in this area and in Area IV. In September 1909 no less than 2¾ tons weight of prawns were caught in seven days fishing. Of other Crustacea probably *Calappa lophos* is the commonest.

Mollusca are more abundant than on the muddy grounds off the Sunderbuns. A spiny species of *Murex* (*M. tenuispina*), several species of *Chama* and *Dolium* are typical. *Astropecten* and

Squilla were typical representatives of the Echinoderms and Crustacea respectively. The typical fish of this area are the Sparoids, the "red flat" of the "Golden Crown" (*Pagrus spinifer*) and particularly large specimens of *Drepane punctata* being obtained. Shoals of *Scomber microlepidotus* were occasionally met with. The Carangidae, too, were unusually abundant in this area. Of other forms the red mullet (*Upeneoides guttatus*) and species of *Triacanthus* were noticeable. The latter was caught in large quantities off the entrance to Lake Chilka, and it is interesting to note that it is also caught right up on the landward side of the lake by the Ooriya fishermen near Balugaon.

It is interesting to compare Alcock's notes [1] on the shallow-water forms obtained by the "Investigator" in this region and Area IV with the "Golden Crown's" collections.

"..... Four months regular trawling off the Orissa Coast, or rather off the eastern coast of the peninsula between False Point on the north and Gopalpur on the south—a region nearly corresponding with the debouchment of the Máhánaddi delta.

"The physical features here are those of all Indian deltas where the land is making precarious advances on a shoaling muddy sea. Low-lying wastes of drifting sand alternate with still lower-lying estuarine swamps; the coast line presents the unbroken level of a recently formed alluvium, the bed of the sea is an almost imperceptible slope of fine sand and mud, and the more or less turbid waters are consequently so shallow that the twenty-fathom line is distant from five to thirteen miles from shore, while the hundred-fathom line ranges from fifteen to twenty-two miles, as was determined by the "Investigator" in her recent survey. Towards the south, the sea deepens and the bottom becomes sandy.

"The waters of this region swarm with crustaceans and fishes. Penaeidae, Paguridae, and numerous families of the Brachyura exist in the greatest abundance, while the surface waters are crowded with the lower crustacea and with crustacean larvae. The commonest fishes are *Sciaena*, *Kurtus*, *Polynemus*, *Equula*, *Arius*, *Pellona*; *Carcharias*, *Scyllium*, *Trygon*; and, among the Pleuronectids, *Pseudorhombus* and *Cynoglossus*."

If one compared the "Golden Crown" hauls (which were confined to a more limited area) with this, the two leading Pleuronectids would undoubtedly be *Cynoglossus* in the deeper and *Plagusia* in the shallower water. The three leading genera of Elasmobranchs would be *Trygon*, *Pteroplatea* and *Myliobatis*, and the half dozen most abundant Teleosts *Arius*, *Sciaena*, *Caranx*, *Scomber*, *Pagrus* and *Drepane*.

Area IV. The Northern Sircars Coast.

This area extends from the entrance of Lake Chilka to Santapilli (in the Madras Presidency). Trawling was carried on in

[1] "List of Pleuronectidae obtained in the Bay of Bengal in 1888 and 1889," *Journ. As. Soc. Beng.*, vol. lviii, pt. ii, No. 3, 1889, p. 280.

depths of 24 to 35 fathoms off the coasts of the districts of Ganjam and Vizagapatam, but principally off the former. The twenty-four to thirty-fathom grounds off Ganjam, Gopalpur, Sonapur, Baruva and Kalingapatam were thoroughly explored. These grounds were stocked with good edible fish, Percidae for the main part. The net was frequently torn and damaged in these waters owing to the presence of rock-like masses consisting of shells of *Siliquaria cochlearis* and *Spiroglyphus cummingi* interwoven with a Lithistid sponge.[1] One of these reefs was located when hauling off Gopalpur light which bore N.N.E. about 18 miles. The depth of water was 26 fathoms and the reef extended in a W.S.W. direction from that point. The solid nature of the ground in this neighbourhood furnishes a holding place for gigantic fan-like Antipatharia. Other typical forms of this area are *Solenocaulon*, *Rhipidogorgia* and *Eunicella*.

The fish of this area are quite distinct from those of the other three areas explored. Of the Trygonidae, for instance, *Trygon kuhlii* and *T. zugei* are the most characteristic, the latter apparently not being found further north. *Trygon microps*, the largest of the Indian sting-rays, was frequently taken here. On the 9th March 1909, about half-way between Rati beacon and Pundi one was captured which weighed over 400 lb. The bony fishes serve to differentiate this region from those further north, and whole families are met with here which are only represented by isolated individuals or are entirely absent in the other areas. The Centriscidae, for example, are represented by the curious shrimp-fish, *Amphisile scutata*, which was not obtained in Areas I or III, but was occasionally met with on the Arakan Coast.

The Percidae were far more abundant off the Ganjam district than elsewhere and in particular *Serranus pantherinus* and *S. latifasciatus* were typical. Two others that might be mentioned are *Lutjanus marginatus* and *Scolopsis vosmeri*. The Chaetodontidae were first recorded in the "Golden Crown's" hauls from this area, and in particular *Chaetodon vagabundus* var. *pictus*, *Heniochus macrolepidotus* and *Holacanthus xanthurus* were frequently present. These fish are of small size and bright coloration. They are typical coral-reef denizens.

Of the Sciaenidae, the genus *Umbrina* replaces the genus *Sciaena* of more northern waters. *Umbrina macroptera* was only recorded from this area. The Acanthuridae are also typical, the two leading forms being *Acanthurus punctatus* and *A. gahm*.

Two species of Muraenidae were captured here. Both belonged to the genus *Muraena*, the only species identified being *Muraena punctata*. Other families though not restricted to this area were far more common here than elsewhere. Amongst these may be mentioned the Berycidae with *Holocentrum rubrum* and *Myripristis murdjan*, the Sphyraenidae (Barracutas) with *Sphyraena jello* and

[1] For a detailed description *vide* Annandale, "Some sponges associated with gregarious molluscs of the family Vermetidae," *Rec. Ind. Mus.*, vol. vi, p. 47.

S. obtusata and the Balistinae with *Ballistes stellaris*, and *Ostracion turritus*.

The predominant Holothurian was *Colochirus violaceus*. The edible spiny lobster (*Panulirus polyphagus* and *P. homarus*), the crabs *Neptunus pelagicus*, *N. sanguinolentus* and *Charybdis cruci-fera* represented the Crustacea. Of the Molluscs species of *Arca*, *Chama*, *Fusus*, *Melina*, *Nassaria* and *Pleurotoma* may be regarded as typical.

In conclusion I have to thank Dr. N. Annandale, Mr. S. Kemp and Mr. B. L. Chaudhuri for much assistance in the identification of species mentioned in this paper.

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FISH.

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,, "Report on the fishes taken by the Bengal Fisheries Steamer 'Golden Crown.' Part I. Batoidei." *Mem. Ind. Mus.*, vol. ii, No. 1.
(Describes one new genus, five new species and a new variety—
Bengalichthys impennis, gen. et sp. nov.
Trygon favus.
,, *alcockii*.
,, *jenkinsii*.
Urogymnus laevior.
Narcine brunnea.
Myliobatis nieuhofii var. *cornifera* nov.)

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,, and J. T. Jenkins. "Report on the fishes taken by the Bengal Fisheries Steamer 'Golden Crown.' Part III. Plectognathi and Pediculati." *Ibid.*

Jenkins, J. T. "Report on the fishes taken by the Bengal Fisheries Steamer 'Golden Crown.' Part IV. Pleuronectidae." *Ibid.*

Chaudhuri, B. L. "Description of a new species of saw-fish captured off the Burma Coast." *Rec. Ind. Mus.*, vol. ii, p. 391 (*Pristis annandalei*).

,, "Description of two new species of *Caranx* from the Bay of Bengal." *Rec. Ind. Mus.*, vol. iii, p. 141 (*Caranx guptae* and *Caranx auricoronae*).

,, "A new species of *Triacanthus*." *Journ. As. Soc. Beng.* (N.S.), vol. vi, p. 497 (*Triacanthus weberi*).

Crustacea.

Annandale, N. "The rate of growth in *Conchoderma* and *Lepas*." *Rec. Ind. Mus.*, vol. iii, p. 295.

,, "An account of the Indian Cirripedia Pedunculata. Part I. Family Lepadidae (*sensu stricto*)." *Mem. Ind. Mus.*, vol. ii, No. 2.

(Describes as new, from "Golden Crown" collection—

Oxynaspis celata sub-sp. *indica*.
Dichelaspis grayii var. *pernuda*.)

Echinodermata.

Koehler, R., et Vaney, C. "Description d'Holothuries nouvelles appartenant au Musée Indien." *Rec. Ind. Mus.*, vol. v, p. 89.

,, *Les Astéries Littorales du Musée de Calcutta*. Calcutta, June 1910.

Mollusca.

Preston, H. B. "Descriptions of new shells in the collection of the Indian Museum from Burma, Siam and the Bay of Bengal." *Rec. Ind. Mus.*, vol. v, p. 33.

(Contains descriptions of two new species from the Bay: *Dolium varicosum* and *Avicula smithi*.)

,, "Descriptions of five new species of marine shells from the Bay of Bengal." *Rec. Ind. Mus.*, vol. v, p. 117.

(*Drillia ganjamensis*, *Nassa ariel*, *Pteronotus annandalei*, *Martesia delicatula* and *Pandora perangusta*.)

Coelenterata.

Annandale, N. "A pelagic sea-anemone without tentacles." *Rec. Ind. Mus.*, vol. iii, p. 157.

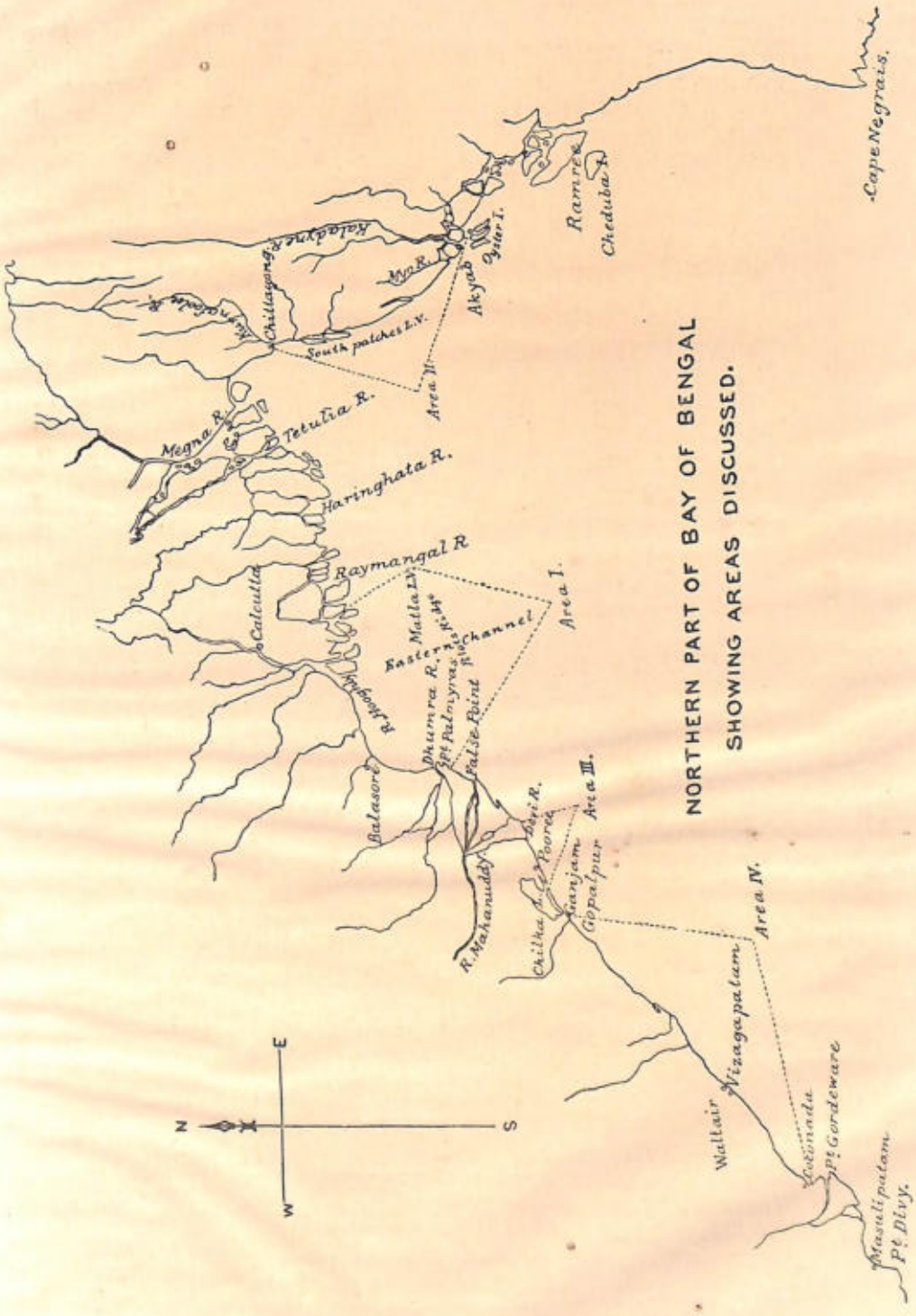
(Specimens of this new form *Anactinia pelagica* were taken on the "Golden Crown.")

Sponges.

Annandale, N. "Some sponges associated with gregarious molluscs of the family Vermetidae." *Rec. Ind. Mus.*, vol. vi, p. 47.

(Describes as new—

Racodiscula sceptrellifera var. *spiroglyphi*.
Racodiscula sceptrellifera var. *siliquariae*.)



A. C. Chowdhary, del.

V. NOTES ON THE COLLECTION OF COCCIDAE IN THE INDIAN MUSEUM (CALCUTTA).

I.—THE GENUS *MARGARODES*.

By E. E. Green, *F.E.S.*, *F.Z.S.*

(Plates ii, iii.)

Margarodes Guilding, *Trans. Linn. Soc. Lond.*, xvi, p. 115 (1828).
Porphyrophora Brandt, *Mediz. Zool.*, ii, p. 355 (1833).
Sphaeraspis Giard, *Compt. Rend. Soc. Biol.*, Paris (10), No. 25, p. 683 (1897).

The genus *Margarodes*, originally erected to contain the single species *formicarum* and, for a long time, restricted to that species, is now justly considered to include *Porphyrophora* of Brandt. *Sphaeraspis* was suggested, by Giard, as a subgeneric name to contain the species *vitium* and *capensis*, but there seems no good reason to separate these from the other typical species.

At the present date eleven reputed species are recognized, of which the recorded distribution is as follows:—

Europe:—*gallica*, *polonicus*, *perrisii* and *mediterraneus*.
Turkey in Asia (Armenia):—*hamelii*.
Africa:—*capensis*, *trimeni*.
United States and West Indian Islands:—*formicarum*, *rileyi*, *hiemalis*.
Chili:—*vitium*.

Dr. Giard, in a manuscript note to a paper on the geographical distribution of *Margarodes*, mentions the receipt of a species (allied to *formicarum*, *trimeni*, etc.) from Madagascar. In the same paper he states, on the authority of Trimen, that there are certain indications of the existence of the genus *Margarodes* in Australia.

In addition to the above localities, Mrs. Fernald—in her Catalogue—attributes *capensis*, *rileyi* and *hamelii* to Europe, *polonicus* to Central America, and *formicarum* to the East Indies; but I can find no authority for these records, and am inclined to believe that they have been inserted in error, or owing to faulty identification. The species *capensis* is certainly confined to South Africa: *rileyi* is similarly peculiar to Central America, unless—as suggested by Giard—it is identical with *hiemalis* of Cockerell. I am uncertain about *polonicus*, but it seems extremely doubtful that it should occur in such widely separated countries as Europe and Mexico. It is equally doubtful if *formicarum* (or any other species of *Margarodes*) has ever been found in the East Indies.

This being so, there has hitherto (with the exception of my short note in the *Journal of the Bombay Natural History Society*, vol. xix, No. 3, p. 761) been no satisfactory record of a *Margarodes* from the Indian Region. The insect presently described under the name of *M. indicus* at least supplies the first indubitable record from India proper.

Before proceeding to describe the Indian representative of *Margarodes*, a brief account of the life history and development of the remarkable insects of this genus will be necessary.

According to Giard, who observed the process in living examples, the eggs are deposited underground, in a mass of waxy filaments secreted by the adult female. From these emerge larvae of a more or less typical form. They are normally hexapod, but Silvestri has described a species (*mediterraneus*) in which the larvae have a single (anterior) pair of legs. The larval antenna appears to be normally 6-jointed, but the abnormal larva of *mediterraneus* exhibits only three antennal joints. The larvae, according to Mayet, attach themselves to the roots of plants and increase in size. Whilst growing (again according to Mayet) they secrete the envelope of the cyst that subsequently encloses the nymph.

It is this second (encysted) form that has attracted the attention of many observers by the wonderful pearly lustre which has gained for the insects the popular name of "Ground Pearls"—as suggested in the generic name *Margarodes*. These pearl-like cysts are found in the soil and were originally supposed to be associated with ants (hence the name of the type species—*formicarum*), but this observation requires corroboration. There is, however, nothing improbable in such an association, very many Coccidae being attended by ants for the sake of their sugary excretions. Giard has determined a species of *Brachymyrmex* as attending *M. vitium*, in Chili. The cysts may occur in enormous numbers. Riley (*Insect Life*, vol. iv, p. 359) states that, in certain parts of Florida, they compose over half the soil. Long before the nature of the organism was recognized, the cysts were used for ornamental purposes, being strung into necklaces and manufactured into various fancy articles. The cysts, when fully developed (see pl. ii, fig. 8, and pl. iii, figs. 9, 16, 17, and 18), are of irregular form, and are composed of overlapping closely applied laminate brittle scales which give to the object somewhat the appearance of a miniature fir-cone or of the fruits of certain palms. They vary in colour from pale yellow to deep bronzy brown, these differences being apparently due to age rather than to species. The lustre also varies with age, and is brightest in individuals that have lost some of the superficial laminae. Any determination of species based solely upon the character of the cysts must be extremely unreliable.

The nymphal insect contained in these cysts may well have perplexed the earlier entomologists. It consists of a globular sac, without any superficial indications of structural characters. It shows neither eyes, limbs, nor any of the usual organs. By very

careful microscopical examination, minute rudiments of antennae may be distinguished, but of buccal apparatus there is practically no sign, though Giard asserts that it exists and is functional. He remarks:—"The suctorial filaments are completely retractile in the active larva, as also in the nymph. Consequently, the very small mouth is easily overlooked, especially in *M. vitium* where the buccal plates are completely rudimentary and where nothing in the general form of the insect reveals the position of the opening. The sucking tubes are shed at each moult, but the animal never becomes really astomatous until the last transformation." The mouth-parts are, however, so very much reduced, that it is difficult to believe that much nourishment can be taken in by the usual means during this stage. Mayet suggests that the insects may absorb liquid food (? by osmosis) through the skin.

Coccidae are peculiar amongst the natural order Rhynchota, in that the males normally undergo a complete metamorphosis, passing through an active larval and a passive pupal stage before appearing in the adult winged form. But, with the exception of *Margarodes* and its allies (included in the subfamily Margarodinae), the female Coccid, though undergoing certain changes of form, continues to feed and grow throughout its development. In the case of *Margarodes*, after remaining for a considerable period (possibly extending over years, in adverse conditions) in this resting stage, the female eventually breaks through the cyst and reappears as a normal hexapod insect (see fig. 15). The anterior limbs are specially adapted for digging. Their femora are greatly thickened: the tibia and tarsus are fused together for greater strength, and terminate in a stout horny claw (figs. 19 to 22). The antennae of the adult female are comparatively short and stout, gradually tapering to the extremity, of from 7 to 9 joints.

All observers agree that the adult female has no trace of a rostrum or buccal apparatus of any kind. It would appear, therefore, that the insect must take in a sufficient store of nutriment during the larval stage (which is probably prolonged for some time after the formation of the cyst) to sustain it during the succeeding nymphal and imaginal stages. We find a similar condition in certain Lepidoptera in which the adult insects take no food.

The early development of the male insect has apparently never been observed. Whether the male larva proceeds to secrete a cyst similar to that of the female, or whether it constructs a specialized puparium, is not known. The males are scarce, in collections, and have usually been captured on the wing, or running on the ground. If it were not for the characteristic front legs, there would be little reason to connect these males with the female *Margarodes*. Fortunately this connection has been actually established. Prof. Cockerell (*The American Naturalist*, vol. xxxiii, No. 389, p. 415) describes the discovery of "a couple of small winged insects, hurrying to and fro (on the ground) as if they had lost something.... Presently, one of them began to dig into

the earth, and in a moment completely buried itself, leaving only the tips of its long abdominal filaments visible." Prof. Cockerell dug it out and discovered the object of its search, which proved to be an adult female *Margarodes*. The appearance of a male *Margarodes* may be gathered from fig. 1, and from the subsequent description of *M. indicus*.

In my study of this interesting genus I have unfortunately not had access to the earlier authors: but Signoret, in his classical *Essai sur les Cochenilles*, has given a useful resumé of the previous work on the subject. I append a list of the publications that I have been able to consult.

1. Signoret, V. .. *Essai sur les Cochenilles* (1868—76).
2. Riley, C. V. .. "*Margarodes* in the United States," *Insect Life*, vol. vii, p. 359 (1895).
3. Mayet, V. .. "La Cochenille des Vignes du Chili (*Margarodes vitium*)," *Rev Viticult.* (1895).
4. Silvestri, F. .. "Descrizione di una nuova Specie di *Margarodes*," *Bul. Soc. Ent. Ital.*, xxxviii, p. 140 (1906).
5. Giard, A. .. "Sur les Transformations de *Margarodes vitium*," *Compt. Rend. Soc. Biol.*, Paris (May 1894).
6. ,, .. "Troisième Note sur le Genre *Margarodes*," *Compt. Rend. Soc. Biol.*, Paris (Nov. 1894).
7. ,, .. "Quatrième Note sur le Genre *Margarodes*," *Compt. Rend. Soc. Biol.*, Paris (May 1895).
8. ,, .. "Sur le Distribution geographique des Cochenilles du Genre *Margarodes* et sur deux Especes nouvelles de ce Genre," *Compt. Rend. Soc. Biol.*, Paris (July 1897).
9. Cockerell, T. D. A. .. "On the Habits and Structure of the Coccid Genus *Margarodes*," *American Naturalist*, vol. xxxiii, No. 389 (May 1899).

Amongst a collection of Coccidae submitted to me by the Superintendent of the Indian Museum, I found three examples of a male Coccid that I at once recognized as belonging to this genus. The remarkable fossorial front limbs and the presence of long tufts of silky filaments on the abdomen permitted of no doubt as to the systematic position of the insect. Subsequently, several small parcels of empty nymphal cysts of a *Margarodes*, collected at various Indian localities, were received from the same source. From one of these cysts I extracted a fragmentary and decayed example of the adult female insect.

In the absence of complete examples of the adult females, it is impossible to say with certainty that the cysts are all of the same species, or that they are specifically connected with the males first examined. The probabilities, however, are in favour of their being so. With one exception (a single large nodular example, fig. 14), the cysts—though varying in size and form—are all of a similar structure.

From such meagre material it may, perhaps, be considered imprudent to describe the insect as a new species: but as it is equally impossible to assign it with certainty to any of the known species, and in consideration of its geographical position, I have ventured to do so,—principally in the hope that the publication may attract attention to the existence of the genus in India, and so lead to fresh discoveries and a better knowledge of the habits of this interesting insect.

Margarodes indicus, sp. nov.

Adult ♂ (pl. ii, figs. 1 to 7): described and figured from dried (pinned) examples, partially restored by boiling in caustic potash.

Colour dark brown. Details of body segments not absolutely determined.

Antenna with 13 subequal joints: 1st shortest, cylindrical, remainder obconical to oval, 3rd joint largest: all the joints (except 1st) with fine hairs, not arranged in whorls. The antennae spring from two broad plates which might, perhaps, be considered as basal joints, in which case the number of antennal joints would be taken as 14.

The normal number of antennal joints in male Coccidae, of all subfamilies and genera, is 10. A few abnormal species (usually apterous forms) have a less number, but in no other genus than *Margarodes* has a greater number than 10 been observed. In fact, this is the first indubitable record of a greater number. Signoret, in attributing 13 antennal joints to the male of *Margarodes* (*Porphyrophora*) *hamelii*, on the authority of Brandt, expresses a doubt as to the correctness of the observation. In the light, however, of this Indian species, it is quite probable that Brandt has given the correct number for his species.

Head almost entirely occupied by the large compound eyes, which meet below and are separated by a narrow channel above (fig. 2). A single ocellus, rather larger than one of the facets of the compound eye, can be distinguished on each side, impinging upon the margin of the compound eye.

Wings large and ample: semi-hyaline, very slightly fuscescent. Venation obscure, but apparently more complex than in other Coccids. Costal area (from base to two-thirds of length) semi-opaque, brownish red; apparently enclosed by a distinct nervure which throws off a short branch from near its base, towards the costa. There appear to be four other nervures (see

fig. 1), but they are ill-defined and colourless and are demarked chiefly by ridges of the wing membrane.

Halteres narrow, each terminating in a single hooked bristle (fig. 6).

Legs stout, the femora very broad. Anterior limb (fig. 4) evidently fossorial: the tibia and tarsus short and stout, the strong claw firmly fused to the tarsus without any definite line of demarcation: tibia, tarsus and claw of approximately equal length. In the other limbs (fig. 5), the tibia and tarsus are normal and the claw articulated to the latter: tibia more than twice length of tarsus: a minute ungual digitule on claw of mid and hind legs, none on claw of front leg.

Abdomen broad, with a strong fold on each side: 7th and 8th abdominal segments dorsally prominent, each with a dorsal tuft of long glassy filaments (equal in length to the whole body of the insect) which are directed upwards and backwards, arising from transverse bands of crowded polygonal cells (fig. 7): terminal segment shovel-shaped, the intromittent organ slender, forming a backward loop within the body before passing through the genital sheath (fig. 3).

Length 2·75 to 3·25 mm. Expanse of wings approximately 8 mm.

Locality: Jahada, Nepal, India, 14-ii-1908. Coll. Indian Museum.

When boiled in potash, the insect gave out a bright crimson stain.

Adult ♀. A fragmentary example of an adult female was extracted from one of the cysts from Bangalore (sample 2), described below. Judging from the dried remnants, the insect was probably yellow in life. Owing to the decayed and imperfect condition of the specimen, few details of the body can be made out; but there are many large and stout hairs (almost spines), both on the dorsum and venter, and numerous bluntly pointed conical spines (fig. 23) on the marginal area. Fortunately one of the anterior limbs remains intact. This leg (fig. 19) is of the typical fossorial form: the femur very broad and robust, with a few longish stout hairs on its inner area: the tibia small and triangular, with two long stout hairs on its inner margin: the tarsus and claw closely fused together, curved, tapering to a sharp point, with two stout lateral hairs near the base, and three or four stout curved hairs on the inner margin corresponding to the ungual digitules.

In the development and position of the hairs on this limb, *M. indicus* approaches *M. formicarum* (fig. 20), rather than the two African species (figs. 21 and 22): but differs in the greater number and size of the ungual hairs. It will be observed that it is very much smaller than the corresponding limb of the other species with which I have been able to compare it (*vide* figs. 19 to 22, all enlarged by 50 diameters). But the whole insect is proportionately small. The imperfect condition of my example

prevents an accurate determination of its dimensions, but I estimate that its total length cannot have been more than 2 mm., while *M. capensis* measures approximately 6 mm. in length, and *M. trimeni* 4·5 mm.: the length of *M. formicarum* is given, by Signoret, as 5 mm. Size, however, appears to be an unreliable character. Giard, in his "Third note on the genus *Margarodes*," remarks: "According to the conditions of nutrition in which the nymph finds itself, the latter is able to transform itself into an adult female of very different sizes. Certain adult females of *M. vitium* are no more than 2 mm., while others attain a length of 5 or even 8 mm. As a result one often finds adult females smaller than some of the larvae."

The Indian Museum collection contains several small gatherings of empty nymphal cysts of *Margarodes* which, in the absence of evidence to the contrary, may be considered to belong to this same species. They are described separately, according to the circumstances of their collection.

(*a*) A small tube containing 4 cysts (immature examples). Label:—6804/16, Bangalore, S. India, ca. 3000 ft., 12-x-1910. "Among weeds in Service Tank, Bangalore. N. Annandale."

These examples vary in size from 1 to 1·75 mm. (long. diam.). They are irregularly ovoid: of a bright golden yellow colour to rich golden castaneous, with iridescent lustre. Shell thin: one with traces of overlapping scales on one side, the others without scales.

(*b*) A tube containing about 45 cysts. Without a label, but believed to be part of the gathering from Service Tank, Bangalore.

Size ranging from 0·75 to 2 mm. Colour varying from very pale yellow to dark castaneous brown: intermediate forms with bright iridescent lustre. Many of the smaller and all the larger cysts with well-developed overlapping scales (fig. 9). The largest cyst (fig. 8) with the scales overlapping in opposite directions from the two extremities, possibly a composite cyst. Most (especially the smaller) have a short conical process on the lower surface, which probably marks the point of attachment to the root of some plant (fig. 10).

(*c*) A small tube containing more or less fragmentary cysts Label:—4319/4. "Madras, Editor of *Asian*."

Length of largest example 2·5 mm. Form elongate oval: with large overlapping scales (fig. 11). Colour golden bronzy yellow, with iridescent lustre.

(*d*) Small bottle containing numerous decomposed cysts filled with earthy matter.

Label:—"Pearl-like globules. Received 12-xi-1891 through Dir. L.R. & A., Bombay, from the Collector

of Khandesh. They were found in the ground and are thought to be of similar origin to the 'Ground Pearls' of the West Indies." These examples are very old and decomposed and consict mostly of an earthy core slightly overlaid with nacreous matter. Average diameter 3 mm. Surface nacreous, whitish, opaque, rather furfuraceous (from decay), with slight lustre, covered with an intricate network of fine cracks: inner surface more distinctly lustrous. A few examples with traces of one or two large overlapping scales (fig. 12): others smooth (fig. 13). The loss of colour is evidently due to exposure and decay, and the opacity to the presence of air between the laminae.

(*e*) Pill-box, containing 15 cysts (and some small seeds and shells of small molluscs).

Label:—4146/16. "Surface of flood-water, edge of the River Hoogley, at Tribeni (near Calcutta), 31-vii-1909." Size varying from 1 to 5 mm. There are a few only of the smaller size, the greater number ranging from 2 to 2·5 mm. Colour of average examples pale yellow to bright golden yellow, iridescent. Form and character of overlapping scales similar to the specimens described under (*b*).

A single large example of exceptional form (fig. 14). Size 5 mm.: colour dull castaneous, without lustre: of very irregular form, nodular, overlapping scales almost completely obscured. This example may be of compound origin, and is possibly of a distinct species.

Any attempt to differentiate the species by the form, size, colour or structure of the nymphal cysts is unsatisfactory. All these characters are inconstant and vary indefinitely in a single parcel. Such differences probably depend very largely upon the age and development of the individual. *M. mediterraneus* appears to be exceptional in being devoid of overlapping scales throughout its development. In *M. rileyi* (fig. 18) the scales are larger and somewhat looser than in *trimeni* (figs. 16, 17) and the West Indian forms. The Indian examples that I have seen are, on the average, considerably smaller than those from the African and American regions; but it would be possible to match individuals from India with particular examples of *formicarum*, *trimeni* or *rileyi*, in size, colour and structure.

The characters of the adult females, where known, are more reliable. There are slight differences in the pelage and other dermal characters, and in the size and proportions of the limbs. The enlarged front legs, in particular, afford useful characters. Thus, in *capensis* (fig. 21), the tibio-tarsus and claw are proportionately shorter and more robust than in *trimeni* (fig. 22). In the

few examples that I have had under observation I notice a marked difference in the pelage of the anterior femora. In *formicarum* (fig. 20) there are many long stout hairs on the inner area of this joint: in *trimeni* (fig. 22) there are a few short stout hairs: in *capensis* (fig. 21) these hairs are more numerous but very short and fine: while in *indicus* (fig. 19) there are five or six stout longish hairs. It is possible, however, that the greater development of the hairs, as shown in the figures of the anterior limb of *formicarum* and *indicus*, may be partly due to the fact that my examples of these species were extracted from unopened cysts, while those of *capensis* and *trimeni* had emerged naturally. It is conceivable that the hairs may be quickly worn down, in life, owing to the fossorial habits of the insects.

The formation of the overlapping scales in the nymphal cysts is difficult to understand. Fissures, resulting from internal pressure, followed by the exudation of fresh liquid secretion from inside (as has been suggested by some authors) could not possibly result in this structure Mayet explains the process as follows:— "All the time that they are growing, the larvae secrete the envelope of the cyst which, formed of juxtaposed lamellae, enables them to develop by the sliding of these lamellae one over the other." But against this explanation is the fact that the smaller and presumably younger cysts are composed of a homogeneous envelope, devoid of overlapping scales which appear only at a later period. Having only dead and dried cysts at my disposal, I am unable to suggest any alternative explanation. The solution of the mystery can be resolved only by a close study of living examples, from the earliest stage of development.

It is greatly to be desired that *Margarodes indicus* should be traced to its actual habitat. The true origin of the examples that have hitherto been collected in India is obscure. One parcel was collected on flood-water and these examples may have been transported for many miles before coming to rest. Another gathering was made in the Service Tank, Bangalore, and had probably been carried there by the action of water. The most definite information is in connection with the sample "from the Collector of Khandesh." These are said to have been "found in the ground." But the examples show unmistakable evidence of exposure and decay. Nothing is known of the plant or plants upon the roots of which it lives. The subterranean habit of the insect makes its discovery more or less of an accident. The adult winged males are the most likely to be observed. The other stages of the insect should be searched for in the locality that gave birth to the males. Possibly the male insects themselves (as in the instance described by Prof. Cockerell) may afford a clue to the exact position of the females.

SUPPLEMENTARY NOTE.

Since the foregoing remarks on the genus *Margarodes* have been in the press, additional material has been received from Mr. L. C. Coleman, Entomologist to the Government of Mysore.

This material consists of two very distinct species, both of which appear to differ widely from typical *M. indicus* and cannot be identified with any previously known species. One of them may possibly represent fresh examples of the form (*d*) received from Bombay. The other (represented by nymphal cysts only) is totally unlike any recorded species of the genus.

Though the material to hand is not complete enough to permit of a full description, the characters are sufficiently distinct for a preliminary definition of the species.

Margarodes papillosus, sp. nov.

Nymphal cyst globular, smooth; the nacreous covering brittle, very thin, transparent and colourless, revealing the reddish yellow body of the enclosed nymph. Diameter 2 to 2·5 mm. Cuticle of nymph closely crowded with minute translucent dermal cells (text-fig. 1): when the tissue is torn, the fracture follows the contour of the cells. Rostrum distinct, but doubtfully functional. A minute tubercle bearing a single stout seta, on each side of the rostrum, probably represents rudimentary antennae. The four principal spiracles are situated on the venter of the thorax, far from the margin, and there is a supplementary series of smaller spiracles situated submarginally on each side of the abdomen.

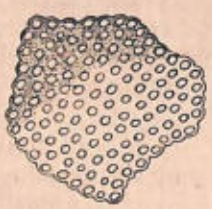


Fig. 1.—*M. papillosus*. Fragment of derm of nymph, × 450.

One of the cysts contained a female imago, almost ready to emerge; but the limbs are not fully chitinized and are consequently unsuitable for accurate comparison with other species. Body broadly ovoid; strongly convex; lateral margins of abdominal segments slightly prominent. Antennae 7-jointed; broad at base,

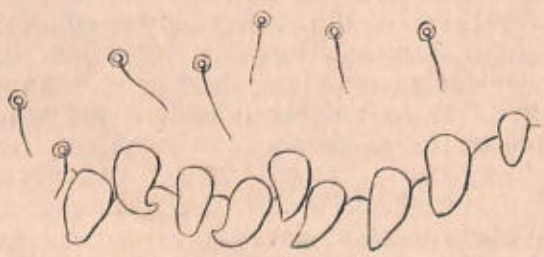


Fig. 2.—*M. papillosus*. Part of one of the median groups of papillae, adult female, × 450.

tapering gradually to extremity, terminal joint subglobular: a few spiny hairs at apex of 7th and on anterior margins of 3rd to 6th joints. Front legs very stout and dense: tibio-tarsus terminating in a long curved claw. Intermediate and hind limbs smaller and more slender. Thoracic spiracles large and conspicuous, situated close to the coxae of the anterior and intermediate legs. Dorsum of abdomen with eight transverse series of bluntly pointed papillae which are disposed in three groups—one median and two lateral—on each segment. The median groups each consist of a single row of papillae (text-fig. 2): those of the lateral groups are crowded and spring from polygonal cells (text-fig. 3) which are less noticeable

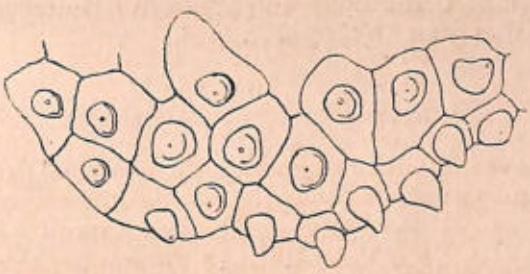


Fig. 3.—*M. papillosus.* Part of one of the lateral groups of papillae, adult female, × 450.

in connection with the median groups. There are a few small hairs immediately anterior to each of the median groups of papillae, and a few ill-defined translucent areoles are scattered irregularly over the body. The submarginal area, on each side of the thorax, is roughened by minute prominent rounded dermal cells. Length 3 mm., breadth 2·25 mm.

Described from 3 nymphs and 1 female imago. Found "near egg-cocoons of Acridiid grasshoppers;" Bellary District, Madras, Others reported to have been found under rose trees; Bangalore, Mysore. The association with eggs of grasshoppers is probably accidental.

The nymphal cysts of this species resemble those of *M. mediterraneus*, Silvestri, from which species they differ by the coarser punctuation and the presence of conspicuous translucent dermal cells. The adult female is sufficiently characterized by the dorsal groups of papillae.

Margarodes niger, sp. nov.

Nymphal cyst practically naked, the usual nacreous envelope being represented only by a few whitish fragments closely adherent to the dense chitinous derm of the encysted nymph. Form globular: diameter 7·25 mm. Colour opaque dull black. The surface appears smooth to the naked eye, but under magnification is found to be minutely and regularly pustulate, the pustules of equal size and contiguous. The cyst contains a white creamy

liquid, permeated by numerous tracheae. Rostrum internal, the tentorium strongly chitinized. After boiling in caustic potash, the black derm becomes partially decolorized and separates into two layers. The outer layer swells and becomes rugulose but still retains its pustular structure. The inner layer is minutely granular.

Mr. Coleman informs me that he dissected fresh cysts of this form, and disclosed an insect with fossorial front limbs similar in every respect to those of *Margarodes*. Unfortunately these specimens were not preserved.

Described from 2 nymphal cysts. Found in soil, associated with egg-cocoons of grasshoppers; Bellary District, Madras.

The globular black cysts might easily be mistaken for the seeds of "Indian Shot" (*Canna indica*).

EXPLANATION OF PLATE II.

FIG. 1.—*Margarodes indicus*, adult male, × 16.

,, 2.— ,, ,, ,, head, front view, × 30.

,, 3.— ,, ,, ,, abdomen, from below, × 50.

,, 4.— ,, ,, ,, anterior leg, × 50.

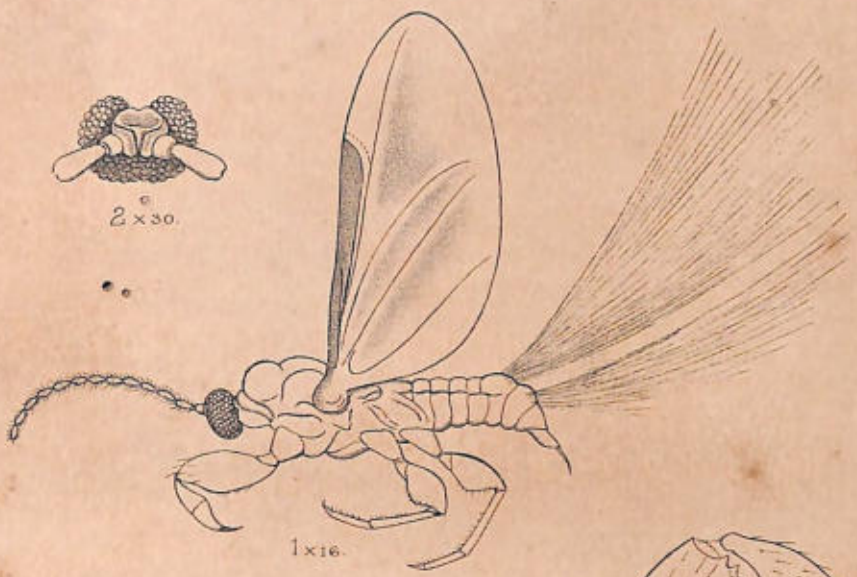
,, 5.— ,, ,, ,, posterior leg, × 50.

,, 6.— ,, ,, ,, one of the halteres, × 50.

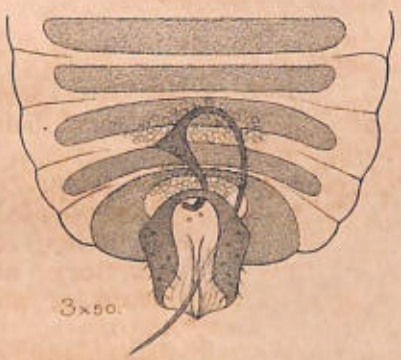
,, 7.— ,, ,, ,, part of secretory area, from dorsum of abdomen, × 250.

,, 8.— ,, ,, nymphal cyst (Bangalore), × 20.

2×30.



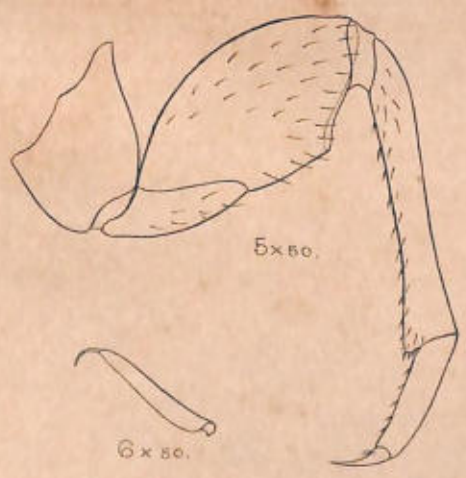
1×16.



3×50.

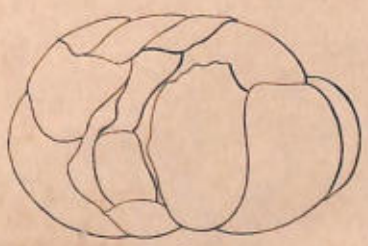
4×50.

7×250.



5×50.

6×50.



8×20.

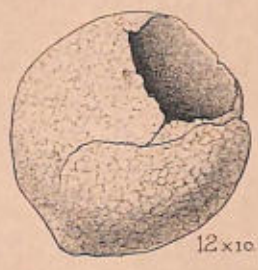
E. E. Green, del. A. C. Chowdhary, lith.

EXPLANATION OF PLATE III.

FIG. 9, 10.—*Margarodes indicus*, nymphal cysts (Bangalore), × 20.
,, 11.— ,, ,, ,, ,, (Madras), × 14.
,, 12, 13.— ,, ,, ,, ,, (Khandesh), × 10.
,, 14.— ,, ,, ,, ,, (Calcutta), × 7.
,, 15.—*Margarodes trimeni*, adult female, side view, × 12.
,, 16, 17.— ,, ,, nymphal cysts, × 7.
,, 18.—*Margarodes rileyi*, ,, ,, × 10.
,, 19.—*Margarodes indicus*, anterior limb, × 50.
,, 20.—*Margarodes formicarum*, ,, ,, × 50.
,, 21.—*Margarodes capensis*, ,, ,, × 50.
,, 22.—*Margarodes trimeni*, ,, ,, × 50.
,, 23.—*Margarodes indicus*, dermal spines of adult female, × 450.

9×20.

11×14.



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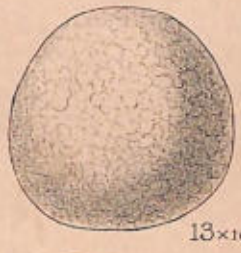

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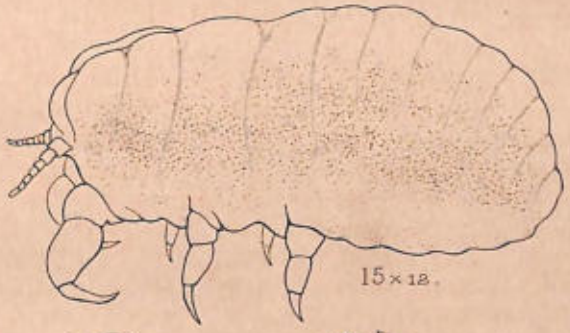

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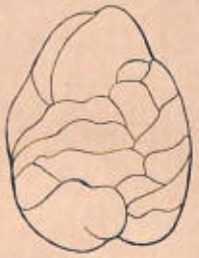

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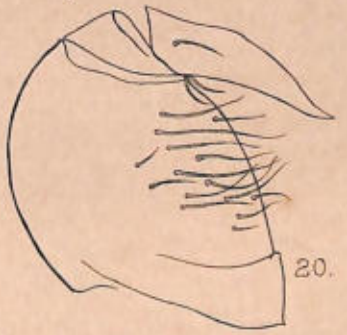

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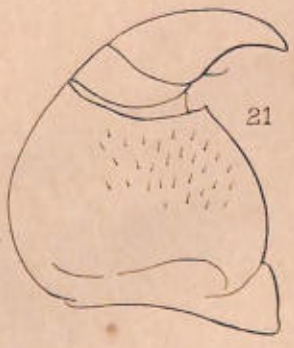

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E. E. Green, del.

A. C. Chowdhary, lith.

VI. ON THE NERVOUS SYSTEM OF *AMPULLARIA GLOBOSA*.

By EKENDRANATH GHOSH, *Assistant Professor of Biology, Medical College, Calcutta.*

The present animal is a common pond-snail of Bengal, and can be procured in any number from the ponds in the suburbs of Calcutta. Having access to an ample supply of specimens, I availed myself of the opportunity of studying the nervous system by dissecting a large number of them.

The comparative anatomy of the genus *Ampullaria* was studied by Prof. E. L. Bouvier, who published an excellent monograph [1] on the subject in connection with other Prosobranchiate Molluscs in 1887. He described the nervous system and general morphology of *Ampullaria carinata*, which differs from the present species in several interesting points. In 1910, Capt. R. E. Lloyd described the anatomical features of the present species in his *Introduction to biology for students in India* [2]. The book, being meant for the junior students of biology, dealt with the matter in a concise form, and did not enter into any detail. The present article is meant to describe the subject in some detail.

General.—The cerebral ganglia are widely separated by a ribbon-shaped inter-cerebral commissure. The cerebro-pleural and cerebro-pedal commissures are long, while the pleuro-pedal commissure is practically absent, the ganglia being closely apposed to, although distinct from, each other; this constitutes a "hypoathroid condition." The supra-intestinal nerve passes from the right pleural over the oesophagus to the supra-intestinal ganglion also connected to the pleural ganglion of the left side by a secondary commissure forming a zygoneurous type [2]. The infra-intestinal nerve passes from the left pleural ganglion to the infra-intestinal, being connected to the pleural ganglion of the other side on its way to the latter. The pedal ganglia are connected to each other by an inter-pedal commissure.

Each cerebral ganglion gives off a fine nerve connected to the buccal ganglion of the same side through the intervention of a small nerve from the latter.

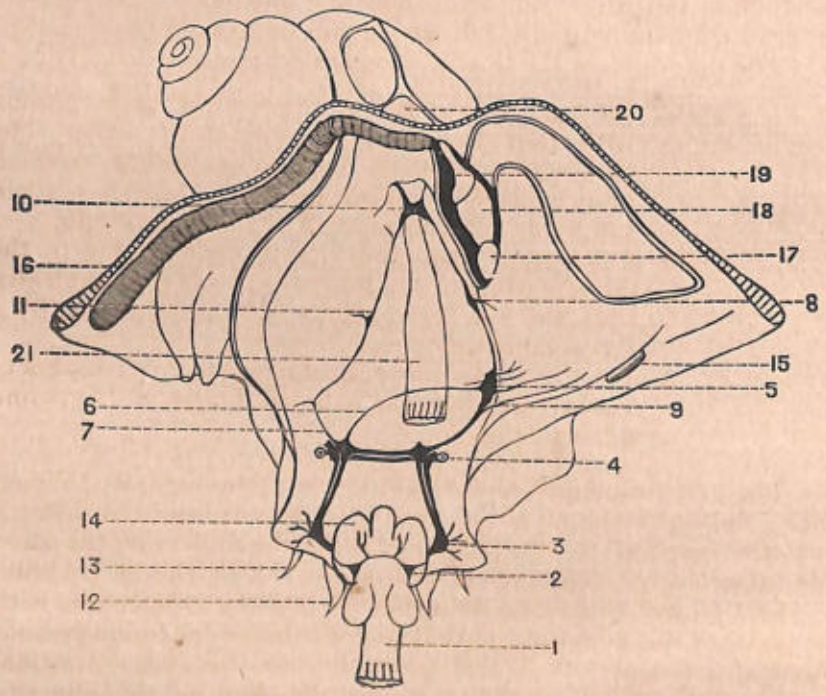
Cerebral ganglion.—Each ganglion is triangular in shape and is situated on the sides of the buccal bulb on its dorsal aspect. From the antero-superior angle of the ganglion is given off the flattened ribbon-like inter-cerebral commissure to the ganglion of the opposite side. The connective lies at the anterior end of the buccal bulb and on its dorsal surface. From the postero-inferior

angle of the cerebral ganglion and from the point below it are given off the large flattened cerebro-pleural and cerebro-pedal commissures.

The nerves from the cerebral ganglia are :—

(1) A nerve to the labial palp of the side. It divides into two branches.

(2) A nerve to the tentacle. It gives off a small branch near its origin to the integument on the outer side of the tentacle.



Dissection of *Ampullaria globosa* :

1, oesophagus reflected forwards ; 2, buccal ganglion (left) ; 3, cerebral ganglion (left) ; 4, pedal ganglion (left) with otocyst ; 5, supra-intestinal ganglion ; 6, supra-intestinal nerve ; 7, infra-intestinal nerve ; 8, accessory supra-intestinal ganglion ; 9, pallial nerve (left) ; 10, visceral ganglion ; 11, infra-intestinal ganglion ; 12, labial palp ; 13, tentacle ; 14, buccal bulb ; 15, osphradium ; 16, gill ; 17, ampulla of the heart ; 18, ventricle ; 19, auricle ; 20, kidney ; 21, crop.

(3) A nerve to the eye. It supplies a branch from its outer side to the integument of the head.

(4) A nerve to the buccal ganglion through the intervention of a nerve from the latter ganglion.

(5) A nerve to the side of the buccal bulb towards the ventral aspect.

(6) A nerve from the posterior part of the ganglion near the cerebro-pedal connective to the body wall at the back part of the head.

(7) Several small nerves from the inner aspect of the lower border of the cerebral ganglion. Some of these supply the small muscular strands from the integument to the buccal bulb, while others end in the ventral wall of the head.

Both the cerebral ganglia give off nerves having similar distribution.

Buccal ganglion.—Each ganglion is triangular in shape, and is placed at the junction of the oesophagus with the buccal bulb towards the ventral aspect. Each is connected to the cerebral ganglion of the same side by means of a fine nerve. It supplies nerves to the buccal bulb, salivary glands and the crop.

The nerves from the buccal ganglion are:—

(1) A fine nerve from the anterior angle anastomosing with that from the ganglion of the other side. It gives off, a little beyond its origin, a small branch which divides into two branches again supplying the ventral wall of the buccal bulb.

(2) A nerve from the outer angle running up to the dorsal surface of the buccal bulb; it communicates with the cerebral ganglion of the same side by a fine commissure.

(3) A nerve from the posterior angle which passes backwards to supply the salivary gland of the same side and the crop.

The cerebro-pleural and cerebro-pedal commissures are long, thick, flattened commissures passing downwards and backwards from the cerebral to the pleural and pedal ganglion of the same side respectively. They are placed on the side of the buccal bulb.

Left pleural ganglion.—It is placed in close connection with the pedal of the same side so that the pleuro-pedal commissure is practically absent. It is also connected to the supra-intestinal ganglion by a thick secondary connective, and to the opposite pleural ganglion by a portion of the infra-intestinal nerve which passes through the latter in its course to the infra-intestinal ganglion.

The nerves from the left pleural ganglion are:—

(1) The left pallial nerve which lies at first in the same sheath with the secondary connective between the left pleural and the supra-intestinal ganglion. It then leaves the latter and passes up to the ventral aspect of the mantle flap just behind the thick margin lying in a canal throughout its course. It supplies the mantle and the osphradium. The position of the nerve is marked by a translucent line on the dorsum of the foot.

(2) A small nerve to the left siphon flap.

(3) A number of small nerves behind and laterally to the surrounding structures (including the dorsal portion of the foot).

Left pedal ganglion.—This is closely connected with the left pleural ganglion. It is connected to the opposite ganglion by an inter-pedal commissure. The nerves from the ganglion are :—

(1) A short stout nerve to the otocyst.
(2) Several stout nerves to the foot.

Right pleural ganglion.—This ganglion is similar to that on the left side. It gives off :—

(1) A pallial nerve to the mantle and the penis and penial sheath in male.
(2) The supra-intestinal nerve is given off from the right pleural to the supra-intestinal ganglion.
(3) A nerve to the small right siphon flap.

Right pedal ganglion.—This is similar to the left one in all respects.

The secondary commissure from the left pleural to the supra-intestinal ganglion is a stout and short nerve which lies in a canal on the left side of the dorsum of the foot in the same sheath with the pallial nerve. The position of the nerve can be clearly distinguished by a translucent line on the integument over it.

Supra-intestinal ganglion.—This ganglion is a fusiform body lying in a small sinus of connective tissue on the left side. The cavity in which it lies is covered over by a thin translucent membrane so that the position of the ganglion can be easily pointed out through the integument. The ganglion receives the supra-intestinal nerve from the right pleural ganglion on its right side and is connected to the left pleural ganglion by a secondary connective. The left visceral nerve arises from its posterior end.

It gives off the following nerves :—

(1) An accessory pallial nerve. It arises from the left side of the ganglion and passes up to the mantle flap lying just in front of the posterior border of the thick rim, and parallel to the pallial nerve of the same side.
(2) Two small nerves from the left side of the ganglion passing to the mantle flap. The posterior divides into two branches at a little distance from its origin.
(3) A fine nerve from the right side to the dorsal integument of the foot.

The supra-intestinal commissure is a fine nerve passing from the left pleural over the anterior end of the crop to the supra-intestinal ganglion. The track of the nerve is sometimes represented by a translucent line on the integument over it.

The left visceral commissure is a stout nerve passing backwards along the left side of the dorsum of the foot to the visceral ganglion. Two small nerves are sometimes given off from it to the floor of the mantle chamber.

Accessory supra-intestinal ganglion.—This is a small fusiform swelling on the left visceral commissure. It is present in many specimens but not in all. When present the ganglion gives off two nerves, one from each side, to the integument on the dorsum of the foot and to the floor of the mantle chamber. These nerves are fairly constant, and are present even when the ganglionic swelling is not noticed.

The infra-intestinal commissure passes from the left pleural to the right pleural ganglion; it then leaves the latter and passes along the line of union of the integument on the dorsum of the foot on the right side, being bridged over by numerous fibrous strands throughout the posterior half of its course. The commissure often presents a ganglionic swelling, sometimes two, between the right pleural and the infra-intestinal ganglion.

Infra-intestinal ganglion.—This is a small ill-developed ganglion lying on the right side beneath the crop. It gives off a small nerve to the integument of the right side. The nerve passes outwards to the base of a long fringe-like ridge in the mantle-cavity on the right side. It then divides into two branches, which pass along the base of the ridge in front and behind.

Accessory infra-intestinal ganglion.—A small triangular body giving off a small nerve to the integument on the dorsum of the foot. It lies on the infra-intestinal commissure a little behind the infra-intestinal ganglion.

A still smaller ganglion is sometimes present on the infra-intestinal commissure behind the accessory ganglion.

The right visceral commissure is a fine nerve from the infra-intestinal ganglion to the visceral, lying on a thin membrane extending from the foot to the base of the visceral hump on the right.

The commissure sometimes presents a small fusiform swelling with two nerves from the right side. A small nerve is sometimes given off from the right side of the commissure just before it ends in the visceral ganglion.

Visceral or abdominal ganglion.—This is a triangular ganglion lying on the right side of the pericardium beneath the integument at the base of the visceral hump and behind the posterior end of the pulmonary aperture.

The nerves from the visceral ganglion are:—

(1) A small nerve to the heart.
(2) A stout nerve supplying branches to the stomach, intestine, liver, kidney and reproductive organs.

In conclusion it may be noted that the present species agrees with *Ampullaria carinata* in the general arrangement of the

commissures and of most of the ganglia. But in the present species there is a distinct infra-intestinal (sub-intestinal) ganglion constantly present. Moreover, the presence of one or more accessory infra-intestinal ganglia has been observed in a large number of specimens.

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1. Bouvier, E. L. "Système nerveux, morphologie générale et classification des Gastéropodes Prosobranches," *Ann. Sci. Nat.* (Zool.) (7), iii, 1887.
2. Lloyd, R. E. *An introduction to biology for students in India.*
3. Pelseneer, P. Article "Mollusca" in *Text-book of Zoology* edited by Sir E. R. Lankester.

VII. DESCRIPTION OF *APHIOCHAETA FERRUGINEA*, A HITHERTO UNDESCRIBED SPECIES OF PHORIDAE THAT CAUSES MYIASIS IN MAN.

By E. BRUNETTI.

In the autumn of 1907 I bred a number of specimens of a species of Phoridae from the body of a newly-dead lizard (*Calotes versicolor*, Daud.). This was not intentional, but as no spirit was handy to preserve the lizard, the bottle remained uncorked for a few days, but was closed up as soon as signs were perceived that young larvae were developing.

When the flies appeared, the majority were removed and pinned, and the bottle recorked, but a few were seen to remain, and from these a second generation was bred which emerged August 23—27, 1907. Some notes were kept at the time, but these have been mislaid.

Unfortunately no description of the species was published but a few specimens were sent out to various correspondents under the name of *Aphiochaeta ferruginea*, and it now appears that the species has been recognized to exist in many parts of the tropics outside the Orient.

Mr. F. M. Howlett figures it in Lefroy's "Indian Insect Life," and also Col. A. Alcock in his "Entomology for Medical Officers;" and from co-types sent by the Indian Museum to the British Museum, Mr. E. E. Austen has identified as this species, specimens in the National Collection from West Africa and Central America, in addition to those from Oriental localities. He also records it from Sierra Leone and British Honduras, so that it is apparently generally distributed throughout the whole tropical zone.

From the fact that it has been proved to attack man, infesting the intestines and even able to complete its life cycle as an internal human parasite, considerable interest has centred round it recently, and more than once enquiries have been made of me for the published description. As a matter of fact it has till now been merely a *nomen nudum*, but a belated full description is now provided.

In the Indian Museum are the remains of one or two examples which were sent to that Institution by Dr. Crombie, 5-xi-91, having been "reared from eggs passed with the excrement of a European in Rangoon, eggs, grubs and flies being all voided

together." They were sent to the late M. Bigot for identification, and he returned them as "? *Phora bicolor*, Sch." *P. bicolor*, Sch., renamed *meigeni*, Becher, by this latter author, is now referred to *Aphiochaeta*, and is a species with a reddish brown to blackish thorax and bare arista, and must be, I think, different from my species, although they are evidently closely allied. However, so far as can be ascertained from the remains of Dr. Crombie's specimens, it seems highly probable that they belong to *ferruginea*.

Aphiochaeta ferruginea, mihi.

♂ ♀. India, Ceylon. Long. 2¼—3 mm.

Head.—Brownish yellow, yellowish, often more or less tinged with grey, sometimes entirely greyish. Eyes black, microscopically pubescent, posterior orbit with a row of short black bristles; two strong macrochaetae below the lower angle of each eye, and a vertical row of short bristles on the cheeks. Antennae pale yellowish, varying to brownish yellow, arista long and microscopically pubescent. Palpi brownish yellow or yellowish, with several shorter bristles on outer side, a few hairs on inner side and five or six separated strong spines towards the tip. Frons generally concolorous but sometimes with brownish irregular marks in the middle on a yellowish ground colour, the vertical impressed line sometimes very distinct. The frons is furnished with four rows of four macrochaetae in each. The upper or vertical row are reclinate, equidistant, the outer ones at the upper angles of the eyes, the median pair on the inner side of the two upper ocelli, and slightly below the vertical margin. *Behind* the vertical margin is a bristle on each side, almost immediately contiguous to the outer bristle of the vertical row. These post-vertical bristles are convergent. The 2nd row is just below the lower ocellus, and consists of four equidistant bristles, the median pair fractionally but perceptibly higher on the frons than the outer ones. The bristles in this row are generally reclinate but sometimes are almost at right angles to the frons. The 3rd and 4th rows are so composed as to almost make a single semicircular row of eight. They probably, however, represent two rows of four each, those forming the 3rd row placed thus: the outer pair near the eyes as usual (and immediately under the outer ones of the 2nd row but rather more distant vertically from them than these latter are from the vertical or 1st row); the inner bristles rather closer than usual to the outer ones, leaving a wide space of the frons between the inner pair, which latter are much lower on the frons than the outer pair. Of this row, the outer ones are always reclinate, but the median ones are often more nearly horizontal.

The 4th row is placed wholly on the middle of the frons in a short semicircle, the two median ones the lowest, and the outer ones still proximad of the median pair of the 3rd row. Of this 4th row, the outer ones are more or less horizontal, the median pair always very distinctly proclinate.

In some specimens the outer pair of the 3rd row are rather further removed from the median pair, and in this case these latter alone may be considered as forming the 3rd row, and the median pair, with the outer two of my fourth row, as forming a row of four representing the 4th row. There would then be a pair of additional proclinate median bristles below this fourth row. The previous interpretation of their arrangement is apparently the truer one.

Thorax.—Generally bright ferrugineous or brownish yellow, varying in shades and with or without an admixture of grey: occasionally with two faint greyish dorsal lines. Some strong bristles of unequal length and number laterally from the shoulders (where there is always one strong humeral bristle) to the posterior corners, there being generally four towards the hinder border of the dorsum. Some stronger ones in front of the wings; three small ones close together near the fore coxae, a fan-shaped row of six or more small but distinct ones at the extreme base of the costa, and a similar row behind the base of the wing. Sides of thorax rather lighter; scutellum concolorous, with four strong bristles, the outer pair usually the larger.

The whole surface of the thoracic and scutellar dorsum is covered with minute stiff bristles.

Abdomen.—Dark ferrugineous or brownish yellow, practically bare and *very variable*. Normally brownish yellow, the posterior half (or thereabouts) of each segment black or blackish, but this colour sometimes occupies the greater part or whole of one or more segments; in some specimens a clearer space, more or less oval in shape, remains in the centre of the segments; or the abdomen may be wholly black or blackish, with or without pale edges to the segments, this character itself being present or absent irrespective of other coloration.

Sometimes the abdomen is black or dark reddish ferruginous with the centre part generally pale, forming a light wide irregular dorsal stripe. Belly generally brownish yellow or some kindred shade.

Genitalia in ♂ dark, not prominent, bluntly conical, with a few hairs; in ♀ the ovipositor is subcylindrical, pale yellowish, with two stiff hairs at tip.

Legs.—Pale dirty yellow, minutely pubescent. Coxae with some strong black bristles at tip. Femora without distinct bristles, the hind pair are often paler in colour, and are generally blackish towards the tips, often only very slightly so. Tibiae with a distinct row of short bristles on outer side, the four posterior tibiae with two terminal spurs, the hind pair having a close row of very minute hairs on the outer side, adjacent to the row of bristles. Tarsi slightly blackish.

Wings.—Pale yellowish, a little iridescent, costal border shortly bristly with two divaricating rows as far as the tip of the 3rd longitudinal vein, which, shortly forked, reaches about the middle of the wing, the 1st longitudinal ending just beyond the

middle of the costal cell. Of the light veins, all of which attain the wing-margin, the 1st takes a single, distinct curve upward, the 2nd and 3rd are moderately bisinuate (sometimes much less so), the 4th is nearly straight. Halteres pale yellow.

Described from a good series (mostly ♀ ♀), bred by me in Calcutta from a dead lizard (*Calotes versicolor*, Daud.) which had remained for a day or two in an empty pickle bottle. The first generation appeared early in August and the imagines, not being all removed for a few days, a second generation, bred from the first, appeared from August 23rd to 27th. The description also embodies the examination of a short series bred in the Indian Museum from a water beetle (*Cybister limbatus*, F.) taken at Raniganj (Bengal), these specimens emerging 22 and 23-vii-08. A few other specimens in the Museum collection, and in my own, from various parts of India, have also been examined, from Sylhet, 8-i-05; 23-ii-05, 18-iii-05, [*Major Hall*]; Calcutta, 21—25-ii-07; and I have one ♂ from Peradeniya (1,500 ft.), Ceylon, taken November 1907.

Notes.—This species is very variable in colour, ranging from bright ferruginous to grey, the proportion of black on the abdomen totally altering the general appearance of the insect. The species, however, once well understood, is tolerably easy to recognize, and is apparently of almost world-wide distribution throughout the tropical regions and probably some adjacent portions of the temperate zone also.

MISCELLANEA.

GENERAL.

MIMICRY OF A MUTILLID BY A SPIDER.—On a railway embankment about two miles south of Cuttack I recently collected a curious spider which I mistook at first sight for a female Mutillid. It was running about on bare soil in a manner peculiarly like that of a Mutillid; the "cephalothorax" was reddish and the "abdomen" black with white spots. The white spots have unfortunately disappeared entirely in spirit, leaving the "abdomen" uniformly black, but even now the rough red "cephalothorax" blackened over an area in front corresponding to the head of a Mutillid, the apparently velvety (in reality somewhat polished and finely punctured) black "abdomen," and the general shape of the specimen give it a very *Mutilla*-like appearance. A few minutes before finding this specimen I had obtained a specimen of *Mutilla pondicherensis*, which it resembles closely in form and general colour, differing however in the markings on the abdomen, those of the spider consisting in life, to the best of my recollection, entirely of white spots without any bands. There were, I believe, three (or two ?) transverse rows of these round spots, each row consisting of one median and two lateral spots, those of the anterior row being much larger and more widely separated from each other than the rest. The spider and the *Mutilla pondicherensis* found near it are preserved together in spirit, in the Indian Museum collection, and as it is impossible for us at present to get the spider identified I publish this note as a record of its appearance in life for the benefit of whoever may ultimately work out the collection. Mr. E. E. Green informs me that he has observed a similar phenomenon in Ceylon; he has already published a note on it in *Spolia Zeylanica* (vol. iv, 1907, pp. 181-2), and a further note is in preparation which will be accompanied by a coloured figure. My specimens have been submitted to him for examination and he tells me that he believes the spider to be the same as his, in which case its name is *Coenoptichus pulchellus*, Simon (= *Myctocryptus mutillarius* of a later paper by Karsch).

F. H. GRAVELY.

XIPHOSURA.

CAPTURE OF *Limulus* ON THE SURFACE.—From time to time, as more and more observations on the planktonic fauna of the ocean are carried out, the occurrence of unusual constituents are reported and it seems worthy of being placed on record that on the night of the 19th of December, 1911, an adult specimen of *Limulus muluccanus*, Latreille (= *Tachypleus gigas* (Müller)[1]),

[1] *Vide* Pocock, *Ann. Mag. Nat. Hist.* (vii), vol. ix, 1902, p. 262.

measuring approximately 39 cm. in length, was captured in a large surface tow-net by the R.I M.S.S. "Investigator." The net had been shot at 6-30 p.m., shortly after the ship had been anchored for the night at a spot about 4 miles west of the entrance to Hinzé Basin on the south Burma coast (97° 45½′ E., 14° 43½′ N.) in about 10 fathoms, and had been allowed to drift with the tide, being kept on the surface by means of a bamboo float.

How an animal, so obviously a bottom-dweller, had been carried or made its own way to the surface, must, I fear, remain a mystery.

R. B. SEYMOUR SEWELL.

BRACHIOPODA.

NOTE ON THE DEVELOPMENT OF THE LARVA OF *Lingula*.—Up to the present time, of the various contributions to our knowledge of the development of the *Lingula* larva that have been published, only two can be considered in any way to approach completeness, to wit, those of Brooks[1] and Yatsu.[2] The accounts given by these two observers in the main agree very closely though differing in slight details, of which one of the most important is the length of the peduncle that is formed before protrusion from the shell takes place: according to Brooks the peduncle attains considerable length before it is protruded from the shell, whereas according to Yatsu only a short peduncle is formed. This difference may have been due either to the fact that Yatsu's specimens were kept in captivity during the latter part of their development or to a specific difference in the larvae obtained, those of Brooks's being the larvae of *Glotidia pyramidata*, whereas Yatsu's examples were those of *Lingula anatina*.

During the months of December and February, 1911, several of these larvae were captured in the surface tow-net off the mouth of Hinzé Basin and the neighbouring waters of the south Burma coast about four miles from shore and as they differ in one or two particulars from the previous accounts it has been thought that a brief account of these discrepancies may be of some little value.

The chief differences noted are two in number:—

1. *The stage of formation and protrusion of the peduncle.*—Both Yatsu and Brooks agree in stating that the peduncle first makes its appearance at the end of the 6-, or commencement of the 7-pairs of cirri stage, and the former observer found that in his specimens, in captivity, protrusion took place at the commencement of the 10 p.c. stage. The youngest specimens obtained by me in December had already reached the 9 p.c. stage

[1] W. K. Brooks, "The development of *Lingula* and the systematic position of the Brachiopoda," *Chesapeake Zool. Lab.* Scientific Results of the Session of 1878, p. 35. Baltimore, 1879.

[2] N. Yatsu, "On the development of *Lingula anatina*," *Journal of the College of Science*, Tokyo, vol. xvii, art. 4.

and in these the peduncle had only just begun to develop, while in the oldest specimen, which had reached the 11 p.c. stage, no sign of protrusion was seen. In February only a single specimen was obtained but this one was remarkable in that it had already reached the commencement of the 14 p.c. stage and the peduncle was still only a small rudiment. In this connection it is interesting to note that as regards the length of peduncle formed, the present specimens agree closely with the description given by Brooks of the larvae obtained by him in America and contrast markedly with Yatsu's specimens from Japan.

Although, so far as I know, no specimens of Brachiopoda have been obtained in the region of Hinzé Basin, several examples of *Lingula anatina* have been found at other parts of the Burma coast and it would seem probable that my larvae are those of this species.

If this be the case, there can, I think, be no doubt that the short peduncle in Yatsu's specimens is a result of confinement in unnatural surroundings and is not a natural condition.

2. *The stage at which the change of shape of the shell takes place.*—Both the above-mentioned accounts agree in stating that the change of shape of the shell from transversely oval to longitudinally oval takes place at the 6-7 p.c. stage, and Yatsu gives the following measurements of his specimens in support of this statement:—

	Length.	*Breadth.*
5 p.c. stage ..	313 μ	386 μ
6 p.c. stage ..	411 μ	444 μ
7-8 p.c. stage ..	663 μ	615 μ

In the table below I have given the measurements of my specimens:—

	Month in which obtained.	Length.	Breadth.	Ratio of hinge to length.	Stage of development.
1	December ..	625μ	683μ	1 : 1·97	9 p.c. stage.
2	,, ..	629μ	666μ	1 : 1·99	,, ,, ,,
3	,, ..	683μ	633μ	1 : 2·41	,, ,, ,,
4	,, ..	750μ	725μ	1 : 2·90	Commencing 10 p.c. stage.
5	,, ..	850μ	789μ	1 : 3·00	10 p.c. stage.
6	,, ..	875μ	808μ	1 : 2·92	,, ,, ,,
7	,, ..	858μ	808μ	1 : 3·03	Commencing 11 p.c. stage.
8	,, ..	892μ	775μ	1 : 2·97	,, ,, ,, ,,
9	,, ..	900μ	833μ	1 : 2·99	11 p.c. stage.
10	,, ..	908μ	800μ	1 : 2·87	,, ,, ,,
11	,, ..	916μ	808μ	1 : 3·14	,, ,, ,,
12	February ..	1114μ	1114μ	1 : 3·25	Commencing 14 p.c. stage.

From the above it would appear that this change of shape takes place in larvae, obtained during December at about the 9 p.c. stage but in the 14 p.c. stage in those existing during the month of February.

Another point that seems worthy of note is the season at which these larvae were obtained. Both Brooks and Yatsu obtained their specimens during the month of August and, according to the latter observer, in Japan the breeding season extends from July to the end of August, and at no other period of the year are larvae to be found. The occurrence of larvae during the winter months in the plankton off the Burma coast may be due to either a local peculiarity or possibly to the existence of two breeding seasons during the year, one in the summer months July and August, and a second from December to February, but in either case I attribute the delay in the formation and protrusion of the peduncle and the change in shape of the shell to the less favourable time of year at which the development was taking place.

R. B. Seymour Sewell.

REPTILES.

Notes on the distribution of some Indian and Burmese Lizards :—

1. Distribution of *Liolepis* in the Indian Empire.—The large and conspicuous lizard *Liolepis belliana*, Gray, is a characteristic feature of sandy tracts in Tenasserim and has been stated to occur in South Canara. Careful inquiries have convinced me, however, that it does not occur anywhere west of the Bay of Bengal It is very unfortunate that many of the older records of the occurrence of both reptiles and other animals in the Madras Presidency are equally unreliable. This is owing to two causes :—(i) A considerable number of Burmese specimens have, in at least one instance, been mixed with collections from S. India and all have been attributed to the latter. This has been pointed out by Major F. Wall as regards certain snakes, and it is undoubtedly the case also as regards *Liolepis belliana*. It is a particularly unfortunate occurrence, because there is an actual affinity between the faunas of the mountains of S. India and the countries east of the Bay of Bengal which such mistakes tend to obscure. (ii) In a large number of cases specimens have found their way into public collections labelled *not* with the name of the locality in which they were originally found but with that of the locality of the institution from which they were sent to specialists or museums in Europe. Certain missionary colleges are largely responsible for such mistakes, and old records of such localities as Trichinopoly are worthless, unless they have been recently corroborated.

2. The distribution of *Mabuia bibronii* (Gray).—This very distinct little skink is stated, vaguely, in the "Fauna" to occur in the "Carnatic," but the real interest in its distribution

lies in the fact that it appears to be entirely a maritime species. It is common on sand-dunes by the sea on the Indian shore of the Gulf of Manaar and occurs on the coast of Ceylon. It is common on the shore at Madras and I recently took a specimen in a little banyan-grove on a sand-hill close to the sea on the Orissa coast a few miles north of Puri. I have never seen the species more than a few hundred yards above high-tide mark. A diligent search on the shore at Trivandrum and at other places on the Travancore coast failed to reveal a specimen and I can find no record of the occurrence of the species anywhere in the Malabar zone.

3. A SPECIMEN OF *Gymnodactylus peguensis*, BLGR.—This lizard was originally described from two specimens taken by the late Signor Fea at Palon (*Ann. Mus. Genova*, 2nd ser., vol. xiii, p. 314, pl. vii, fig. 2, 1893) and has since been recorded from Lower Siam (Laidlaw, *Proc. Zool. Soc. London*, 1901, p. 304). Until recently it was not represented in the collection of the Indian Museum, but we have now received a fine specimen from Mr. C. G. Rogers, who took it under a stone in the East Yoma Forest Reserve on the west side of the Pegu Yomas (Thyetmyo district) on Oct. 31st or Nov. 1st at an altitude of about 1,000 feet. Mr. Rogers describes the coloration as being "chocolate brown; spots olive green." In spirit the ground colour is greyish and the spots dark brown. The markings are much more conspicuous than is ever the case with *G. rubidus*, with which Boulenger compares the species.

N. ANNANDALE.

VIII. MATERIALS FOR A SURVEY OF THE MOSQUITOES OF CALCUTTA.

By C. A. PAIVA, *Assistant, Indian Museum.*

[NOTE.—The delay in the appearance of this paper is due to the fact that owing to the absence during almost the whole time of the survey as well as for many years previously, of any scientific officer who could devote more than a small part of his time to the supervision of the conservation of our extensive entomological collections, Mr. Paiva has been unable to devote more than a fraction of his time to mosquito work. For the same reason the survey cannot be regarded as exhaustive, or even sufficient for the "fringe area" to which it was confined, since the methods employed were rough and ready in the extreme. Their chief defects lie in the lack of adequate supervision over the collectors, and in the identification by means of the adults only of the larvae and pupae obtained. With regard to the first of these defects, Mr. Paiva tells me that it was easy to keep a check on the truth of the collectors' statements as to the nature of the breeding-places from which different collections of larvae were brought in, as he quickly found that some species preferred one sort and others preferred others, a fact which could not be taken into account by an ignorant collector anxious to avoid any suspicion that he neglected filthy water. But he was quite unable either to see that every type of breeding-place found was regularly sampled or to instruct the collectors personally in the art of finding larvae in large areas of water over which they might be dispersed; and it is probably on this account that no species known to transmit malaria has been revealed in the collections made either by the corporation kerosening-coolies or by the collectors subsequently employed by the Museum; for it is well known that these mosquitoes breed in clean water. With regard to the second defect mentioned above, it may be pointed out that just as different species of wild animals differ in their ability to thrive in captivity so some species of mosquito develop in captivity more readily than others, and although identifications ought to be checked by rearing up the larvae, they ought always, in the first instance, to be based on the larvae and pupae themselves; for otherwise there is a danger that some species may be completely overlooked owing to their inability to develop under the conditions to which they are subjected. To have done this, however, it would have been necessary for Mr. Paiva to devote the whole of his time to the work at the actual time when the survey was in progress, and this it was impossible for him to do; in addition to which, at the

commencement of the survey, the Museum did not possess a collection of properly named mosquito larvae on which he could have based his identifications. Such a collection has now been formed, both of the common species obtained during the survey, and of some of those found in Calcutta tanks; and I should like to take this opportunity of thanking Major Christophers, I.M.S., and Capt. Davys, I.M.S., for the assistance they have given me by sending isolated larval and pupal skins, together with the adults which emerged from them, of several species not common in Calcutta. But the absence of Mr. Paiva on medical certificate, an absence which will certainly be of long duration and from which it is very doubtful whether it will ever be safe for him to return, has rendered it impossible for the Museum to undertake, as had been hoped might be made possible, a second and more thorough survey on the lines indicated above. And it is in the hope that the experience and unavoidably imperfect results of what has already been done may be of use to others that the present paper has been compiled.—F. H. Gravely, Asst. Supdt., Indian Museum.]

Early in October 1909, the Calcutta Corporation commenced the destruction of mosquito larvae in that part of the town locally known as the "Fringe Area," and as it was important to know what species abounded in that area, living specimens of larvae were daily sent to the Indian Museum from every spot which was visited, together with the precise locality and breeding ground of these larvae.

Larvae were received with considerable regularity but for two interruptions which were occasioned by the Durga Puja and Christmas vacations. The larvae were successfully reared in the Museum, and the mosquitoes that emerged from each batch were carefully pinned and labelled. After a large number had been collected, I identified them to the best of my ability.

The Calcutta Corporation stopped the supply of mosquito larvae on the 26th February 1910, without previously informing the Museum authorities that the work was not to be carried on any longer by them. As it was the intention of the authorities of the Museum to carry on the breeding of mosquito larvae for a complete year, arrangements had to be made to secure men to collect larvae during the remaining period, *i.e.*, till the first week of October 1910. It was an extremely difficult task to secure really reliable men for the work and this caused an interruption of a little more than three weeks. On the 22nd March 1910, the work of collecting larvae commenced again, and after several changes of collectors, two men were finally selected for the work. In a short time the daily supply of larvae became enormous and consequently very large numbers of mosquitoes emerged daily. These could not all be pinned, so they were killed and put into separate pill-boxes and after all the mosquitoes had been thus duly arranged, I counted and identified them and made the necessary entries in a rough register. Thus did the work continue till the beginning of October 1911.

In the early part of the survey, I did not think it necessary to separate the *Culex* with the unbanded proboscis from those with the banded proboscis, but later on I considered it advisable to keep them separate. Hence it will be seen that from March 22nd 1910, the two forms are given as *Culex* A (unbanded proboscis) and *Culex* B (banded proboscis).

The following species were bred during the twelve months of the survey:—

Culex A.
Culex B.
Culex concolor, Desv.
Leucomyia gelida, Theob.
Stegomyia scutellaris, L.
Stegomyia fasciata, Fab.
Desvoidea obturbans, Wlk., and varieties.
Toxorhynchites immisericors, Wlk.
Myzomyia rossii, Giles.
Myzomyia ludlowi, Theob.

The area dealt with in the survey has been divided into ten districts which are briefly defined and described in Table I.

Table II gives full particulars of the work done during the year. Each column represents a fortnight's work; Roman figures are used to indicate the districts from which the various larvae were brought in; and the actual number of adults that emerged is shown by Arabic figures in brackets.

In the next three Tables (III, IV and V) the breeding habits for the three principal seasons are compared:—*viz.* the "hot," "rainy" and "cold" seasons.

The hot season in Calcutta generally commences early in March and extends at least to the end of May or the beginning of June. There are occasional showers of rain during this period, but mosquitoes do not find much stagnant water about to encourage the breeding of larvae. Some species however are rather common at this time of the year.

The rainy season commences in June or July and ends after the 15th of October. At this time water is most plentiful and hence it is the most suitable period for the breeding of mosquito larvae.

The cold season starts in November and lasts till the end of February at latest. There is very little or no rain during this time and mosquitoes do not seem to be so plentiful.

It is generally during the cold season that the Calcutta Corporation undertakes the destruction of mosquito larvae. A more suitable time of the year for this kind of work would perhaps be the rainy season as during that time larvae are found in abundance in all kinds of situations, and mosquitoes are most common then. The constant rain may render it difficult to do this work satisfactorily however.

The most common situation in which larvae were found during the rainy season was in earthen pots, except in the case of one species (*Myzomyia rossii*) which was found chiefly in open drains, but during the other two seasons, tanks, open drains, cisterns, cesspools and earthen pots were all utilized as breeding places with about equal frequency. Other artificial collections of water, such as that in tubs, metal cans, iron and earthen pans also served as breeding places, but did not seem to be patronized very much by mosquitoes; probably because some of these were less common, whilst others, being shallow, quickly dried up. In one instance, a canal served as a breeding place for *Myzomyia rossii*.

Table VI shows the number of specimens of each species that emerged during each of the three different seasons and their relative percentage. It will be seen that *Culex* A was the most abundant mosquito in all the seasons. *Myzomyia rossii* was commoner during the hot and rainy seasons than during the cold weather. The largest number of mosquitoes emerged during the rainy season, being as much as 69·9% of the year's total, clearly indicating that the larvae were more easy to obtain at this time than at any other.

The larvae of *Culex* A were found mostly in open drains during all the seasons.

Larvae of *Culex* B were found in about equal proportion in tanks, open drains and earthen pots during the rainy season, and in open drains during the hot season.

Culex A (with the proboscis unbanded) belongs rightly to the *fatigans* group of that genus, and I have noticed all varieties, both in respect to size and markings, emerge from a batch of larvae collected at one time from a single piece of water.

The forms of *Culex* with the banded proboscis (*Culex* B) belong to the *impellens* group.

These were the only two forms of the smaller species of *Culex* which emerged from larvae received during the year's survey.

Larvae of *Culex concolor*, Desv., were not very plentiful and were chiefly found during the rainy season in small collections of water, *viz.*, cesspools, tubs, iron pans and earthen pots, in company with larvae of *Culex* and *Stegomyia*. These larvae are of carnivorous habits and small collections of water are most suitable for them as they can easily capture any other larvae which may breed along with them in these situations.

Larvae of *Leucomyia gelida*, Theob., were only common during the rains, and were obtained chiefly from earthen pots, although some were got from tanks and open drains. This species appears to be entirely absent in the "Fringe Area" during the other two seasons.

Larvae of *Stegomyia scutellaris*, L., were procured in very large numbers during the three seasons from earthen pots, but chiefly during the rains.

During the other two seasons larvae were obtained from open drains and metal cans as well.

Larvae of *Stegomyia fasciata*, Fab., like *S. scutellaris*, were obtained mostly from earthen pots. These two species generally choose small collections of stagnant water to breed in. They will never be found to breed in any foul-smelling water, at least this is what I have observed. They do not seem to like muddy water either.

S. scutellaris and *S. fasciata* are the two principal mosquitoes which are such a source of annoyance in Calcutta during the day. They are purely day feeders and I have never yet caught one in a room after it has become dark.

Larvae of *Desvoidea obturbans*, Wlk., were found in cesspools and earthen pots during all the seasons, and during the cold season were very plentiful in open drains, which apparently contained foul stagnant water. The larvae of this species find cesspools very suitable for breeding. They seem to thrive in foul water.

Larvae of *Toxorhynchites immisericors*, Wlk., breed chiefly in earthen pots and were found in fairly large numbers in such situations during the rainy season. During the other two seasons very few were obtained.

Larvae of *Myzomyia rossii*, Giles, found open drains most suitable during the rainy season, but during the other two seasons they were very numerous in tanks as well.

Larvae of *Myzomyia ludlowi*, Theob., were most common during the rainy and cold seasons, scarcely any having been got during the hot season. Their principal breeding grounds were open drains and earthen pots.

The last two species closely resemble one another. The only constant difference between *M. ludlowi* and *M. rossii* is that in the former the legs are speckled, and it is doubtful, as Theobald suggests in vol. v of his "Monograph of the Culicidae of the World," whether it is really more than a variety. Theobald still retains *ludlowi* in the genus *Myzomyia*, but Maj. S. P. James, I.M.S., now regards it the type of a new genus.

Table VII indicates the difference between the proportion in which the various kinds of breeding places are utilized in different localities. This may perhaps be due in some degree to selection on the part of the collectors; but I do not think that it can be entirely accounted for in this way, in which case a difference in the relative abundance of the various kinds of breeding places in the different districts is indicated.

Earthen pots in most cases proved to be the most usual breeding places. In some cases open drains were found to be equally suitable.

Earthen pots were quite common in districts i, ii, iii, vi, viii, ix and x. Larvae of every species found during the survey were taken from earthen pots, especially during the rainy season.

District vi gave the largest number of mosquito larvae, then came districts i, ii, viii, ix, x, iii, vii, iv and v according to the number of larvae found in each district.

From the foregoing remarks it will be seen that not a single specimen of the larvae of any species known to carry malaria has been found in the fringe area, where malaria is most common as far as Calcutta is concerned. Adults of some of these species are to be found in houses in the fringe area when carefully searched for but they must either breed beyond the limits of the area, or in comparatively large areas of water where the collectors did not make proper investigations

TABLE I.[1]

I. Bounded by Circular Canal, Maniktala Road and Upper Circular Road. Includes many oil mills, rope factories, flour mills and bustees; tanks very numerous, some of them clean and others dirty.

II. Bounded by Maniktala Road, Circular Canal, Beliaghata Road, and Upper Circular Road. Includes Sealdah station with its extensive railway yards, a large gas works, a large flour mill, an ice factory, and bustees. There is one tank which is covered with weeds.

III. Bounded by Beliaghata Road, Circular Canal, Beliaghata Canal, Convent Road, Middle Road Entally, and Lower Circular Road. Includes Beliaghata railway station, railway workshops, pumping station, Campbell Hospital with a big clean tank in its grounds, a big dirty tank covered with green slime and water lilies, and ground for entraining rubbish; the rest is composed of bustees with the exception of a small European quarter in the south.

IV. Bounded by Beliaghata Canal, Kankurgachi Chord (E.B.S. Ry.), the line to Diamond Harbour, and Convent Road. Includes a small canal of very dirty smelling water running close behind a slaughter-house, and the Roman Catholic Orphanage with open grounds and a clean tank; all the rest is covered with bustees and small tanks.

V. Bounded by Beliaghata Canal, the Municipal Boundary, New Tengra Road, and Tengra Road. Includes continuation of dirty canal found in District IV, with some brackish water tanks to the north of it, many hide godowns, tanneries, etc., and some bustees.

VI. Bounded by Middle Road Entally, the line to Diamond Harbour, Tiljalla First Lane, Karaia Road, and Lower Circular Road. Includes European quarter, cemetery, etc., on the west; all the rest of the district is occupied by bustees with numerous tanks covered with green slime, and a few tanneries in the south-east.

VII. Bounded by Kankurgachi Chord (E.B.S. Ry.), Tengra Road, New Tengra Road, and Municipal boundary (Topsi Road and Tiljalla Road). Includes Mohammedan cemeteries and bustees with tanks covered with green slime on the west, and more open country on the east.

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[1] This table has been compiled, since Mr. Paiva left Calcutta, with the assistance of Mr. Hodgart, who made the necessary investigations; previously it had been thought that a map would perhaps have been sufficient.—F. H. G.

TABLE I—*continued.*

VIII. Bounded by Beck Bagan Bazaar Lane, Tiljalla First Lane, Molvi Ahmad Khan Bahadur's Road, E.B.S. Railway, Garcha Road, Hazra Road, Ballygunge Circular Road. Includes European quarters and a few bustees; many tanks both clean and dirty.

IX. Bounded by Lower Circular Road, Ballygunge Circular Road, Hazra Road and Russa Road. Includes Port Trust Offices with small depôts for coolies, large European quarter, and a few bustees; many tanks, both clean and dirty.

X. Bounded by Lower Circular Road, Russa Road, Hazra Road, Tolly's Nulla, and Bhawanipur Road. Includes General Hospital, Lunatic Asylum, European quarter, and bustees; there are a few tanks, these including a large municipal tank which is clean and free from weeds.

Rains

TABLE IV.

June to October.

	Tank.	Open drain	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Total.
Culex A (*fatigans* group) ..	2·5%	40·7%	2·5%	10·6%	2·7%	3·2%	7·2%	30 %	..	..	..	99·4
Culex B (*impellens* group) ..	24·4%	26·1%	..	6·7%	5·4%	..	4 %	33·2%	..	..	..	99·8
Culex concolor.. ..	..	8·8%	..	13·2%	25 %	..	23·5%	29·4%	..	..	..	99·9
Leucomyia gelida ..	27·3%	16·4%	1·3%	..	..	..	..	54·7%	..	..	..	99·7
Stegomyia scutellaris ..	..	0·3%	1·4%	..	5·6%	3·4%	4·9%	83·3%	..	..	0·7%	99·6
Stegomyia fasciata ..	4·3%	4·8%	7·5%	..	16·8%	5·4%	2·7%	57·2%	..	..	0·9%	99·6
Desvoidea obturbans ..	3·1%	14·8%	1·6%	32%	0·4%	1 %	4·1%	42·8%	..	..	..	99·8
Toxorhynchites immisericors	..	1·7%	..	1·7%	15·5%	..	..	81 %	..	..	..	99·9
Myzomyia rossii ..	15·4%	59·5%	0·4%	0·7%	0·2%	1·6%	8·4%	13·3%	..	..	..	99·5
Myzomyia ludlowi ..	0·2%	47·1%	9·9%	..	3·9%	1·1%	..	37·6%	..	..	..	99·8

Hot Weather — TABLE III. — March to May.

	Tank.	Open drain.	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal	Earthen pan.	Total.
Culex A (*fatigans* group) ..	15·7%	69·2%	1·6%	2·7%	3·8%	0·5%	..	6·2%	..	..	..	99·7
Culex B (*impellens* group)..	3·7%	77·7%	..	..	..	..	..	18·5%	..	..	..	99·9
Culex concolor ..	..	..	..	..	..	..	..	..	..	..	..	..
Stegomyia scutellaris ..	..	41·6%	..	..	..	..	..	58·3%	..	..	..	99·9
Stegomyia fasciata ..	..	8·3%	30·1%	..	9 %	3·1%	..	49·3%	..	..	..	99·8
Desvoidea obturbans ..	..	19·1%	..	57·3%	..	..	..	23·5%	..	..	..	99·9
Toxorhynchites immisericors	..	..	..	..	..	..	..	..	..	..	..	..
Myzomyia rossii ..	51·1%	41 %	..	0·4%	..	0·4%	..	6·4%	..	0·3%	..	99·6
Myzomyia ludlowi ..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE VI.

	March to May.		June to October.		November to February.		Total for the year.
	Total.	Seasonal Percentage.	Total.	Seasonal Percentage.	Total.	Seasonal Percentage.	
Culex A	3,830	55·3%	8,201	47·1%	982	59·8%	13,013
Culex B	54	0·7%	475	2·7%			529
Culex concolor	..	..	68	0·3%	1	..	69
Leucomyia gelida	..	..	73	0·4%	6	0·3%	79
Stegomyia scutellaris	36	0·5%	1,277	7·3%	16	0·9%	1,329
Stegomyia fasciata	385	5·5%	1,760	10·1%	236	14·3%	2,381
Desvoidea obturbans	89	1·2%	2,587	14·8%	248	15·1%	2,924
Toxorhynchites immisericors ..	1	..	58	0·3%	1	..	60
Myzomyia rossii	2,523	36·4%	2,527	14·7%	143	8·7%	5,193
Myzomyia ludlowi	5	..	356	2 %	7	0·4%	368
Total ..	6,923	99·6%	17,382	99·7%	1,640	99·5%	25,945
Percentage for the year	26·7%		66·9%		6·3%		99·9%

IX. NOTES ON FRESHWATER SPONGES.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent, Indian Museum.*

XIV.—THE GENERIC POSITION OF "*Spongilla ultima*."

In describing the species which I called *Spongilla ultima* I was struck by its resemblance in general structure to those which I assigned to the genus *Corvospongilla* (see *Faun. Brit. Ind., Freshwater Sponges*, etc., pp. 105, 122, figs. 19, 26), but as I failed to find in the parenchyma of the original specimens a single birotulate flesh-spicule, the species was inevitably assigned to *Spongilla*. During a recent visit to Tanjore in the Trichinopoly district of the Madras Presidency I obtained a sponge which agreed closely in most characters with "*Spongilla*" *ultima* but contained many such flesh-spicules. A fresh examination of the type specimen was therefore made and, after much hunting, a birotulate spicule was found, closely resembling those of *Corvospongilla lapidosa*. Moreover, specimens of *C. ultima* sent me from Travancore still more recently contain many birotulate flesh-spicules. It is evident, therefore, that these sponges are specifically identical and should be assigned to *Corvospongilla*. The birotulate spicules of this genus are often so few in number that great difficulty is experienced in finding them, and it is by no means improbable that other freshwater sponges of hard consistency and with gemmules in which the spicules are arranged horizontally may ultimately, on a critical examination of fresh material, have to be assigned to *Corvospongilla*. The Tanjore specimens of *C. ultima* were growing on the edge of a concrete basin which formed the outflow of an irrigation-channel full of very muddy water. They were almost black in colour and grew out from their support in flattened leaf-like expansions, some of which were divided horizontally into two thin layers by a chitinous membrane. The gemmule-spicules were not quite so irregular or heterogeneous as those of the original specimens, which were from Cape Comorin, but very few gemmules were found and it is probable that at the season at which the specimens were taken (October) the outer layer of spicules was not fully formed. The newly acquired Travancore specimens were taken in July and have well formed gemmules.

I take this opportunity to correct another error in my volume in the "Fauna." On pp. 54 and 121 it is stated or implied that the megascleres of the Bornean sponge *Tubella vesparium* are spiny. They are perfectly smooth and are distinguished from those of the Burmese *T. vesparioides* by their stouter form.

X. NOTES ON PEDIPALPI IN THE COLLECTION OF THE INDIAN MUSEUM.

By F. H. GRAVELY, *M.Sc., Assistant Superintendent, Indian Museum.*

III.—SOME NEW AND IMPERFECTLY KNOWN SPECIES OF HYPOCTONUS.

With the exception of *H. andersoni*, Oates, and *H. stoliczkae*, n. sp., all the specimens on which the following descriptions are based have been added to our collection during the last year. Figures will be published in a subsequent paper dealing with the Oriental Pedipalpi as a whole, in which also I propose to discuss generic definitions in the light of the facts here published.

A.—Species with tibial spurs on the last pair of legs only.

H. dawnae, n. sp.

This species is abundant on the eastern slope of the Dawna hills in the Amherst District of Lower Burma from Sukli near the top of the range to Thingannyinaung at the bottom. I obtained a single specimen from Misty Hollow near the top of the western slope. It may, perhaps, be found over the whole of both slopes in the rains.[1] The presence of a distinct though faint and incomplete ridge between the eyes might seem to indicate that the species ought to be placed in the genus *Thelyphonus*. In all other respects, however, it is a typical *Hypoctonus*. The form of the tibial apophysis of the male especially is that of a *Hypoctonus* and not a *Thelyphonus*.

Description.— ♂. Length of carapace 9·5–10·5 mm., maximum breadth 5·5—6 mm. Colour black above, with reddish-brown legs; beneath the body and arms are redder though darker than the legs. Carapace usually smooth in front and at the sides, more or less transversely rugose behind the median pair of eyes which eyes are separated from one another by a ridge whose width is about equal to the diameter of each eye. Behind this rugose area two coarsely granular bands extend backwards, one on either side of a median furrow of varying distinctness, each of them separated by a somewhat narrower smooth band from a distinct though not very strong granular ridge which extends forwards from the lateral eyes towards the median ones as in the genus *Thelyphonus*, disappearing about halfway between the two. The whole of the posterior part

[1] My collections were made towards the end of November only.

of the carapace is granular. Terga of abdomen finely granular. Trochanters and femora of second to fourth legs and tibiae of fourth legs granular above, the femora becoming smooth distally. Abdominal sterna finely and closely granular at the sides, finely but less coarsely granular between the muscular impressions on the fifth and sixth (fourth and fifth visible) segments. Arm and hand normally smooth and polished throughout above with only a few sparse punctures.[1] Trochanter with five strong teeth above and two below, the space between these two sets of teeth armed with more or less distinct rows of small denticles; femur and tibia rather large, the former armed with a stout spine below and the latter with a more or less distinct denticle (sometimes obsolete) below and a conspicuous conical process (sometimes double) at the base of the apophysis above; apophysis triangular in section, broad and flat above, strongly grooved along the anterior face, truncate distally, upper anterior margin slightly concave, posterior margin slightly concave proximally slightly convex distally, the former margin meeting distal margin in an even curve, the latter in a dentiform acute angle, distal margin armed in addition with one spiniform tooth. Inner margin of hand denticulate throughout and concave at base of fixed finger; fixed finger denticulate on both sides; moveable finger long and evenly curved; hand armed at base of moveable finger with two stout spines of which the anterior is remarkably large. Foot of antenniform leg evidently very liable to injury and specimens with an abnormal number of joints on one side at least are abundant, the long terminal joint being apparently the first to be regenerated since it is always present when the appendage is healed; normally the joints are moderately long, but the proportions they bear to one another are not altogether constant

♀. Size, colour, and general texture of integuments as in the male. Arm and hand much smaller than in male, tibial apophysis triangular, with a simple denticle at base, two more just below apex, and a row along anterior margin; second (i.e. first visible) abdominal sternum more than twice as broad as long, posterior margin slightly concave on either side, being moderately produced in the middle line with the convexity thus formed broadly rounded; impressions very faint, apparently four in number, one pair situated close together with another pair even fainter outside and slightly behind them tinged with a faint greyish streak; immediately behind the central pair the sternum is clouded with black; the concave portion of the posterior margin on either side of the median lobe and immediately behind the outer impressions is likewise blackened

H. browni, n. sp.

The following description is based on the examination of a single specimen found by Mr. J. Coggin Brown at Parni, Monglong,

[1] In a single specimen the arm and hand are slightly dulled by a very fine rugosity which is most marked at the base of the tibial apophysis and fixed finger.

Hsipaw State, North Shan States, Upper Burma. The species is very closely allied to the preceding and may be only a variety of it; but until the male is found this question cannot be settled.

Description.—♂. Unknown.

♀. Length of carapace 8·5 mm., maximum breadth 5 mm. Texture of integuments as in *H. dawnae*, but with the median finely punctured areas of the fifth and sixth abdominal sterna very narrow. Legs of a much darker colour than in the preceding species, the coxae and trochanters above and the femora being almost black. Arm and hand as in the preceding species. Second (first visible) abdominal sternum a little less produced behind than in that species, the posterior margin being almost straight on each side instead of distinctly concave, otherwise the same

H. andersoni (Oates).

No specimen of this species appears to have been found since Oates originally described it from two specimens obtained by the Yunnan Expedition. The badly mutilated specimen which he described as the female cannot, I think, be mature, and the female of the species must be regarded as still unknown, the description of an immature specimen of *Hypoctonus* being worthless.

The male, as is well shown in Oates' figure (1889, pl. II, fig. 12) is one of the most distinct species hitherto described (though closely allied to *H. ellisi* described below), and it is difficult to see how Kraepelin (1897, p. 49, and 1899, p. 231) could possibly come to regard it as a variety of *H. formosus*. In reality it must be classed with Kraepelin's *H. gastrotrichus* on account of the presence of tibial spurs on the last pair of legs only.[1] As Oates

[1] *H. kraepelini*, Simon, also belongs to this group. Simon's description of this species (1901, pp. 77-8) is inadequate and his statement that it is closely related to *H. saxatilis*—more so, one is led to assume, than to any other known species—is misleading. The type specimens (one mature specimen and several young) from Bukit Goah, in the State of Jalor (Siamese Malay States) at an altitude of less than five hundred feet above sea level [I am indebted to Dr. Annandale for the correct spelling of this locality together with information as to the altitude at which he obtained the specimens], have been sent me for examination by Mr. Doncaster, the Curator of the Cambridge Museum, to the collections of which they belong; they may be redescribed as follows :—

♀. Length of carapace 11 mm., maximum breadth of carapace 6 mm. Carapace more extensively granular and rugose than in *H. ellisi* (see below), granulation of legs weaker. Colour much as in that species but slightly darker. Arm and hand resembling those of the female of *H. ellisi* in all points except that the tibia and hand are somewhat more elongated, each being about 1½ times as long as broad. The outermost tooth of the trochanter of the right arm is double in the only mature specimen I have seen, but this is no doubt an abnormality—it does not occur either in the left arm or in any of the young specimens. Second (i.e. first visible) abdominal sternum about twice as broad as long, posterior margin on each side perceptibly but very slightly more concave than in *H. ellisi*, the rounded middle portion somewhat less obtuse but scarcely produced. Impressions very obscure, apparently four in number arranged in a curve opposite the rounded middle portion of the posterior margin with which they enclose a broadly *navicula*-shaped area, the outer pair of impressions tinged with black. Tibial spurs confined to last pair of legs except in the one mature specimen in which one is also present on the second (but not third) right (but not left) leg, which is clearly an abnormality.

makes no mention of this feature and as only the female of *H. gastrotrichus* is known, it is not to be wondered at that Pocock (1900), though he refused to follow Kraepelin in regarding *H. andersoni* as a variety, did not succeed in placing it correctly.

H. ellisi, n. sp.

Mr. C. E. Milner, of the Indian Forest Service, to whom I wrote in the hope of obtaining the unknown female of *H. sylvaticus*, sent me some time ago six specimens of *Hypoctonus* collected by Mr. Ellis in the Zigon Division (Burma) under rocks during blasting operations in connection with a road in the Yoma north-east of Zigon town. Three of these proved to be *H. sylvaticus*, whilst three (one male and two females) belong to a new species closely allied to *H. andersoni*.

Description— ♂. Length of carapace 8 mm., maximum breadth 4·5 mm.; colour of body and arms dark brown above, that of legs pale brown; surface of carapace smooth at sides and transversely rugose in middle in front of lateral eyes, finely granular throughout behind, incompletely grooved in the middle line; terga of abdomen finely granular throughout; trochanters and femora of of 2—4th legs and tibiae of 4th legs finely granular above; anterior half of hand finely granular below; posterior lateral angles of 1st, whole of 2nd, 3rd and 4th, sides of 6—8th visible abdominal sterna finely and closely punctured and more or less transversely striate; rest of surface of body and appendages smooth and polished or sparsely punctured. Arm with a conspicuous denticle dorsal to the coxal process which is rather long and slender; upper margin of trochanter entirely without teeth, anterior surface with two or three vertical rows of denticles, one obsolete tooth on lower margin; femur very sparsely punctured, rather slender, its free inner edge about equal to anterior margin of trochanter, one obsolete denticle on lower side; tibia also very sparsely punctured, stem of tibial apophysis slender, lightly curved in the middle, expanded on the anterior edge of the upper side at first gradually then very abruptly into a flattened and downwardly curved blade which ends abruptly just before the narrow pointed extremity, lower edge of posterior side likewise expanded below the tip but thicker and the expansion nowhere abrupt; hind margin of dorsal expansion not produced backwards as in *H. andersoni*. Hand somewhat massive; fixed finger very broad, its inner margin strongly convex with the distal half very hairy, outer border finely denticulate; moveable finger with strongly curved and somewhat hairy basal portion, grooved along upper and lower and less strongly along outer margin, and followed by an abruptly defined distal portion which is straighter, slenderer, smoother, and sharply pointed at its extremity.

♀. Length of carapace 9·0—9·5 mm., maximum width of same 5·0 mm. Colour, granulation, etc. as in male except for absence of all granules from lower surface of hand. Coxal process of arm shorter than in the male, with denticles above it less

conspicuous; trochanter with five long marginal teeth above and two stouter ones below, anterior surface with rows of denticles as in male; femur much shorter than in male, armed with one tooth on lower surface, with or without a smaller one above; tibia and hand each about as broad as long, former larger than latter; tibia with one tooth above at base of apophysis and one below close to anterior margin; hand with two teeth below, the anterior and larger one close to anterior margin, the other immediately behind it: tibial apophysis with two teeth on posterior side near apex, very strongly toothed on anterior side; inner side of hand (including fixed finger), hardly perceptibly concave, toothed throughout except close to base and distal extremity, apposable margins of both fingers more finely denticulate except distally where they are smooth, moveable finger shorter and less strongly curved than in male, its lower margin strongly denticulate. Second (i.e. first visible) abdominal sternum twice as broad as long, posterior margin not produced, being practically straight on each side and very obtusely rounded in the middle: anterior margin raised up to form a strong transverse ridge in front of a pair of large and deep circular pits situated not far from one another on either side of the middle line.

B.—Species with tibial spurs on both third and fourth pairs of legs.

H. oatesii, Poc.

Of this species only the male has as yet been described. Mr. G. Mackrell of the Lungla (Sylhet) Tea Co. has however succeeded in obtaining both sexes for me from Shamshernager, Sylhet, at an altitude of about 100 feet.

Description.—♂. See Pocock, 1900, pp. 112—3.

♀. Length of thorax 10 mm., maximum breadth 5·5. Colour and texture of integuments as in male, except that the arms are not so strongly granular and the anterior abdominal sterna are not rugose at the sides. Trochanter as in male but with teeth of upper margin longer and sharper, the anterior margin moreover meeting the inner margin in a somewhat sharper angle. Femur much shorter than in male, armed with one small tooth above and one long one below; tibia and hand as in female of *H. ellisi*. Second (i.e. first visible) abdominal sternum scarcely half as long as broad, posterior margin not abruptly produced in middle; one pair of distinct circular impressions present.

H. sylvaticus, Oates.

Of this species only the male has as yet been described. I am indebted to Mr. C. E. Milner for specimens of both sexes which were captured for him by Mr. Ellis under rocks in the Zigon Division (Burma) in the Yoma N. E. of Zigon town during blasting operations in connection with a road.

Description.—♂. See Oates, 1889, pp. 18—9, and Pocock, 1900, pp. 115—6.

The colour of the legs of the Indian Museum specimen are uniformly pale as in *H. saxatilis*, but the specimen agrees perfectly with *H. sylvaticus* and not with *H. saxatilis* in structure.[1]

♀. Length of carapace 9·0—9·5 mm.; maximum breadth 5 mm. Colour and texture of integuments as in the male except for the absence of any sign of the extraordinary rugosity of the sides of the anterior abdominal sterna found in that sex. Trochanter of arm with five distinct teeth above and two below; femur shorter than in male, armed with several strong granules on the inner side above and one tooth below; tibia and hand as in the preceding species. Second (i.e. first visible) abdominal sternum scarcely half as long as broad, distinctly and more or less abruptly produced in the middle; one pair of distinct but very broad and shallow circular impressions present.

H. stoliczkae, n. sp.

The three specimens (♂, ♀, and juv.) from which this species is described are all from Punkarbari, and are apparently those from that locality referred to by Stoliczka (1873, pp. 127 and 134—136) under the name *Thelyphonus* (conf.) *angustus*. Oates (1889, p. 6) states that these are referable to the young of *Uroproctus assamensis*, a species which they resemble in the presence of a tooth on the inner side of each coxal process of the arm. Of the ridge between the median and lateral eyes there is however no trace. As the species is obviously related to forms belonging to the Burmese genus *Hypoctonus* (especially *H. wood-masoni*) and not to those of the South Indian genus *Labochirus* I have referred it to the genus *Hypoctonus* in spite of the presence of teeth on the coxal process, although this will necessitate a revision of the generic definition.

Description.—♂. Length of thorax 12 mm., maximum breadth 7 mm. Colour dark brown throughout. Carapace granular (almost spinulose) throughout, granules coarser in front than behind; trochanters and femora of 2—4th legs and tibia of 4th legs granular above; arms, except their coxae which are striate and sparsely punctured, and inner side of remaining joints strongly granular, abdominal terga also granular throughout; abdominal sterna granular at sides only, those of the first three ventrally visible segments being much more coarsely marked than the rest and almost rugose. Coxal process of arms with one or two [2] more or less distinct teeth on the inner margin near the apex and sometimes one on the outer margin also, one tooth also dorsal to base of coxal process; trochanter armed with one or two teeth below and five somewhat obscure teeth above, anterior surface with rows of denticles; femur moderately stout, its free inner margin

[1] This is not the only case in which I have found the colour of the legs to be misleading. Structure I believe to be alone reliable.

[2] The two arms of the single specimen before me differ greatly in the extent to which they are armed with spines and teeth.

quite as long as anterior margin of trochanter, with or without one strong tooth below; tibia about as wide as long, stouter than femur, one small tooth below close to anterior margin at base of moveable finger, front margin oblique, the inner side above being about 1½ times as long as the outer; posterior side of tibial apophysis curved, slightly expanded dorso-ventrally at the end, lower anterior margin produced towards the hand to form an extensive plate widening gradually from its commencement at about ⅓ of the distance from the base of the apophysis to its extremity and terminated abruptly a little before the end. Hand very thick dorso-ventrally on the outer side; inner side thin, widely excavate at base of fixed finger, the excavation exactly fitting the ventral plate-like expansion of the anterior margin of the tibial apophysis when the two are brought together; fixed finger broad, roughly parallel-sided, almost vertically truncate distally; moveable finger evenly curved, the apex crossing beneath the moveable finger when closed, and apposable to extremity of plate-like expansion of tibial apophysis.

♀. Length of cephalothorax 10 mm., maximum breadth of same 6 mm., colour much paler than in male [1] and granulation weaker throughout. Coxal process of arm as in male; trochanter with marginal teeth well developed; femur thinner and proportionally shorter than in male, armed with one weak tooth above and one very strong one below; tibia and hand scarcely longer than broad, armed as in *H. ellisi*, *H. wood-masoni*, etc. Second (first visible) abdominal sternum about twice as broad as long, middle of posterior margin somewhat abruptly produced, surface traversed by a fine groove extending slightly forwards across the middle-line from about the middle of each half of this margin, a single pair of moderately distinct circular impressions situated about half-way between this groove and the anterior margin of the segment.

IV. NEW ORIENTAL TARTARIDES.

Schizomus (*s. str.*) *cavernicola.*

Locality.—This species lives under stones in the depths of the larger of the two famous Farm or Khayon caves near Moulmein where I obtained two specimens, both adult females. I also saw, but failed to capture, some immature specimens, probably of the same species, that were living under stones in a crevice which forms the approach to an upper entrance of the small cave.

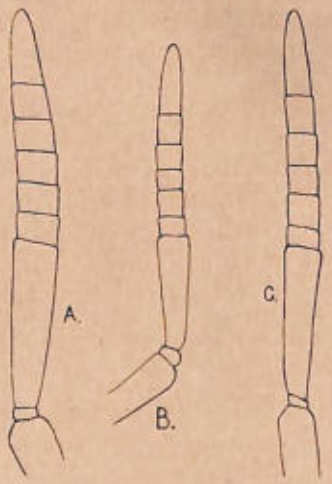
♂. Unknown.

[1] I believe that the colour of these animals is to some extent affected not only by age and by the recency of the last moult but also by the mode of preservation (e.g. the strength and nature of the spirit) employed. In the present instance, however, in view of the small size of this specimen in comparison with the male, it probably indicates that the specimen is scarcely mature; distinctive characters of the anterior abdominal sterna are already developed but they will probably be found to be intensified in perfectly matured specimens.

♀. *Cephalothorax.*—A well-defined pair of white eye-spots present: cephalic sternum about two-thirds as broad as long.

Arms.—Slightly less than half as long as the body. Anterior margin of lower part of trochanter straight or slightly concave, meeting lower margin in an angle of about 60°. The lower angle of the femur about equidistant from basal and distal ends of the upper margin of the joint or a trifle nearer to the former than to the latter. Patella a little more than twice as long as deep; claw about half as long as upper margin of tarsus.

First legs.—Very long and slender, nearly half as long again as body. Coxa terminating behind base of trochanter of arm. Femur a little longer than tibia, tibia a little longer than foot (about one third as long again). Foot nine or ten times as long as



Foot of first leg of new Oriental Tartarides × 60.

A. *Schizomus* (*s. str.*) *cavernicola* ♀.
B. *Schizomus* (*Trithyreus*) *greeni* ♀.
C. *Schizomus* (*Trithyreus*) *kharagpurensis* ♀.

deep, deepest at end of metatarsus; second metatarsus a little longer than sum of five proximal tarsal joints; terminal tarsal joint not quite as long as sum of three proximal joints and about two-fifths the length of the whole metatarsus.

Fourth legs.—About as long as body; femur two-fifths as deep as long.

Tail.—Short and stout, little more than three times as long as deep, four-jointed, the two proximal joints together about three-fifths or a half of the length of the two distal joints together.

Colour.—The general colour is grey-green, paler below than above. The membranes between the sclerites are white and very conspicuous as in *S.* (*Trithyreus*) *vittatus*, although the sclerites are not as dark as in that species. The distal part of the chelicerae but not of the other appendages is reddish brown.

Length.—About 4 mm.

This species is not very closely related to any hitherto described. It resembles Simon's α group in the proportions of the claw of the arm and the foot of the first leg, but not in those of the tail.

Schizomus (*s. str.*), n. sp.

Locality.—Chaibassa, where a single immature specimen was obtained among stones on the shaded side of an old quarry. I do not think it advisable to describe this species till mature specimens are found.

Schizomus (*Trithyreus*) *greeni*, n. sp.

Localities.—Mr. E. E. Green found the type specimen under a stone at Ambalangoda, S. Province, Ceylon, in company with *Amitermes quadriceps*. He has also sent me a specimen caught in the compound of the Museum, Colombo, on July 20th, 1911.

♂. Unknown.

♀. *Cepholothorax.*—Eye-spots absent; cephalic sternum rather more than three-fifths as wide as long.

Arms.—About half as long as body. Trochanter with lower front angle (about 120°) rounded and inconspicuous, anterior margin convex. Lower angle of femur also inconspicuous, about equidistant from basal and distal ends of upper margin. Patella rather more than twice as long as deep (about two and a half times). Claw scarcely half as long as upper margin of tarsus.

First legs.—About as long as body. Coxa terminating a little behind base of trochanter of arm. Femur somewhat longer than tibia. Foot about five-sixths as long as tibia, and about ten times as long as deep, deepest at end of metatarsus; second metatarsus scarcely as long as sum of first five joints of tarsus; terminal tarsal joint somewhat longer than three proximal tarsal joints together and quite two-thirds as long as whole metatarsus.

Fourth legs.—About as long as body; femur two-fifths as deep as long.

Tail.—Broken in both specimens.

Colour.—Brown.

Length.—About 3 mm.

This species seems to stand nearer to *S.* (*T.*) *modestus* than to any other included in Hansen's table (1905, pp. 51-3.)

Schizomus (*Trithyreus*) *kharagpurensis*, n. sp.

Locality.—Kharagpur in the Midnapore subdivision of Bengal where a single female was collected by Mr. Hodgart.

♂. Unknown.

♀. *Cephalothorax.*—Eye-spots absent; cephalic sternum about three quarters as broad as long.

Arms.—About three-fifths of the length of the body. Anterior margin of lower part of trochanter slightly convex, meeting lower margin in an obtuse angle (about 110°). Lower margin

of femur rounded. Patella about two-fifths as deep as long. Claw not quite half as long as upper margin of tarsus.

First legs.—Long and slender, slightly longer than body. Coxa terminating behind base of trochanter of arm. Femur slightly longer than tibia, tibia longer than foot. Foot about twelve times as long as deep, deepest at end of metatarsus; second metatarsus scarcely as long as sum of five proximal tarsal joints; terminal tarsal joint slightly longer than sum of three proximal tarsal joints, and about three-fifths of the length of the whole metatarsus.

Fourth legs.—Somewhat shorter than body; femur about two and a half times as long as deep.

Tail.—About six times as long as deep, four-jointed as in *Schizomus s. str.*, the distal joint about one and a half times as long as the sum of the three proximal ones.

Colour.—Brown.

Length.—About 4·5 mm.

This species differs from all hitherto described in the combination of a divided second thoracic tergite with a four-jointed tail; there seem moreover to be indications of a division of the long distal joint into two parts, though of this I am not certain.

Schizomus (*Trithyreus*), n. sp.

Locality.—Pass between Chaibassa and Chakardharpur in Chota Nagpur. I obtained a few immature specimens under stones in the bed of a small stream in the jungle.

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XI. DESCRIPTION OF A NEW SPECIES OF FRESHWATER CRAB FROM SOUTHERN INDIA.

By J. R. HENDERSON, *M.B., F.L.S., Superintendent, Madras Government Museum.*

PARATELPHUSA (LIOTELPHUSA) MALABARICA, N. SP.

Carapace moderately flat, its length about three-fourths the greatest breadth, its depth about half the length. Under a lens the surface is seen to be minutely pitted, and there are fine oblique striae near the lateral borders; the striae are faintest posteriorly, and behind the short antero-lateral border of the carapace they curve downwards and forwards on to the under-surface of the branchial area. The anterior striae are finely crenulated.

Cervical groove limited to a well-defined crescentic depression forming the posterior boundary of the mesogastric area; on either side of this crescent, about quarter of the way back from its tip, is a somewhat ill-defined groove, which passes backwards and outwards for a short distance. The post-frontal mesogastric furrow is well-defined, and faintly bifurcate posteriorly.

Front slightly more than two-fifths the greatest breadth of the carapace, strongly deflexed, and with the margin almost straight. Both the front and the upper orbital margin have a clearly defined elevated edge. Outer orbital angle moderately prominent; lower orbital margin elevated, and finely crenulated.

Antero-lateral borders of the carapace short, but well-defined, and faintly crenulated; lateral epibranchial tooth small and subacute.

Epigastric crests scarcely distinguishable as distinct elevations, but represented by oblique faintly eroded patches on either side of the mesogastric furrow. Post-orbital crests low, but fairly distinct, commencing at a point nearly behind the inner orbital angle.

Sixth segment of the male abdomen with its proximal and distal ends practically of equal width, but the segment slightly narrower towards the middle; the length of the segment is greater than its breadth.

Antennal flagellum very short.

Terminal joint of mandibular palp bilobed.

Exopodite of the external maxillipeds reaching the middle of the merus, and provided with a well developed flagellum. The ischium is smooth and not grooved, a very faint hollow, best seen at the proximal end, being the sole representative of the usual groove. The merus is much broader than long.

The chelipedes are unequal in the adult male, but not markedly so ; in the female the disparity is but slight. The merus and carpus, particularly the former, are squamulose on the upper surface, while the hand is practically smooth ; the spine at the inner angle of the carpus is well developed. The fingers in adult males are shorter than the palm, and somewhat unevenly toothed ; they gape slightly when closed, while their tips are horny and somewhat blunt.

The legs are a little longer than the smaller cheliped, and their joints, particularly the three terminal ones, are beset with rows and tufts of setose hairs. The dactyli are armed, above and below, with yellow setose spines, a few of which are also seen on the propodi.

The colour of recent spirit specimens is bronze green above, with the undersurface and chelipedes yellowish. The distal halves of the fingers are pale brown.

Dimensions of the carapace in a male :—length 13 mm. ; breadth 17 mm. ; depth 6 mm. ; width of front 6·5 mm. Dimensions of carapace in a female (the largest specimen taken) :—length 16 mm. ; breadth 21 mm. ; depth 9 mm. ; width of front 8 mm.

This species can be readily distinguished from the other species which Alcock (Catalogue of the Indian Decapod Crustacea in the collection of the Indian Museum, part I, fasciculus II, p. 109, 1910) assigns to his subgenus *Liotelphusa*. In *L. lævis* (Wood-Mason) from Assam, the carapace is more convex, the post-orbital crest is fainter, and the post-frontal groove shallower; the ischium of the external maxillipeds is longitudinally grooved, and the length of the sixth segment of the male abdomen just equals its distal breadth. From *L. austrina*, Alcock, the only species hitherto known to occur in Southern India, with which it agrees as regards the long sixth abdominal segment in the male, it can readily be differentiated. In *L. austrina*, the front is distinctly bilobed, and the post-orbital crest is very faint, while the ischium of the external maxillipeds is longitudinally grooved. In *Phricotelphusa campestris*, Alcock, from Bengal, there is a similar arrangement of the epigastric crests, but in this species the exopod of the external maxilliped has no flagellum.

Locality.—I obtained nine males and eleven females, one of the latter with young in the abdominal pouch, from a stream near Kavalai, in the Cochin State Forests, last October. The locality is situated at an elevation of about 1,000 feet above sea level. They were living under stones at the side of the stream, in comparatively dry places, and few were actually observed in the water.

Paratelphusa (*Barytelphusa*) *jacquemontii*, (Rathbun) was common in the same stream, but this crab was only seen in the water.

The type (Crustacea Reg. No. $\frac{7936}{10}$) is preserved in the Indian Museum.

XII. NOTES ON DECAPODA IN THE INDIAN MUSEUM.

IV.—Observations on the primitive Atyidae with special reference to the genus *Xiphocaridina*.

By Stanley Kemp, *B.A., Assistant Superintendent, Indian Museum.*

For the last few years efforts have been made to improve the collection of Atyidae in the Indian Museum and, thanks to the energy displayed by numerous correspondents, the series will, it is hoped, shortly become thoroughly representative of this important part of the Indian freshwater fauna. In course of time a full report on this family and on the Palaemonidae will be issued, forming a part of the Museum Catalogue of Indian Decapod crustacea.

The Atyid fauna of the Indian Empire comprises, so far as is at present known, only three genera, *Atya*, *Caridina* and *Xiphocaridina*. *Ortmannia* (*Atyoida*) does not seem to occur, and this, in view of Bouvier's theory of the mutational origin of that genus and of *Atya*, is a most unfortunate circumstance. It is, however, still hoped that specimens will be found which will provide material for some further consideration of this interesting question.

Atya appears to be very scarce. A few specimens from the Andamans are the only Indian representatives of the genus in the collection, while in addition there is a single example from Ceylon. *Caridina*, the prevalent genus, occurs in great abundance in every suitable locality, inhabiting both fresh and brackish water and ascending to altitudes of at least 6,000 ft. Of *Xiphocaridina* a single species only is known, obtained at Tezpur, on the north bank of the Brahmaputra R. in Assam, and in the native state of Manipur further to the east. It is with this last form that the present note is concerned.

The Atyidae as a whole must be regarded as a very primitive family of Caridea, in spite of the fact that the peculiarly modified chelae indicate a considerable degree of specialization. *Xiphocaridina* is one of the most primitive of the known genera, and it is through such forms as this and *Xiphocaris* that the common ancestry of the Atyidae and the deep-sea pelagic shrimps of the family Hoplophoridae has been traced. Bouvier (1909*a*), following Ortmann (1895), has laid great stress on this interesting feature of Caridean evolution, and his careful researches leave no room for doubt on the point.

The most conspicuously primitive feature of the genera *Xiphocaris* and *Xiphocaridina* is the possession of well-formed exopods on all the peraeopods, a schizopod-like character which they share with one other Atyid genus, *Palaemonias*, Hay, from the mammoth cave of Kentucky. In three other genera, *Syncaris*, *Troglocaris* and *Atyaëphya*, exopods are also found on certain thoracic legs, but never on all, while they are uniformly absent from *Atya*, *Caridina* and *Ortmannia*, genera which comprise the large majority of known species of the family, and from *Limnocaridina*, *Caridella* and *Atyella* that constitute the peculiar Atyid fauna of lake Tanganyika.

Until comparatively recently the distinctions between *Xiphocaris* and *Xiphocaridina* were not recognized; but Bouvier (1909*a*) had pointed out that the West Indian *X. elongata*, the type of the former genus, differs from its supposed congeners in New Zealand, China and Australia in several important structural features. He consequently created for the latter species a new genus, *Xiphocaridina*.

Xiphocaridina is distinguished from *Xiphocaris* by the presence of supra-orbital spines on the carapace, by the anteriorly excavate carpus of the first peraeopods, by the presence of tufts of hairs on the tips of the fingers of the chelae (a character found in all Atyidae with the exception of *Xiphocaris*) and by the absence of arthrobranchs at the base of the first four peraeopods.

From a consideration of these characters it is evident that *Xiphocaridina* has proceeded on a line of specialization similar to that which has resulted in the evolution of *Caridina* and this fact determined Bouvier in his choice of its name. *Xiphocaris*, as at present understood, is the most primitive genus in the family; except for the complete suppression of the mandibular palp, it bears a very close resemblance to the Hoplophoridae.

Palaemonias, Hay (1902, p. 226), is distinguished from both the preceding genera by the distal excavation of the carpus of the second pair of peraeopods and by the unpigmented and non-facetted eyes. It appears to resemble *Xiphocaris* in the absence of a supra-orbital spine and *Xiphocaridina* in the reduction of its branchial system.[1]

Up to the present time only the following species of Atyidae with the full number of exopods on the thoracic limbs have been described :—

Xiphocaris elongata (Guérin).
Cuba; Hayti; Dominica; St. Domingo.

Xiphocaridina compressa (De Haan).
Yokohama; Tokio; Flores; Queensland; Victoria; New South Wales; Norfolk Is.

[1] Hay states (p. 229) that "the gills seem to be only four in number, on each side attached to the first four peraeopods, but there may be a rudiment on the fifth." In *Xiphocaridina* there are seven gills (one rudimentary) on either side and twelve (one rudimentary) in *Xiphocaris*.

Xiphocaridina curvirostris (Heller).
New Zealand; Chatham Is.

Palaemonias ganteri (Hay).
Mammoth cave, Kentucky.

It is consequently a matter of some considerable interest that one of these primitive Atyidae still persists in India, and the identification of this species with *Xiphocaridina curvirostris*, hitherto known only from New Zealand, presents a difficult problem in geographical distribution.

The material available consists of the following specimens:—

Tezpur, Darrang District, Assam. Col. H. H. Godwin-Austen. Twenty-four specimens, two of which are ovigerous females, ranging in length from 24 to 42 mm.

Manipur Hills, Manipur state. Col. H. H. Godwin-Austen. Three specimens (none ovigerous) from 24·5 to 28 mm. in length.

These examples were found many years since and it must, I think, be the case that the species is very strictly localised. On a visit to Assam a year ago I had ample opportunities of collecting freshwater crustacea at Mangaldai in the Darrang District and on the neighbouring Assam-Bhutan frontier, localities at no great distance from Tezpur. Special efforts were made to rediscover *Xiphocaridina*; but the search proved quite unavailing, although several interesting species of *Caridina* were obtained in abundance in the tributaries of the Brahmaputra.

For assistance in the identification of the specimens collected by Col. Godwin-Austen I am under considerable obligation to Prof. E. L. Bouvier, who was kind enough to forward me a transcript of one of his papers on Atyid evolution that had not at that time been received in our Calcutta libraries. He also furnished me with several references which afforded valuable information and spared me from his small series in the Paris museum a specimen of *X. curvirostris* from New Zealand for comparison with the Assam examples.

Subsequently, Dr. C. Chilton, to whom I wish to convey my sincere thanks, furnished me with a considerable number of specimens, obtained in the R. Avon at Christchurch, New Zealand.

I have thus been able to make a careful comparison of Indian and New Zealand examples and no doubt whatever remains in my mind of the complete identity of the two forms. Inasmuch, however, as this determination raises questions of geographical distribution of no little importance a mere statement of fact would not perhaps be acceptable and in searching for some standard of comparison between the two forms it has seemed best to adopt the somewhat laborious method of measurements, as employed by de Man (1908) in the discrimination of varieties of *Caridina nilotica*. The figures are shown in the tables on pp. 116—117 and it will be seen that, judged by this criterion, there is no room for doubt regarding the identity of the forms from the two localities. In the proportions of the antennular peduncle and antennal scale, in the

Measurements of *Xiphocaridina curvirostris* (Heller).[1]

	Tezpur, Assam.					R. Avon, New Zealand.				
Sex	♀	♀	♀	♀	♂	♀	♀	♀	♂	♂
Total length	37·5	35	33	29	37	43	39·5	37	34·5 ov.	29
Length of rostrum ..	7·0	8·0	?	6·1	6·4	7·7	7·1	6·6	7·1	5·9
Length of carapace ..	8·3	7·8	7·1	5·8	6·0	9·2	8·2	8·0	6·8	5·5
Length of antennal scale ..	6·0	5·7	5·2	4·5	5·0	6·5	5·8	5·7	5·4	4·6
First peraeopod—										
Length of carpus ..	1·42	1·44	1·43	1·05	1·28	1·79	1·57	1·53	1·40	1·16
Breadth of carpus ..	·83	·73	·73	·53	·53	·91	·84	·78	·58	·52
Carpus: length ÷ breadth ..	**1·71**	**1·97**	**1·96**	**2·00**	**2·41**	**1·97**	**1·87**	**1·96**	**2·41**	**2·23**
Length of chela	2·12	2·06	1·90	1·65	1·58	2·48	2·23	2·12	1·84	1·31
Breadth of chela ..	·76	·74	·74	·56	·55	·87	·85	·77	·60	·56
Chela: length ÷ breadth ..	**2·80**	**2·78**	**2·57**	**2·95**	**2·87**	**2·85**	**2·62**	**2·76**	**3·07**	**2·34**
Length of dactylus ..	1·0	·90	·91	·77	·72	1·09	·96	·84	·89	·62
Chela-length ÷ carpus-length	**1·43**	**1·43**	**1·33**	**1·56**	**1·23**	**1·37**	**1·42**	**1·39**	**1·31**	**1·13**
Second peraeopod—										
Length of carpus ..	3·45	3·12	2·88	2·24	2·63	3·51	3·16	3·02	2·19	2·25
Breadth of carpus ..	·56	·51	·45	·38	·39	·56	·49	·49	·44	·35
Carpus: length ÷ breadth ..	**6·16**	**6·12**	**6·40**	**5·89**	**6·74**	**6·27**	**6·45**	**6·16**	**5·00**	**6·43**
Length of chela	2·00	1·90	1·79	1·53	1·53	2·20	1·95	1·88	1·67	1·30
Breadth of chela ..	·58	·56	·53	·45	·44	·64	·59	·58	·50	·45
Chela: length ÷ breadth ..	**3·58**	**3·39**	**3·38**	**3·40**	**3·48**	**3·44**	**3·31**	**3·24**	**3·34**	**2·89**
Length of dactylus ..	1·23	1·07	1·05	·91	·91	1·18	·95	1·02	·91	·77
Carpus-length ÷ chela length	**1·72**	**1·64**	**1·61**	**1·46**	**1·72**	**1·60**	**1·62**	**1·61**	**1·31**	**1·73**
Third peraeopod—										
Length of propodus ..	3·67	3·58	3·17	2·77	3·02	4·28	3·77	3·59	3·19	2·77
Length of dactylus ..	1·03	·91	·91	·77	1·14	1·14	1·08	1·0	1·27	·92
Propodus length ÷ dactylus-length	**3·56**	**3·93**	**3·48**	**3·60**	**2·65**	**3·75**	**3·49**	**3·59**	**2·51**	**3·01**
Breadth of dactylus ..	·28	·25	·22	·18	·23	·29	·25	·25	·24	·20
No. of dactylar spines ..	10	10	10	8	16	11	10	11	17	13
Fifth peraeopod—										
Length of propodus ..	4·17	3·43	3·58	3·06	3·51	4·84	4·37	4·05	3·81	2·93
Length of dactylus .	1·21	1·10	1·08	·82	1·05	1·35	1·21	1·20	1·25	·93
Propodus-length ÷ dactylus-length	**3·45**	**3·30**	**3·31**	**3·73**	**3·34**	**3·60**	**3·61**	**3·37**	**3·05**	**3·15**
Breadth of dactylus ..	·31	·26	·26	·24	·21	·33	·24	·30	·24	·22
No. of dactylar spines ..	66	59	63	46	65	70	65	71	70	62
Ova—										
Length	..	·40	·40	..	..	..	·45	·43	..	..
Breadth	..	·25	·25	..	..	..	·26	·26	..	..

[1] The measurements of total length are only approximate. Those of the rostrum, carapace and antennal scale are given to the nearest tenth of a millimetre. As regards the dimensions of the eggs the average of six measurements is entered in the case of each ovigerous female examined.

Proportional lengths of segments of peraeopods in *Xiphocaridina curvirostris*.

(FEMALES ONLY.)

	Tezpur, Assam.			R. Avon, New Zealand.		
	Minimum	Average.	Maximum	Minimum.	Average.	Maximum.
First peraeopod—						
Carpus: length ÷ breadth ..	1·71	**1·9**	2·00	1·87	**1·9**	1·97
Chela: length ÷ breadth ..	2·57	**2·8**	2·95	2·62	**2·7**	2·85
Chela-length ÷ carpus-length ..	1·33	**1·5**	1·56	1·37	**1·4**	1·42
Second peraeopod—						
Carpus: length ÷ breadth ..	5·89	**6·1**	6·40	6·16	**6·3**	6·45
Chela: length ÷ breadth ..	3·38	**3·4**	3·58	3·24	**3·3**	3·44
Chela-length ÷ carpus-length ..	1·46	**1·6**	1·72	1·60	**1·6**	1·62
Third peraeopod—						
Propodus-length ÷ dactylus-length ..	3·48	**3·4**	3·93	3·49	**3·6**	3·75
Fifth peraeopod—						
Propodus-length ÷ dactylus-length ..	3·30	**3·4**	3·73	3·37	**3·5**	3·61

Rostral formulae[1] of *Xiphocaridina curvirostris*.

Tezpur, Assam

3)3+6+7 / 5	2)2+4+2+3 / 4	7)3+4+1+2+? / 4	2)2+6+1+4 / 4
2)2+5+1+5 / 3	3)3+7+2+5 / 5	2)2+5+1+5 / 4	2)2+8+2+4 / 6
2)2+4+1+4 / 4	2)2+4+1+1+4 / 5	2)2+6+1+? / 4	2)2+6+4 / 4
2)2+5+1+1+4 / 4	2)2+5+1+4 / 3	2)2+6+4 / 4	2)2+4+1+3 / 4
3)3+4+1+1+? / 4	2)2+5+1+1+? / 5	2)2+6+2+4 / 3	

Manipur.

2)2+4+1+1+5 / 4	2)2+4+4 / 4	3)3+5+1+1+5 / 4

R. Avon, Christchurch, New Zealand.

3)3+5+1+4 / 3	2)2+5+1+3 / 5	2)2+5+1+4 / 5	3)3+2+1+1+6 / 8
2)2+4+1+4 / 4	3)3+4+1+? / 4	2)2+5+1+4 / 5	2)2+4+1+1+4 / 6
2)2+4+1+4 / 4	2)2+5+1+4 / 5	2)2+5+1+6 / 4	2)2+5+1+5 / 4
3)3+5+1+4 / 4	3)3+7+6 / 4		

[1] The numbers of dorsal teeth are given above and those of the ventral below the horizontal line. In the case of the dorsal series, the full number is shown to the right of the bracket, the plus signs indicating gaps between individual teeth or series of teeth. The figure on the left, separated by the bracket, represents the number of teeth situated on the carapace behind the orbital notch. In the present species it will be noticed that these teeth invariably form a distinct series, isolated by a toothless space from those further out on the limb of the rostrum.

characters of the mouth parts, in the relative length of the peraeopods and the spinulation of their meral and carpal segments, in the branchial formula and in the armature of the telson there appears to be the closest possible resemblance between the two forms.

In point of fact, the sole difference that I have been able to discover is one of colour. In the majority of the New Zealand specimens received from Dr. Chilton the proximal part of each of the setae which fringe the antennal scale and uropods is bright purple and the same coloration is found on the terminal spinules of the telson. This curious pigmentation undoubtedly vanishes in alcohol and, although it is well shown in most of Dr. Chilton's specimens, which were collected in 1910, it could hardly be expected to have persisted in the examples from Assam which have been lying in alcohol for many years.

Xiphocaridina curvirostris was first described by Heller (1862) as a species of *Caridina* from specimens obtained at Auckland. A fuller account by the same author appeared in 1865 and in 1876. Miers included it, also under the genus *Caridina*, in his Catalogue of New Zealand Crustacea. Three years later (1879) Thomson described it as a new species of Palaemonidae, *Leander fluviatilis*; but in 1903 he realized his mistake and gave a fresh account of it[1] under the name *Xiphocaris curvirostris*. In Ortmann's revision of the Atyidae (1895) it appears as *Caridina curvirostris* with a note to the effect that it probably belongs to the genus *Xiphocaris*. Bouvier does not refer to the species in his valuable paper published in 1905; but he mentions it subsequently—using Thomson's name. *fluviatilis*—as a member of his new genus *Xiphocaridina* (1909, *a*, *b*).

The curious distribution of *Xiphocaridina curvirostris* does not, I believe, find any exact parallel among other freshwater Crustacea.

Perhaps its most peculiar feature is that the other species of the genus, *X. compressa*, which inhabits S. Australia, Flores, China, Korea and Japan appears to extend in a band completely separating the two localities in which it is known to exist. But in the present state of our knowledge it is impossible to lay any emphasis on this point, for it may well be that *X. curvirostris* still remains to be discovered in many other localities.

On turning to Ortmann's work on "The geographical distribution of freshwater Decapods and its bearing on Ancient Geography" (1902) it is at once seen from the maps illustrating the hypothetical distribution of land and sea in past geologic periods that, according to this author's views, no direct land connection between New Zealand and Assam has existed in any recent epoch. In the Lower Cretaceous, however, when a land-bridge connected S. India with Madagascar and S. Africa, and when the whole of Northern India was submerged and formed the eastern limit of the

[1] The figures given on Pl. xxix are poor.

great central sea now represented by the N. Atlantic and the Mediterranean, there existed a 'Sino-Australian' continent. This involved Eastern Asia, the Indo-Malaysian Archipelago and Australia, extending southwards to the Antarctic regions and from it a tongue of land reached out to New Zealand by way of New Guinea and Norfolk Island. During Upper Cretaceous times the 'Sino-Australian' continent was divided by a neck of water extending across the region now occupied by Sumatra and Celebes and the land extension from Madagascar to S. India reached north to the northern or Asiatic part of that continent. In Lower and Upper Tertiary times New Zealand was completely isolated as it remains at the present day; in the former period India was merely an island, an eastern sea-connection between the 'Mediterranean' and Indo-Pacific extending across Assam and Burma, while in the latter it approaches the shape which it at present bears.

On these theories the explanation of the discontinuous distribution of *X. curvirostris* is possible, though it can hardly be said to be very convincing. We must assume that *Xiphocaridina curvirostris* evolved from some unknown marine or freshwater ancestor in early Cretaceous or pre-Cretaceous times and remained unchanged until the present day. In the Lower Cretaceous period it would have opportunities of spreading to New Zealand on the one hand and to Lower Burma on the other. Subsequently, while becoming isolated in New Zealand it must have persisted in Burma or in the country existing to the west of it until Assam reappeared during the Upper Tertiary period.

The existence of *Xiphocaridina compressa* both in China and Japan and in Australia seems to show that this species also, according to Ortmann's theories, must have remained without sensible modification for almost as long a period. Every zoologist will readily call to mind other instances tending to a similar conclusion.

Although no exactly parallel case of geographical distribution seems to be known among freshwater Crustacea, the Megascolecid Oligochaeta of the sub-family Octochaetinae afford an instance of a closely similar nature. According to Michaelsen (1909) this sub-family is found only in India and New Zealand [1] and although no species appear to be common to the two, two genera, *Octochaetus* and *Hoplochaetella*, occur in both localities.

Michaelsen holds that the only possible interpretation of these facts is that at one period a direct land connection existed between India and New Zealand. He remarks (p. 203): "I need not explain to any zoo-geographer that the discontinuation of these two regions of distribution in the Octochaetinae is quite a common matter in geographical distribution, the two regions, New Zealand and India, perhaps together with a third region, Madagascar, the home of *Howascolex*, representing the peripheral parts

[1] Michaelsen mentions that another genus, *Howascolex*, known only from Madagascar, might perhaps also be regarded as a member of this sub-family.

of a circular distribution, the internal parts of which have been obliterated by the mighty development of younger and stronger forms, in this case the vigorous genus *Pheretima*, which, from Burma to New Hebrides in one direction and Japan in another, has suppressed and partly exterminated all other genera of earthworms, those of its own phylum or sub-family as well as those of other tribes."

It is, however, difficult to bring the case of *X. curvirostris* in line with this view. There is no evidence that *X. compressa* represents a young and vigorous type which has exterminated its near ally in localities lying between Assam and New Zealand; on the contrary it would rather seem that both species are archaic forms that must have arisen almost simultaneously and, while it is by no means impossible that *Caridina* may have suppressed *X. curvirostris* in Eastern Asia, it is difficult to see why the same cause should not have effected its destruction in Assam.

The genus *Xiphocaridina* is unquestionably a very primitive one and it may be predicted that such forms are less liable to evolve varieties, local races or other species than those exhibiting a greater degree of specialization.[1] That this is so is indeed self-evident, for a primitive form, if it be primitive, must necessarily have existed without considerable modification for a prolonged period and the mere fact that it has done this is an indication that it is less likely to adapt itself to any altered conditions of its environment than is a form which by its very specialization showed that in the past it had given a more ready response to such changes.

The full significance of the unchanged condition of *X. curvirostris* is, indeed, only realized when the great range of variation in certain other Atyidae is considered. *Caridina nilotica* is a species of wide African and Asiatic distribution. Specimens found in Bengal differ in certain measurable features from the type which occurs in Egypt and Dr. de Man has distinguished them under the name of *C. nilotica* var. *bengalensis*. Among other varieties of the same species it agrees most nearly with var. *gracilipes* found in Celebes and Salayer Is. Even within the limits of India and Ceylon, however, the form exhibits a most remarkable tendency to split into races, and series of specimens from Calcutta, Madras, Tuticorin, Ceylon and the Andamans each seem to possess its own particular characteristics.

[1] Pocock (1889) has described several species very closely allied to *Xiphocaris elongata*; but subsequent authors have preferred to regard them merely as varieties. I am, however, of the opinion that these forms are not deserving even of varietal recognition and believe that the suggestion which Pocock himself made, that they only represent stages in the growth of a single species, is likely to prove true. The rostra of large specimens of *Xiphocaridina curvirostris* are as a rule relatively shorter than in smaller examples, and this is also the case with several species of *Caridina*. In these instances, however, the variation has not nearly so great a range as in *X. elongata*. On the other hand there appears to be some evidence that two distinct races of *X. compressa* exist on Norfolk Is. (see Thomson 1903, p. 449, and Grant and McCulloch, 1907, p. 151).

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XIII. FAUNA SYMBIOTICA INDICA.

Introductory Note.

The following papers are the first in a series that I propose to publish as occasion offers. It will deal with Indian animals of different species found living together in a manner that apparently implies something more than fortuitous concurrence. Such relations actually range in an almost unbroken chain from parasitism on the one hand through commensalism to temporary, if not accidental association on the other. In these days of extreme specialization in systematic zoology, it is perhaps just as well that, even in describing new species, attention should be called not only to their taxonomic position but also to their bionomics. Many of the species described in this series will be Polyzoa or Cirripedia, but I do not pledge myself to restrict my investigations to any particular group or groups of animals and I hope to have the help of specialists from time to time.

N. A.

No. 1.—POLYZOA ATTACHED TO INDO-PACIFIC STOMATOPODS.

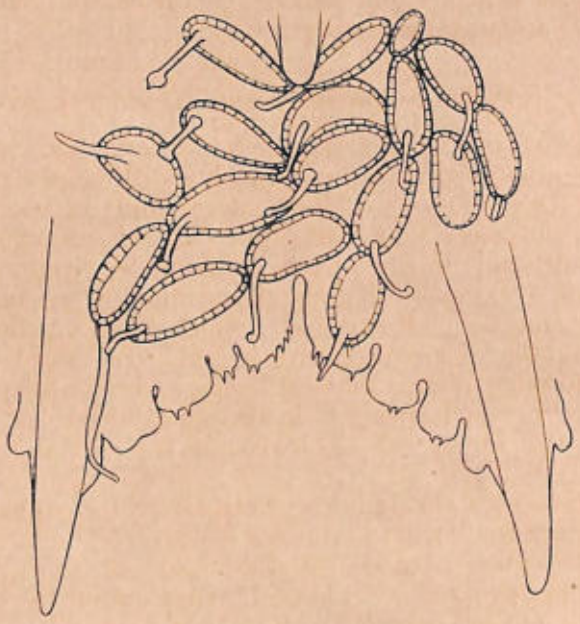
By N. Annandale, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

A biological feature of the Stomatopoda which they share to some extent, at any rate in Indian seas, with the Decapoda Natantia and Anomoura, is the rarity with which other living organisms are attached to any part of their body. In this respect they are in strong contrast with the crabs and Reptantia, which in a large proportion of cases have small Cirripedia (usually species of *Dichelaspis* or *Poecilasma*) attached to the gills, even when the external surface is quite clean. In the collection of Stomatopoda belonging to the Indian Museum, or at present on loan in Calcutta, Mr. Kemp and I have not succeeded in finding more than half a dozen instances of sessile organisms being attached to any part of the animal.

In the case of a *Squilla*, unfortunately not identified, from the Bay of Bengal a few immature barnacles of the genus *Dichelaspis* (probably *D. warwickii*) were found attached to the pleopods, while on the dorsal surface of the carapace and abdomen of an example of *Squilla holoschista* from S. India there are several small *Balani* which I have not yet been able to identify. Mr. H. B. Preston is describing in this part of our

"Records" a peculiar mollusc taken on an Indian species of *Gonodactylus* (p. 126, *postea*).

In two instances only (one instance embracing two individuals of the Stomatopod) did we find polyzoa on the integument, and in none did we come across Hydroids or other Coelenterates. The two polyzoa are of considerable interest, one as representing a new genus and species of uncertain affinities and the other as being identical with a British species. Both species belong to the suborder Ctenostomata.



Platypolyzoon investigatoris on telson of *Squilla investigatoris*, × 17.

Triticella korenii, G. O. Sars.

T. korenii, *Hincks, Brit. Mar. Polyzoa*, p. 545, pl. xlv, figs. 8—10; pl. lxxx, fig. 6, and text-figure No. 31.

The carapace, mantidiform limbs and telson of a specimen of *Squilla fasciata* from the Bay of Tokyo, Japan, lent by Prof. K. Kishinouye, bear numerous little tufts of a polyzoon which appears to be in every way identical with the above-mentioned species. Hincks states that in European waters it is found on various crustacea, from between tide-marks to very deep water.

PLATYPOLYZOON, gen. nov.

Zoarium consisting of flattened, recumbent zooecia growing directly one from another in linear series with occasional lateral

(also recumbent) branches originating from lateral buds; sometimes more than one lateral bud on each side of a zooecium.

Zooecia membranous, hyaline, oval, very flat but with the margin supported by vertical chitinous rods; orifice situated at the summit of an elongate but slender vertical tubule which rises from near the anterior end of the dorsal surface of the zooecium. Parietal muscles consisting of short vertical strands situated round the periphery of the zooecium within the chitinous rods. Gonads arranged round the margin of the zooecium just within the parietal muscles.

Polypide elongate and slender; tentacles not numerous; no gizzard or cardiac antechamber.

Platypolyzoon investigatoris, sp. nov.

Zoarium with comparatively few lateral branches, forming a sparsely ramifying figure; no branches with subsidiary branches observed; rarely more than one lateral bud on each side of a zooecium, not more than two observed; the terminal bud of a branch sometimes drawn out into an elongate, slender process.

Zooecia oval, measuring about 1·0 mm. by 0·5 mm.; colourless except for the chitinous rods, which have a yellowish tinge. Orificial tubule of great relative length, very slender. Parietal muscles forming short, vertical, somewhat fan-shaped strands with the narrow end arising from the inner surface of the ventral wall and the broad end attached to the dorsal wall of the zooecium.

Polypide with the tentacles very long; the stomach slender and elongate; the retractor muscles delicate.

Habitat, etc.—Attached to the telson of two of the type specimens of *Squilla investigatoris*, Lloyd, from off the S. W. Coast of Arabia; 110 fathoms (R.I.M.S. "Investigator").

The affinities of the new genus and species are somewhat doubtful. The zooecia have a superficial resemblance to those of *Flustrella* and it is possible that *F. flabellaris*, Kirkpatrick,[1] from the China Sea may be related. Nothing, however, seems to be known about either the method of budding or the anatomy of Kirkpatrick's species. The structure of the orifice and the method of budding of *P. investigatoris* differ greatly from those found in *F. hispida* (Fabr.), the type-species of its genus, and possibly the former is related rather to *Arachnidium*, from which, however, it differs in that the zooecia are not separated by stolon-like processes. This is perhaps a difference of no great morphological importance, for the terminal bud in the branches of *P. investigatoris* sometimes takes the form of a slender elongate process. The form of the zooecia and the general appearance of the zoarium are strongly reminiscent of the freshwater genera *Arachnoidea* and *Hislopia*,[2] and indeed the relationship between

[1] *Ann. Mag. Nat. Hist.* (6), vol v. p. 23, pl. iv, figs. 3, 3a (1890).
[2] Annandale, *Rec. Ind. Mus.*, vol. vi. p. 198 (1911).

Arachnidium and the new genus may be strictly compared with that between these two genera; but the structure of the polypide differs from that of any of the Paludicellina and the method of budding, although superficially similar, may be distinguished at once by the fact that more than one lateral bud is sometimes produced on the same side of a zooecium. On the whole, therefore, I am inclined to regard *Platypolyzoon* as allied to *Arachnidium*.

A word may be said about the function of the chitinous rods that surround the zooecium in the new species. They appear to be capable of being straightened into erect supports, but in most of the zooecia in the type specimens are bent in a >-like manner, so that the dorsal wall of the zooecium is closely approximated to the ventral. This appears to be due to the fact that the parietal muscles are strongly contracted and is possibly connected with the extrusion of the tentacles of the polypide, which in nearly all the zooecia are in a semi-extruded condition.

No. 2.—ON A NEW GENUS AND SPECIES OF MARINE PARASITIC GASTROPOD FROM THE INDIAN REGION.

By H. B. Preston, *F.Z.S.*

Epistethe, gen. nov.

Shell imperforate, subhyaline, vitrioriform with sunken spire, the last whorl overhanging the penultimate.

Epistethe gonodactyli, sp. nov.

Shell thin, semi-transparent, sub-corneous, ovate, depressed, greyish white above, shading to brownish yellow on the last whorl; whorls 3, rapidly increasing, the first minute, the second overlapped and partly concealed by the last which is, towards the latter portion, developed above into a membranaceous infrasutural projection, and is proportionately very large, marked with radiate creases and sculptured with microscopic, silky, arcuate, transverse striae; suture impressed in the earlier, cavernous in the later stage; base of shell somewhat convex; columella callously, outwardly margined, descending in a curve; labrum thin, membranaceous, receding below, very slightly projecting in front; aperture depressedly sub-ovate. Alt. 3·5, diam. max. 6·5, diam. min. 5 mm. Aperture: alt. 3·5 (nearly), diam. 3·75 mm.

Habitat.—Parasitic on the ventral surface of a Stomatopod crustacean, *Gonodactylus chiragra*, from shallow water in the Persian Gulf; also found on specimens of the same species from the Andaman Islands.

Through the unfailing courtesy of Mr. A. C. Robson of the British Museum, who very kindly examined the animal for me,

Epistethe gonodactyli, × 2.

as far as it was possible to do so without actually abstracting it from the shell, I am able to supply the following note:—"The parasite is found closely adhering to the ventral surface of its host's thorax. The means of fixation were not evident under the circumstances in which the animal was examined, though it seems likely that the foot may be modified as an adhesive organ. The only other character of interest that can be made out without dissection, is the presence of (?) epipodial fringes displayed all round the region of the foot extending two or three millimetres beyond the shell aperture as it rests applied to the body of the host. These fringes have a nodulated surface and are in many places extensively foliated. As a mere guess I am inclined to think they may be respiratory in function, but such a question can only be solved by dissection. There seems to be no reason, upon superficial anatomical grounds, for identifying it with *Cochliolepis parasiticus* (Stimson, *Proc. Bost. Soc. N. Hist.*, 1859, Vol. VI). Examination of from sixty to seventy specimens of *Gonodactylus chiragra* from the same and other eastern localities, in the collection of the British Museum, failed to reveal more examples."

I am in some doubt as to the actual systematic position of the present genus; from the shell characters alone and from the fact of its being parasitic in its habits, I would suggest the neighbourhood of *Robillardia*[1] though the foliated surface of the foot recalls certain members of the Trochidae.

[1] *Ann. Mag. Nat. Hist.*, London, 1889, vol. iii, pp. 270—71.

XIV. OBSERVATIONS ON THE INVERTEBRATE FAUNA OF THE KUMAON LAKES, WITH SPECIAL REFERENCE TO THE SPONGES AND POLYZOA.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent,* and STANLEY KEMP, *B.A., Assistant Superintendent, Indian Museum.*

[The following notes are, in the main, the results of a visit paid to the Kumaon lakes in May, 1911, by Mr. Kemp. We have, however, incorporated also observations made by myself in October, 1907.—*N. A.*]

PART I.—GENERAL.

By STANLEY KEMP and N. ANNANDALE.

The Kumaon lakes[1] are situated at altitudes of from 3,600 to 6,400 feet in the lower ranges of the Western Himalayas in the administrative district of Naini Tal. According to Theobald their origin "is due to the obstruction of local drainage caused by the debris of old moraines on the retrocession of the glaciers at the termination of the glacial epoch." None of them are of any great size, the largest, Naini Tal, covering an area of about 120 acres. The depth is as a rule considerable and in Naukuchia Tal may reach as much as 132 feet.

The principal lakes are five in number :—

	Altitude. Feet.	Maximum depth. Feet.
Malwa Tal ..	3,600	127
Naukuchia Tal ..	4,000	132
Bhim Tal ..	4,450	87
Sat Tal ..	4,500	61½
Naini Tal ..	6,400	93

The banks of the lakes are steep and in most cases composed of stones, at some points with a considerable amount of fine mud.

[1] For particulars of the geology and structure of these lakes see Theobald's paper "The Kumaon Lakes," *Rec. Geol. Surv. Ind.* XIII, p. 161 (1880), and Holland's Report on the geological structure and stability of the hill slopes around Naini Tal, *Mem. Geol. Surv. Ind.*, 1897.

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Although water-plants occur in the lakes, they do not form the rank masses of vegetation that often choke small ponds in the vicinity. In the middle the bottom is composed, probably in all cases, of very fine mud; but little dredging has been undertaken. In Bhim Tal and Naini Tal a certain amount of fine silt is always held in suspension in the water; this is less conspicuously the case in Sat Tal and Malwa Tal, while the water of Naukuchia Tal is remarkable for its clearness.

MALWA TAL.

This lake, which was visited only in May, is situated in a narrow gorge some 3,000 feet in depth. The most striking feature of its fauna appears to be the great luxuriance of the Phylactolaematous Polyzoa.

The most abundant form was *Fredericella indica*, a species hitherto known, in an evidently depauperated phase, from lakes in the Western Ghats and in the plains of Travancore In Malwa Tal the species formed a luxuriant growth consisting of numerous vertical branches, sometimes as much as 35 mm. long, closely pressed together and entangled. It exhibited, however, no tendency to the formation of solid bodies such as are composed by the zoaria of "*Alcyonella*." *F. indica* was found in greatest profusion at the east end of the lake, covering the under surfaces of stones in dense bushy masses; but it also occurred, though more sparingly, in other parts of the lake on the stems of water-plants. The polypides were for the most part (in May) in a state of activity and very few statoblasts could be found in the zooecia.

Plumatella diffusa was also abundant, but its polyparia were as a rule of small size. This species always forms recumbent colonies on flat horizontal or vertical surfaces but in some places the individual zooecia reach a greater length than is the case in Malwa Tal. The specimens were found most abundantly in this lake on the under surface of stones, in many cases together with *Fredericella*. *Plumatella emarginata* and *P. allmani* were both rare, the latter species being found on the stems of a rush.

One of the most interesting animals found in the lake was a new species of *Stolella*, a genus allied to *Plumatella* and recently described from the Indo-gangetic plain. The new species (*S. himalayana*) grew on the lower surface of stones together with *Fredericella* and *Plumatella*, but was very rare, only three specimens having been obtained. It formed a sparse and absolutely flat growth and seemed in danger of being overwhelmed by the more vigorous species associated with it In all three specimens there were indications that active growth had not long been in progress and numerous minute colonies, in which it was evidently just starting, were found in the vicinity of the larger zoaria. In some cases the valves of a statoblast still adhered to the pair of polypides which as yet formed the whole polyparium. The typical form of *Lophopodella carteri* was found in abundance on the

lower surface of stones and less frequently on the stems of water plants. Many of the polyparia were undergoing division and the majority contained fully formed statoblasts. This polyzoon was also found in all the other lakes of Kumaon except Naukuchia Tal and nowhere in the district was it associated with any species of alga as was the case in Igatpuri lake in the Western Ghats.[1]

The only sponge obtained in Malwa Tal was *Spongilla lacustris* subsp. *reticulata*, a form which is common in the plains of India and occurs in the W. Ghats at an altitude of over 2,000 ft. The sponge formed a small basal mass with delicate branches and was of a green colour. It occurred, in no great abundance, on the stems of plants growing in the south-eastern corner of the lake.

Of the higher crustacea only a single species (*Potamon atkinsonianum*) was obtained. As Alcock[2] has shown, *P. atkinsonianum* is closely allied to *P. koolooense*. The latter form extends from the Nepal Terai to Afghanistan, while the former ranges from the Shan States to Simla. The species are characteristic respectively of the Eastern and Western Himalayas; but the two occur together over an area reaching from Nepal to Simla and both have been taken on the shores of the Kumaon lakes.

The entire absence of Palaemonidae and Atyidae is characteristic of all the lakes and of the streams in their immediate vicinity.

When Malwa Tal was visited in May the plankton was anything but rich. Small Copepods occurred, but not in large numbers, while Cladocera and Ostracoda were extremely scarce. A few specimens of a Rotifer belonging to the family Anuraeidae were obtained and also a few Hydrachnids. A minute Peridiniid was found in small numbers. It resembles *Ceratium longicorne*, Perty, in the length of its processes, but agrees with *C. kumaonense*, Carter,[3] in having three processes instead of four: in some individuals, however, a rudiment of the fourth process can be detected, springing laterally from the anterior surface. The only adult aquatic insects which were observed were a Gerrid and a Corixid; small dragon-fly larvae were abundant and a few Ephemeridae were obtained.

NAUKUCHIA TAL.

This lake, also only visited in May, is, as is implied by its name ("the Lake of Nine Corners"), of irregular shape, not being situated in a narrow gorge.

The fauna is at once distinguished from that of Malwa Tal by the entire absence of polyzoa, so far as could be ascertained, and by the profuse growth of sponges.

The most abundant of the latter was a form of the widely distributed *Ephydatia fluviatilis*, a species not hitherto known to

[1] Annandale, *Fauna of British India*, Freshwater Sponges, etc., p. 234, pl. iii, fig. 4, and West, *Journ. As. Soc. Bengal*, 1911, p. 83.
[2] *Cat. Ind. Dec. Crustacea*, pt. I, fasc. II (Potamonidae), p. 26 (Calcutta, 1910).
[3] *Ann. Mag. Nat. Hist.* (4), VII, p. 229 (1870).

occur in India, throughout the plains of which it is apparently represented by the allied "*Spongilla*" *meyeni* of Carter. In Naukuchia Tal the species was found in two phases the peculiarities of which were probably due solely to environment. When attached to water weeds it assumed the form of solid irregular masses often of considerable size and when attached to stones round the margin of the lake grew as thin films usually more or less circular in outline.

A new variety of *Spongilla bombayensis*, a species hitherto recorded from the Western Ghats, the Mysore plateau, the Island of Bombay and S. Africa, was distinguished from all forms previously found by the production of delicate vertical branches on a basal film. It grew on branches of trees at the edge of the lake. Specimens of *Spongilla cinerea* found in the same situation showed no tendency to the formation of branches, but coated the bark in an almost uniform layer about 1 cm. thick. This sponge has hitherto only been found in the island of Bombay and in the Western Ghats.

The only large crustacean which was obtained was a specimen of *Potamon atkinsonianum*.

The plankton resembled that of Malwa Tal, but Entomostraca seemed less abundant, while Peridiniaceae were more plentiful. In addition to *Ceratium longicorne*, which here appeared not infrequently in its typical development, a few specimens of *Peridinium apiculatum*, Ehrenburg, were observed Insects again were exceedingly scarce, but a Rhynchoton belonging to the Naucorid genus *Heleocoris*, not seen in Malwa Tal, was found clinging to the under surfaces of stones on the margin of the lake.

Cladocera, aquatic insects and molluscs occurred in great abundance in a small pond lying above the level of the lake near its northern end.

BHIM TAL.

Owing to the fact that this lake has been dammed at its eastern corner and provided with sluices in connection with the water-supply, the level of the water and the area covered by it can be regulated artificially to a considerable extent. It was visited in October, 1907, and in May, 1911, and on both occasions the sluices were closed and the lake full.

Both sponges and polyzoa are fairly abundant in Bhim Tal; but the former grow less luxuriantly than in Naukuchia Tal, and the latter than in Malwa Tal. The following species were found:—*Ephydatia fluviatilis*, *Spongilla carteri*, *Plumatella diffusa*, *P. allmani*, *P. emarginata*, *P. tanganyikae*, *and Lophopodella carteri*. *Fredericella indica* was not obtained.

Of the sponges in this list only gemmules[1] were found in October, 1907; but growing specimens were collected in May, 1911

1 Annandale, *Journ. As. Soc. Bengal*, 1907, p. 24.

Both sponges and polyzoa were found in greater abundance than elsewhere on branches of trees growing towards the north end of the lake, in an area left entirely dry when the sluices are opened. *Lophopodella carteri* appeared to be equally abundant on the two occasions on which the lake was visited; but *Plumatella allmani* was only taken in October, 1907, and *P. diffusa*, *P. emarginata* and *P. tanganyikae* in May, 1911.

Most of the specimens of *Ephydatia fluviatilis* exhibited a peculiar external modification; growing on narrow twigs, their base necessarily covered a narrow but elongated surface; in consequence their growth was mainly in a vertical plane, the best developed having the form of a large cockscomb.

Here, as in Naukuchia Tal and Malwa Tal, a small leech belonging to the genus *Glossosiphonia*[1] was found in considerable numbers. In May it was noticed that in small pools in the partly dried river bed at the north end of Bhim Tal, individuals of this leech were in the habit of attaching themselves to large water beetles belonging to the genera *Hydrophilus* and *Cybister*: as a rule to the former. The position chosen was invariably the apex of the dorsal surface of the elytra, where in some cases as many as four specimens were found. Leeches could not be discovered beneath the wing-cases and it is difficult to suggest any reason for the association of the two forms, except that leeches attached to water-beetles must have a considerable chance of escape from pools that are drying up, owing to the fact that the beetles have the power of flight. The species of the genus *Glossosiphonia* are known to feed chiefly, if not entirely, on soft-bodied animals, and in the present case it was clear that they were unable to penetrate the hard integument of the insects. Mollusca were abundant in these pools, but only to one specimen, belonging to the genus *Limnaea*, was a leech attached.

In Bhim Tal itself no large water-beetles appeared to exist. *Glossosiphonia* was found under stones round the margin of the lake, frequently with young ones of a pale green colour attached to the ventral surfaces. At least three other Hirudinea were found together with this form, one of them probably representing the genus *Limnatis*. In addition a small dark grey planarian was not uncommon.

As regards the plankton the most notable feature on both occasions was the enormous abundance of a *Ceratium*; but whereas in 1907 the form that occurred could be identified with *C. longicorne*, Perty, in May, 1911, the majority of the specimens agreed closely with Carter's original figure of *C. kumaonense*. It is obvious that much research on the Peridiniaceae of the Indian lakes is necessary before any statement can be made as regards the limits of the "species"—even of those already recorded.

1 Mr. W. A. Harding has kindly informed us that this species is closely allied to the British *G. heterodita* but probably represents a form hitherto undescribed. It is perhaps specifically identical with a species occurring in Calcutta but not as yet found in association with beetles in that locality.

Although there appears to be some evidence that these two forms are merely phases of one species, it is noteworthy that *C. kumaonense*, to use the name without prejudice, is the common form in Bhim Tal at a time of year at which *C. longicorne* predominates in other lakes situated in the same district and at approxinately the same altitude.

SAT TAL.

This lake is situated about two miles west of Bhim Tal at a slightly greater elevation. Originally, as is implied by the name, seven lakes existed, but only two sheets of water of any considerable size now remain. The larger, Sat Tal proper, is U-shaped and in former times comprised two separate lakes; but a neck of shallow water now connects the large eastern part with the smaller, but much deeper, western part.

The fauna of Sat Tal is in some respects similar to that of Bhim Tal, but the plankton is poor and the *Ceratium*, found in such abundance in the latter lake, was (in May) almost entirely absent. Two species of sponge were found, *Ephydatia fluviatilis* and *Spongilla carteri*, the latter being very common. Of polyzoa, *Lophopodella carteri* was plentiful on the branches of trees growing in the eastern part of the lake and *Fredericella indica* was found in the same situation along with a few colonies of *Plumatella tanganyikae*. The water bug *Heleocoris*, noticed in Naukuchia Tal, was not uncommon; but other aquatic insects were, as usual, extremely scarce. Small leeches similar to those obtained in Bhim Tal occurred under stones on the margin of the lake.

The plankton was very scanty: a few copepods were found and *Peridinium apiculatum* was comparatively plentiful. The few examples of *Ceratium* that were obtained had the same form as those observed in Malwa Tal.

In May a small pool of water existed at the bottom of a deep ravine situated close to the weir at the north-west corner of the lake. This, as was found to be the case with the ponds in the vicinity of Bhim Tal and Naukuchia Tal, sustained an abundance of insect and molluscan life.

Gurud Tal, a small lake situated close to Sat Tal but at a slightly greater elevation, could not be examined systematically owing to the absence of a boat. Judging, however, from an inspection of the bank, its fauna did not appear to differ in any notable way from that of the larger lake.

NAINI TAL.

This, the largest of the Kumaon lakes, is situated at an elevation of about 6,400 ft., nearly 2,000 ft. higher than Bhim Tal; but notwithstanding its greater altitude the fauna did not present any considerable difference from that found in the lower lakes, though, on the whole, it appeared to be less rich.

In May almost all the margin was occupied by a dense belt of water-weeds, many of which possesed very long stems and grew from considerable depths. These weeds afforded support to large colonies of *Lophopodella carteri* and *Fredericella indica* and it was noticed that *L. carteri* invariably lived on the upper parts of the stems, extending to within a foot or so of the surface, while *F. indica* always occupied a lower position. Together with these polyzoa large colonies of Vorticellids were conspicuous, more particularly near the surface of the water. The only sponge observed was *Ephydatia fluviatilis*, which grew both on the stems of water-plants and on the under surface of stones on the western bank.

The scarcity of aquatic insects was again a very noticeable feature; but a leech of the predaceous family Herpobdellidae which seemed to be rare in the other lakes was not uncommon under stones.

In May the plankton was decidedly richer than in Sat Tal. Copepods were comparatively abundant and Rotifers of the family Anuraeidae were by no means uncommon. *Ceratium* was exceedingly scarce; the few specimens observed had the same form as those found in Malwa Tal.

At the northern end of Naini Tal, situated at an elevation of about 7,000 ft., there is a small temporary sheet of water bearing the name of Suka Tal. In May, 1911, this was completely dried up, but from earth brought back to Calcutta and placed in an aquarium a few Cladocera and Ostracoda were reared. It was in Suka Tal in October, 1906, and May, 1909, that specimens of an interesting Anostracous crustacean, *Pristicephalus priscus*, were obtained. This species, which has recently been described by Prof. von Daday,[1] seems to be restricted to the Western Himalayas. It has been found in two localities in the Simla Hills and, in addition to Suka Tal, at Bhowali, a village on the road between Bhim Tal and Naini Tal. In May, 1911, the species seemed to be entirely absent from small pools in the vicinity of the Kumaon lakes, although it was abundant in 1907 in the same months near Simla. The erratic appearance and disappearance of the species of Branchiopoda is well known.

The table on the next page illustrates the distribution of Porifera and Polyzoa in the five principal lakes of the district. None of our specimens are from deep water, none having been procured from a greater depth than about 6 feet.

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1 "Mon. Syst. Phyllopodes anostracés" (Ann. Sc. Nat. Zool. (Paris), 9e série, XI, p. 224, fig. 29; 1910).

	Malwa Tal, 3,600 ft.	Naukuchia Tal, 4,000 ft.	Bhim Tal, 4,450 ft.	Sat Tal, 4,500 ft.	Naini Tal, 6,470 ft.
PORIFERA—					
Epydatia fluviatilis	..	C	+	+	+
Spongilla carteri	..	..	+	C	
Spongilla cinerea	..	+			
Spongilla lacustris subsp. *reticulata* ..	+				
Stratospongilla bombayensis var. *pneumatica*	..	C			
POLYZOA—					
Lophopodella carteri	+	..	C	C	C
Fredericella indica	C	..	..	+	C
Plumatella diffusa	+	..	+		
Plumatella allmani	+				
Plumatella emarginata	R	..	R		
Plumatella tanganyikae	..	..	+	R	
Stolella himalayana	R				

[C = common; + = present; R = rare.]

Imperfect as the above observations are, the following general conclusions as regards the fauna of the Kumaon lakes may be stated with some confidence:—

1. The zoo-plankton (more particularly the smaller crustacea) is, at any rate in the month of May, much more abundant in the small pools in the neighbourhood of the lakes than in the lakes themselves; this is also the case as regards aquatic insects.

2. Sponges and polyzoa are remarkably abundant in most of the lakes, but no specimens of the latter group were taken in Naukuchia Tal.

3. Both sponges and polyzoa, with a few exceptions (*e.g. Stolella himalayana*), contain numerous resting reproductive bodies in May. This agrees with what occurs in the plains of India, except that the production of these bodies is usually completed and the vegetative part of the organism has decayed about a month or six weeks earlier. It is very different from what occurs in European lakes, in which the resting reproductive bodies are usually found at the approach of winter.

4. Mollusca such as *Limnaea* and *Planorbis* reach a larger size in the small pools in the vicinity of the lakes than in the lakes themselves.

5. No species of Caridea occurs in the lakes. Decapoda are represented solely by two species of *Potamon* (*s. s.*).

6. A 'species' of *Ceratium* occurs in abundance in the lakes and exhibits great variation. One form of this "species" predominates in each lake at a given date (at any rate in May) but the predominant form is not always the same in different lakes at the same date.

PART II.—SYSTEMATIC AND GEOGRAPHICAL NOTES ON THE SPONGES AND POLYZOA.

By N. ANNANDALE.

PORIFERA.

1. SPONGILLA (EUSPONGILLA) LACUSTRIS subsp. RETICULATA, Annand.

This sponge was only taken in the lowest of the lakes, Malwa Tal (alt. 3,600 feet), in which it was abundant and bore numerous well-developed statoblasts in May. The race is widely distributed in the plains of India, in which it flourishes chiefly in wet weather.

2. SPONGILLA (EUSPONGILLA) CINEREA, Carter.

Specimens were taken in Naukuchia Tal (alt. 4,000 feet) in May. They formed a layer never more than about 10 mm. thick on twigs and are (in a dry condition) of a pale yellow colour. The oscula were small and to some extent radiate, and the skeleton-spicules a little more coarsely spined than in the type, in which the oscula are much larger and non-radiate. The dark greyish colour of Carter's specimens was probably due to their having grown in muddy water. Specimens from the R. Godaveri at Nasik and the R. Bhima at Khed in the Poona district were of a bright green colour but resembled those from Kumaon in the structure of the skeleton-spicules and oscula. Except for the specimens from Naukuchia Tal the species is only known from the Bombay Presidency, the specimens recorded by Prof. Max Weber [1] from the Malay Archipelago as *S. cinerea* actually representing not this species but *S. proliferens*, mihi.

3. SPONGILLA (EUNAPIUS) CARTERI, Carter.

Sponges were taken in Bhim Tal (alt. 4,450 feet) and Sat Tal (alt. 4,500 feet) in May and gemmules were found floating on the former lake in October. This is perhaps the commonest of the Spongillidae in India. The specimens from Kumaon bore well-developed gemmules in May, a month in which these bodies are also fully formed in the plains. At lower altitudes, however, the sponge has usually disintegrated by this date, whereas in Kumaon it was evidently still in declining vegetative vigour.

[1] *Zool. Ergeb. Niederl. Ost-Ind.*, vol. i, pp. 35, 46 (1890).

4. Spongilla (Stratospongilla) bombayensis, Carter.

Specimens from Naukuchia Tal (alt. 4,000 feet) differ sufficiently from the typical form as found in Bombay and Mysore to be regarded as the types of a new variety for which, in the *addenda* to my volume in the *Fauna of British India* (p. 241), I have proposed the name *pneumatica*. Their most striking feature is the thick but irregular pneumatic coat superimposed on the gemmule outside the gemmule-spicules. They are also remarkable for possessing short vertical branches, and one specimen takes the form of a delicate cup attached by its base to a twig.

Ephydatia fluviatilis subsp. himalayensis, nov.

Ephydatia fluviatilis, Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 242 (1911).

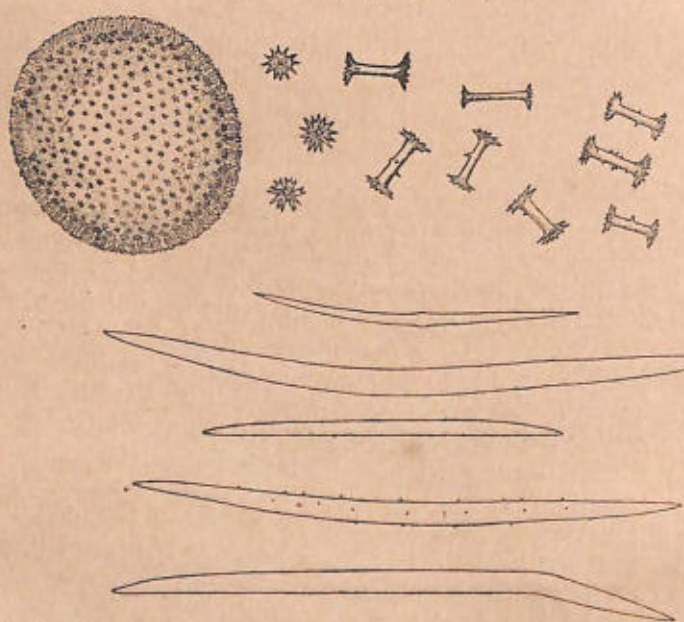

Fig. 1.—Gemmule (×75) and Spicules (×240) of *Ephydatia fluviatilis* subsp. *himalayensis*.

Specimens belonging to this common and widely distributed species were taken in May in several of the lakes, in which it appears to replace *E. meyeni*, Carter, the form common in the plains of India. In Naukuchia Tal, the water of which is remarkably clear, Mr. Kemp was able to see that they did not occur at depths much greater than 10 feet. Gemmules were also taken on the surface of Bhim Tal in October and were attributed to *E. robusta*[1] (Potts), which is probably only a variety of *E. fluviatilis*. The sponge from the lakes of Kumaon, however, although very

[1] Annandale, *Journ. As. Soc. Bengal*, 1907, p. 24, fig. 7.

near to *E. robusta*, exhibits certain peculiarities which seem to entitle it to be regarded as a distinct local race. For this new subspecies the name *himalayensis* is proposed. Many of the specimens are well preserved but I can detect no trace of "bubble-cells" in their parenchyma.

E. fluviatilis subsp. *himalayensis*, may be distinguished from the typical form of the species by the following characters:—

(i) The skeleton-spicules are very variable in length and usually rather slender. The majority are long.

(ii) Scattered amongst the smooth skeleton-spicules of the ordinary type there are a few particularly slender ones which have, widely and sparsely scattered over the middle region, a comparatively small number of very minute spines, the tips being always smooth.

(iii) The gemmule-spicules are somewhat variable in proportions but as a rule rather shorter than is ordinarily the case in the species. Their rotulae are narrow and often almost regularly, although always deeply indented round the margin. The shafts are slender and either smooth or provided with a few comparatively short spines.

The external form of the sponge is very variable and seems to depend to a large extent on the nature of the object to which it is attached. Specimens growing on slender twigs at the surface form a compressed crest like a cockscomb, those attached to stones at the bottom spread out in a flat film of little depth, and those fixed to delicate water-weeds form irregular nodules. No large specimens were obtained, none having a superficial area of more than a few square centimetres. The specimens (dry and in spirit) have a faint yellowish colour. They contained (in May) numerous well-formed gemmules.

Habitat.—Kumaon, W. Himalayas: Naukuchia Tal (4,000 feet), Bhim Tal (4,450 feet), Sat Tal (4,500 feet) and Naini Tal (6,400 feet) (*Kemp*, May, 1911).

In the possession of spined skeleton-spicules *E. fluviatilis* subsp. *himalayensis*, resembles a form of the species which Weltner [1] has recently described from Issyk-Kul in Turkestan. It does not possess, however, the monstrous amphistrongyli of the latter and appears to have less spongin in its skeleton. The external surface is also smoother and the canals are less capacious.

POLYZOA.

The following is a list of the polyzoa taken in the Kumaon lakes; the species have been described in my volume on the Fresh-

[1] "Beiträge zur Kenntniss der Fauna Turkestans—viii. Spongillidae des Issyk-Kul-Sees und des Baches bei Dschety-Ogus." *Travaux de la Société Imp. des Naturalistes de St. Pétersburg*, xlii. p. 63. text figures 8-30. and pl. I, figs. 1-7 (1911).

water Sponges, Hydroids and Polyzoa in the "Fauna of British India," but it now seems necessary to regard one (*Plumatella tanganyikae*) as the type of a new subgenus.

1. FREDERICELLA INDICA, Annandale.

Taken by Mr. Kemp in Malwa Tal, Sat Tal and Naini Tal (3,600—6,400 feet) in May. The specimens from the Himalayas differ from those on which the original description of the species was based (from lakes in the W. Ghats near Bombay and in Travancore) in their much more luxuriant growth. They form dense bushy masses, in some cases with vertical branches as much as 3·5 cm. long. The type specimens were, however, taken in November and were evidently just re-assuming active growth after a period of quiescence.

I have recently (March 2nd, 1912) found this species growing with fair luxuriance on the leaves of *Vallisneria spiralis* in a canal at Cuttack in Orissa. Some of the zoaria contained statoblasts; in others they were absent. The ectocyst was paler in colour than in Mr. Kemp's Kumaon specimens.

2. PLUMATELLA EMARGINATA, Allman.

Bushy masses of this common and universally distributed species were taken in May in Malwa Tal and Bhim Tal.

3. PLUMATELLA DIFFUSA, Leidy.

Common in Malwa Tal and Bhim Tal in May: one of the few species as yet taken in the plains of North-Western India.

4. PLUMATELLA ALLMANI, Hancock.

Taken in Malwa Tal in May by Mr. Kemp and in Bhim Tal in October by myself. Specimens from these lakes show every gradation between the form originally described by Hancock and Allman's *P. elegans*; they possess, however, an apparent peculiarity in coloration in that the older zooecia are invariably surrounded by a band of dark pigment near the middle.

AFRINDELLA, subgen. nov.

This subgenus is distinguished from *Plumatella* (*s.s.*) by the manner in which the orifice is closed when the polypide retracts its lophophore. The stiffened ectocyst of the zooecium, instead of merging gradually into the much softer and more flexible tentacle-sheath, terminates abruptly and the tip of the zooecium therefore becomes truncate—as a rule obliquely truncate, because the stiffened ectocyst is produced at the dorsal end of the periphery, which is oval in outline, further than at the ventral. Immediately following the sharply defined orificial margin thus produced and in direct

continuity with it, the dorsal end gives rise in some zooecia to a small semicircular projection or hood even darker than itself but somewhat more flexible. At each side of the periphery a projecting valve, which is colourless, softer and still more flexible, is formed in continuation of the stiffened wall, and the two valves are joined together round the ventral end by a narrow fringe of integument similar to that of which they are themselves formed. The terminal wall of the zooecium may therefore be said to be surrounded for the greater part of its extent by a projecting fringe or border the surface of which has the roughened appearance characteristic of the external ectocyst, although the colour and stiffness of the latter are absent. Although I talk of this structure as a projecting border, its distal margin is, as a matter of fact, in direct continuity with what becomes the proximal end of the tentacle-sheath when the polypide is fully extended, just as its proximal margin is in continuity with the wall of the zooecium.

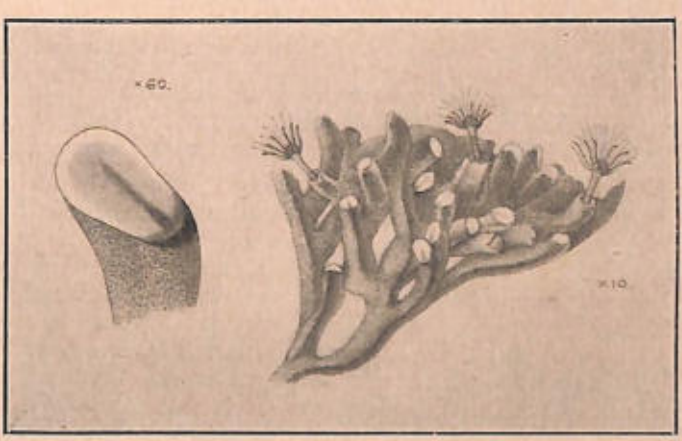

Fig. 2.—Part of zoarium of *P. tanganyikae* from Cuttack, × 10, with the tip of a single zooecium, × 60.

When the polypide retracts its lophophore, the hood (when it is present) is drawn downwards to a slight extent, owing to the fact that it is attached distally to the tentacle-sheath, and bends over the orifice. For the same reason the lateral valves close together tightly, completely covering the orifice. If retraction of the lophophore is spasmodic or unusually violent the valves are dragged into the zooecium so far that a kind of antechamber is formed above them, of course open at the tip. When the lophophore is extended, the valves are thrust apart and the hood is forced into line with the end of the orificial wall. Before the tentacles emerge, however, a bulbous transparent mass appears between the valves and forces them asunder. It is the still partially-invaginated tentacle-sheath.

It was not until I had had an opportunity of examining at leisure with a binocular microscope healthy living colonies of

Plumatella tanganyikae that I realized the complexity of the opercular apparatus in this species, but once this had been realized, it was not impossible to trace the same structures in preserved specimens from both Africa and India, although the much paler colour of the ectocyst in the former made the observation more difficult than it was in the case of Indian examples of the species. The peculiarities described in the preceding paragraphs would fully justify the recognition of *P. tanganyikae* as the type-species of a distinct genus, were it not for the fact that the different species of *Plumatella* (*s. s.*) exhibit considerable variation in respect to the manner in which the orifice is closed. In those species (*e.g.*, *P. repens* and *P. fruticosa*) in which the zooecial wall is fairly flexible and there is no furrow along its dorsal surface, the polypide is merely withdrawn by the retractor muscles, in the same way as the tip of the finger of a glove might be withdrawn by pulling strings attached to its internal surface. The walls of the zooecium collapse together and the result is a rounded tip with a minute round aperture in the middle. In those species, however, (e.g., *P. emarginata* and *P. diffusa*) in which the external ectocyst is somewhat inflexible, a furrow (that is to say, a narrow longitudinal area on which the ectocyst is thinner and softer) extends from the orifice along the dorsal surface of the zooecium and forms at one end the dividing line between valves not dissimilar to those which close together over the tentacle-sheath in *P. tanganyikae*. The lophophore emerges between them just as it does in that species. In *P. tanganyikae* there is usually no furrow on the distal end of the zooecium proper, although there often is one on the proximal part; but occasional zooecia may be found in which, in the absence of a dorsal hood, the soft integument of the valves and the separation between them extend for a short distance along the dorsal surface of the zooecium. Even in such zooecia, however, the separation between the stiff zooecial wall and the soft opercular part of the ectocyst is much more clearly defined than it ever is in such species as *P. emarginata*.

P. tanganyikae must be recognized as the type-species of the new subgenus *Afrindella*, for it is not certain, though highly probable, that a similar method of closing the zooecium occurs in Kraepelin's *P. philippinensis*, which in other respects appears to be closely related.

5. PLUMATELLA (AFRINDELLA) TANGANYIKAE, Rousselet.

P. tanganyikae, Rousselet, *P.Z.S.*, 1907 (I), p. 252, pl. XIV, figs. 1-4

P. bombayensis, Annandale, *Rec. Ind. Mus.*, II, p. 169, figs. 1, 2.

P. tanganyikae, *id. Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 225.

I do not think that the form I described as *P. bombayensis* can be distinguished specifically from Rousselet's African species,

as intermediate specimens occur; but Indian specimens represent a distinct race for which the name *bombayensis* must stand. Mr. Kemp found this species somewhat sparingly in Bhim Tal and Sat Tal in May. His specimens have a peculiar reddish colour and their zooecia are longer and slightly less recumbent than those from the W. Ghats. They were attached to small stones.

I have recently (March 2nd, 1912) found several colonies of this species growing, together with *Fredericella indica*, on the leaves of *Vallisneria spiralis* in a canal at Cuttack in Orissa. They resembled those found on the lower side of stones from Igatpuri but were evidently young.

It is curious that no species of *Plumatella* with broad statoblasts (except the aberrant *P. punctata*, Hancock) has as yet been found in India. Braem[1] has recently described (together with a new species of *Victorella*) a form allied to, if not identical with, *P. fungosa* (Pallas) from Issyk-Kul in Turkestan, but I know of no similar form in this country.

6. STOLELLA HIMALAYANA, Annandale.

Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 246, fig. 49.

This species is described and figured in the *addenda* to my volume in the "Fauna" (p. 246, fig. 49) from specimens taken by Mr. Kemp in Malwa Tal in May. At that season the species was evidently scarce, but the zooecia contained few statoblasts (only free ones) and numerous young colonies were being formed by the budding of old statoblasts on the stones to which the adult zoaria were attached.

S. himalayana differs from *S. indica*,[2] the type species of the genus, in the following characters:—(i) the zooecia are entirely recumbent; (ii) each zooecium is separated from all others by the stolon-like prolongation of their bases; and (iii) the zoarium produces lateral branches almost in a cruciform manner.

7. LOPHOPODELLA CARTERI (Hyatt).

I found this species fairly common in Bhim Tal in October and Mr. Kemp took it in great profusion in the same lake and in Malwa Tal and Sat Tal in May. At both seasons statoblasts were being produced in large numbers, but in my specimens a large proportion of these were more or less ill-formed, the hooked processes being deficient or obsolete. These specimens were made the types of my variety *himalayana*. Mr. Kemp's were, however, quite normal. *L. carteri* was originally found in the island of Bombay and is abundant in November in Igatpuri lake in the

[1] "Beitrage zur Kenntniss der Fauna Turkestans—viii. Bryozoen und deren Parasiten," *Trav. Soc. Imp. Naturalistes St. Petersburg*, vol. xlii, p. 5, figs. (1191).

[2] *Rec. Ind. Mus.*, iii, p. 279, fig. (1909). Professor K. Ramunni Menon of Madras has recently sent me specimens of *S. indica* from that city.

W. Ghats. A record of "*Lophopus*" from Madras may actually refer to this species, statoblasts of which have been found in German East Africa. A race (*davenporti*, Oka) occurs in Japan and is distinguished by the stronger development of the hooked processes at the ends of the statoblasts.

GEOGRAPHICAL DISTRIBUTION OF THE SPECIES.

The following list shows practically all that is known of the distribution of the sponges and polyzoa that have been found in the Kumaon lakes, at any rate so far as India is concerned. It would seem to provide evidence that the aquatic fauna of the Malabar Zone[1] is less restricted than it at one time appeared to me. Recent investigations, however, undertaken in different parts of India, prove that the African element which is so marked a feature of that fauna is more widely distributed in India than was at first realized. In particular, a species (a somewhat peculiar species, it is true) of *Corvospongilla* has been found in the Ganges valley,[2] while both *Fredericella indica* and *Plumatella tanganyikae* have been discovered in the main Peninsular Area of India. It is noteworthy that the Gangetic *Corvospongilla* differs from its congeners in having free statoblasts provided with a well-developed pneumatic layer, but a species of the genus more typical in this respect (*C. ultima*)[3] has also been found at Tanjore far to the east of the Western Ghats.

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[1] See Alcock, *Cat. Ind. Dec. Crustacea Ind. Mus.*, part i, fasc. ii (Potamonidae), 1910; also the general introduction to my volume on the Freshwater Sponges, etc., in the *Fauna of British India*, p. 10.

[2] Annandale, *op. cit.*, p. 243.

[3] This species is wrongly attributed to *Spongilla* in the "Fauna" (p. 105).

Geographical Distribution of the Sponges and Polyzoa of the Kumaon Lakes.

[Forms of which the names are marked with an asterisk are apparently peculiar to the lakes of Kumaon.]

Name of Species.	Malabar Tract.	Peninsular India (Main Area).	Indo-Gangetic Plain.	Distribution outside India.
SPONGES.				
Spongilla lacustris subsp. *reticulata.*	Igatpuri, W. Ghats ..	Madras, etc. ..	Gangetic delta ..	Typical form of the species widely distributed in Europe, N. Asia and America.
Spongilla cinerea ..	Bombay (island); Igatpuri; Poona district.	....	....	....
Spongilla carteri ..	Many localities ..	Many localities ..	Many localities ..	Mauritius; Malay Archipelago; E. Europe; ? Central Africa.
Spongilla bombayensis var. *pneumatica* *	Bombay (island); Igatpuri (*typical form*).	Bangalore (*typical form*) ..	....	Natal, S Africa (*typical form*).
Ephydatia fluviatilis subsp. *himalayensis.**	....	....	....	Europe; America; N. Asia (*typical form*) Turkestan (? *var.*); S. Africa (*var*).
POLYZOA.				
Fredericella indica ..	Igatpuri, W. Ghats; Travancore (plains).	Cuttack, Orissa ..	....	A specimen from N. Assam may belong to this species, but it is doubtful even whether it is *Fredericella.*
Plumatella emarginata ..	....	....	Gangetic delta ..	Europe, N. America, etc.
Plumatella diffusa ..	....	....	Gangetic delta, etc. ..	Europe, N. America
Plumatella allmani	....	....	....	England.
Plumatella (Afrindella) tanganyikae.	Igatpuri, W. Ghats ..	Cuttack, Orissa ..	....	Central Africa (L. Tanganyika).
*Stolella himalayana** ..	....	....	....	....
Lophopodella carteri ..	Bombay (island); Igatpuri.	? Madras	....	E. Africa (*typical form*); Japan (*subspecies*).

XV. FAUNA SYMBIOTICA INDICA.

No. 3.—POLYZOA ASSOCIATED WITH CERTAIN GANGETIC TORTOISES.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent, Indian Museum.*

(Plate XIII.)

It was noticed that peculiar lichenoid patches were present on the carapaces of a number of tortoises captured in the Ganges near Rajmahal in March, 1912, by Mr. B. L. Chaudhuri and brought alive to Calcutta At first sight the patches were taken for algae, but a close examination showed that they were formed of one or both of two species of polyzoa, namely *Hislopia lacustris* and an undescribed form of *Plumatella* closely allied to *P. tanganyikae*. The tortoises in the collection belonged both to the Testudinidae and the Trionychidae, the former being represented by three species of *Kachuga* (*K. dhongoka*, *K. lineata* and *K. smithii*) and one of *Hardella* (*H. thurgii*), while the Trionychidae comprised *Trionyx gangeticus* and *T. hurum*. The polyzoa were not found on either species of *Trionyx* or on *K. smithii* (a small species), but one or both occurred on most of the larger specimens of Testudinidae. Probably the skin of the mud-turtles is too soft and slimy for their proper attachment or growth.

The tortoises had been out of the water for at least twenty-four hours before they were examined and the polypides of the polyzoa had perished, but fortunately the zooecia remained in sufficiently good condition for an investigation of the general structure and specific characters.

HISLOPIA LACUSTRIS, Carter.

Annandale, *Faun. Brit. Ind.*—Freshwater Sponges, etc., pp. 190, 200—205, figs. 35A, 38 and 39.

The zoaria on the tortoises' shells each cover an area of several square inches and are of luxurious growth, almost every zooecium producing its full complement of three buds and the whole colony being closely compacted, without, however, the zooecia overlapping. The individual zooecia are small, measuring on an average slightly over 1 mm. in length and being very variable in breadth ; they are as a rule irregularly polygonal in outline and have the proximal end narrower than the distal. The orifice is circular or subcircular and as a rule lacks spines, although it

has a well-marked chitinous border. The zooecia are too closely fitted together for a flat membrane to intervene, but their chitinous margins are well developed.

Most of the zoaria in the collection had been overgrown by the Phylactolaematous species next to be described. They were only found on the carapace of *Hardella thurgii* in this instance, but *Hislopia lacustris* commonly occurs on the shells of molluscs of the genus *Vivipara* as well as on the leaves of *Vallisneria spiralis*, on logs, stones and other inanimate fixed or floating objects. Major Walton discovered the polyzoon *Stolella indica* growing over large zoaria in the United Provinces and the bases of the type-specimens of the sponge *Corvospongilla burmanica* from Pegu contained the remains of zooecia. The species is widely distributed in the tropical parts of eastern Asia.

PLUMATELLA (AFRINDELLA) TESTUDINICOLA, sp. nov.

Zoaria forming quite flat, oval or circular lichenoid patches with undulating or sinuous borders and in some instances as much as 10 cm. in diameter; consisting of zooecia laying parallel and closely adjacent in one plane and radiating in branches from a common centre.

Zooecia entirely recumbent, narrow, elongate, with the orifice opening almost vertically; the proximal part a little flattened, without dorsal keel or furrow; the ectocyst densely covered with minute sand-grains, translucent brownish, indistinctly annulated, paler on the distal than on the proximal part.

Polypide not observed.

Statoblasts.—Only fixed statoblasts are apparently developed. They occur in great profusion, entirely filling many dead zooecia and arranged in moniliform series. As the dorsal wall of the zooecium decays they are left adhering with its ventral wall to the host's carapace and reproduce the pattern of the zooecium, often almost completely. They are, as a rule, broadly oval, measuring about 0·52 × 0·35 mm., but sometimes they are circular and occasionally kidney-shaped. The surface is polished and without a trace of reticulation and the capsule is surrounded by a stout chitinous ring separated from it by a deep peripheral groove; the colour is black or very dark brown.

Localities and hosts.—R. Ganges near Rajmahal, on carapace of *Hardella thurgii*, *Kachuga dhongoka* and *K. lineata*: staloblasts also observed on young specimens of *K. dhongoka* from Allahabad and Fatteghar.

The structure of the zooecium closely resembles that of the zooecia of some forms of *Plumatella tanganyikae*, which I have recently adopted as the type-species of the new subgenus *Afrindella* (Rec. Ind. Mus., vii, p. 140) and I have little doubt that I am right in referring the new species to that subgenus. It is unfortunate, however, that the polypides of the type-specimens are not in a fit state for examination. The statoblasts somewhat

resemble those of *Fredericella*, to which belong the only species hitherto described in which all of these bodies are devoid of a ring of air-cells. The fixed statoblasts of *Plumatella*, however, always resemble those of *Fredericella*, and that to a different extent in different species. It is probable in the present instance that the production of fixed statoblasts only is an adaptation correlated with the peculiar method of life adopted by the polyzoon. As the tortoises to which it is attached leave the water for purposes of oviposition, if not for other purposes also, it is perhaps necessary that the *Plumatella* should not altogether lose their services as beasts of burden at any period in its life-cycle, solid objects to which it can affix itself being few and far between in the mud of the Ganges.

In its general appearance *P. testudinicola* bears a remarkable but of course quite superficial resemblance to certain Cheilostomes and Ctenostomes that encrust flat surfaces. The method of budding is, however, completely different, for the closely compacted parallel branches of the zoarium are produced by linear budding or by the production in the first instance of two divergent buds at the tip of a parent zooecium. Except at and near the centre (which is the oldest part of the zoarium) there is no organic connection between the different branches, which, at any rate near the periphery, merely lie alongside one another. In the older parts of the colony it is clear that the production of divergent buds in the position indicated has been frequent but that they, or rather the branches produced from them by linear budding, have become closely pressed together and therefore parallel, not apparently having the power of raising themselves from the basis to which they adhere. Thus the method of budding differs from that of such forms as *Membranipora* and *Hislopia* in that lateral buds are never produced, while there is no single zooecium from which the branches radiate outwards as in *Flustrella* and many other encrusting forms. Indeed, it seems probable that each apparent colony is not really a single zoarium but rather the result of budding on the part of a group of statoblasts or embryos from each of which branches have been produced in one or in two directions. In *Plumatella tanganyikae*, although compact flat zoaria are often found, it is always possible to see that their branching is fundamentally bilateral and probably arises from the fact that the two first polypides produced from a single statoblast or embryo have diverged from one another before fixation was completed. In *P. testudinicola*, on the other hand, each colony appears to have arisen from a group of separate but closely adjacent individuals, the branches of which have been forced to diverge by mutual pressure. It is, however, difficult to be quite sure of this without studying young growing zoaria, which I have not seen, as the central part of old zoaria is always in a more or less decayed condition.

My specimens of the new species were taken in March, and it is evident that the vegetative phase of their life-cycle was practi-

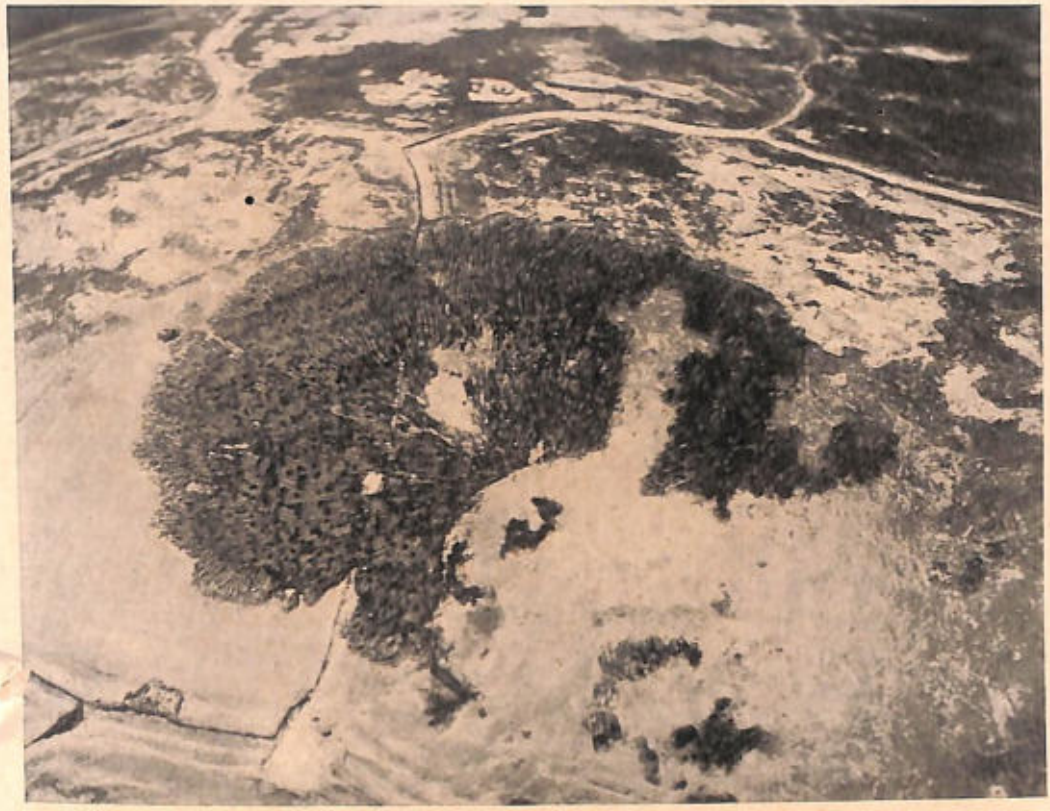
cally complete, statoblasts being produced in large numbers. *P. testudinicola*, like so many other Indian representatives of the Phylactolaemata, would appear, therefore, to be essentially a cold-weather form. On *Hardella thurgii* the zoaria grew over those of *Hislopia lacustris* and the zooecia were much less regular in their arrangement than when they were alone. The smooth shell of *Kachuga lineata* seemed, on the other hand, to encourage the production of the regularity and parallel growth so characteristic of the branches of the species.

EXPLANATION OF PLATE XIII.

Photographs of the type-specimens of *Plumatella* (*Afrindella*) *testudinicola* on the carapace of *Kachuga lineata*.

FIG. 1.—The whole zoarium (*nat. size*).

,, 2.—The central part of the same zoarium (*enlarged*), showing statoblasts (s) *in situ*.



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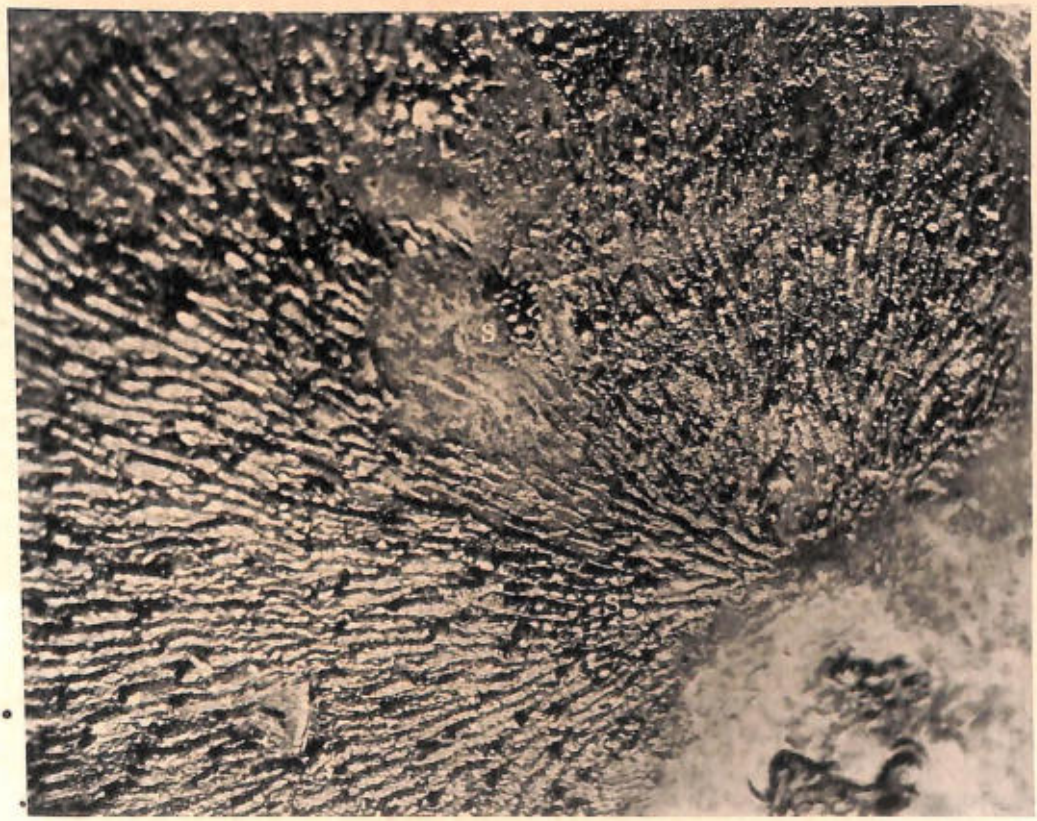

Photo by N. Annandale. 2.

XVI. THE INDIAN MUD-TURTLES (TRIONYCHIDAE).

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*, *Superintendent, Indian Museum.*

(Plates V—VI.)

The main object of the present paper is to supplement Mr. G. A. Boulenger's admirable account of the Indian Chelonia published in the volume on Reptilia and Batrachia in the "Fauna of British India." It is now twelve years since this volume appeared and although additions to our knowledge of the Trionychidae since that date have not been very numerous or important so far as India is concerned, the fact that its author had not access to the bulk of the large collection accumulated in the Indian Museum by the late Dr. J. Anderson and his contemporaries and successors rendered certain omissions unavoidable.

I have been able, moreover, to institute special inquiries into the distribution of certain species and races and have received assistance in so doing from several naturalists in different parts of India, especially from Dr. J. R. Henderson, Superintendent of the Madras Museum, and from my colleague Mr. B. L. Chaudhuri, who has supplied me with valuable information.

One species and two subspecies not recognized by Mr. Boulenger in the "Fauna" are here described. The species belongs to the genus *Trionyx* and is interesting because it represents this genus in a geographical area in which information about its distribution was peculiarly scanty.

This *Trionyx* was described, it must be confessed inadequately, by Dr. Anderson, who named it *T. nigricans*. It inhabits a tract of country intermediate between the Brahmaputra river-system and the Arrakan streams in which a Burmo-Malay species of the genus first makes its appearance. I have found it necessary, moreover, to recognize the races of *Emyda* that occur in Chota Nagpur and Orissa on the one hand and in Ceylon on the other as distinct subspecies. The name *intermedia* is here proposed for the former race, while Gray's "*ceylonensis*" is available for the latter.

LIST OF THE INDIAN TRIONYCHIDAE.

1. Dogania subplana (Geoffr.). Mergui, Malay Peninsula, Sumatra, Sinkep I., Java, Borneo, and the Philippines.

2. Trionyx gangeticus, Cuvier.	The river-systems of the Indus, the Ganges and the Mahanaddi.
3. ,, leithii, Gray. ..	The rivers of western, central, and northern India.
4. ,, hurum, Gray. ..	The lower reaches of the Ganges; the Brahmaputra as far east as its entry on the plains.
5. ,, nigricans, Anderson.	Chittagong.
6. ,, formosus, Gray. ..	The Irrawaddi, the Sittang and the Salween.
7. ,, phayrei, Theobald.	Arrakan, Pegu, Tenasserim, the Malay Peninsula, Sumatra, Java, and Borneo.
8. ,, cartilagineus (Boddaert).	Pegu, Tenasserim, Siam, Cambodia, the Malay Peninsula, Sumatra, Borneo and Java.
9. Pelochelys cantoris (Gray).	The lower Ganges system, Burma, the Malay Peninsula, Annam, S. China, Borneo, Sumatra, the Philippines and New Guinea.
10. Chitra indica (Gray). ..	The Ganges and Irrawaddi system, as far as the base of the Himalayas in the former.
11. Emyda granosa (Schoepff).	The valleys of the Indus and the Ganges; the Arrakan Coast.
11*a*. ,, ,, intermedia, nov.	Chota Nagpur; the Central Provinces; Orissa and the north-east of the Madras Presidency.
11*b*. ,, ,, vittata, Peters.	The greater part of the Bombay Presidency (including Cutch); the whole of the Madras Presidency except the north-eastern part; Travancore.
11*c*. ,, ,, ceylonensis, Gray.	Plains of Ceylon.
11*d*. ,, ,, scutata, Peters.	The valleys of the Irrawaddi and the Salween.

From the above list it will be seen that the Trionychids of the Indian Empire fall naturally into three groups, if considered from a geographical point of view:—(1) those of the Indo-Gangetic and Brahmaputra river-systems; (2) those of the valleys of the rivers of Peninsular India, and (3) those of Burma.

The exact limits of these areas are, however, not strictly observed, for while the typical form of *Emyda granosa*, a characteristic Indo-Gangetic race, ranges in a south-easterly direction as far as the Arrakan Coast, the common Indo-Gangetic *Trionyx* (*T. gangeticus*) is apparently not only replaced in Arrakan by

T. phayrei but also separated from that species in Chittagong by *T. nigricans*, in many respects an intermediate form. Very little information is as yet available about the exact distribution of the South Indian species of *Trionyx*, but we now know that an Indo-Gangetic species (*T. gangeticus*) occurs in the Mahanaddi.

Both the southern race of *Emyda granosa* (subsp. *vittata*) and the northern or typical form have been found to be different from that which occurs in the Central Provinces and Chota Nagpur and inhabits even the valleys of rivers such as the Kasai and the Barakar which actually reach the sea through the Hughli estuary, south of the Hughli itself.

The Burmese forms are either endemic or found also in the Malay Peninsula, except the monotypic genus *Chitra* which has only been found in the Ganges and the Irrawaddi. *Trionyx formosus* is only known from the Irrawaddi, the Salween and the Sittang; *Emyda granosa scutata* only from the valleys of the two former rivers, while *Dogania subplana* and *Trionyx cartilagineus* are typical Malayan forms. *T. phayrei*, on the other hand, in all probability originated in the hills of Arrakan and has made its way southwards into the Malay Peninsula and certain islands of the Malay Archipelago and eastwards into Indo-China.

Only one of the Indian Trionychids has a really wide geographical range in both the Malayan and Indian sub-regions, namely *Pelochelys cantoris*. This appears to be a somewhat scarce species wherever it occurs, although it has been found both in the lower reaches of the Ganges and in New Guinea, as well as in many intermediate localities.

In preparing these notes I have not thought it necessary to give detailed reference to all the works that have appeared before or since the publication of Mr. Boulenger's volume in the "Fauna." To do so in respect to previous works is needless except in a few instances, whereas a full bibliography of recent references can be extracted from Dr. E. Siebenrock's "Synopsis der rezenten Schildkröten" (Zool. Jahrbucher, Jena, 1909). I have referred to this most useful work throughout simply by the author's name with the page number added.

Genus DOGANIA, Gray (1844).

Siebenrock, p. 605.

This genus, which is not recognized by Mr. Boulenger (at any rate in the "Fauna") as distinct from *Trionyx*, has the whole series of costal plates separated by neurals, instead of having the last pair of costals in contact in the middle line. The plastron [1] is also less fully ossified than in *Trionyx* in a restricted sense, and the branchial skeleton differs in that the basihyoid bones are in close contact in the middle line.

Only one species, which is widely distributed in Malaysia and occurs in the coastal districts of Burma, is known to exist.

1 Siebenrock, S. B. K. Akad. Wiss. Wien, CXI, pp. 817—8, fig. 2, 1902.

1. Dogania subplana (Geoffr.).

Boulenger, Fauna, p. 9.

Distribution.—Arrakan, Tenasserim, Mergui Archipelago, the Malay Peninsula, Sumatra, Java, Borneo, and the Philippines.

Specimens :—

Burma.

11589 (spirit) : juv.	.. Tibu, King I., Mergui Archipelago.	..	*Dr J. Anderson.*
13468-9 (stuffed) : juv.	,,	,,	,,
661 (spirit) : juv.	.. "Sinkep I., off E. Coast of Sumatra"	..	*J. Wood-Mason.*

The two specimens in spirit are very young; their coloration has been obscured by fading but six rather small ocelli can still be distinguished on the disk, while the head and neck bear traces of longitudinal markings. The stuffed specimens from Mergui are probably half-grown, the disk measuring about 23·6 cm. in length. These and the young individual in spirit from the same district are referred to by Dr. Anderson in his "Fauna of the Mergui" (Jour. Linn. Soc. Zool., xxl, p. 342).

Mr. H. C. Robinson informs me that this is a purely estuarine and marine species.

Genus TRIONYX, Geoffr. (1809).

Boulenger, Fauna, p. 10 (*partim*): Siebenrock, p. 595.

This genus, which is by far the largest in the family and occurs in the warmer parts of all the continents except Europe, is well represented in the Indian fauna, to which at least eight species can be assigned.

The species are difficult to recognize, unless cranial and skeletal characters are considered as well as coloration. The lower jaw in particular affords diagnostic features of great importance in most species.

The branchial skeleton of this genus is less fully ossified and less complex than in some genera of the family. I have been able to find specific differences in it in some species. The basal part consists in the adult of three pairs of bones, a pair of basihyals in front, followed by two pairs of basibranchials. The basihyals are widely separated by a cartilaginous plate in which small irregular ossifications sometimes occur; their external margins are somewhat protuberant anteriorly but do not form regular horns. The basibranchials are in close contact in the middle line; the large cornua are articulated to prominent condyles situated on their external margins. The hypobranchials are well developed. They are articulated to the posterior border of the posterior basibranchials. The ceratobranchials and pterygobranchials are sometimes represented by cartilage, sometimes ossified.

An examination of the fine collection accumulated in this museum by the late Dr. John Anderson renders it necessary to reinstate one species (*T. nigricans*) inadequately described by him and since ignored by most writers on the Chelonia. All the recognized Indian and Burmese species are represented in the Indian Museum, but *T. leithii* and *T. cartilagineus* only by young specimens. We possess the types of the following described species:—

T. buchanani, Theobald. (= *T. hurum*, Gray). No. 1090 (skeleton). Proc. As. Soc. Bengal, 1874, p. 78.

T. nigricans, Anderson. Nos. 1898 and 735 (skeletons). Ann. Mag. Nat. Hist., (4) XVI, 284 (1875).

Mr. Boulenger suggests in his "Catalogue of the Chelonians, etc. in the British Museum" (p. 243) that at least some species of *Trionyx* are dimorphic, the two phases differing in the form and structure of the jaw and their characteristic features being produced, in the case of the individual, by the method of obtaining food adopted at an early age.

So far as the Gangetic species are concerned I have been unable to obtain any evidence that this is so. Two distinct species, the skulls of which are different at all ages, occur together, namely *T. gangeticus* and *T. hurum*. The former has a blunt, the latter a sharp snout; and the youngest skulls can be distinguished with ease by the length of the symphysis of the lower jaw. I have examined many hundreds of living individuals, as well as a large series of skulls, and have never come across a specimen that was in any way intermediate between the two species in structure; while only one specimen of *T. hurum* (No. 16627) had some resemblance to *T. gangeticus* in colour, or rather differed so widely in this respect from normal individuals of its own species that its superficial appearance was reminiscent of *T. gangeticus*, although it lacked the characteristic head-markings of that species.

A not uncommon abnormality in the Indian species is an upward curvature of the vertebral column that results in the carapace, instead of being flat, assuming a conical form and actually in some instances being deeper than it is broad. The presence of a deep groove on the middle line of the carapace is another common abnormality.

The nature of the food of the members of the genus is apparently a disputed point. So far as my own observations go, they are practically omnivorous, at any rate when living in a semi-domesticated state. In the Malay Peninsula certain individuals (probably of *T. cartilagineus*) haunt rivers in the vicinity of villages and act as scavengers. The specimens of *T. formosus* that are kept in the Arrakan Pagoda at Mandalay feed readily on curry and rice and those of (?) *T. hurum* that live in somewhat similar conditions in a tank attached to one of the temples at

Puri in Orissa, eat sweetmeats made of parched rice and palm-sugar. In such conditions they grow very tame and come to feed when called. Those at Puri are popularly believed to be the descendants of a man named Gopal who offended Juggernaut; they are summoned by the priests by this name, to which they answer sometimes—but by no means always—by appearing on the surface and swimming towards the edge of the tank.

The distribution of the Indian species of *Trionyx* is a matter of considerable interest but one in need of further elucidation, especially in respect to the species that occupy the rivers of western and southern India. There can be no doubt that one species (*T. gangeticus*) occurs both in the Indus and the Ganges, but whether this is the only form that will be found in the former river we do not know. Whether *T. leithii* is to be found in all the rivers of western, central and northern India we do not know. What species occur, if any do occur, in the rivers that water the southern and south-western parts of the Madras Presidency, and whether any species occur in Ceylon are questions that I have been unable to solve.

In the Gangetic delta, and I believe in the other parts of India, *Trionyx* is regarded as an important article of diet. Very large numbers are caught, chiefly in the Khulna district, for the Calcutta market and are sent to town by train. They are captured in nets in autumn, when the rivers begin to sink, and are stored in the vicinity of Calcutta in small ponds, their fore and hind feet being sewed together and a hole, to which a string is attached, bored in the cartilaginous part of the disk. In this condition they live for many months. The only species I have actually seen treated in this way are *T. hurum* and *T. gangeticus*, but I understand *Chitra indica* is dealt with in a similar manner.

Key to the Indian species of Trionyx.

1. Two neural plates between the first pair of costals.
   (A) A strong longitudinal ridge on the mandibular symphysis; coloration of adult very dark..... *T. nigricans.*
   (B) The longitudinal ridge on the mandibular symphysis feebly developed or absent.
      a. Mandibular symphysis produced in front, its length being much greater than that of the orbit; at least four large and conspicuous ocelli as well as a dark reticulation on the disk of the young, that of the adult dark..... *T. hurum.*
      a[1]. Mandibular symphysis not much longer than the orbit.
         a. Disk pale, with radiating dark lines but no ocelli in the young; inner margin of mandible ridged..... *T. gangeticus.*

a'. Disk of young with four ocelli; inner margin of mandible without a ridge.....*T. leithii.*

11. A single neural plate between the first pair of costals; a strong longitudinal ridge on the mandibular symphysis.

A. Epiplastra widely separated immediately in front of the entoplastra.....*T. formosus.*

B. Epiplastra in contact in front of the entoplastra.

a. Plastral callosities feebly developed, finely sculptured.....*T. phayrei.*

a¹. Plastral callosities well developed, deeply sculptured.....*T. cartilagineus.*

The above key is based on the one given by Mr. Boulenger on pp. 10 and 11 of his volume in the "Fauna," but has been modified to include the species omitted by him.

A table of measurements of the skulls of this genus and of *Dogania* preserved in the Indian Museum is given at the end of this paper.

2. Trionyx gangeticus, Cuvier (pl. v, figs. 1, 1a, 2).

Boulenger, Fauna, p. 12: Siebenrock, p. 596.

DISTRIBUTION.—The Indus, the Ganges, the Mahanaddi and their tributaries; probably also the Brahmaputra system. Mr. Boulenger is wrong in suggesting that this species does not occur in the Indus, for specimens from Karachi are identical, at any rate so far as head-markings and skull-characters are concerned, with those from Lower Bengal. The species, although not so abundant in the Calcutta market as *T. hurum*, is sold for food in considerable numbers, being brought from different places in the Gangetic delta, especially from Khulna.

SPECIMENS:—

BENGAL.

1805 (no skull)	Calcutta.	*Purchased.*
1808 ,,	,,	,,
1806 (skl.)	,,	
1080-3 : 1089 (skulls)	,,	,,
78-9 (skull)	,,	,,
3870 (skulls)	,,	,,
1720-2 (stuffed)	,,	,,
1724 ,,	,,	,,
1716 ,,	,,	,,
1893 (carapace & skull)	,,	*Dr. J. Anderson.*
1895 (skl.)	,,	,,
1052-3 (skulls)	Ganges.	,,
1054 ,,	,,	?
288 (spirit)	Hughli.	?
879 (32 b. A. S. B.)	Calcutta.	*E. Blyth, Esq.*
881 (32 d. A. S. B.): juv.	,,	,,

881 (32 d. A. S. B.): juv.	Calcutta.	*E. Blyth, Esq.*
882 (32 e. A. S. B.) ,,	,,	,,
883 (32 f. A. S. B.) ,,	,,	,,
884 (32 g. A. S. B.) ,,	,,	,,
1084-6 (skulls)	,,	,,
16750-1 (skl.)	Probably from Khulna Dist.	*Dr. N. Annandale & B. L. Chaudhuri, Esq.*

United Provinces.

1810 (carapace): juv.	Allahabad.	*E. Atkinson, Esq.*
1729 (stuffed)	,,	*J. Cockburn, Esq.*
468 (spirit)	,,	,,
285 (,,)	,,	,,
286 (head in spirit)	,,	,,
756 (skull)	,,	,,
1732 (stuffed)	Agra?	*Dr. Stoliczka.*
1727 ,,	Agra.	,,
1728 ,,	,,	*Riddell Museum, Agra.*

Sind.

1835-6 (skulls)	R. Indus, Karachi.	*Karachi Museum.*
3869, 3871-2 (heads in spirit)	,,	,,

Very old individuals lose the characteristic markings to a greater or less extent, sometimes becoming of an almost uniform pale olive-green all over the dorsal surface of the head and body. The ventral surface is never dark. The iris varies in colour from emerald-green to golden yellow.

The bony carapace of the largest specimen I have seen measures 48·5 cm. in length by 53·4 cm. in breadth. So far as I am aware, there are always two neural plates between the first pair of costals. The presence or absence of a callosity on the entoplastron is not correlated, either in this species or in *T. nigricans*, with age or sex. In some small individuals it is present, while in other much larger and evidently older ones no trace of it can be found. The median projection of the hyoplastra,[1] except in very young individuals, is double and comparatively short and stout, disappearing altogether in very large specimens, in which the two hyoplastra are in contact or almost in contact in the middle line for the greater part of their length. The sculpture on the sternal callosities is very deep and strong. The skull becomes much broader and blunter with age. The hypobranchials (fig. 1) are long and comparatively slender. In old individuals they are followed at the distal end by four or five short flattened oval bones, but in the young these are represented by cartilage.

[1] Cf. Siebenrock, S. B. K. Akad., Wiss. Wien, CXI, p. 280, fig. 3.

3. Trionyx leithii. Gray.

T. leithii, Gray, P. Z. S. 1873, p. 102, pl. viii. fig. 2; *T. gangeticus, id., ibid.*, pl. viii. fig. 1.

Boulenger, Fauna, p. 12.

DISTRIBUTION.—The limits of distribution of this form are very imperfectly known. It was described from Poona in the Western Ghats and was taken by the late Colonel Beddome in the Nelambar River, which is also in the Malabar zone. Mr. Boulenger states that the species occurs in the Kistna River and that the figure of it reproduced by Gray in 1873 as representing *T. gangeticus* was a copy of a drawing of specimens from Fatteghar.[1] The late Dr. W. T. Blanford obtained specimens in the Upper Mahanaddi system and in the lower reaches of the Godavari.

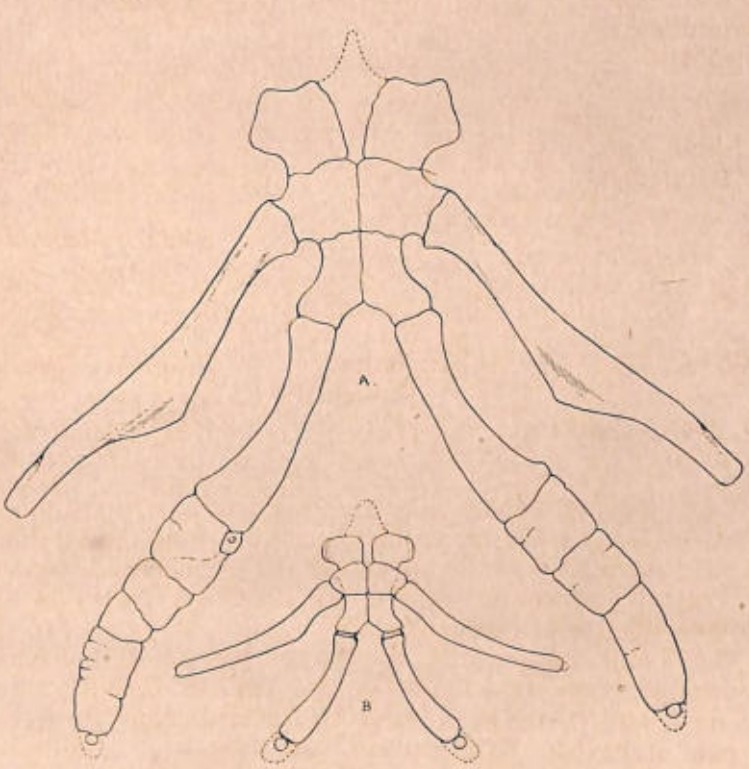

FIG. 1.—Branchial Skeleton of *Trionyx gangeticus*, × ⅔.
A, of adult; B, of young.

SPECIMENS:—

16503 (spirit): juv. ? ?

[1] There are two places of this name in N.-W. India, one on the R. Ganges, the other in Patiala State and within the limits of the Indus system.

881 (32 d. A. S. B.)	juv.	Calcutta.	*E. Blyth, Esq.*
882 (32 e. A. S. B.)	,,	,,	,,
883 (32 f. A. S. B.)	,,	,,	,,
884 (32 g. A. S. B.)	,,	,,	,,
1084-6 (skulls)		,,	,,
16750-1 (skl.)		Probably from Khulna Dist.	*Dr. N. Annandale & B. L. Chaudhuri, Esq.*

UNITED PROVINCES.

1810 (carapace): juv.	Allahabad.	*E. Atkinson, Esq.*
1729 (stuffed)	,,	*J. Cockburn, Esq.*
468 (spirit)	,,	,,
285 (,,)	,,	,,
286 (head in spirit)	,,	,,
756 (skull)	,,	,,
1732 (stuffed)	Agra?	*Dr. Stoliczka.*
1727 ,,	Agra.	,,
1728 ,,	,,	*Riddell Museum, Agra.*

SIND.

1835-6 (skulls)	R. Indus, Karachi.	*Karachi Museum.*
3869, 3871-2 (heads in spirit)	,,	,,

Very old individuals lose the characteristic markings to a greater or less extent, sometimes becoming of an almost uniform pale olive-green all over the dorsal surface of the head and body. The ventral surface is never dark. The iris varies in colour from emerald-green to golden yellow.

The bony carapace of the largest specimen I have seen measures 48·5 cm. in length by 53·4 cm. in breadth. So far as I am aware, there are always two neural plates between the first pair of costals. The presence or absence of a callosity on the entoplastron is not correlated, either in this species or in *T. nigricans*, with age or sex. In some small individuals it is present, while in other much larger and evidently older ones no trace of it can be found. The median projection of the hyoplastra,[1] except in very young individuals, is double and comparatively short and stout, disappearing altogether in very large specimens, in which the two hyoplastra are in contact or almost in contact in the middle line for the greater part of their length. The sculpture on the sternal callosities is very deep and strong. The skull becomes much broader and blunter with age. The hypobranchials (fig. 1) are long and comparatively slender. In old individuals they are followed at the distal end by four or five short flattened oval bones, but in the young these are represented by cartilage.

[1] Cf. Siebenrock, S. B. K. Akad., Wiss. Wien, CXI, p. 280, fig. 3.

3. Trionyx leithii, Gray.

T. leithii, Gray, P. Z. S. 1873, p. 49, fig. 3. *T. gangeticus*, *id.*, *ibid.*, pl. viii.

Boulenger, Fauna, p. 12. Siebenrock, p. 597.

DISTRIBUTION.—The limits of distribution of this form are very imperfectly known. It was described from Poona in the Western Ghats and was taken by the late Colonel Beddome in the Nelambar River, which is also in the Malabar zone. Mr. Boulen-

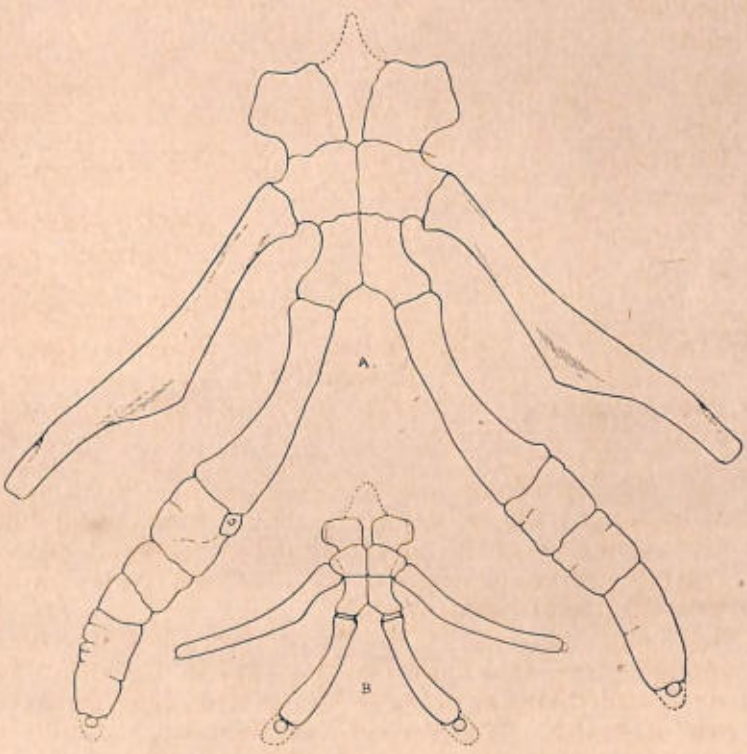

FIG. 1.—Branchial Skeleton of *Trionyx gangeticus*, × ⅔.
A, of adult; B, of young.

ger states that the species occurs in the Kistna River and that the figure of it reproduced by Gray in 1873 as representing *T. gangeticus* was a copy of a drawing of specimens from Fatteghar.[1] The late Dr. W. T. Blanford obtained specimens in the Upper Mahanaddi system and in the lower reaches of the Godavari.

SPECIMENS:—

16503 (spirit): juv. ? ?

[1] There are two places of this name in N.-W. India, one on the R. Ganges, the other in Patiala State and within the limits of the Indus system.

1731	(stuffed: skull separate): juv.	Hasdo R. (tributary of the Mahanaddi), Bilaspur district, Central Provinces.	*Dr. W. T. Blanford.*
522	(spirit: skull separate): juv.	Godavari valley.	,,

The only specimens in our collection that can be assigned to this species are young individuals. A figure of the plastron of the largest is reproduced below (fig. 2).

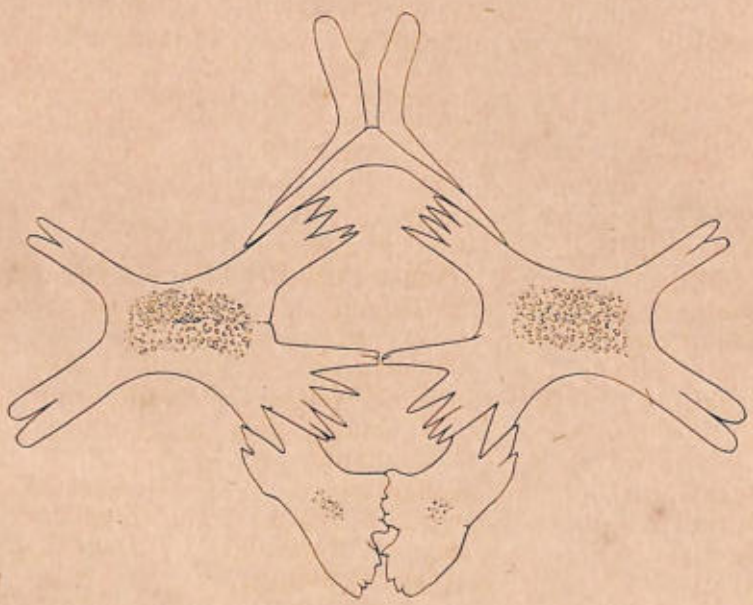

FIG. 2.—Plastron of *Trionyx leithii* (young), × ⅓.

4. **Trionyx hurum**, Gray (pl. v, fig. 3).

Boulenger, Fauna, p. 13, fig. 5 (young): Siebenrock, p. 597.

DISTRIBUTION.—The lower reaches of the Ganges; the Brahmaputra as far north and east at the point at which it debouches on the plains. The species is said to occur also in Indo-China,[1] and in the Malay Peninsula,[2] but the latter locality rests on insufficient evidence. Although *T. gangeticus* makes its way as far north as the base of the Nepal foot-hills and as far west as Karachi, I have been unable to obtain any evidence that *T. hurum* is found much above Rajmahal. Moreover the only specimen (No. 10627) I have seen that was actually taken in Bengal outside

[1] Mocquard, "Les Reptiles de l'Indo-China" (*La Revue coloniale*, 1907, p. 13).

[2] See Flower, P. Z. S. 1896, p. 861, and 1899, p. 620.

the Gangetic delta was so peculiar in coloration that it may well represent a distinct local race. Specimens from Assam are perfectly typical in coloration. I have seen a consignment of over 500 individuals from Khulna being unloaded at the railway station. The "fishery" takes place mainly in October.

SPECIMENS:—

BENGAL.

1050 (skull)	Calcutta.	*Dr. J. Anderson.*
1920 (skl.)	,,	,,
1797 (skl. deformed)	,,	,,
1049 (skl.)	Ganges.	,,
1047 (skull)	Calcutta.	*Purchased.*
270 (skl.) : juv.	,,	,,
1796 (skl.)	,,	,,
1784 (stuffed)	,,	,,
6846 (spirit) : juv.	,,	,,
271-2 ,,	,,	,,
1090 (Skl.) Type of *T. buchanani*, Theob.	,,	,,
16752 (skl.)	Gangetic delta.	*Dr. N. Annandale.*
292 (spirit) : juv.	R. Hughli.	*Purchased.*
287; 289-91 (spirit) : juv.	,,	?
273-4; 276 (spirit) : juv.	Calcutta.	*Dr. W. Theobald.*
16627 (Skl.)	Oodhua *nallah*, R. Ganges, near Rajmahal.	*B.L. Chaudhuri, Esq.*
283; 660 (spirit)	Kaligunge.	*W. Dodgson, Esq.*
16505 (head in spirit)	Dacca, E. Bengal.	*H. E. Stapleton, Esq.*
5578 (spirit)	Nattore, Rajshahi Dist., E. Bengal.	*T. R. Doucett, Esq.*

ASSAM.

659 ,,	Nazir, N. of the Naga Hills, E. Assam.	*J. M. Foster, Esq.*
303 ,,	,,	,,
402-4 ,,	Sibsagar.	*S. E. Peal, Esq.*
11373 ,,	Dilcoosh, N. E. Assam.	*J. Ingles, Esq.*

In this species the coloration of the dorsal surface normally grows darker and more obscure with age, although the ventral surface is dark in the young and only assumes its uniform pale colour in half-grown individuals. Buchanan (Hamilton) in his collection of drawings now preserved in the Asiatic Society of Bengal's library figured three stages as distinct species. The first of these drawings (No. 52) is labelled *Testudo ocellata* and represents the young in which four large ocelli and a bold reticulation of black lines are conspicuous on the dorsal surface of the

disk. The second (No. 54), which is labelled *Testudo hurum*, represents an older individual in which the ocelli have become obsolescent, the ring of bright reddish yellow which surrounds the central dark spot having faded and the spot itself having increased greatly in size, while the reticulate lines have multiplied and become more vermicular in character. The third drawing (No 53) evidently represents a much larger specimen; it is labelled *Testudo chhim*. The whole of the dorsal surface of the disk has darkened and only small and somewhat obscure yellowish spots represent the pale ground-colour of the juvenile disk. The ventral surface is represented as dark olive faintly speckled with a pale shade in the first figure and uniformly pale in the others. The coloration of the head varies somewhat in the adult as regards the relative proportions of the yellow and the dark green areas. The former colour usually predominates on the snout and on the sides of the head behind the mouth and the latter on the post- and inter-orbital regions, forming a more or less close and dense reticulation. In the young the two colours are more definitely separated. In old individuals traces of dark radiating lines can sometimes be detected on the edge of the disk, while that of the young is usually spotted minutely with yellow. The iris is greyish.

The specimen from near Rajmahal to which allusion has already been made was altogether abnormal in coloration. It was a half-grown individual with a disk measuring 27·6 cm. in length. The whole of the dorsal surface was of an almost uniform pale olive, green on the head and neck and greyer on the limbs than on the disk, which showed no trace of ocelli—markings of which traces can usually be detected in even larger individuals. The disk, however, had an obscure mid-dorsal stripe crossed by five cross-bars, all of a slightly darker shade than the ground-colour. The posterior part of the upper surface and sides of the head was obscurely clouded with dark olive. The whole of the ventral surface was pale and the iris was pinkish white. Fortunately a record of the colours of this specimen, which is preserved as a skeleton, was kept in the form of rough water-colour sketches and a cast of the fresh specimen was made and painted accordingly.

The snout does not become much blunter or the head broader with age in this species. In some very old individuals, however, the nasal aperture is, on the skull, considerably broader than the inter-orbital space, but this appears to be due, judging from the rugosity of the bones, either to senility or to disease. The hypobranchials (fig. 3) are comparatively short and broad; even in aged individuals they bear at the distal end only a cartilaginous plate containing a small ossicle.

The size reached by this species is not so great as that commonly attained by *T. gangeticus*. The largest individual I have seen was a male recently purchased in Calcutta and said to have come from Khulna. Its dorsal disk measured 60 × 40·9 cm. and its bony carapace 41·6 × 40·9 cm., the disk being rather narrower than usual.

Specimen No. 1094, an articulated male skeleton, is the type of Theobald's pseudo-species *T. buchanani*. It presents a very large male only slightly smaller than the one to which I have just referred, the bony carapace measuring 38·4 mm. in length and being distinctly broader than long.

The structure of the carapace and sternum of *T. hurum* is closely similar to that found in *T. gangeticus* except that the two

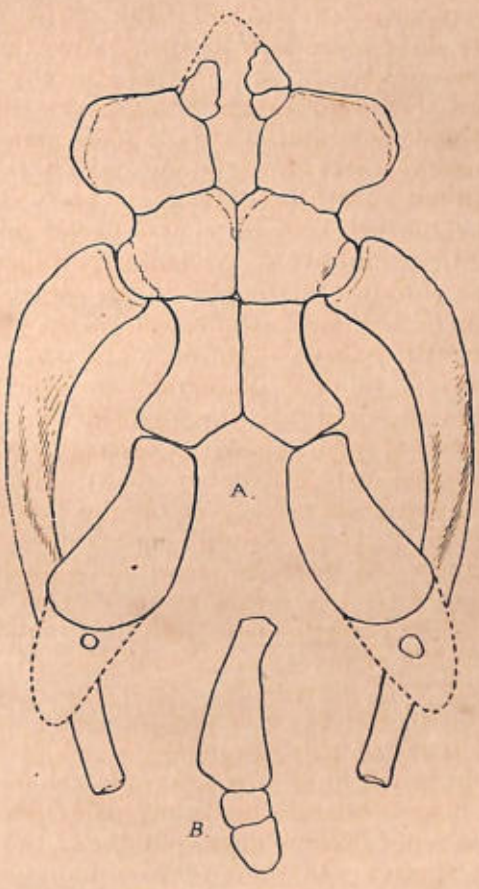

FIG. 3.—Branchial skeleton of *Trionyx hurum* and *T. formosus*.
A, complete apparatus (nat. size) of adult *T. hurum*.
B, hypobranchial, etc. of *T. formosus* (nat. size).

hyoplastra approach one another at a rather earlier stage and that their median processes are slighter and always single although distinctly bifid at the tip.

A not uncommon abnormality, noticed in both young and old individuals, is the presence of three neural plates between the first pair of costals. This is due to the separation of a small bone, sometimes quite symmetrically, from the central part of the anterior border of the first normal neural plate.

5. Trionyx nigricans, Anderson (pl. v, fig. 5).

Anderson, Ann. Mag. Nat. Hist., (4), XVI, p. 284 (1875).

The first pair of costals are separated by two neural plates. The posterior paired bones of the plastron are provided with well-developed callosities on which the sculpturing is only a little less strong than in *T. gangeticus*, and in some individuals there is also a callosity on the entoplastron. The hyoplastra do not meet in the middle line and are strongly divergent posteriorly, although they are relatively larger than in *T phayrei*; their median process is single, short, stout and blunt, indistinctly bifid at the tip. The epiplastra are narrowerly separated or actually in contact in front of the entoplastron.

The skull is moderately broad, the snout a little longer than the diameter of the orbit; the interorbital width is greater than that of the nasal fossa and the postorbital arch is about one-third as wide as the orbit; the zygomatic arch is horizontal, less distinctly curved than in *T. phayrei*.

The alveolar surface of the upper jaw bears low median and internal longitudinal ridges. The lower jaw has a strong longitudinal ridge on the symphysis, which is a little longer than the orbit; there is no internal alveolar ridge.

Anderson describes the external characters as follows:—

"Carapace rather flattened on the back, with the vertebral groove ill-defined anteriorly, but well marked posteriorly. Nuchal swelling broader than in *T. gangeticus*, but not prominent, the carapace on either side being flattened. Alae of plastron well defined, projecting equally beyond the carapace. Nuchal flap narrow, and covered with rather large nodose folds; and the hinder portion of the cartilaginous margin of the carapace with little nodosities. The rugosities of the osseous carapace coarser than in *T. gangeticus*.

The under surface of the thighs and tail and of all the soft parts, including the head and neck, covered with little papillae. No trace of rugosities on the axygos plate of the plastron visible through the skin.

The tail in the female does not reach to the margin of the cartilaginous portion of the carapace.

Colour of the carapace dark blackish plumbeous, with a tinge of olive due to the presence of blackish spots, among which are inter-mixed many rusty brown spots, which overlie as it were the black spots. The head, neck, and upper surface of the limbs are almost black; the upper lip in its two posterior thirds is white; and there is a great white blotch over the ear.

The area between the neck and the four legs is whitish; and there are some white spots on the margin of the carapace. The head is reticulately spotted; and there is a distinct infraprae-orbital band, and a trace of another above the eyes; but the head is so black that these markings are difficult to distinguish. The under surface of the head and neck is almost black; and the

plastron is densely spotted with blackish purple, especially over the bones, and the tail is similarly marked. The claws are yellow."

DISTRIBUTION.—With one exception the specimens of this species are labelled as being from Chittagong in the extreme south-eastern corner of the old Province of Bengal. The one exception is labelled as being from Calcutta, but this locality is probably incorrect and in view of the fact that large numbers of Trionychids are imported into this city for food, carries in any case very little weight unless supported by independent evidence. It should therefore be ignored, unless it can be substantiated by the capture of specimens in the Gangetic delta, the probability being that *T. nigricans* is a species intermediate in habitat, as it is in structure, between *T. gangeticus* and *T. phayrei*.

SPECIMENS:—

BENGAL.

1918 (skl.)		.. Chittagong Tanks	..	*A. L. Clay, Esq.*
754 (skl.)		.. ,, ,,	..	,,
1908 (skl.)		.. ,, ,,	..	,,
1898 (skl.), 735 (skl. no skull)	Types.	.. ,, ,,	..	,,
1849 (skl.)		.. "Calcutta"	..	*Dr. J. Anderson.*

T. nigricans may be stated in general terms to resemble *T. phayrei* in the structure of its skull and mandible and *T. gangeticus* in that of its carapace and plastron. In coloration, however, it evidently differs from both and neither its skull nor its plastron agrees precisely with that of the species which they respectively recall. All the specimens appear to be adult and both sexes are, to judge from Anderson's labels, represented. The bony carapace of the largest measures 40·3 cm. in length by 46·7 cm. in breadth.

6. **Trionyx phayrei**, Theobald (pl. v, fig. 4).

Anderson, P.Z.S. 1871, p. 154, fig. (plastron): Boulenger, Fauna, p. 14: Flower, P.Z.S. 1899, p. 620: Siebenrock, p. 598.

DISTRIBUTION.—Arrakan, Pegu, Tenasserim, the Malay Peninsula, Sumatra, Java (*Max Weber*) and Borneo. In Arrakan this species occurs in mountain streams and Flower states that he found a specimen in a similar situation in Johore. As Mr. H. C. Robinson has pointed out to me, the locality "Penang" must be accepted with caution, for there is a Chinese temple on the island in which tortoises from many different parts of the Malay Archipelago are kept.

SPECIMENS:—

755 (skull and plastron)	.. "Penang"	..	*Dr. J. Anderson.*
1094 (stuffed: skull separate)	.. Arrakan	..	(*Purchased*).

Both these specimens present fully adult individuals and have already been referred to in published works. No. 1094 is the one mentioned by Theobald on p. 15 of his "Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal" as *T. guntherii*, Gray; while the other (No. 755) is all that remains of the specimen described in detail by Anderson in 1871.

I was at first inclined to think that neither could belong to the species described by Theobald as *T. phayrei*, because of the broadness of the skulls (fig. 4) and of the fact that the callosities

FIG. 4.—Adult skull of *Trionyx phayrei* from below (reduced).

of the plastron are distinctly though not deeply sculptured. It is, however, probable that these discrepancies are due entirely to the fact that most of the specimens hitherto examined have not been fully adult, for parallel if not quite as great differences may be noticed between the skulls of half-grown and of full-grown individuals of *T. gangeticus* as those that evidently exist between the skull figured by Gray under the name *T. jeudi* (and by Boulenger in his British Museum Catalogue (p. 252, fig. 76) under that of *T. phayrei*) and those now before me. It is evident, moreover,

that Anderson in describing and figuring the plastron of his specimen did not remove the outer integument, which still adheres to the bone, and that in consequence he believed the surface to be smoother than actually was the case. As a matter of fact it is more nearly smooth than that of any Indian species, although by no means devoid of sculpturing.

The bony carapace of specimen No. 1094 measures 40·3 cm. by 50·6 cm.; that of No. 755 was, according to Anderson, slightly smaller. The median processes of the hyoplastra in this species are single, slender and pointed. They are never bifid at the tip.

T. phayrei is connected with *T. gangeticus* through *T. nigricans*, from which it differs chiefly in having only one neural plate between the first pair of costals. The skull is also broader than that of *T. nigricans*, in fully adult individuals.

7. Trionyx formosus, Gray (pl. v, fig. 6).

Boulenger, Fauna, p. 14: Siebenrock, p. 598.

DISTRIBUTION.—The Irrawaddi, Sittang and Salween Rivers. In the Irrawaddi this species is found near the Chinese frontier, as well as in the lower reaches. Numerous individuals, many of which are deformed, are kept in a small pond at the Arrakan Pagoda in Mandalay. I take it they belong to this species. It is very possible that statements regarding the occurrrence of *T. hurum* in the Malay Peninsula actually refer to *T. formosus*, but the latter species has not been definitely recorded from any Malay locality.

SPECIMENS:—

		BURMA.	
1786 (skl.)	..	Moulmein	.. *Maj. Sladen.*
277-8 (spirit)	..	Mandalay	.. ,,
634 (skull)	..	Bhamo	.. *Maj. Lowndes.*
1837 (skl. juv.)	..	Burma	.. *Dr. J. Anderson.*
1063 (skull)	..	,,	.. *Hon. A. Eden.*
605 (skl.)	..	,,	.. *Maj. Sladen.*
685 (skl.)	..	Irrawaddi	.. *Maj. Lowndes.*
687 (spirit)	..	,,	.. *Hon. A. Eden.*
1051 (carapace and palastron)	..	,,	.. *Dr. F. Stoliczka.*
766 (skl.)	..	Burma	.. *Hon. A. Eden.*

This appears to be a comparatively small species. The bony carapace of the largest specimen in the collection measures only 27·4 × 26·5 cm.; its skull appears to be fully adult. In this specimen there are actually two neural bones between the first pair of costals, but the suture is asymetrical and there can be no doubt that the condition is abnormal. In most cases the median process of the hyoplastra is short, single and rather stout, its

apex being bluntly pointed. In one skeleton, however, the right process is double.

The branchial skeletion (fig. 3, p. 163) resembles that of *T. hurum*, but the distal bones of the posterior process are more fully ossified, the hypobranchial being followed by two distinct bony plates of moderate size.

8. Trionyx cartilagineus (Boddaert).

Boulenger, Fauna, p. 15: Siebenrock, p. 599.

DISTRIBUTION.—Pegu, Tenasserim, Siam, Cambodia, the Malay Peninsula, Sumatra, Java, Borneo. This is evidently a Malayan species which has made its way into Lower Burma. It appears to be scarce in Pegu and Tenasserim but to be the common species of the Malay Peninsula.

SPECIMENS :—

BURMA.

2632 (spirit: skull separate): juv. .. R. Irrawaddi .. *Dr. W. Theobald.*

MALAY PENINSULA.

13207 (spirit): juv. .. Perak .. *Dr. J. Anderson.*

Both of the above specimens are very young. Their skulls, which I have had removed, show the specific characters quite clearly.

Genus PELOCHELYS, Gray (1864).

Boulenger, Fauna, p. 15: Siebenrock, p. 606.

This genus is closely allied to *Chitra* but may be readily distinguished therefrom by the large and prominent orbits, which occupy a less anterior position on the skull. The plastron and carapace are very similar in the two genera. *Pelochelys* is another monotypic genus but has a much wider range, so far as we know, than *Chitra*.

9. Pelochelys cantorii, Gray.

DISTRIBUTION.—The lower reaches of the Ganges, (?) Assam, Burma, Indo-China, Siam, the Malay Peninsula, Borneo, the Philippines and New Guinea. *P. cantorii* appears to be a scarce species in all the localities in which it is found. I have not seen a single fresh specimen, and the two old ones in our collection are probably immature.

SPECIMENS :—

BENGAL.

1781 (skl.) .. R. Hughli, Calcutta .. *Dr. J. Anderson.*
886 (33 a. A.S.B.) .. , ,, .. ?

Genus CHITRA, Gray (1844).

Boulenger, Fauna, p. 16: Siebenrock, p. 608.

This genus, of which only one species is known, is easily recognized by the elongate appearance of the skull, the eyes being situated close to the snout, and the complex form and unusually complete ossification of the branchial skeleton. The plastron[1] and carapace do not differ materially from those of *Trionyx*. The photographs reproduced on plate vi show clearly the general structure and proportions of the branchial skeleton, although its position relative to the skull is perhaps a little distorted. The basal part consists of four pairs of bones either sutured in the middle line or narrowly separated. Those of the most anterior pair (fig. 2, 1) are in close contact with one another for the greater part of their length as well as being firmly sutured to the next pair. They are roughly triangular in shape and probably represent the basihyal element, although they are not produced into horns at the sides. Behind them follow three other pairs of bones which may be taken to be the basibranchial; those of the first pair are smaller than those of the two posterior pairs and remain separated in the middle line even in old individuals. Those of the next pair are transverse in shape and form a median suture; they support the greater cornua, which are articulated to their sides. These bones are comparatively stout and long and are not expanded dorso-ventrally; they bear very large and well-developed muscular impressions near the proximal end of their external margin. The posterior processes are of great size and considerably expanded in the lateral plane, their ossification being unusually complete. Each consists of three broad bones fitted together by serrated sutures. The first of these is much the longest of the three and probably represents the hypobranchial and ceratobranchial fused together. In this case the second bone would be the epibranchial and the third the pterygobranchial. The former is a short plate of bone, the latter, although no broader at its outer margin, is bluntly produced towards the ventral margin in such a way that it is more than twice as broad within as it is without. The whole process curves inwards and upwards towards its fellow. In the large specimen mentioned below the length of the bony hyoid apparatus is nearly as great as the skull; the basal part measures 9 cm., each horn 11 cm., and each posterior process 13 cm. in length.

10. Chitra indica (Gray) (pl. vi, figs. 1, 2).

DISTRIBUTION.—The Ganges and Irrawaddi river-systems, as far as the base of the Himalayas in the former. The species is not uncommon in the Gangetic delta and large individuals can often be bought in the Calcutta market, in which, however, they are less abundant than *T. hurum* and *T. gangeticus*.

[1] Siebenrock, S.B.K. Akad. Wiss. Wien, CXI (1), p. 833, fig. 12, 1902.

Specimens:—

Bengal.

1776; 1113 (skl.) ..	Calcutta.	.. *Purchased (Dr. J. Anderson.)*
3543 ,, ..	Zoological Gardens, Calcutta.	*Peer Bux.*
1046 (skull) ..	R. Hughli, Calcutta	?
1055 ,, ..	Dacca, E. Bengal	.. *Dr. Wise.*
16753 (skl.) ..	Probably from Khulna	*B. L. Chaudhuri, Esq.*

United Provinces.

483 (spirit): juv...	Allahabad	.. *J. Cockburn, Esq.*

Chitra indica is apparently the largest of the Indian Trionychids. The bony carapace of the largest specimen examined measures 52·3 cm. × 59·7 cm. The length of its skull (pl. vi, figs 1, 2) measured from the tip of the snout to that of the articular condyle is 17·8 cm., and the greatest breadth 10 cm. The carapace may be distinguished from any purely Indian species of *Trionyx* by possessing only one neural bone between the first pair of costals. The epiplastra are more widely separated from one another than in *T. hurum* and *T. gangeticus* and the anterior part of each is shorter than in most species of *Trionyx*. There are three or four processes on the inner margin of each hyoplastron.[1]

Genus EMYDA, Gray (1831).

Boulenger, Fauna, p. 49: Siebenrock, p. 590.

A consideration of this genus, which probably occurs only in the Indian Empire and in Ceylon, raises questions of considerable taxonomic and geographical interest. As a genus it is easily distinguished from all other Trionychids of the Oriental Region by the fact that the hind limbs are protected by cartilaginous flaps or valves which can be closed over them on the ventral surface. Mr. Boulenger recognizes three species in the "Fauna," but expresses a doubt as to whether two of them are really distinct. After examining a large series of skeletons and specimens in spirit and seeing living individuals in different parts of India, I find it possible to recognize only one species with several local races or subspecies.

The branchial skeleton resembles that of *Trionyx* but differs in having the basihyals in close contact, the lateral margin of each basihyal produced into a blunt horn, the posterior margin of the posterior basibranchials deeply emarginate and the hypobranchials (with which the ceratobranchials are perhaps fused) very long and slender.

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[1] Siebenrock, S.B.K. Akad. Wiss. Wien, CXI (1), p. 845, fig. 18, 1902.

The peculiar structure of the carapace and plastron of this genus, in which the soft parts can be more completely protected than in any other Indian genus of the family, may perhaps be correlated with a peculiarity in habits. *Trionyx* usually inhabits rivers and appears to be active at all times of the year, but *Emyda* lives in ponds and lakes and undergoes, at any rate in northern India, a considerable period of hibernation. Specimens were brought me in February at Purulia which had been dug from the mud in the basin of a dried pond, while the individuals which inhabit the Museum tank in Calcutta disappear for the whole of the cold weather. Not only can the characteristic cartilaginous flaps of the plastron close tightly over the hind limbs, but the anterior part of the carapace is flexible, owing partly to the fact that the nuchal plate is not as a rule united to the first pair of costals; it can be bent down to meet the anterior margin of the plastron in such a way that the retracted head and fore limbs are completely concealed, while the posterior part of the disk, including the marginal bones, can be bent down in a similar manner to protect the thighs and tail.

The typical form of *E. granosa*, although it rarely leaves the ponds in which it lives, is fond of sunning itself on logs or stones projecting above the surface of the water. It is extremely timid and difficult to approach. I have taken a young specimen of the South Indian form (*vittata*) at the edge of a pond among weeds.

11. **Emyda granosa** (Schoepff).

The distribution of this species cannot be considered apart from the question of the characters whereby its local races are separated. So far as it is possible to judge from the collection before me, three local races occur in India, one in Burma and one in Ceylon. They are:—

(1) Indian races:—*E. granosa* (typical form), subspecies *intermedia*, nov., and subspecies *vittata*, Peters.
(2) Burmese race:—Subspecies *scutata*, Peters.
(3) Ceylon race:—Subspecies *ceylonensis*, Gray.

(1) The *forma typica* is confined in India proper to the valleys of the Indus and Ganges, but it probably occurs in Assam and certainly does so on the coast of Arrakan.

The subspecies *intermedia* occurs in the valleys of the Barakar and Kasai rivers, which reach the sea, just south of the Ganges, through the Hughli estuary, and in those of the Mahanaddi and the Godavari. Politically its range extends through Chota Nagpur, the Central Provinces, Orissa and the north-eastern part of the Presidency of Madras.

The subspecies *vittata*[1] is found in the Madras Presidency, over the greater part of which it ranges, occurring on the Mysore

[1] Siebenrock (p. 591, footnote) states that the Vienna Museum possesses a specimen of this race which appears to have come from Celebes, but the evidence as regards its *provénance* is not satisfactory.

plateau at an altitude of at least 3,000 ft. and also at sea level on the coast. It also occupies the greater part of the Bombay Presidency, including Cutch.

(2) The Burmese race (*scutata*) is only known from the valleys of the Irrawaddi and the Salween.

(3) The Ceylon race (*ceylonensis*) is confined to the plains of that island.

A. *Forma typica.* The granulations on the carapace and more especially on the plastral callosities are small, even and regular and are not arranged in concentric curves. The head and the carapace, at all ages, are of a dark olivaceous shade conspicuously spotted with yellow. There are usually 14 bony marginal plates situated round the posterior part of the carapace. The entoplastral callosity is never very large and the xyphoplastral callosities are never in contact for the whole of their length, invariably diverging from one another above. The median process of the hyoplastra is long and slender.

B. *intermedia* (pl. vi, fig. 3). The granulations of the plastral callosities are coarser and more irregular, the granules being larger but not arranged definitely in concentric curves. The head of the young is very obscurely marked; the carapace is deep olive-green with obscure paler markings. The head of the adult bears very conspicuous longitudinal dark lines; its carapace is dark olive-green with a darker vermicular reticulation. The entoplastral callosity is of moderate size and the two xyphoplastral callosities are never in contact for the whole of their length. The marginal and the median hyoplastral process are as in the preceding race.

C. *vittata.* The granulations of the plastral callosities are still coarser than in *intermedia* and the granules tend to be arranged in concentric curves. The head of the young bears longitudinal dark lines, but the carapace is without markings at any age. In older individuals the dark lines on the head tend to disappear, the colour being an almost uniform

dark brown. In other characters this race resembles *intermedia*.

D. *scutata*. The granulations of the plastral callosities resemble that of the *forma typica*, but the pale markings on the head and carapace are completely absent. In the young the carapace bears obscure dark spots, which tend to form a reticulation in the adult. The entoplastral callosity is very large. The marginal bones never fuse together; all are small and there are usually 18 present. The median hyoplastral process is very short and the xyphoplastral callosities are often in contact for their whole length.

E. *ceylonensis*. This race is closely allied to *vittata*, from which it is distinguished by the great relative size of the entoplastral callosity, by the facts that the xyphoplastral callosities are in contact for their whole length and that the marginal bones show a greater tendency towards fusion (only 12 being usually present), and by the extreme shortness in the adult of the median xyphoplastral process. The carapace of the young is obscurely spotted with a dark shade and there are black longitudinal lines on the head. The adult as a rule appears to be devoid of definite markings.

The only differences between these races lie in coloration, in the sculpturing of the plastral callosities, in the degree of ossification attained by the plastron, and in the number of posterior marginal bones that normally fuse together in the adult. Except coloration and plastral sculpturing none of these differences can be called constant, and even in coloration and sculpturing a certain amount of variation occurs. It may therefore be well to discuss each character separately.

To deal with coloration first: I should state that while I have seen a considerable number of living individuals of the typical form of the species and of the races *intermedia* and *vittata*, I have only been able to make a detailed examination of fresh material in the case of the two former and have not seen living individuals of either the Burmese or the Ceylon race. Specimens preserved in spirit, however, even for many years, as a rule show at least traces of the characteristic markings, except that the dorsal reticulation of the race *intermedia* disappears completely.

Moreover, Dr. J. R. Henderson has been kind enough to send me notes on the natural colours of the Madras race (*vittata*) at different stages. These notes confirm observations made on specimens preserved in spirit.

The spots on the dorsal disk of the Indo-Gangetic race are variable in size, number and arrangement but are perfectly distinct even in the largest individuals. Sometimes the larger spots have dark centres and resemble irregular ocelli. The markings on the head are much more regular. A large pale spot covers the greater part of the snout and of the interorbital region, being interrupted in the latter by a circular or nearly circular dark spot. There are two smaller pale spots beneath each eye and another above the angle of the mouth. A broad pale stripe runs obliquely backwards from below the eye towards the tympanic region and two longitudinally oval spots, sometimes united to form a V-shaped mark, form an angle above it, the anterior spot starting from the posterior upper border of the orbit. Sometimes the oblique stripe is broken up into two or more spots. There are also two or three smaller pale spots on each side of the back of the head. So far as can be judged from specimens preserved in spirit, those from Calcutta agree closely with those from Akyab on the one hand and Karachi on the other.

The pale spots on the back of the young of the race *intermedia* are very obscure and could not be recognized except in fresh specimens. The dark reticulation on the back of the adult is much more distinct but fades gradually in spirit The dark lines on the head are, however, much more persistent. They are also conspicuous on small specimens of the Ceylon race (*ceylonensis*) that have been in spirit for many years.

The races of *Emyda granosa* fall into two groups as regards the sculpturing on the plastral callosities ; in one group (consisting of the typical form, *intermedia* and *scutata*) the granules are much more regular, more uniform in size and more widely distributed on the surface of the bone than they are in the other, in which they tend to run together and to be arranged in concentric curved lines. The second group consists of *vittata* and *ceylonensis*. This difference is best observed in young individuals. The size of the entoplastral callosity is correlated to some extent with the degree of ossification attained by the other bones of the plastron. When the callosity is very large the xyphoplastra are always in close contact for the whole of their length on the inner margin. These characters, however, vary greatly in all races and it is only by examining *fully adult* individuals that satisfactory results can be obtained.

The following measurements, all of which are taken from the skeletons of adult females, show at any rate the large size of the entoplastral callosity in the adult of the Ceylon race. There is, however, considerable variation in the size of this callosity in specimens from India, although it is never nearly so large as it is in the race *ceylonensis*.

	Calcutta.	*Madras.*	*Ceylon.*
Length of carapace	22·8 cm.	22·5 cm.	24·5 cm.
Breadth ,, ...	21·0 ,,	20·4 ,,	19·0 ,,
Length of entoplastral callosity ..	2·2 ,,	2·5 ,,	5·0 ,,
Breadth ,, ,, ..	2·5 ,,	1·7 ,,	5·5 ,,
Length of xyphoplastral callosity	5·3 ,,	5·0 ,,	5·7 ,,
Breadth ,, ,, ..	3·3 ,,	3·5 ,,	3·5 ,,

In measuring the carapace the length of the marginals is omitted and the longest measurement of the callosities that can be obtained in a straight line is given.

The relative size of the anterior marginals is due in the first instance to the fusion or non-fusion of several bones. The full number of marginals appears to be eighteen, nine on either side. In all the Indian races, and also in the Ceylon race, several of the most anterior of these bones normally fuse to form a single plate, the fusion taking place at a comparatively early age. Many irregularities, however, occur and it is often the case that the number of bones which have fused on one side is not the same as that of those which have fused on the other. Moreover, the pattern of the granules on the ventral surface often shows the line in which fusion has occurred, even in old individuals. Especially in the Ceylon race, moreover, the bone fused by the fusion of the first three marginals tends to increase greatly in width as the animal grows old. In the Burmese race (*scutata*) no such fusion normally occurs, but it is noteworthy that in a half-grown individual from Akyab which exhibits all the other characters of the typical *granosa* the marginals remain separate as in *scutata*, although in a slightly larger individual from the same locality the first three bones on either side are completely fused.

Emyda granosa (Schoepff).

BENGAL.

875-7 (stuffed): 13470-1 (carapace) 1714: 1772 (skl.) 1027-32 (plastra)	Calcutta and neighbourhood.	*Purchased*; *Dr. J. Anderson*; *E. Blyth, Esq.*; *Medical College.*
242-3, 226-8, 239, 13580, 213-6, 218, 233-5, 237-8, 220, 4229-32, 370-1, 16501, 240-1 (spirit)	Ditto	*Purchased*; *Dr. J. Anderson*; *E. Blyth, Esq.*; *W. Theobald, Esq.*; *O. L. Fraser, Esq.*; *Dr. J. T. Jenkins*; *C. Swaries, Esq.*; *D. Cunningham, Esq.*
1034-42 (skulls)	Calcutta or N. W. Provinces	?
1824 (skull)	Jessore	*C. Tweedie, Esq.*
1023 (skl.)	Sunderbunds	*O. L. Fraser, Esq.*

Sind.

3878-80 (spirit)	R. Indus, Karachi	*Karachi Museum Ex.*
3377 ,,	Jempir	,, ,, ,,

Burma.

244-5 (spirit)	Akyab	*Deputy Commissioner, Akyab.*
12627-9 ,, : juv.	Jergo I., Off Arrakan Coast.	*Indian Marine Survey.*

Emyda granosa intermedia, Annandale.

Chota Nagpur and Orissa.

1663, 1665, 1669-71, 1673-5, 1677-80, 1688, 1686, 1689, 1694 (skl.)	Hazaribagh.	*Lt.-Col. Boddam.*
250 (spirit)	,,	,, ,,
1662, 1664, 1666-7, 1672, 1676, 1681-2, 1692-3 1685 (skl.)	Chota Nagpur	*Col. Dalton.*
1733-41 (plastra)	,,	,,
1024, 1683 (skl.)	Singhboom	*H. Hayes, Esq.; Lt.-Col. Boddam.*
257-61, 294 (spirit)	,,	*H. Hayes, Esq.*
246 (spirit)	Surjuga	*Dr. V. Ball.*
251-3 ,,	Ranchi	*Col. Dalton.*
16694 (skl.)	Chaibassa.	*Rev. A. Logsdail.*
405-7 (spirit)	Sambalpur.	*Dr. V. Ball.*
12568 ,,	Dharma	*C. H. Dreyer, Esq.*
16764 ,, TYPE.	Near Purulia, Manbhum Dist.	*Dr. N. Annandale*
16765 ,,	,, ,,	,, ,,

Central Provinces.

249 (spirit)	Raipur	*Dr. W. T. Blanford.*

Madras Presidency.

15990 (spirit)	Gopkuda I., Lake Chilka, Ganjam.	*Museum Collector.*
15991 (skl. & skull)	,, ,, ,,	*Dr. W. T. Blanford.*
520-1 (spirit)	Godavari River	,, ,,

Emyda granosa vitata, Peters.

Madras Presidency.

13497 (spirit)	Coconada, Coromandel Coast.	— *Mairguy, Esq.*

263-5 (spirit)	Travancore	*Prince Rama Varma.*
254-6 ,, } 1022 (skl.) }	Madras	*Madras Museum.*
16689 (spirit) : juv.	Bangalore (3,000 ft.)	*Dr. N. Annandale.*

BOMBAY PRESIDENCY.

1660 (skl.) : 1043 (skull)	Cutch.	*Dr. Stoliczka.*
247-8 (spirit) : 566 ,,	Goa	*Purchased ; Dr. J. Anderson.*
1774 (skull)	Sind	*Dr. W. T. Blanford.*

Emyda granosa ceylonensis, Gray.

280-2 (spirit)	Ceylon	*Dr J. Anderson.*
1025-6 (skl.)	,,	*Dr. Kelaart.*
1043 (skull)	Colombo	*Dr. J. Anderson.*

Emyda granosa scutata, Peters.

1705-7 (skl.)	Burma	*Hon. A. Eden.*
783 (skull)	,,	,, ,,
266-7, 269, 3885, (spirit) : juv.	,,	*Hon. A. Eden, Maj. Sladen, Dr. W. Theobald, Dr. F. Stoliczka*
268 (spirit) : juv.	Moulmein, Lower Burma.	*Dr. W. T. Theobald.*
1708 (skl.)	Bhamo, Upper Burma	*Capt. Lowndens.*
1709 ,,	Mandalay, ,, ,,	*Maj. Strover.*

Lydekker (Pal. Ind. III (ser. x), p. 197 (43), 1886) states that *Emyda vittata*, Peters, occurs as a fossil in the Siwalik deposits of the Punjab and suggests that the Indo-Gangetic form (*granosa*) had not been produced when these beds were formed.

The shell he figures as that of the former, however, resembles the race *ceylonensis* (which he did not distinguish from *vittata*) in having the xyphoplastral callosities in contact for the whole of their length, agreeing in other respects well enough with *vittata*. It is not improbable that it actually represents a form from which both of the southern races have been evolved. The other fossil remains figured by the same author appear to have belonged to forms that were both less highly specialized and considerably larger than the modern ones. They show, however, that in Post-Tertiary times two types of plastral sculpturing had already become fixed. The North Indian and Burmese races may be descended from *Emyda sivalensis* or *E. palaeindica*, and there are indications that *scutata* possibly represents the latter species. If it could be proved that the different races of the one surviving species were derived from comparatively recent fossil forms that were specifically distinct from one another, it would be permissible

to cite them as instances of convergence produced by isolation, the ancestors of different species isolated by some means from one another having, in the absence of enemies and the presence of a liberal supply of food, tended to revert in general structure to their common but long extinct ancestor, while retaining certain unimpor-

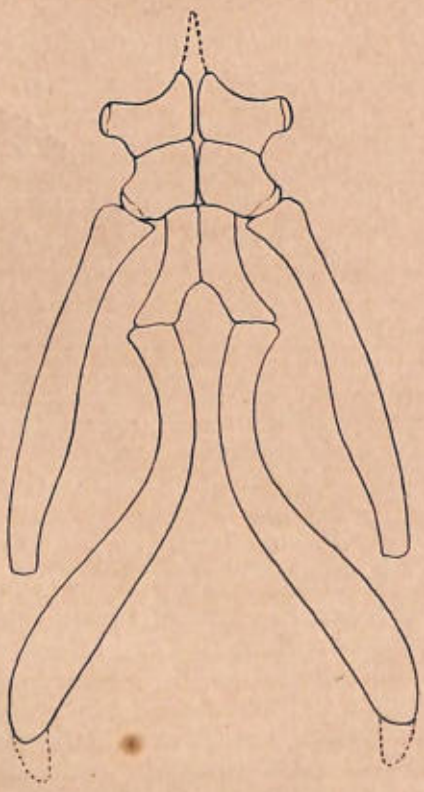


Fig. 5.—Branchial skeleton of *Emyda granosa*, × 2.

tant distinctive features. Theoretically it would be difficult in that case to regard such forms as local races of one species, but in practice this seems at present to be the only possible course to adopt, if we are to pay any attention to geographical considerations in distinguishing between subspecies and varieties. (See Annandale, Fauna Brit. Ind.—Freshwater Sponges, etc., p. 18, 1911.)

Measurements of Skulls of TRIONYX *and* DOGANIA.

Species.	Sex.	Reg. Nos.	Length.	Breadth.	Orbit.	Snout.	Inter-orbital width.	Nasal aperture (width).	Post-orbital Arch.	Mandibular Symphysis.
T. gangeticus, Cuv.	..	1893	134 mm.	96 mm.	22 mm.	36 mm.	17 mm.	19 mm.	12 mm.	20 mm.
,,	..	1080	127 ,,	94 ,,	21 ,,	35 ,,	16 ,,	20 ,,	13 ,,	19 ,,
,,	♂	78	123 ,,	95 ,,	20 ,,	34 ,,	16 ,,	20 ,,	11 ,,	13 ,,
,,	..	16751	118 ,,	88 ,,	20 ,,	32 ,,	15 ,,	19 ,,	12 ,,	18 ,,
,,	♂	79	117 ,,	86 ,,	21 ,,	32 ,,	16 ,,	21 ,,	9 ,,	18 ,,
,,	♂	756	116 ,,	87 ,,	18 ,,	33 ,,	15 ,,	17 ,,	11 ,,	18 ,,
,,	..	1081	113 ,,	84 ,,	19 ,,	33 ,,	13 ,,	18 ,,	9 ,,	18 ,,
,,	..	1835	111 ,,	92 ,,	20 ,,	34 ,,	15 ,,	18 ,,	12 ,,	20 ,,
,,	..	1089	102 ,,	75 ,,	18 ,,	30 ,,	13 ,,	15 ,,	9 ,,	13 ,,
,,	..	1054	104 ,,	75 ,,	17 ,,	29 ,,	11 ,,	16 ,,	9 ,,	.. ,,
,,	..	1082	92 ,,	68 ,,	15 ,,	26 ,,	12 ,,	14 ,,	8 ,,	14 ,,
,,	♀	1083	92 ,,	63 ,,	17 ,,	25 ,,	9 ,,	14 ,,	7 ,,	12 ,,
,,	..	1084	89 ,,	62 ,,	16 ,,	23 ,,	9 ,,	13 ,,	6 ,,	15 ,,
,,	..	1052	88 ,,	62 ,,	16 ,,	23 ,,	10 ,,	15 ,,	7 ,,	15 ,,
,,	..	1085	74 ,,	51 ,,	14 ,,	18 ,,	7 ,,	11 ,,	5 ,,	.. ,,
,,	..	3870	84 ,,	58 ,,	14 ,,	22 ,,	8 ,,	12 ,,	5 ,,	.. ,,
,,	..	1051	88 ,,	60 ,,	16 ,,	23 ,,	10 ,,	14 ,,	6 ,,	13 ,,
,,	..	1086	77 ,,	52 ,,	14 ,,	19 ,,	7 ,,	11 ,,	5 ,,	11 ,,
,,	..	1727	68 ,,	48 ,,	14 ,,	17 ,,	7 ,,	10 ,,	3 ,,	11 ,,
,,	..	16750	60 ,,	41 ,,	12 ,,	15 ,,	6 ,,	9 ,,	4 ,,	10 ,,
T. hurum, Gray.	..	16752	129 ,,	87 ,,	21 ,,	38 ,,	16 ,,	19 ,,	14 ,,	30 ,,
,, [1]	..	1090	125 ,,	87 ,,	23 ,,	37 ,,	18 ,,	18 ,,	13 ,,	.. ,,
,,	..	1050	100 ,,	62 ,,	16 ,,	29 ,,	12 ,, ?	13 ,,	7 ,,	23 ,,
,,	..	1920	88 ,,	58 ,,	16 ,,	28 ,,	11 ,,	11 ,,	7 ,,	22 ,,
,,	♀	1047	83 ,,	49 ,,	14 ,,	24 ,,	11 ,,	10 ,,	7 ,,	20 ,,
,,	..	1049	70 ,,	41 ,,	13 ,,	20 ,,	9 ,,	9 ,,	6 ,,	15 ,,
,,	..	16627	72 ,,	43 ,,	13 ,,	19 ,,	9 ,,	10 ,,	4 ,,	16 ,,
T. nigricans, Andr.	..	1894	126 ,,	93 ,,	21 ,,	34 ,,	20 ,,	18 ,,	10 ,,	24 ,,
,,	..	1898	125 ,,	90 ,,	21 ,,	32 ,,	16 ,,	17 ,,	10 ,,	22 ,,
,,	♀	754	105 ,,	82 ,,	19 ,,	21 ,,	13 ,,	15 ,,	8 ,,	21 ,,
,,	..	1908	104 ,,	74 ,,	18 ,,	28 ,,	12 ,,	15 ,,	8 ,,	19 ,,
,,	♀	1918	? ,,	74 ,,	18 ,,	28 ,,	15 ,,	14 ,,	9 ,,	?
,,	..	1731	40 ,,	26 ,,	9 ,,	9 ,,	3 ,,	5 ,,	2 ,,	6 ,,
T. formosus, Gray.	..	1787	88 ,,	67 ,,	17 ,,	25 ,,	13 ,,	12 ,,	9 ,,	18 ,,
,,	..	1786	89 ,,	60 ,,	15 ,,	25 ,,	13 ,,	11 ,,	8 ,,	21 ,,
,,	..	605	87 ,,	56 ,,	16 ,,	24 ,,	12 ,,	11 ,,	7 ,,	?
,,	♂	1063	79 ,,	54 ,,	13 ,,	20 ,,	11 ,,	10 ,,	6 ,,	17 ,,
,,	..	634	59 ,,	42 ,,	12 ,,	16 ,,	7 ,,	8 ,,	4 ,,	13 ,,
T. phayrei, Theob.	♂	755	140 ,,	114 ,,	25 ,,	39 ,,	21 ,,	16 ,,	12 ,,	27 ,,
,,	..	1094	? ,,	128 ? ,,	25 ,,	42 ,,	21 ,,	20 ,,	13 ,,	26 ,,
D. subplanus	..	661	32 ,,	22 ,,	7 ,,	8 ,,	2 ,,	4 ,,	1 ,,	5 ,,
,,	..	13488	70 ,,	52 ,,	7 ,,	17 ,,	5 ,,	8 ,,	1 ,,	10 ,,

1 Type of *T. buchanani*, Theob.

ADDENDA.

The following specimens have been added to the collection or assigned to their proper position since the foregoing paper went to the press :—

TRIONYX GANGETICUS (p. 157).

Bengal.

16791 (skl.)	..	Oodhua, near Rajmahal..	*B. L. Chaudhuri, Esq.*
16791 ,,	..	R. Mahanaddi, Sambalpur	,,
16712 ,,	..	,, Cuttack	*Mrs. L. de Monte.*

Central Provinces.

1087-8	(skulls : juv.)	Nasdo R. (tributary of the Mahanaddi), Bilaspur district.	*Dr. W.T. Blanford.*

TRIONYX HURUM (p. 160).

16781	(skl : skin of head in spirit).	Oodhua, near Rajmahal..	*B. L. Chaudhuri, Esq.*

This specimen agreed fairly well in coloration with the one (16627) from the same locality described on p. 162 but was rather darker.

EMYDA GRANOSA INTERMEDIA (p. 172).

Orissa.

16911 (skl.)	..	R. Mahanaddi, Cuttack..	*Mrs. L. de Monte.*
16785-6 (spirit.)	..	,, Sambalpur..	*B. L. Chaudhuri, Esq.*

Specimen No. 16785 is melanic, the whole of the dorsal surface being of an almost uniform black while the ventral surface is strongly tinged with dark pigment.

EXPLANATION OF PLATE V.

MANDIBLES OF INDIAN SPECIES OF *Trionyx*.

Figs. 1, 3, 4, 5 reduced; 1a, 2, 6 natural size.

FIG. 1, 1a, 2.—*Trionyx gangeticus*.
1, 1a. Old and young individuals from the R. Ganges;
2. Young individual from the R. Mahanaddi.

FIG. 3.—Adult of *T. hurum* from the Gangetic delta.

FIG. 4.—Adult of *T. phayrei* from Arrakan.

FIG. 5.—Adult of *T. nigricans* from Chittagong.

FIG. 6.—Half-grown individual of *T. formosus* from Burma.

[The small projections at the tip of the jaw represented in fig. 1 are artificial.]

EXPLANATION OF PLATE VI.

All figures reduced.

FIG. 1, 2.—Skull and branchial skeleton of *Chitra indica*.

1. basihyal; 2, 3, 4. basibranchials; 5. greater cornu; 6. hypobranchial and ceratobranchial fused; 7. epibranchial; 8. pterygobranchial.

FIG. 3.—Type specimen of *Emyda granosa* subsp. *intermedia*.

Mandibles of Indian Species of Trionyx.

Photo by A. C. Chowdhury. Bemrose Colls., Derby

EXPLANATION OF PLATE VI.

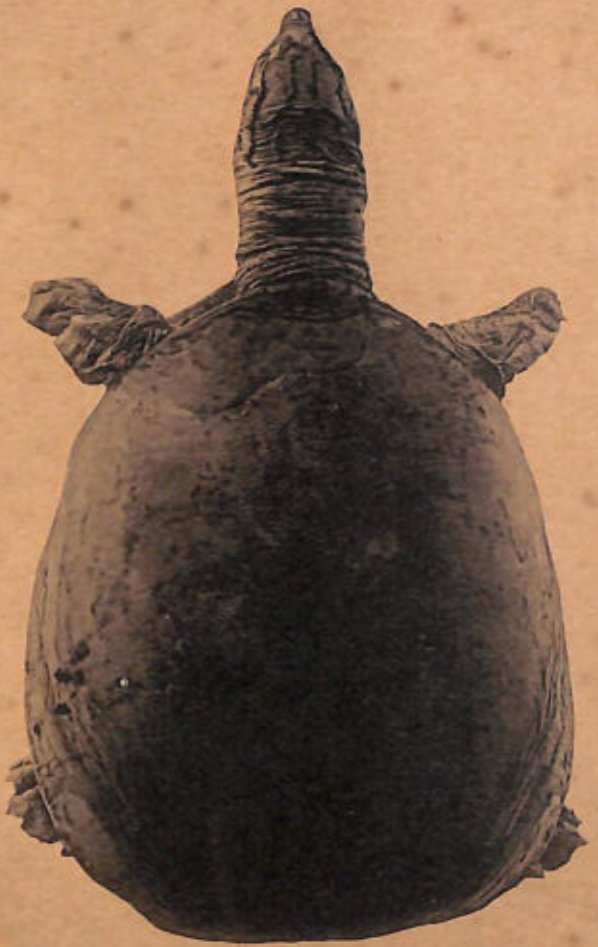
All figures reduced.

FIG. 1, 2.—Skull and branchial skeleton of *Chitra indica*.
1. basihyal; 2, 3, 4. basibranchials; 5. greater cornu; 6. hypobranchial and ceratobranchial fused; 7. epibranchial; 8. pterygobranchial.

FIG. 3.—Type specimen of *Emyda granosa* subsp. *intermedia*.

Photo by A. C. Chowdhury

1.



3.

2.

Figs. 1, 2. Chitra indica. Fig. 3. Emyda granosa intermedia, subsp. nov.

Bengal Colo. Derby

XVII. ON THE ANATOMY OF *ATOPOS* (*PODANGIA*) *SANGUINOLENTA* (STOLICZKA, M.S.).

By EKENDRANATH GHOSH, *L.M.S., B.Sc., Assistant Professor of Biology, Medical College, Calcutta.*

(Plates xxv–xxvii.)

INTRODUCTION.

The present article is based on several specimens of a slug collected more than forty years ago by the late Dr. F. Stoliczka in Penang[1] and at present in the possession of the Indian Museum. They have been placed at my disposal through the kindness of Dr. N. Annandale for anatomical investigation. Although left in alcohol for so many years, the animals were still in such a good condition as to allow me to make out the anatomical features in full detail with a few exceptions only. Having access to Simroth (12) and Collinge's (3, 4, 5, 6) publications, I took the opportunity of comparing the anatomy of other species of *Atopos* (of which *Podangia* is a subgenus) with that of the present species. As the animals had not been lately identified, it was necessary for me to consider the external characters fully and in minute detail, including the coloration. Unfortunately the colours of the animals have probably faded through long immersion in alcohol, but I have described them as they are at present.

Before passing on to the anatomy at once I shall try to find out the positions of the animals and the genus to which they most probably belong.

The specimens were placed in the family of Vaginulidae (Veronicellidae, Gray), order Pulmonata, under the name of *Veronicella sanguinolenta* by Stoliczka.[2] In 1891 Simroth in his admirable monograph (12) defined a new genus *Atopos* which he established for three species of *Vaginula*, Latrille,

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[1] Apparently he obtained the specimens in the "more wild and deep ravines of the north-western part of the island." (Journ. As. Soc. Bengal (2) XLI, p. 261 (1872).

[2] Stoliczka probably referred to these specimens in his paper on the mollusca of Penang (1873), but he only named them in MS. Collinge in "A CHECK LIST OF THE SLUGS," published by Cockerell and himself (3), writes on page 223 "*Atopos pulverulentus* apparently includes a specimen in the British Museum from Penang (Theobold), marked '*V. sanguinea*, Stol.' It has the body beautifully marbled with black and grey, the sole pale orange-tinted. Length about 54 mm. Bluntly keeled." No date is assigned to *A. pulverulentus*, Benson, on page 195 of the same paper and I am unable to trace the description.

which is considered to be identical with *Veronicella*, Blainville (17). He also described the anatomy of these three species.

The genus *Atopos* is mainly defined by the following characters :—

The body is thickest at the junction of the anterior one-third and posterior two-thirds, with a median keel on the dorsal surface of the mantle (notum); the transverse section of the body forms an isosceles triangle with a short base (formed by the foot); the female generative aperture is situated close to the anus and the renal and respiratory apertures in the groove between the mantle and the sole, a little behind the male generative aperture (although a little distant from it); the male generative aperture is situated behind the right lower tentacle.

Simroth also separated a few other species of *Vaginula* and placed them in a new genus which he named *Prisma*. The genus is characterized by the body of the animal being prismatic in transverse section.

Before the publication of Simroth's paper (12), Heude founded another genus *Rathouisia* for *Vaginulus sinensis*, the name of which he changed to *R. leonina*. The characters of the genus *Rathouisia* are briefly as follows :—

The animals are elongated, limaciform ; the mantle is not slimy; the upper tentacles are long; the lower tentacles are bifid; the posterior end of the foot is pointed, and extends beyond the mantle. The male generative aperture is placed behind the right lower tentacle. The female generative aperture rather approaches the male one, and is placed a little behind it, the anus and the excretory and respiratory apertures are placed close to the female generative aperture.

Later on, Heude united the genera *Atopos*, *Prisma* and *Rathouisia* to establish a separate family Rathouisiidae, characterized by a keeled mantle, male and female generative apertures distant and the anal and respiratory apertures placed near the female opening, in contradistinction to the absence of a keel, the position of the female generative aperture on the right in the middle of the body and that of the anal and respiratory apertures nearly at the posterior end of the body in the family of Vaginulidae (7, 11).

In 1900 Babor (2) established a new subgenus *Podangia* for *Atopos schildii* which differs from other species of *Atopos* in the following characters. The body of the animal is slender and high, with a distinct head separate from propodium. The foremost part of the notum is bent over the head covering it as a hood. The ommatophores (upper tentacles) are short, thick and distinctly annulated. Under each ommatophore is a crescent-shaped flap of integument produced into a process on each side and blended with the lower tentacle and the integument on the side of the mouth. The surface of the mantle is uniformly granulated with scattered tubercles in addition. The sole is small, with finely wrinkled border and with numerous

compact lobes. The groove between the foot and the mantle is shallow. The snout is elongated, with a small triangular mouth.

Taking the above characters into consideration, it seems to me that the animal belongs to the subgenus *Podangia*,[1] and as the colouring of the body differs from that of *P. schildii* it may be provisionally designated as *Atopos* (*Podangia*) *sanguinolenta*.

EXTERNAL CHARACTERS (pl. XXV, figs. 1 & 2).

GENERAL. The animal is elongated, limaciform. The body is compressed from side to side and is tapering to a point at the posterior end. The height and width of the animal is greatest at about one-fourth the length from the anterior end. The surface of the mantle is granulated uniformly and it also bears small scattered tubercles in addition. The tubercles are more numerous on the lateral aspect specially towards the margin of the mantle. The keel in the middorsal line is prominent but rounded. The margin of the mantle (perinotum) is sharp, wrinkled and inflexed. The foremost part of the mantle is bent over the head to form a hood-like covering. The anterior border of the hood is slightly notched. The posterior end of the mantle extends well beyond the foot. There is no distinct snout, the mouth being placed in a depression on the ventral aspect of the head. The head is distinctly separate from the propodium. The ommatophores are short, thick, and cylindrical, and are marked with annular wrinkles, they seem to be non-retractile (i.e. non-invaginable), as in all the specimens examined they were protruded to their full lengths although a little bit contracted. The lower tentacles are short, contractile and are each connected at the base with a flap of integument (precephalic flap) beneath. Each precephalic flap is a continuation forward of the head from the ventral aspect and is separated from its fellow of the opposite side by a long narrow gap extending behind to a little in front of the mouth. The anterior border of the flap is thin and convex; the outer border is broadly S-shaped, being concave in front and convex behind; the antero-external angle is pointed and the antero-internal rounded (pl. xxv, fig. 4). The anterior end of the foot is truncated and is produced in front to form the propodium. The posterior end of the foot is narrow and pointed and it does not extend beyond the mantle border. The margin of the foot is produced into a thin rim. The sole is wrinkled irregularly with small

[1] The colouring of *P. schildii*, as described by Babor [illegible] is follows:—The dorsal surface of the mantle (notum) is dark brownish grey, the foremost part of the mantle which forms a hoodlike covering of the head is of course pale. The head and foot are hazel-nut brown in colour.

The anatomy of *P. schildii* having been compared with that of *A. semperi* and *Rathouisia* in a few lines only, is of little use for the determination of the species.

lobules. The foot is separated from the mantle border by a shallow groove.

COLORATION.—The dorsum of the mantle is now reddish buff with dots and blotches of purplish black; of the tubercles some are of the same colour as the blotches. The lateral surface of the mantle is purplish black above, forming a broad longitudinal band with irregularly sinuous margins and of about one-third the height of the notum in width; this band is continuous with that of the opposite side round the anterior hood-like portion of the mantle; below there is another bluish black band with irregular margins, this is also continuous with that of the opposite side round the anterior end of the mantle by a narrower band of the same colour. The margin of the mantle (perinotum) is yellowish grey, with bluish black dots just below the band above. The ommatophores, lower tentacles and the dorsal surface of the precephalic flap are slaty blue. In life the colour of the dorsal surface of the mantle was probably bright red and the lower lateral band was probably dark blue.

MEASUREMENTS.—The animals having contracted in different degrees, and having been distorted by long immersion in alcohol, it is very difficult to get an accurate measurement to be of any use afterwards. Still it was thought best to note down the different measurements of all the specimens so as to form an idea of an average dimension. The length is taken along the midventral line after straightening the animal but without stretching it. The figure thus obtained was then compared with that resulting from measuring the animal along the midventral line in the distorted condition, and it was seen to be practically the same in both the cases. Another measurement is also taken along the keel from end to end. The width of the notum is taken to be the longest distance between the two lateral surfaces of the animal, and this is found to correspond generally to the junction of the anterior one-fourth and the posterior three-fourths of the body. The height of the notum is the longest perpendicular distance between the keel and the margin of the notum.

The measurements are given below in a tabulate form; they are all taken in centimetres.

Number of specimens.	1	2	3	4	5	6
Length along the venter	7·8	7·6	7	6·9	6·9	6·4
Length along the dorsum		10·9	9·1	10 2	9	8·8
Width of the notum	1·1	1·0	1·0	1·0	1·0	1·0
Height of the notum	1·4	1·3	1·2	1·3	1·2	1·2
Width of the foot	·7	·6	·65	·65	·6	·5
Distance of the male genital aperture from the anterior end of the foot ..	·3	·3	·3	·3	·3	·3
Distance of the female genital aperture from the anterior end of the foot ..	1·3	1·3	1·25	1·3	1·3	1·2
Length of the ommatophore ..	·3	·2	..	..	·2	·2
Length of the lower tentacle ..	·15	·15	..	..	·15	·15
Length of the cephalic flap ..	·4	·3	..	..	·3	·3
Width of the flap ..	·3	·3	..	..	·3	·3

ANATOMY.

I. BODY WALL (pl. xxv, fig. 3).

Minute structure.—The body wall consists of the following layers :–

(1) The *epidermis* consists of a single layer of epithelium. The cells of the epithelium are columnar in shape and are placed side by side except at their extreme narrow ends of attachment, where they are a little separated from each other. The free borders of the cells are refractile and striated, but it is doubtful whether they are ciliated. The protoplasm is granular and is marked with faint longitudinal striations. The nuclei are large and oval, and are placed in the middle of the cells. The attached narrow ends of the cells probably contain brown pigment granules in some places. Between these epithelial cells are scattered fine ducts of unicellular

glands which are sometimes placed so close to the surface of the body that the epithelial cells over them become more or less flattened and displaced sidewise.

(2) The *dermis* or corium consists mainly of connective tissue with a few muscle fibres and unicellular glands. The glands are large flask-shaped cells generally placed beneath the epithelial layer. The cell-content consists mainly of the secreted materials with a little protoplasm and a small nucleus at the base. Immediately beneath the epithelial layer the connective tissue consists of large bundles of white fibres placed nearly at right angles to the surface and of smaller bundles which are branched off from the vertical ones and are spread horizontally in all directions. The fibres ultimately form a close network in the interstices of which lie the connective tissue cells. These are round, oval or fusiform cells with large nuclei. Some of these and others with branching processes contain brown pigment granules, which are densely placed beneath the epidermal layer. Beneath this are one or two layers of several muscle fibres scattered irregularly. The deeper layers of connective tissue consist of loosely arranged bundles of white fibres with a few yellow fibres and numerous connective-tissue cells. These cells are free from pigment granules.

II. Respiratory system (pl. xxv, fig. 5).

The pulmonary chamber is much atrophied; it forms a small oval sac lying in the anterior-third of the body beneath the right lateral wall of the mantle. It extends almost to the junction of the mantle with the foot below and stops short of the middle line above. The pulmonary chamber seems to open to the interior by an aperture placed at the antero-lateral corner to the right; the aperture is placed just behind the anus. The pericardium extends obliquely on the roof of the pulmonary chamber from the right antero-lateral towards the left postero-lateral corner. The kidney lies on the roof at the back. The roof of the pulmonary chamber is closely adherent to the inner surface of the mantle.

III. Vascular system (pl. xxv, fig. 5).

The *pericardium* lies obliquely on the roof of the pulmonary chamber. The dorsal wall of the pericardium seems to be closely adherent to the body-wall.

The *ventricle* is placed in front of the auricle. The ventricle is a thick-walled pyriform sac with the ventral surface flattened

and the dorsal one convex. The *auricle* is thin-walled and is smaller than the ventricle.

Minute structure of the ventricle.—The ventricle is surrounded by a single layer of columnar epithelium. The muscles are arranged in various directions. The cavity of the ventricle is irregular and is traversed by numerous strands of muscle fibres. There is no epithelial lining in the cavity.

The *aorta*, just after its origin from the anterior end of the ventricle, divides into two; one passes forwards to the buccal bulb, while the other curves backwards and passes beneath the ventral aspect of the albumen gland closely applied to it, and seems to enter into the substance of the ovary; it also gives origin to several small vessels which supply the albumen gland.

The *pulmonary artery* (8) lies along the left side of the kidney, before it ends in the auricle; it receives numerous vessels from the kidney.

IV. KIDNEY (pl. xxv, fig. 5).

The kidney is a flattened triangular body lying on the roof of the pulmonary chamber at the back. In position it lies just over the accessory digestive gland to the right. The surface of the kidney is provided with a network of vessels which open into the pulmonary arteries. The margins of the kidney are thinned out and is continuous with the membranous wall of the pulmonary chamber. The ureter could not be traced.

In *A. strubelli* (10), the pulmonary chamber is a more or less round sac with the heart placed transversely and kidney to the left extending over more than half of the pulmonary chamber.

Minute structure.—The kidney consists of a mass of tubules which converge to open into the ureter which seems to lie along the right (?) side of the kidney. The tubules are long and wavy with wide lumen. They are all placed side by side with thin layers of intervening connective tissue. The wall of the tubules consists of a single layer of polyhedral cells placed on basement membrane. The nuclei of the cells are oval, and are placed at the bases of the cells.

The sections of kidneys from two specimens show numerous cystic bodies contained in the cells of the tubules. These cystic bodies, which are doubtlessly parasitic, seem to be the oocysts of a sporozoon. They are mostly round or oval, although many are irregular in shape. The wall seems to consist of a thick layer of cuticle which did not allow the staining fluid to penetrate into the interior. The cysts contain from one to six spores with distinct round nuclei. The spores are spherical, or facetted when there are more than one in a single cyst. The oocysts were too little advanced to show the formation of sporozoits. This sporozoon seems to belong to the genus *Klossia* (fam. Polysporocystidae, order Coccidiidea).

V. Digestive system (pl. xxv, figs. 6–13, and pl. xxvi, figs. 14–16).

(i) The *buccal bulb* forms a tubular or elongated conical proboscis lying in a muscular sheath when retracted. The sheath opens on the ventral aspect of the head to form the mouth. The wall of the sheath is continuous behind with the wall of the buccal bulb just in front of the opening of the oesophagus into the latter.

(ii) The buccal bulb is continuous behind with a thick-walled conical sac which forms the *radula sac*. Collinge (3) describes the buccal bulb as divided into two portions lying respectively in front and behind the opening of the oesophagus. The radula sac is surrounded by a distinct muscular sheath.

The *radula* (pl. xxv, figs. 11–13) is a wide ribbon-like structure which does not seem to extend far forwards in the proboscis. The teeth are arranged in **V**-shaped rows with the apex of v directed backwards. There is no central. The lateral teeth are uniform in shape except the two median ones which are slightly different from others. There is no marginal. There are never less than 19 teeth on each side of the middle line. Each tooth is unicuspid and presents a shallow cup-like process in the middle.

The teeth of the radula in *A. strubelli* (10) are similar to those of the present species except that there is no cup-like process in the former.

(iii) The *salivary glands* could not be found in the specimens dissected. They were described in several species of *Atopos* by Collinge (3, 4) and Simroth (12). Each gland was described to consist of a glandular mass and a long duct opening into the bucca bulb just behind the attachment of the muscular sheath on the ventral aspect. In *A. sarasini* (4), the two glands unite to form a single mass, although the two ducts are separate.

(iv) The *oesophagus* (pl. xxv, fig. 6) is a narrow tube arising from the dorsal surface of the buccal bulb behind the proboscis-sheath in the middle line or a little to its left. It then takes a U-shaped curve the bend of which is directed to the left. The tube then curves to the right, and down the side and ventral aspect of the anterior end of the radula sac to the mid ventral line, and then sharply turns forwards for some distance beneath the proboscis-sheath. It again turns backwards and passes beneath the short intercerebral connective to the undersurface of the digestive gland into the cavity of which it opens a little in front of the junction of the anterior one-third and posterior two-thirds of its length.

In *A. maximus* (3), the oesophagus passes to the left and then takes a U-shaped curve to pass beneath the radula-sac, it then passes backwards and to the left beneath the intercerebral connective to the under surface of the digestive gland and opens into it at a point about one-fourth the length of the gland from the anterior end. In *A. sarasini*, the oesophagus takes a similar sigmoid curve, but passes to the right at first and

then to the left. In *A. leuckarti* and *A. strubelli*, it ends in the anterior end of the digestive gland.

Minute structure (pl. xxv, fig. 10).—The oesophagus consists of the following coats from without inwards:—

(1) A thin layer of connective tissue consisting of a few white fibres and elongated fusiform connective tissue cells. Just beneath this layer are seen two nerves (oval in transverse section) passing along the sides of the ventral surface of that portion of oesophagus which passes backwards from beneath the intercerebral commissure to the digestive gland.

(2) Alternate layers of longitudinal and transverse muscle-fibres with loose connective tissue intervening between them. The fibres do not form continuous bundles, but are arranged irregularly. The fibres of different layers often communicate with one another. The bundles become smaller and smaller as we pass inwards. The longitudinal fibres become predominant on the inner side and form several longitudinal folds, generally nine in number, which project into the cavity of the tube.

(3) The mucous membrane consists of a single layer of columnar epithelium. The cells seem to be ciliated.

(v) *The digestive gland, mid-gut gland* or *liver* (pl. xxv, figs. 6 and 8) is a large elongated conical (or fusiform) body wide and rounded in front, but tapering and pointed behind. It occupies more than the posterior two-thirds of the body. In front it lies in connection with another small gland, the accessory digestive gland, and it is connected at its hinder end to the terminal body-wall by strands of connective tissue. The outer surface of the gland is smooth, but presents some transverse fissures. The inner surface is raised into numerous folds and papillae which increase the absorbing surface to a great extent. The wall of the gland is thick, and the gland is circular in transverse section.

In *A. strubelli* and *A. semperi* (10), the outer surface of the gland is finely lobulated but the inner surface is smooth and circular in transverse section. In both the gland is of dark colour and is conical in shape. In *A. leuckarti* (10) the gland is irregularly lobed and presents a process to the left from near the anterior end.

Minute structure (pl. xxvi, figs. 14, 15).—The whole gland is surrounded by a thin layer of connective tissue (consisting of white fibres and connective-tissue cells). This ensheathing layer gives off numerous strands which converge and pass inwards to form the core of numerous papillae and folds which project into the cavity of the gland. These strands consist of connective-tissue fibres with a few muscle cells. These strands are surmounted by a single layer of cells which are placed side by side without any interspace between them. The cells are arranged to form

tubular spaces (simple tubular glands) between the contiguous connective tissue strands. Each space communicates with the cavity of the digestive gland by a wide mouth. The epithelium consists of elongated ciliated cells with the nuclei placed at the base. Numerous goblet cells are found between these ciliated cells. The bases of many of these ciliated cells are occupied by a number of amoeboid (?) corpuscles with large round nuclei.

The *accessory digestive gland* (pl. xxv, figs. 6, 8) is a small triangular body lying in front of the digestive gland. The ducts of this gland open into the intestine as the latter passes forward from the left side of the gland. In the drawing of the alimentary canal of *A. maximus* (5) ducts of two other glands (not represented in the figure) are shown to open into the digestive gland. Hence it might be inferred that the above gland opens into the digestive gland. No such glands seem to be present in *A. strubelli*, *A. semperi*, and *A. sarasini* (4.) The process from the digestive gland in *A. leuckarti* seems to be homologous with the accessory gland.

Minute structure (pl. xxvi, fig. 16.)—The gland is surrounded by a connective tissue-sheath. It consists of a large number of lobules held together by connective tissue. Each lobule consists of a group of irregularly polyhedral cells closely apposed to one another, although fine channels (with walls composed of connective-tissue cells only) are often found passing between the cells. The protoplasm of most of the cells is coarsely granular and is stained red with eosin. These are undoubtedly zymogen granules. The nuclei are oval or rounded, and are obscured in many cells by these granules. A small proportion of cells have clear protoplasm with finer granules and more distinct nuclei. The gland is richly supplied with blood vessels which are placed inside the lobules. They generally form bundles in the middle of the lobules.

(vi) The *intestine* is a stout but thin-walled tube arising from the left side of the digestive gland towards the ventral aspect and close to the opening of the oesophagus. It forms a U-shaped loop lying embedded on the dorsal surface of the gland and then passes along the left side or on the dorsal aspect of (figs. 6, 18) the accessory gland, over the groove on the albumen gland and vagina obliquely to end in the anus, which lies on the right side in the groove between the foot and the overhung margin of the mantle closely behind the female genital aperture.

In *A. strubelli* (10) and *A. leuckarti* (10), the intestine seems to be directly continuous with the oesophagus at the anterior broad end of the midgut gland, which opens into the gut by a wide aperture at the junction of the two. In *A. sarasini* (4) the intestine forms a M-shaped loop lying embedded in the wall of the gland and comes out from its anterior end. The oesophagus is continuous with the intestine with a wide aperture (at the junction) which communicates with the cavity of the midgut gland.

Comparing the alimentary canal of these slugs with that of the more typical groups of pulmonates, *e.g.* the land snails, it should be observed that in the present animal there is no distinct dilatation of the midgut in the form of stomach quite distinct from the liver, which opens into the gut by small ducts in contradistinction to the separate stomach and liver in the land snails. Here the stomach might be considered to have become incorporated with the cavity of the gland, the wall of which presents numerous tubular glands homologous with a separate digestive gland.

VI. REPRODUCTIVE SYSTEM.

As in other pulmonates, the male and female genital organs are united in the same individual. There is some difference in opinion about the connection between the male and female organs at their proximal ends. Simroth's (10) descriptions and figures of the genital organs of his three species show that there is a common hermaphrodite gland from which are given off the vas deferens and oviduct; this condition then corresponds to the second of three types of genital ducts described by Lang (8). Collinge (3, 4), however, could not find out any connection between the two in his specimens. Although I found the two organs separate from each other, I have a good deal of doubt about the validity of Collinge's view for the reasons noted below. On examining under the microscope the stained sections of the organ which corresponds to what Collinge described as ovary, I observed spermatozoa in different stages of development to my full satisfaction in addition to immature ova. As I had only old spirit specimens to dissect, it occurs to me that the so-called ovary is really a hermaphrodite gland the fine vas deferens of which I could not trace. As the hermaphrodite and albumen glands lie over the penial sheath it seems to me that the vas deferens, being very fine and small, gets torn as the above glands are lifted up from their position and are separated from the penial sheath. Still as I could find out no connection between the two organs in the several specimens I dissected, I leave the question for further consideration in future.

(I) MALE GENITAL ORGANS (pl. xxvi, fig. 20).

(1) A fine thread-like tube (pl. xxvi, fig. 20a) opening into the posterior end of the penial sheath near the attachment of the retractor muscle of the penis. It lies along the left side of the penial sheath and the stout tube in front, and extends to near the external opening of the right Simrothian gland. The same arrangement is seen in both *A. maximus* and *A. sarasini* described by Collinge (4) who called the tube vas deferens. Considering the anatomy of the genital organs of other pulmonates, this tube seems to be homologous with the flagellum. This has

been described in *Helix pomatia* and other pulmonates of the same family (7, 8).

Minute structure (pl. xxvii, figs. 27 and 28).—The tube is composed of the following coats from without inwards :—

(1) A thin layer of connective tissue.
(2) A layer of longitudinal muscle-fibres.
(3) A layer of circular muscle-fibres.
(4) A submucous coat of connective tissue (with a few muscle-fibres) raised into a number of longitudinal folds, generally ten, projecting into the lumen.
(5) A single layer of columnar epithelium with numerous goblet cells (secreting cells).

(2) The *penial sheath* consists of two portions :—(1) A stout hollow spindle-shaped structure giving attachment to the retractor muscle at its proximal end ; (2) a stout tubular structure arising from the distal end of the first portion and ending in the external aperture at the base of the right lower tentacle.

Minute structure.—The tubular portion consists of alternate layers of longitudinal and transverse muscles arranged irregularly. The wall is thrown into large longitudinal folds, the core of which is formed mainly of longitudinal muscle fibres. The presence of these large folds shows the great extensibility of the penial sheath. The epithelium consists of a single layer of cubical (or short columnar) cells.

(3) The *penis* is a more or less cylindrical structure lying in the proximal portion of the penial sheath when retracted. The penis is attached to the sheath at the proximal end and is traversed by a fine channel continuous with the lumen of the tube described above, and opening into the tip by a small aperture.

(4) The *retractor penis muscle* is a short thick band extending from the inner side of the body wall on the right, a little behind the female genital aperture, to the proximal end of the penial sheath and penis.

(5) The *Simrothian glands* (pl. xxvi, figs. 19, 20a) are two tubular structures, one on each side, opening on the outer side of the lower tentacles, the right one being placed close to the male genital aperture. Each gland can be divided into four portions—(1) a long stout tubular portion coiled in various ways ; (2) a short narrow portion, also tubular in structure, coiled closely ; (3) an elongated slightly curved conical portion continuous with the second one at the tapering end and ending in the next in a broad base ; (4) a very short narrow tube with a small cylindrical process from the outer side.

The structure of the Simrothian glands in *A. maximus* and *A. sarasini* resembles closely that of the present species except that there is no distinct fourth portion and the process arises from the proximal end of what corresponds to the third division

in the present species. There is no left Simrothian gland in *A. sarasini* (4).

Minute structure.—First portion (pl. xxvi, fig. 24).—The wall consists of the following layers from without inwards :—

(1) A thin layer of connective tissue forming a sheath round the tube.
(2) A layer of large granular cells more or less cylindrical in shape and with large nuclei placed on one side; they are arranged radially and obliquely, being attached to the first layer at their outer ends and to the next by the inner. In a transverse section one finds several oblique sections of the cells. These seem to be muscle-cells.
(3) A layer of muscle-fibres arranged longitudinally.
(4) A layer of transversely arranged muscle-fibres.
(5) A layer of submucous tissue. It forms numerous folds projecting into the lumen. Small muscle-fibres can be traced into it from the fourth layer.
(6) The mucous membrane consists of a single layer of columnar epithelium.

Second portion (pl. xxvii, fig. 26).—The different layers are :—

(1) An outermost layer of connective tissue.
(2) A thick transverse layer of muscular fibres intermingled with white and yellow fibres.
(3) A single layer of cubical cells with round nuclei. The epithelium is not folded.

Two or more loops of this portion of the tube may be held together in connective tissue.

Third portion (pl. xxvii, fig. 25).—The various layers are :—

(1) A layer of thick longitudinal muscle-fibres—the individual fibres are separated by connective tissue.
(2) A thin transverse layer of muscle-fibres; some of these are continued into the folds of submucous tissue.
(3) A submucous coat of loose connective tissue thrown into ten or twelve folds.
(4) The mucous membrane consists of a single layer of columnar cells with oval nuclei.

(6) The external aperture of the male genital organ seems to be situated on the inner side of a triangular process between it and the base of the right lower tentacle.

(II) FEMALE GENITAL ORGANS (pl. xxvi, figs. 17, 18).

(1) The *hermaphrodite* gland is a large lobulated body lying closely apposed to the posterior end of the albumen gland. The dorsal surface is marked with a longitudinal groove for the

intestine. The ventral surface is concave and rests on the penial sheath.

Minute structure (pl. xxvi, fig. 21).—The gland is composed of a number of lobules held together by connective tissue, which forms a thin sheath round the whole gland and also extends between the adjacent lobules. Each lobule is oval in shape and gives rise to a duct of its own which unites with others from the adjacent lobules to form the main duct of the gland. The lobular ducts could be distinctly followed to the oviduct by the naked eye. Each lobule consists of a single layer of flattened epithelium supported on a thin layer of connective tissue (forming the wall), with a central cavity filled with mature ova and spermatozoa. Each lobule gives origin to both ova and spermatozoa from its wall.

In the formation of an ovum, a cell of the wall enlarges and becomes fusiform in shape; its free surface is covered by a single layer of flattened cells continuous with those of the wall of the lobule. When mature the ovum seems to lie free in the cavity of the lobule.

The cells which ultimately form the spermatozoa seem to divide into a number of round cells (primary sperm mother cells) which become aggregated on the surface of conical or round projections into the cavity of the lobule from its wall. In a section of the lobule one will see several projections, the centre of which consists of a mass of protoplasm with a large nucleus. The primary sperm-mother cells are arranged on the surface of the projections. What seems to occur is the proliferation of an epithelial cell so as to form a mass of round cells on the surface of one which grows more rapidly than others and forms the supporting cell. The protoplasm of this cell is highly granular, and it has got no distinct cell-wall. The primary mother cells seem to divide again to form groups of secondary sperm-mother cells for by careful examination of stained sections under the microscope one will find a second set of smaller cells grouped in a similar way and still attached to a supporting cell. The nuclei of these secondary sperm-mother cells become gradually elongated to form the head of the spermatozoa. The different stages of the change in shape of the round nucleus to a rod-shaped body could be easily followed in stained sections. The protoplasm of the cell then elongates to form the tail of the spermatozoon. The mature spermatozoa then separate from these papillae and lie freely in the cavity of the gland in bunches.

The mature *ovum* (pl. xxvi, fig. 22) is completely surrounded by a single layer of flattened cells (with distinct nuclei) attached end to end. The protoplasm is coarsely granular. The large nucleus lies in the centre and presents a conspicuous nucleolus.

The mature *spermatozoon* (pl. xxvi, fig. 23) consists of a hook-shaped head and a long fine tail. The head is curved and pointed at the tip, but broad and rounded at the base. It is also curved twice before it ends in the tail, which is many times longer than the head.

(2) The *albumen gland* is an elongated body with the posterior end flattened and attached to the ovary. The anterior end is narrow. The upper convex surface of the gland is smooth, but present numerous transverse fissures. It is indented with a longitudinal groove for the intestine. The inner surface is concave and presents a depression for the penial sheath over which it lies.

Minute structure (pl. xxvii, fig. 29).—The gland is composed of a number of lobules bound together loosely by connective tissue. Each lobule is formed by a group of tubular acini, each of which seems to end in a duct which unites with others to form a main duct opening into the oviduct. Each acinus is enclosed by a basement membrane. Inside it is the epithelium consisting of a single layer of polyhedral cells with large round nuclei placed towards the base. The inner free borders of the cells are broken and jagged. The inner two-thirds of the cells are filled with coarse granules. The cavities of the acini are filled with the secreted material which is stained deep blue with hæmatoxylin. The ducts of the acini are lined with columnar epithelium.

(3) The oviduct is a thin-walled tube passing through the substance of the albumen gland and emerges through its anterior extremity to end in the vagina.

Minute structure (pl. xxvii, figs. 30, 31).—The wall consists of a thin outer layer of connective tissue which is continued into the centre of the longitudinal folds projecting into the lumen. Inside this layer is a coat of connective tissue cells with a few fibres between them. These are also continued into the folds and surround the central strands of connective tissue. The mucous membrane consists of a single layer of ciliated columnar epithelium.

(4) The vagina is a stout tubular structure slightly curved with the convexity downward and to the right. The upper surface presents a groove for the intestine.

(5) The receptaculum seminis is an oval body with a fairly long tubular stalk opening into the middle of the vagina on its side.

(6) The female genital aperture in which the vagina ends, lies in the groove between the foot and right mantle border at a distance from the anterior end of the body already noted in a tabular form.

VII. Nervous system (pl. xxvii, fig. 32).

The nervous system is of euthyneurous type. The ganglia are closely united to form a mass round the oesophagus. The cerebral ganglia are closely connected to each other by a short thick intercerebral commissure. The cerebro-pedal and cerebro-pleural connectives are united to form a short thick band on each side. The buccal ganglia are placed on the ventro-lateral aspect of the binder end of the proboscis-sheath at the junction with the radula-sac. The stomato-gastric connectives are long

The pedal and viscero-pleural ganglia of both sides are closely connected to each other to form a reniform mass. The aperture for the oesophagus is very small.

VIII. PEDAL GLAND (pl. xxvii, fig. 33).

Is a tubular structure lying beneath the central nervous system on the dorsal aspect of the foot. The external aperture of the gland lies in the middle line in the groove betwen the head and propodium.

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EXPLANATION OF PLATE XXV.

FIG. 1.—*Atopos sanguinolenta* (nat. size): 1, male genital aperture; 2, female genital aperture.

,, 2.—Ventral view (nat. size): 1, male genital aperture; 2, female genital aperture; 3, anus.

,, 3.—Section of the bodywall, × 460; 1, epidermis, 2, unicellular gland; 3, pigment-containing connective tissue cell; 4, connective tissue cell (without pigment); 5, 6, vertical strands of white fibres; 7, muscle-fibre; 8, subepidermal pigments.

,, 4.—Head (dorsal view), × 4; 1, precephalic flap; 2, lower tentacle (left); 3, ommatophore (left); 4, opening of the left Simrothian gland.

,, 5.—Pallial chamber, × 1½; 1, ventricle; 2, auricle; 3, kidney; 4, aorta; 5, boundary of the pallial chamber; 6, position of the right lateral border of the mantle; 7, position of the mid-dorsal line (of the mantle).

,, 6.—Portion of alimentary canal, × 2; 1, accessory digestive gland; 2, digestive gland; 3, wall of digestive gland cut open to show the internal cavity; 4, cut end of oesophagus; 5, oesophagus; 6, intestine; 7, vagina.

,, 7.—Buccal mass, × 2; 1, proboscis-sheath; 2, proboscis; 3, a portion of oesophagus; 4, radula-sac.

,, 8.—Digestive gland of another specimen, × 1; 1, accessory digestive gland; 2, intestine.

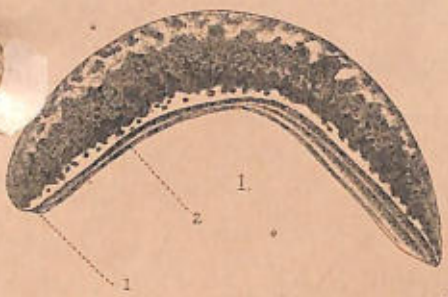
,, 9.—Longitudinal section through the buccal mass, × 3; 1, proboscis-sheath; 2, proboscis; 3, opening of oesophagus; 4, radula-sac; 5, radula.

,, 10.—Transverse section of oesophagus, × 105.

,, 11.—Portion of radula showing teeth, × 60.

,, 12.—Two lateral teeth of radula, × 105.

,, 13.—Two median teeth of radula, × 255.



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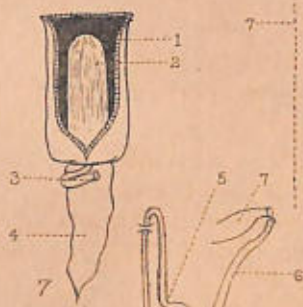

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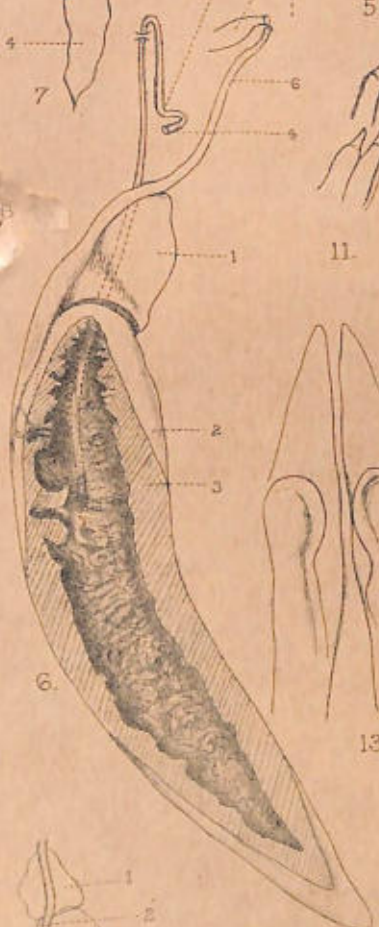

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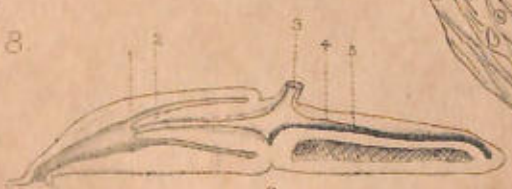

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E. N. Ghosh, del.

A. C. Chowdhary, lith.

EXPLANATION OF PLATE XXVI.

FIG. 14.—*Atopos sanguinolenta*, portion of epithelial layer of digestive gland, × 105; 1, goblet cell.

,, 15.—A transverse section of the wall of digestive gland (diagrammatic).

,, 16.—Section of accessory digestive gland, (stained with eosin and haemotoxylin), × 255.

,, 17.—Female genital organs (dorsal view), × 2; 1, hermaphrodite gland; 2, albumen gland; 3, vagina; 4, visceral artery.

,, 18.—Female genital organs, etc. (ventral view, with vagina unfolded), × 2; 1, hermaphrodite gland: 2, albumen gland; 3, vagina; 4, visceral artery; 5, receptaculum seminis; 8, anterior limit of pallial chamber; 7, kidney; 8, ventricle.

,, 19.—Left Simrothian gland, × 2.

,, 20a.—Male genital organs, × 2; 1, retractor penis muscle 2, penial sheath; 3, right Simrothian gland; 4, flagellum.

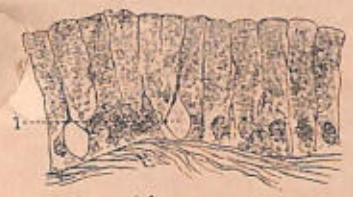
,, 20b.—Longitudinal section of penis and penial sheath, × 2; 1, penis; 2 penial sheath.

,, 21.—Section of hermaphrodite gland, × 124; 1, ovum; 2, sperm-mother cells; 3, developing spermatozoa; 4, free mature spermatozoa.

,, 22.—Section of a mature ovum, × 124.

,, 23.—A mature spermatozoon, × 756.

,, 24.—Transverse section of the first portion of the right Simrothian gland, × 50.



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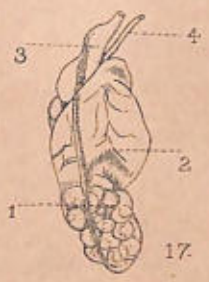

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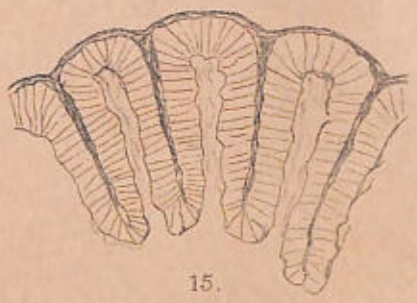

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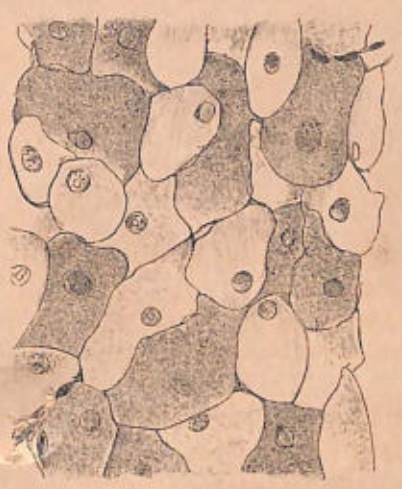

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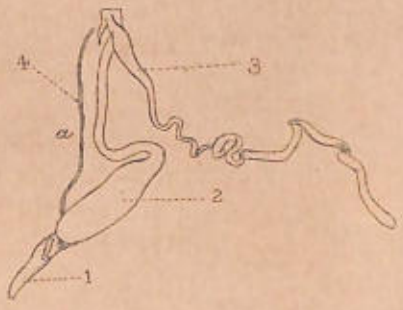

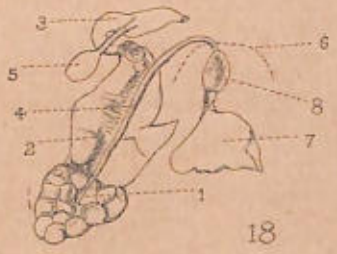

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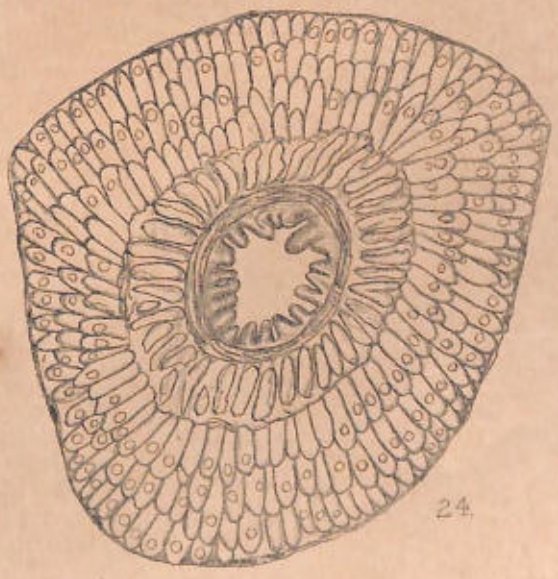

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E.N. Ghosh, del. A.C. Chowdhary, lith.

EXPLANATION OF PLATE XXVII.

FIG 25a.—*Atopos sanguinolenta*, transverse section of the third portion of the right Simrothian gland, × 50.

,, 25b. A portion of the epithelial lining of the third portion of the Simrothian gland, × 460.

,, 26.—Transverse section of the second portion of the right Simrothian gland, × 50.

,, 27.—Transverse section of flagellum, × 255.

,, 28.—Portion of the wall of flagellum (transverse section).

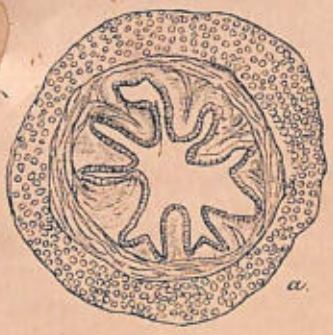
,, 29.—Section of albumen gland, × 255.

,, 30.—Transverse section of oviduct, × 30.

,, 31.—Portion of a fold of oviduct as marked in fig. 30, × 255.

,, 32.—Nervous system, × 4; 1, cerebral ganglion (right); 2, right viscero-pleural ganglion 3, otocyst; 4, right pedal ganglion; 5, right pedal nerve ($\frac{1}{10}$th of the length).

,, 33.—Pedal gland, × 2.



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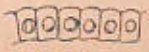

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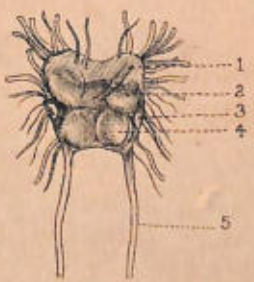

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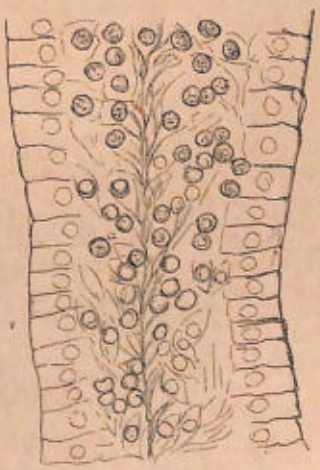


31.

XVIII. NEW CESTODES FROM INDIAN FISHES.

By JAMES HORNELL.

(Plates ix—x.)

I.—PROSTHECOBOTHRIUM UROGYMNI, n. sp.

II.—BALANOBOTHRIUM TENAX, n. gen. et sp.

III.—TETRARHYNCHUS ANNANDALEI, n. sp.

(1). PROSTHECOBOTHRIUM UROGYMNI, n. sp.

(Pl. ix, figs. 1—3).

Two specimens of this fine cestode were obtained from the spiral valve of a male *Urogymnus asperrimus* (Bl. Schn.), trawled in 9 fathoms on the north end of the Periya Par, one of the Ceylon Pearl Banks in the Gulf of Manaar, February 1908.

When alive the larger of the two measured 25 cm. in length, shortening to 14 cm. at death. The species is closely related to *P. dujardinii* (van Beneden), differing therefrom chiefly in its much greater size, the great elongation of the neck and the superior development of the suctorial loculi of the bothridia.

The scolex is furnished with four elongated sessile bothridia. Each is sub-lanceolate in outline, divided into three distinct loculi by two transverse muscular costæ. The most anterior loculus is considerably the longer being equal to the combined length of the two posterior ones. In life the mobile edges of the bothrium curve inwards and all three loculi are distinctly seen as deep sucker-like cavities; in this latter characteristic the present species exhibits a marked divergence from Diesing's type of the genus where the bothridia are described as undivided, each having a suctorial appendage at its posterior extremity. Johnston's description of the same species (*P. dujardinii*) necessitates a modification of the original generic diagnosis as he describes each bothrium as "really divided into three loculi by two transverse curved costæ," adding, however, that the most anterior loculus "is not apparently concave." The distal portion of each bothrium possesses a tongue-like mobility enabling it to twist and turn in search of a new holding when the living worm is dislodged from its attachment within the host's intestine. The tips of the bothridia may then be seen projecting prominently and at a considerable angle from the neck.

In anterior view the scolex appears sub-quadrangular, the thickened anterior extremities of the bothridia forming the four angles; as seen in figure 2 the bothridia extend some distance towards the centre of the "head," by their slight prominence forming a distinct cruciform depression upon the apical surface. The thickened anterior extremity of each bothrium bears a pair of double hooks; each consists of two sub-equal slightly curved long and slender prongs fused together by their bases. The curve in each prong is double—a light divergent curve from its fellow and a somewhat abrupt or right-angled curve on the under side whereby its holding power in attachment is increased. The acute-angled apex of the base of each double hook is approximated to that of its fellow in the same pair. The prongs project considerably and overhang slightly the anterior margin of the proximal bothridial loculi. In colour the hooks are dark brown and in appearance are chitinous. No accessory suckers or acetabula are present, thus differentiating this genus from the otherwise closely allied *Calliobothrium*.

The neck is very long and slender; about 0·4 mm. broad. The proglottides are extremely numerous and always markedly broader than their length. The width of the great majority, 0·75 to 0·9 mm., is characteristically almost twice as great as the length; a few at the posterior extremity as they ripen become somewhat more elongate and narrower. The lateral edge of the proglottides is slightly curved, the posterior margin very slightly produced and overlapping the front edge of the next succeeding. The genital pores are lateral. The general appearance and proportions of the strobila thus approximate closely to what is seen in *P. trygonis*, Shipley and Hornell.

It is noteworthy that the stomach contents of the host which yielded this cestode consisted (with the exception of a fragment of a Nemertine) of a great mass of one or more species of Amphioxus; there were hundreds of individuals in the mass. Other parasites present were *Tylocephalum uarnak*, Shipley and Hornell, in great numbers, a single specimen of *Tetrarhynchus ætobatides*, and numerous individuals of an undetermined Nematode.

The dimensions of the host were:—

Length of body to base of tail	3 ft. 1 in.
Breadth of disc	3 ft. 0 in.
Length of tail	1 ft. 8 in.

The diagnosis of *P. urogymni*, n. sp., is as follows:—Long slender cestode. Head elongated, twice as long as broad, armed with four large sessile, elongated and regularly disposed bothridia, each sub-lanceolate and trilocular with mobile edges and posterior tip; anterior extremity of each bothrium tumid, armed with a pair of double dark brown chitinous hooks. Prongs of each hook slender, equal, curved in two planes, the tips projecting beyond the anterior margin of the proximal loculus.

Neck very long and slender, proglottides very numerous, lateral margins lightly curved, posterior slightly overlapping, usually twice as broad as long, except a few of the most posterior. Length when alive up to 25 cm. Breadth of head under 1 mm.; of typical proglottides, 0·75 to 0·9 mm.

Habitat:—The large intestine of *Urogymnus asperrimus* (Bl. Schn.).

The characteristics of the genus *Prosthecobothrium* may now be amended as follows:—

Scolex with four elongated sessile bothridia divided by transverse costæ into three loculi; no accessory suckers on the anterior margins of the bothridia; a pair of double hooks on the anterior margin of each bothrium.

BALANOBOTHRIUM, n. gen.

Scolex acorn-shaped, consisting of a bulbous head surrounded at the base by a cup-shaped mobile membranous collar; a pair of very minute two-pronged uncini situated at four equidistant points on the upper circumference of the head, a minute acetabulum above each pair of uncini. Neck extremely short. Strobila ligulate, the proglottides short and wide.

(2). BALANOBOTHRIUM TENAX, n. sp.

(Pl. ix, figs. 4–6 and 8–10, and x, figs. 7, 11, 12).

This species has been found on two occasions in Indian seas, the first in 1905, when I found several small and immature ones attached to the spiral valve of a *Stegostoma tigrinum* (Gmel.) trawled on the Ceylon Pearl Banks; the second, in the intestine of an individual of the same host trawled in the Bay of Bengal by the Bengal Government Fishery Steamer "Golden Crown." Those obtained by the "Golden Crown" are much the larger and appear to have reached full development. In the dead condition they attain a length of 32 to 33 cm., three of the five specimens being within this range; the other two are shorter, 18 cm. and 21 cm. respectively. Two of the largest are headless. The scolex consists of a bulbous sub-conical head contracted suddenly at the base to a very short and slender stalk from which a delicate membranous upturned cup-shaped collar is given off. In life the bulbous region of the scolex is wholly embedded within a sac-like diverticulum of the surface membranes of the host's intestine. This diverticulum hangs freely within the cavity of the intestine, its base greatly constricted. The os of its free end is minute and encircles closely the constricted base of the parasite's head bulb. In this way the head of the cestode is so firmly held that in removing the worm it is impossible to withdraw it uninjured from the sac and it becomes necessary to tear or cut away the sac at its junction with the instestine. In life the wide collar below the base of the head bulb functions as a suctorial bothrium, enfolding

and clasping the wall of the distal half of the intestinal diverticulum, so that a double purchase is assured—the diverticulum enveloping the parasite's head and the collar of the latter in turn enfolding the distal half of the hollow intestinal outgrowth (pl. x, fig. 11).

When freed from its adventitious envelope, the head is seen to be capable of considerable change of form and it is probable that by its alternate elongation and contraction it functions as a burrowing or penetrating organ, aided by the suctorial action of the bothridial cup which simultaneously anchors the worm securely in position. To supply the means of contraction well-marked muscle fibres pass from the constricted stalk and spread out over the walls of the head. The musculature of the encircling bothrium is weak, but radial and circular fibres appear to be present.

The head is armed in a peculiar manner with four pairs of minute two-pronged hooks situated at four equidistant points well anterior to its widest circumference. In the small and immature specimens obtained in Ceylon the two prongs of each hook are unequal and strongly recurved and rise from a common horizontal base, the larger from one extremity, the smaller from midway between the two ends. Opposite the base of the larger spine is a minute blunt spur-like process. In the large and fully adult specimens from the "Golden Crown" the common basal bar is stouter and wider and no "spur" is to be seen. So minute are these uncini that they cannot be seen until the head be mounted and examined microscopically and then a $\frac{1}{8}$th-inch objective is required to see the structure clearly. A low fleshy ridge runs backwards from the insertion of each pair of uncini, while immediately anterior to the interspace between the members of each pair is a minute acetabulum (pl. ix, fig. 8).

No definite neck region is present. Closely set grooves of incipient segmentation are apparent immediately behind the scolex; they gradually become more and more definite till the segments appear as distinct proglottides. These attain a maximum breadth of 4 mm. anterior to the terminal chain of ripening proglottides; in this region the length of each proglottis is approximately 0·8 mm. The mean breadth of a proglottis in the second and third quarters of the body may be stated at from five to six times that of its length.

The breadth of the strobila increases very gradually and with perfect regularity from 1·3 mm. in the anterior region to 4 mm. which it attains at the region where the proglottides begin to show a change of form, owing to the development of the gonads, about 3 cm. from the posterior extremity in the largest individuals examined. Thereafter the proglottides tend to decrease in width and become more elongate, but in none does the length become equal to the breadth. The ovaries are large and coarsely lobulated, arranged as a rosette of radially disposed pear-shaped lobes in the centre of the proglottis.

The genital apertures are lateral and placed well forward towards the anterior margin; the disposition is very irregularly alternate in series, that is, those pertaining to a number of consecutive proglottides, from two to six in number, may all open on the same side, to be succeeded by a number which open consecutively on the opposite side.

Both surfaces of the strobila are closely marked by transverse striæ; the lateral margins are almost straight, and there is no overlapping; sometimes the posterior lateral margin may be slightly salient and pointed.

The diagnosis of this species is as follows:—

Scolex consisting of a bulbous sub-conical head encircled at the base by a cup-like bothridial collar. Four pairs of minute two-pronged uncini disposed at equal intervals around the circumference of the head-bulb; the prongs are sharply bent at mid-length and borne upon a common horizontal bar; in young specimens a spur-shaped projection occurs opposite the base of the outer and longer prong.

No definite neck. Strobila ligulate, long and stout, 33 cm. in dead condition. Narrow at anterior end, 1·3 mm., increasing slowly and uniformly in width till it attains 4 mm. in front of the region of ripening proglottides.

Proglottides short, five to six times broader than long in the wide region posterior to mid-length; ripe proglottides characteristically short and length never greater than breadth. Grooves of segmentation apparent immediately behind bothridial collar. Cuticle striated transversely with minute furrows.

Ovaries arranged centrally in a rosette of large pear-shaped lobules. Genital pores lateral, opening well forward and anterior to mid-length; disposition irregular, in alternate consecutive series of from 2 to 6 on the same side.

Habitat:—The large intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal and Gulf of Manaar.

The *type* specimens of this species are deposited in the Indian Museum, Calcutta, No. ZEV $\frac{1825}{7}$.

(3). TETRARHYNCHUS ANNANDALEI, n. sp.

(Pl. x, figs. 13–15a).

Associated with the specimens of *Balanobothrium tenax*, n. sp., described above from the gut of *Stegostoma tigrinum* (Gmel.) were two mature Tetrarhychids. These both measure 3·6 cm. in length (dead).

The head or scolex is well proportioned and about 8 mm. long. Anteriorly it has two well-developed simple bothridia of lappet form, 2 mm. in length by 1·6 mm. in breadth. They are somewhat fleshy in appearance, the border thickened and elevated and slightly emarginate on the posterior edge. Behind the bothridia, the head becomes slender, cylindrical and neck-like, 0·7 mm. wide;

this section is slightly longer than the bothridia. In this region the proboscidial tubules are seen in a prepared specimen to be long and closely coiled, predicating considerable length of the proboscides when extended (they are almost entirely withdrawn in both specimens examined). The posterior region of the head, containing the contractile proboscidial sacs, is characterized by its great relative length which equals the combined lengths of the bothridial and duct regions. It is also slightly wider. The four muscular sacs occupy the whole of this posterior head region; the fibres in their walls are arranged as usual in two sets crossing each other obliquely but in these species the criss-cross appearance so produced is particularly distinct and well marked.

Each of the four proboscides emerges from the summit of a minute perforated papilla situated near the anterior bothridial margin. Each bothrium bears two of these papillæ, separated from one another by a considerable interval.

None of the proboscides was sufficiently everted to enable the arrangement of the hooks to be clearly made out. The majority of them are of a sabre-like curve, distinctly stout and apparently laterally flattened. All are not of the same size, and there appears to be a certain variation in the proportions of these spines, some being shorter and more slender. A few extremely minute sharply curved stout hooks, strongly beaked, and with a large base (pl. x, fig. 15a) are also present

Immediately posterior to the contractile bulbs the worm increases abruptly though slightly in diameter to form a stout cylindrical neck; its surface is wrinkled transversely by a few irregular weak groovings. Its diameter is greatest anteriorly, gradually narrowing till it merges at a distance of one and a half its greatest diameter into the regularly segmented anterior region of the strobila. At first the segments are wider than long and the lines of division difficult to see; after the fifth they become square in lateral view and then gradually increase in length till they attain a length of twice their width. No overlapping occurs and the lateral margins are parallel except in those where the genital pore is developed.

The proglottides number about 25. The last seven are remarkable for the enormous development of the genital pore, in this closely agreeing with *T. macroporus*, Shipley and Hornell, which appears to be a closely allied species. In the present species, the pore is guarded by two great salient tumid lips. In all cases the pores are lateral, but their arrangement is very irregular. In the individual figured (pl. x, fig. 13), of the seven maturing segments, wherein pores are present, we have first one segment (the most anterior of the set) where the pore is on the right side as figured; in the three next succeeding the three pores follow each other consecutively on the opposite side (left) while in the terminal three proglottides, there is again a group of three pores following each other consecutively but this time it is on the right side, giving a formula of R 1, L 3, R 3.

The following measurements are from a specimen preserved in alcohol:—

	Millimetres.
Extreme length	36·00
Length of scolex without neck	8·00
Length of bothridia	2·00
Breadth do.	1·60
Length of region of coiled proboscis sheaths ..	2·00
Breadth do do ..	0·70
Length of contractile bulbs	3·80
Breadth of this region	1·00
Length of neck	1·75
Breadth of neck at anterior end	1·25
Do posterior end	1·00
Length of a mature proglottis ..	1·75 to 2·00
Breadth do. including genital eminence	1·20

This Tetrarhynchid is closely allied to *T. tenuicolle*, Rudolphi, and to *T. macroporus*, Shipley and Hornell. From the former it is sharply divergent in the much greater length of the contractile proboscidial bulbs, while from the latter it is equally sharply marked off by the form of the bothridia which is simple and entire in *T. annandalei*, whereas in *T. macroporus* each is divided into halves. The proboscis hooks in the latter appear also to be shorter and stouter and it is stated that there is practically no neck. In both the latter species the relative proportions of the two regions of the head are nearly the same and there is also approximation in the number and general form of the proglottides and in the great prominence of the lips of the genital pore.

Diagnosis of *T. annandalei*:—

Length 3·6 cm. Head cylindrical, and fairly long, about 8 mm. Bothridia two, lateral, longer than broad, slightly emarginate on the posterior edge and with a raised and thickened margin. Proboscides four, long, and strongly armed with curved hooks, the majority long and sabre-shaped, fairly stout; a small number of very minute recurved forms with elongated base also present.

The proboscis sheaths long and arranged in closely set spirals: this region of the head including with it the part overlaid by the bothridia is about equal in length to the posterior section containing the contractile sacs. *The latter region is characteristically of great relative elongation* and is slightly wider than the anterior head region. The sacs are cylindrical, with the oblique decussation of the muscle fibres well marked. Neck short, one and a half times as long as wide; greatest breadth seen in this worm occurs in the anterior part which increases in width abruptly immediately behind the contractile sacs. Neck wrinkled slightly transversely.

Proglottides about 25. Anteriorly they are wider than long, but soon become square and then rapidly elongate and in the matur-

ing ones length is twice the breadth. The lateral margin parallel, and none of the proglottides overlap. Cuticle sometimes faintly ringed but this may be a *post mortem* effect.

Last five or six proglottides remarkable for enormous development and prominence of the genital pore. This is lateral and situated at beginning of posterior third of the marginal length of each proglottis. Position of the pores are alternate in consecutive groups, usually in alternate series of 3, *e.g.*, right 1, left 3, right 3.

Habitat :—Intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal.

Type specimen in the Indian Museum, Calcutta, No. ZEV $\frac{5020}{7}$.

I have pleasure in naming this elegant form after Dr. Annandale who has done so much to extend our knowledge of Indian Marine Zoology.

EXPLANATION OF PLATE IX.

FIG. 1.—*Prosthecobothrium urogymni*, n. sp.
Lateral view of head, × 50.

,, 2.—Head of the same, viewed from the anterior aspect, × 55.

,, 3.—Outline sketch of proglottides of the same from median region of body, × 40.

,, 4.—*Balanobothrium tenax*, n. gen., n. sp.
Lateral view of the head of an immature individual showing collar turned back. Sketched from life.

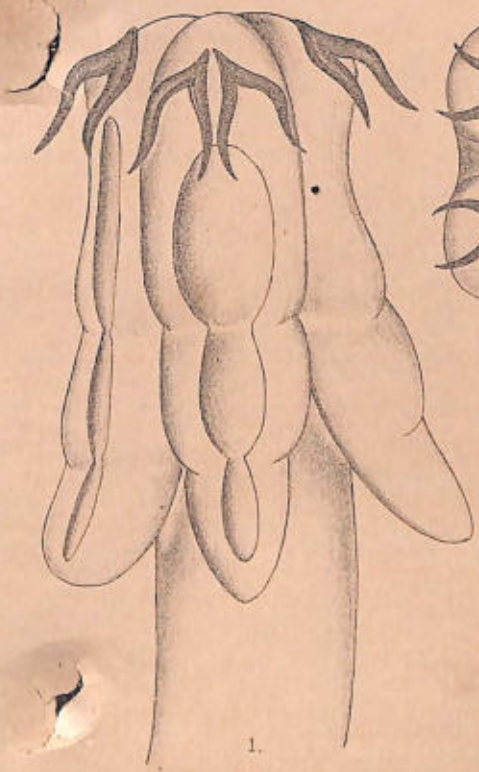
,, 5.—A second view of the same, to show another form frequently assumed when alive.

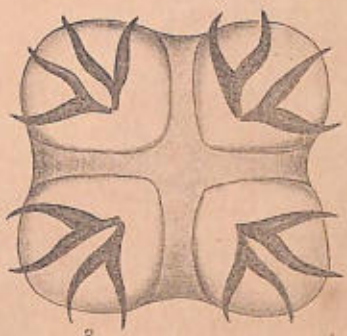
,, 6.—A fully mature individual of the same species. Natural size.

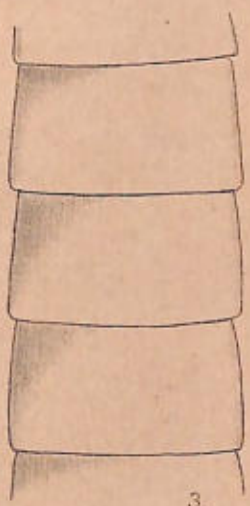
,, 8.—View showing the relative positions of each pair of uncini with the minute acetabulum anteriorly and the tumid ridge posteriorly, × 200.

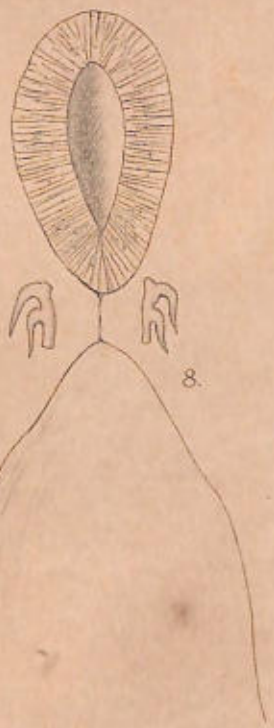
,, 9.—An uncinus from a young individual of the same species.

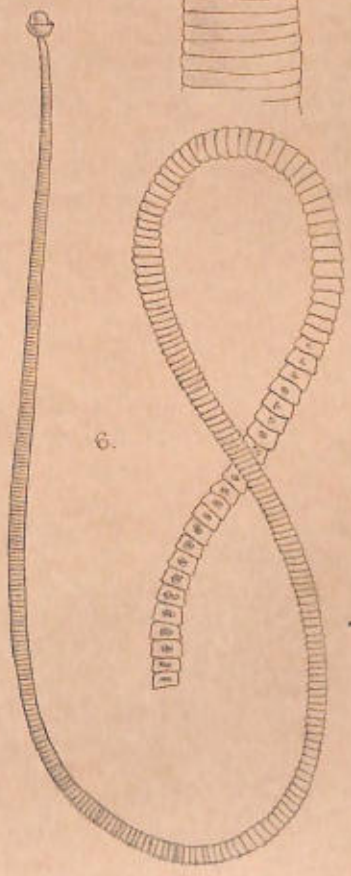
,, 10.—An uncinus from an adult individual, × 800.











Dorothy L. Hornell del. A.C.Chowdhary, lith.

1.2.3. Prosthecobothrium urogymni, n.sp. 4.5.6.8.9.10. Balanobothrium tenax, n.sp

EXPLANATION OF PLATE X.

FIG. 7.—*Balanobothrium tenax*, n. gen., n. sp. View of head; the collar shown transparent to exhibit the base of the head bulb, × 17.

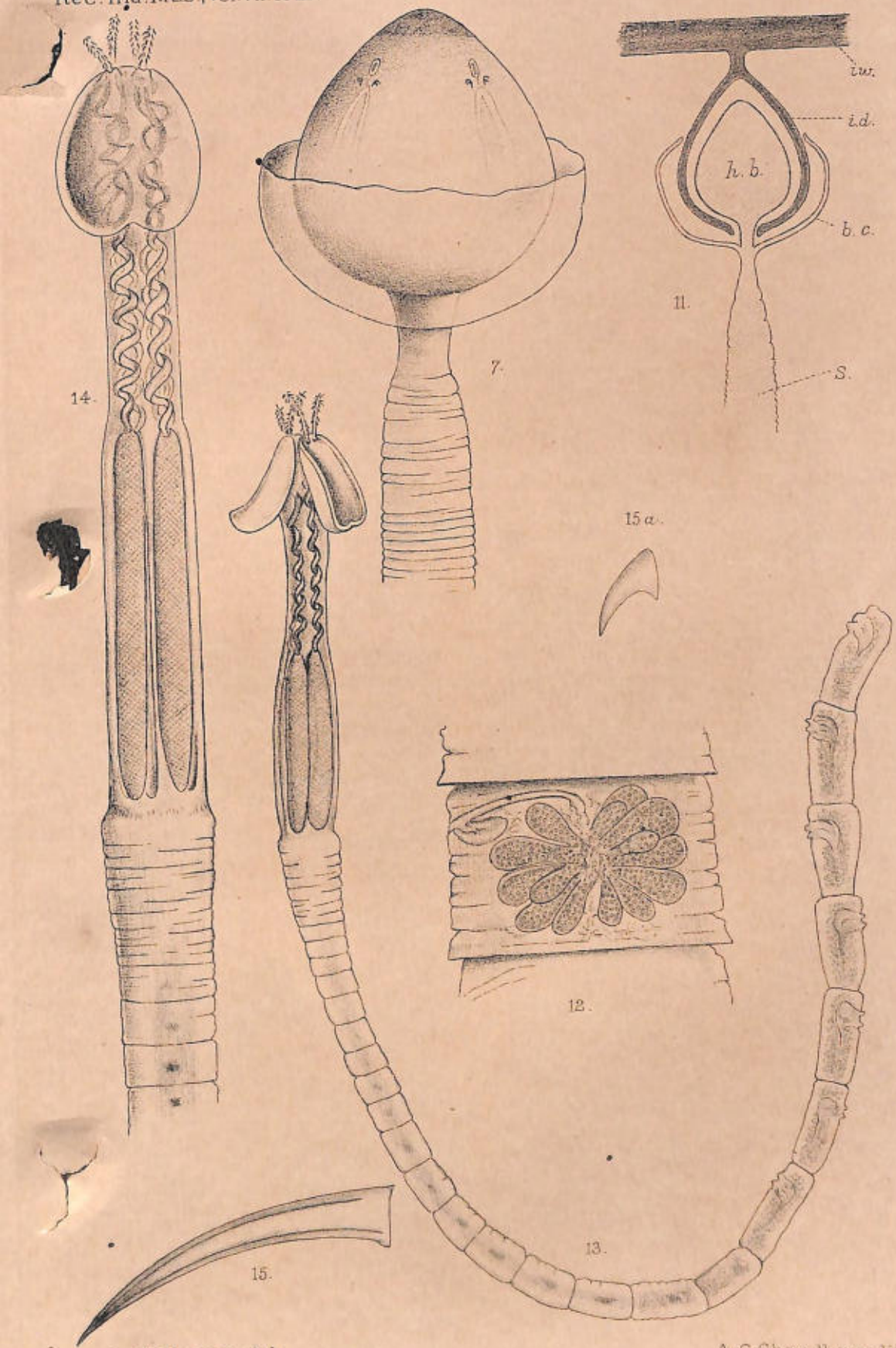
,, 11.—Diagram of a vertical section through the head of the same species when contained within a sac formed by an outgrowth from the intestine of the host, *i.w.*, wall of the intestine; *i.d.*, saccate diverticulum from inner wall of intestine; *h.b.*, head bulb of the cestode; *b.c.*, its bothridial collar; *s.*, anterior end of strobila.

,, 12.—A ripening proglottis from the same species showing the rosette-like ovary with vagina and penis sheath anteriorly on the left, × 11.

,, 13.—*Tetrarhynchus annandalei*, n. sp., × 8·3.

,, 14.—Head of same, × 16.

FIGS. 15 & 15a.—Same. Hooks of proboscis, highly magnified.



Dorothy L. Hornell, del. A. C. Chowdhary, lith.

13. 14. 15. 15a. Tetrarhynchus annandalei, n. sp.

7. 11. 12. Balanobothrium tenax, n. sp.

MISCELLANEA.

Polyzoa.

The occurrence of Entoprocta in Indian waters.—On the stems of specimens of the Hydroid genera *Bimeria* and *Tubularia* collected at Port Canning on March 10th, 1912, I find a minute entoproctous polyzoon that appears to be specifically identical with Busk's *Barentsia* (or *Ascopodaria*) *discreta*, a species originally found at Tristan da Cunha in 100 to 150 fathoms by the "Challenger" Expedition (Busk, *Zool. Rep.* "*Challenger*," vol. xvii, part L (Polyzoa II), p. 44, pl. X, figs 6—12), but recently recorded from Ceylon by Miss L. Thornley, apparently from shallow water (Herdman's *Rep. Ceylon Pearl Fisheries*, part iv, p. 128). My specimens are much smaller than the type-specimens, the full-grown heads measuring only about 0·21 mm. in length and 0·18 mm. in transverse diameter, the same measurements as given by Busk being 0·5 and 0·4 mm. The length of the stalk and the proportions of the muscular bulb at its base vary considerably and the zoaria are colourless. Otherwise I can detect no divergence from Busk's original figures and description. Miss Thornley states that the specimens she examined were of a reddish colour. In view of the conditions under which the species was growing at Port Canning it is not surprising that it should be dwarfed, and I do not consider it advisable in the circumstances to give the phase a separate name. My specimens were found on Hydrozoa that grew on stones and logs partially embedded in dense mud at the edge of the river Mutlah. They were just uncovered by an unusually low tide. The water at the point at which they occurred contains in March about 25·46 *per mille* of saline residue.

Prof. K. Ramunni Menon has recently sent me a specimen of *Barentsia gracilis* (Sars) taken in Madras harbour. The species is common in Europe and has been recorded from the Pacific coast of N. America by Miss Robertson (*Proc. Calif. Acad. Sci.* (3) II, p. 344) and from Australian waters by Kirkpatrick (*Ann. Mag. Nat. Hist.* (6) II, p. 21, 1888).

The list of Entoprocta as yet known from Indian seas is a very short one, comprising, so far as I am aware, only three species:—

Barentsia gracilis. Madras harbour.
,, *discreta* { R. Mutlah, Port Canning, Gangetic delta and Ceylon.
Loxosomatoides colonialis. Brackish ponds, Port Canning.

N. Annandale.

Annelids.

Notes on the rearing of leeches in Mawai, Bara Banki District, United Provinces.—[The leech to which the following notes refer has been identified by Mr. W. A. Harding as *Limnatis* (*Poecilobdella*) *granulosa* (Sav.)]

In this part of the country the leeches are abundantly found in ponds, streams, *jhils* and marshes but seldom in rivers.

The class of people who rear leeches are called "Chohra" and this occupation is the sole means of their livelihood. They use them for medicinal purposes; whenever any part of the human body is inflamed or its blood becomes impure the leeches are made use of to suck out the blood from the diseased part. This remedy is also prescribed with success in slight cases of blood-poisoning by native physicians.

The breeding season commences in April or May just before the beginning of the rains. The breeders pick out a few good adult specimens of leeches and put them in a new earthen pot with some pieces of a sort of black clay (called here 'hair-cleaning clay') with which people generally clean their hair, and sprinkle some water just sufficient to keep them wet. This vessel is closed and put away in a secluded corner of the house where there is no likelihood of any disturbance to the leeches. The breeders are of opinion that they do not form cocoons even if a man's shadow falls over them. This is merely putting stress on the fact that the leeches will not form cocoons if they are disturbed either by the footsteps of man or other accident. To avoid this people in certain places take the further precaution of burying the vessel containing them underground. Every alternate day the vessel is opened and some water is poured in to keep the clay wet.

In the course of a period which varies from a fortnight to a month the breeders find inside the vessel some foamy little whitish masses emitted by the leeches which within two or three days develop into oval-shaped cocoons, soft and partially transparent. As the cocoons get stiff they are carefully picked up and put into closed cups made of the clay already in the vessel. This process is kept up till all the soft cocoons have become hard and have been removed. The cups are changed every alternate day for a fortnight, when it is perceived that the young ones have developed within them. Then the shells are broken up by the breeders themselves in order to help out the weak ones which otherwise would die within the shell, not being strong enough to come out by themselves. Each cocoon contains five or six young ones.

The young ones are kept in fresh water which is changed morning and evening. This method of changing the water twice a day helps them to grow speedily. When the young ones grow sufficiently old to be able to suck blood (which is at once found out by putting a hand in the water as they rush to catch it) they are taken out and placed on some portion of his own body by the breeder, and after they have taken in a little blood they are removed and put back in the water. They are not allowed to

suck blood to their satisfaction, for if they do so they will immediately die. This process is repeated every fortnight until they grow old enough for the purpose for which they are reared. Then this new batch of leeches is divided into two lots, (1) that which is to be used for medicine and (2) that which is reserved for breeding. The latter are called 'seed leeches' and are kept in water which is regularly changed at intervals until the next breeding season sets in, during this period no blood is given to them. They are never used for money-making, for leeches once used for such a purpose are believed to lose their power of breeding.

Whenever the leeches are prescribed for medicine the *Chohra* (breeder) is sent for. He brings with him only those leeches that have not been used for two or three weeks and applies some of them to the intended part. The leeches at once begin to suck in blood with avidity, but if the blood has become mixed with pus they will immediately drop down. If it is not they will suck on till they fall down filled with impure blood, when they seem to lose all energy and look very dull and inactive. The breeder then takes these leeches one by one and pricks it with a needle just near the mouth on the middle line on the back and slowly squeezes out the blood commencing from the tail to the opening made by the needle. This, however, does not kill the leeches. When the trial is over the leeches are thoroughly rubbed by the hands which probably relieves them to some extent of the strain caused by squeezing, and restored to the water for future use.

The breeders are of opinion that the wild leeches do not breed in captivity until perhaps long used to it and it is even difficult to confine them unless they are carefully packed. Their bite when used for medicine is unbearable to the patient. This is not the case with the domesticated ones, the bite of which is comparatively less painful, much like that of an ant.

The leeches can be kept alive for many years if the water in which they are kept is occasionally changed, but those that have been used for medicine can hardly live for more than a year.

M. Mohsin Khan.

Insects.

The habits of some tiger-beetles from Orissa.—Many species of tiger-beetles, though they may have a wide geographical distribution, are curiously particular in their choice of habitat. A well-known instance of this is *Cicindela biramosa*, Fabr., which lives only on the seashore, a fact sufficiently noticeable at such a place as Puri on the Orissa coast, but much more so near Balyghai, a few miles further north. Here the sandy beach on which alone this species lives slopes sharply up for a distance of perhaps twenty or thirty yards and then ends abruptly in a low wall of sand evidently produced by the action of high tides.[1] This wall forms the outer-

[1] I have only visited the place once as yet; this was towards the end of August 1911.

most rampart of a double or treble line of sand-hills running parallel to the sea, and behind these is a flat expanse of sand extending inland to a distance of about two miles and bounded on its inner side by the Sur Lake. With the exception of the green vegetation on the shores of the lake, and of some trees round a small temple on one of the sand-hills, *Spinifex* is the only plant rising above the surface of the sand, and this does not grow luxuriantly. The vegetation is principally composed of small plants lying close on the surface of the ground; except on the beach these occur more or less abundantly over the whole sandy area not affected by the lake. There is nothing resembling the long grass which is of such importance in the well-known Southport sand-hills in England during the early stages of their formation. In spite of this, the Balyghai sand-hills present a much greater appearance of stability than do those at Southport (an appearance in keeping with the nature of the vegetation), the sand being much firmer, probably on account of greater "binding" power. The shore therefore, though sharply marked off from the country out of reach of the tide, differs but little from it in character, and the way in which the darkly coloured and consequently conspicuous *Cicindela biramosa* confines itself absolutely to the former becomes peculiarly striking and suggests that the cause of its restriction must lie either in a restriction of its food to the area between tide-marks or in some effect of the sea on the climate of this particular area. I do not remember to have seen any tiger-beetles on the sand-hills; but there are some curious long-legged heteropterous bugs living there whose appearance and mode of progression is very like that of a tiger-beetle. On the sand further inland *Cicindela cancellata*, Dej., *C. albina*, Wdm., and *C. agnata*, Flt., occur, their markings blending with the general colour of the sand in such a way as to render them almost invisible. All three species may occur together, but their relative abundance differs greatly in different places; the last-named I found particularly plentiful on bare sand not far from the shores of the Sur Lake.[1]

Extensive floods occurred at about the time of leaving Balyghai and consequently the return journey to Calcutta was much impeded, and a night was spent at Cuttack on the way. By this time the floods had subsided again to a considerable extent, and among the bushes on the bank of the Mahanaddi (a big river crossed by the railway not far from Cuttack station) there were exposed at intervals little patches of firm sandy soil of not more than a few square yards extent each. On this dull soil numbers of tiger-beetles were assembled, and on more than one occasion I saw a specimen dig his jaws into the ground, from which I presume that he drew forth some food though I was unable to obtain confirmation of this. With the exception of one brightly marked

[1] Concerning the habits of the above four species see also Annandale in "Annotated list of the Asiatic Beetles in the Collection of the Indian Museum," Pt. I, pp. 13 and 28–30 (Calcutta, 1909).

specimen of *Cicindela venosa*, Koll.,[1] which was collected in the evening after dusk, the only species found in this situation were *C. angulata*, Fabr.,[2] *C. sumatrensis*, Herbst,[3] and *C. agnata*, Flt.[4], and it is perhaps noteworthy that every specimen caught was of a variety with dulled markings, whereas in the longer series of the last named species collected near Balyghai most were of the brightly marked variety. Whether or not these colour differences really depend on the environment I cannot definitely say; but most of the specimens from Balyghai were certainly collected on cleaner, dryer sand of a pale colour, and a beetle of this species collected on clean yellow sand on the bank of a stream near Chakardharpur in Chota Nagpur was of the most brilliant type; whilst two specimens of *C. sumatrensis* collected at the same place were both more brightly marked than those from the muddier sand by the river at Cuttack. Above the bank of the river at Cuttack there was an open grassy area on which the floods had deposited a thin layer of slimy mud. Although continuous with the more sandy river-bank it was inhabited only by two species of tiger-beetles neither of which were to be found there. These species were *C. cognata*, Wdm., and *C. minuta*, Oliv. The latter being a small dark brown species was very inconspicuous on the mud, and evidently chooses mud-banks as its home, for on that part of the bank of the stream near Chakardharpur where the sand on which *C. agnata* and *C. sumatrensis* occurred was replaced by mud, these latter species were replaced by *C. minuta*. *C. cognata*, on the other hand, although dark coloured and not very large, was rendered conspicuous on the mud by its bluish colour, and I suspect that it normally inhabits grassy land such as this had been and would soon be again; for on such land its colour would blend excellently with its surroundings.

In conclusion I have to thank Dr. Horn for the identification of the beetles collected. Dr. Horn informs me that the tiger-beetles of Orissa are as yet but imperfectly known and suggests that all the species I collected there should be mentioned in this note. To those already referred to I have only to add *Collyris distincta*, Chd. var., on the label attached to which Dr. Horn inserts the note "palp. lab. ex parte rufis, ect." This form was abundant in a clump of trees close to the dak bungalow at Balyghai on the shores of the Sur Lake.

F. H. Gravely.

Schizodactylus monstrosus as bait for birds.—Perhaps the bait most commonly used by Indian bird-catchers and falconers for snaring insect-loving birds like the Roller, etc. is the mole-

[1] See Annandale, loc. cit., p. 13.
[2] See Annandale, loc. cit., p. 15.
[3] See Annandale, loc. cit., p. 14, where it is noticed that this species replaces *C. bitramosa* at a short distance from the sea at Trivandrum just as *C. cancellata*, *C. albina* and *C. agnata* do at Balyghai.
[4] See Annandale, loc. cit., p. 13.

cricket (*Gryllotalpa*) called in the Punjab *ghū, ān*. Tethered by a thread to a peg it moves to and fro and by its restlessness attracts notice. It should however be kept in the shade as if exposed for many minutes to a fierce sun it will perish. Perhaps this is the reason that some bird-catchers prefer the great grasshopper with curved wings (*Schizodactylus monstrosus*) called *Mirag* in the Chach-Hazara district and *labāna*[1] in the Punjab. For some of the smaller insect-eating birds it must be too large and terrifying, but it is said to be hardy and to stand the sun far better than its rival for favour, the mole-cricket.

D. C. Phillott.

Fish.

Macrones menoda var. *trachacanthus* (Cuv. et Val.)—The specimen described below was received in the Museum for identification from Mr. Kinnear of the Bombay Natural History Society nearly a year ago, and as it showed some very interesting features and was a proof against Day's charge of misprint and wrong description concerning Cuvier and Valenciennes' species *B. trachacanthus*, it was thought desirable to wait for more specimens; but this short note need not be kept back any longer.

In all essential particulars, including the proportionate length of the barbels and the remarkable filamentous prolongation of the lower lobe of the caudal fin, this fish resembles the species which Cuvier and Valenciennes described in 1839 as a new species from Bengal in their Histoire Naturelle des Poissons, vol. xiv, p. 419, under the name *Bagrus trachacanthus*. The character of the lower lobe of the caudal fin was thus distinctly stated on page 420: "Le lobe inférieur de la caudale depasse l'autre de près d'un tiers et se termine en filet."

Dr. Gunther in 1864 included this species of Cuvier's in a footnote under the genus *Macrones* as one of the doubtful species (Brit. Mus. Cat. Fish, vol. v, p. 75), but it was left to Day definitely to assert that Cuvier's description was a misprint and a wrong one, especially with regard to the filamentous prolongation of the lower caudal lobe. The specimen under examination refutes the charge and is a proof positive that Cuvier's description was not a misprint.

In 1822 Hamilton (Buchanan) published the plates illustrating his descriptions of the fishes of the Ganges. Below fig. 72 of Plate i of these illustrations the name "*Mugil corsula*" occurs in print. Edward Blyth in 1858, in supplying an additional description of the fish represented by this published figure of Hamilton (Buchanan) points out that under the original drawing of this fish of which fig. 72 is a print, the name "*Pimolodus menoda*" occurs in Hamilton (Buchanan's) own handwriting. Moreover fig. 97 of Plate ix of the same set of illustrations is correctly named "*Mugil corsula*," which is described by Hamilton (Buchanan) in his Gangetic Fishes under the same name (p. 221, Gangetic Fishes Text, and

[1] In Chach *labāna* is the name for small bird.

fig. 97, Plate ix of the Illustrations). The species *Pimolodus menoda* represented by fig. 72, Plate i, was described by Hamilton (Buchanan) on page 203 of the Gangetic Fishes, additional description being supplied by Blyth in 1858 as already alluded to above. Priority of the specific name "*menoda*" was recognized also by Gunther in 1864 in the footnote on page 64 of Brit. Mus. Cat., vol. v. In spite of all this it is difficult to understand how in 1869 Dr. Day could describe this species under the name "*Macrones corsula*" (H. B.) based on Hamilton (Buchanan's) fig. 72 of Plate i of *M. menoda* and three specimens obtained from the Mahanaddi at Cuttack (Proc. Zool. Soc., 1869, p. 307). However, in this description of "*Macrones corsula*" no reference is made of Cuvier's species. But later on in the Fishes of India both the prior name *M. menoda* and Cuvier's *B. trachacanthus* are included by Day as synonyms of "*M. corsula.*" In doing this he had several difficulties to encounter and explain away—the most obvious one of which he disposed of in a curious manner. Whereas Hamilton (Buchanan's) species *M. menoda* in his description (Gangetic Fishes, p. 203) and in the drawing (fig. 72 of Plate i) was represented as having the upper lobe of the caudal fin longer than the lower—the lower lobe of the same fin of Cuvier's species was described by him to be filamentous and very much prolonged. Thus the only way by which Dr. Day could fit it in with his decision that it should be considered as the same species as his "*M. corsula*" was to declare that Cuvier's description about the filamentous prolongation of the lower caudal lobe was a misprint (Proc. Zool. Soc., 1869, p. 307). The specimen which is the subject matter of this note, however, proves that Cuvier's description regarding the proportionate length of the barbels and the filamentous prolongation of the lower lobe of the caudal fin is true and could not have been due to a misprint.

It is therefore identified as Cuvier's *trachacanthus* which must be regarded as a distinct variety, if not a species—being included under Hamilton (Buchanan's) species *Macrones menoda* which through a mistake Day called "*Macrones corsula*" in the Fishes of India—the mistake being continued unnoticed in the Fauna of British India.

The specimen should therefore be identified as *Macrones menoda* (H. B.) var. *trachacanthus* (Cuv. et Val.), for which the following short description may be supplied:—

Macrones menoda (H. B.) var. *trachacanthus* (Cuv. et Val.).

Depth of body $4\frac{2}{3}$ in the length, length of head 4. Snout $3\frac{1}{2}$ in the length of head, $1\frac{1}{2}$ as long as the eye the diameter of which is $4\frac{2}{3}$ in the length of head. Barbels eight, nasal extends far beyond the hind edge of the orbit, maxillary to middle of ventral, external mandibular to the middle of pectoral fin and internal mandibular to posterior extremity of opercle. Dorsal I 7, the posteriorly serrated spine is $\frac{2}{3}$ of the length of head. Pectoral I 9, spine posteriorly

denticulated, nearly as long as the head. Ventral 6, does not reach the anal. Anal 12. Caudal 17, deeply lobed, the lower lobe being much longer than the upper and ends in a filamentous prolongation. Adipose dorsal is high and pointed, length of the base being slightly shorter than the base of the anterior dorsal fin. Colour in spirit superiorly greyish brown and inferiorly dull white. Fins stained with black.

B. L. Chaudhuri.

REPTILES.

Aquatic tortoises of the middle Ganges and Brahmaputra.—From enquiries from the actual catchers it appears that there are at least nine distinct species of water-tortises recognized by them in the beds of the Ganges up to Sahebgunge, the Kosi up to Jogbani (Anchra Ghat), the Mahanada in Maldah District and the Brahmaputra up to Goalpara. Of these six species were secured during a trip to Rajmehal undertaken in March, 1912. For the identification of the tortoises I am indebted to Dr. N. Annandale.

Among the hard-shelled species four are distinguished :—

1. The *Sál* or *Sail* (*Kachuga lineata* (Gray) grows to three feet by twenty inches, weighs 20 to 30 seers and is easily distinguished by its larger size and very smooth and oily back from the *Dhoor* which is the common medium-sized species with rough back. The *Sál* does not breed and is not found with eggs until it reaches a much bigger size than the adult *Dhoor*. Two specimens of *Sál* were secured. Dr. Annandale thinks that *Batagur baska* (Gray) is probably confounded with this species by the tortoise-catchers.

2. The *Dhoor* (*Kachuga dhongoka* (Gray)) is a smaller species than the *Sál*. It grows to sixteen inches by twelve inches and weighs eight to ten seers. It has a slightly rough back with pointed knobs in the middle line : the males are said to be very much smaller, not growing more than ten inches in length. The eggs are oval and very long, measuring 5·5 × 3·3 cm., and 30 to 35 are deposited at a time. Twenty-eight specimens of *Dhoor* were secured together with several eggs dug out of sand banks. Some individuals brought forth eggs while being packed. The shell of the egg is very brittle and there is a large air-space inside it, the external surface is obscurely pitted.

Both the *Sál* and *Dhoor* breed in March and deposit eggs on the sand bank of the Ganges but as they leave trailing marks behind, the hiding places of the eggs are easily discovered. Both *Sál* and *Dhoor* have long (oval) eggs, the *Sál's* being much bigger than those of the *Dhoor*. The young ones come out in May or June. They are occasionally caught in the fine nets in the month of June or July.

3. The *Chapaut* or *Chauputa* (*Kachuga smithii* (Gray)) is the smallest species but otherwise very similar to the *Dhoor*. It

does not grow to more than eight or ten inches in length and not more than a seer in weight. It deposits 5 to 8 eggs at a time and buries them in sand. Three specimens were secured.

4. The *Panchuria* (? *Kachuga tectum* (Gray)) similar to the *Chapaut*, is an intermediate species between the *Dhoor* and the *Chapaut*, growing to one foot in length and two seers in weight. No specimens of this species could be found on my trip.

5. The *Kála* or *Kali Kaunltha* of the Bengalis (*Hardella thurgii* (Gray)), is known as *Gaira* among the Gondris who are the expert catchers of tortoises. This species grows to two feet by fourteen inches and weighs 19 to 20 seers. The eggs of the species are not found in the sand bank on the Ganges, but are occasionally met with in the months of August and September, when the water subsides. The eggs are said to be oval. This species is also known as *Kariha* (or *Kariyaon*) among the Teors and Binds on the Kosi side. One specimen was secured.

Of the soft-shelled water-tortoises four species are recognized by the catchers.

6. The *Kataha* or *Kattha* of the Gondris and *Palaiya* of the Binds (*Trionyx gangeticus*, Cuvier) is a roundish low species growing to four feet by three feet and weighing two to three maunds. It brings forth round eggs which are found in the mud after the subsidence of the floods. The eggs are perfectly spherical, measuring 2·3 cm. in diameter. Some eggs were secured on a previous trip. This species is said to be good to eat. One specimen was obtained.

7. The *Keora* of the Gondris (*Trionyx hurum*, Gray) is a smaller species than the *Kataha*. It weighs twelve to fourteen seers, grows to sixteen inches by twelve inches in the disk, and brings forth round eggs. It is said to be very bad eating owing to its rank smell. One specimen was secured on this trip, and another on a former occasion near Rajmahal. Both are unusually pale in colour, lacking to a large extent the characteristic markings of the species. Dr. Annandale thinks it probable that they represent a local race distinguished from the typical one by a more uniform coloration and possibly by being smaller. In any case no structural difference likely to be constant can be detected.

8. The biggest of these soft kinds is the *Sim* (*Chitra indica* (Gray)) which grows to five feet in length of disk and weighs six to seven maunds. Like the *Kataha* it is to be found in the Kosi and also at Kustea and occasionally at Chilmari. It does not bite but disables its victim by blows, often injuring fishing boats by the impact thereof. It is bad and coarse eating. No specimen was secured, but there can be little doubt from the fishermen's description that *C. indica* is the species referred to under the above name.

9. The *Abhua* (*Emyda granosa* (Schoepff)), which is also known as *Matia* because it is supposed to subsist on earth, is a smaller species than the *Kataha*. In winter they are found peeping out of mud holes in the banks. It is said to be numerous

near Kánsàt (Maldah) and in the Gumani River (Murshidabad). It grows to one foot in length. No specimen was secured but there can be little doubt that the identification is correct.

The Santals, the great patrons of tortoise-consumption, recognize only two kinds. One is called *Lepra*, under which name falls *Kattha*, *Keora*, *Sim* and *Abhua* of the Gondris and the other *Hurum*, under which Santali name fall the *Dhoor*, *Sál*, *Goira*, *Panchuria* and *Chapaut* of the catchers. Thus the distinction made by the Santals is a general one, whereas those of the catchers are evidently specific. It may be remarked here that the name *Hurum* is not applied to any of the soft species of water-tortoises in the Santali language.

The following fishing tribes were found catching tortoises in the bed of the Ganges near Rajmahal:—The Binds and Banpars catch them by *bansis* (hook and line), the Teors harpoon them, but the Gondris make a speciality of catching them in nets manufactured for the purpose. Tortoises, great and small, are often caught in the *Bara jal* along with all kinds of fish, but this is an accident and tortoises so caught are often thrown back into the river, as the Malas and Myfarases do not take any interest in them. It is forbidden to the latter people to eat them, while the former consider them unclean.

B. L. CHAUDHURI.

XIX. GORDIENS DU MUSÉE INDIEN.

Nouvelle Series.

Par Lorenzo Camerano, *Professeur à l'Université de Turin.*

Monsieur N. Annandale, Superintendant du Musée d'Histoire Naturelle Indien de Calcutta, a eu l'obigeance de me soumettre la collection de Gordiens appartenant au Musée. L'étude [1] de cette collection permettrà d'établir d'une manière plus exacte la distribution géographique de plusieurs espèces et fera connaitre aussi quelques espèces nouvelles pour la science.

Chordodes pollonerae, sp. nov.

Assam.

♂ Longeur, m. 0. 131. Largeur, m. 0. 001.

L'animal est de couleur brun-noirâtre.

La couche cuticulaire extérieure présente:—

1. Aréoles papillaires, dont la forme rappelle le fruit du mûrier (largeur 12, 13, 14 micromillimètres), leur contour est presque rond ou oval. Elles sont de couleur clair et sont très rapprochée entre elles.

2. Aréoles papillaires semblables aux précédentes: mais plus rélevées et de couleur plus foncé. Ces aréoles se trouvent isolées ou bien se réunissent, çà et là, par groupes de deux, trois, ou quattre.

3. Aréoles papillaires semblables aux précédentes mais munies d'un petit prolongement rèfringent. Ces aréoles sont assez rares.

4. Aréoles papillaires semblables a celles du numéro 2 mais plus rélevées et de forme conique qui entourent en nombre de 7, 8 ou peu plus, 1, 2 ou 3 aréoles papillaires de couleur plus foncé, rondes ou ovales, qui portent dans leur partie superieure des prolongements courts, fins, et réfringents. Je n ai pas observe des prolongements en forme d'épines.

Parachordodes roccatii, sp. nov.

Majkhali, Almora district, Western Himalayas. (*R. Hodgart*).

♀ Longeur, m. 0. 203 (l'extrémité antérieure n'est pas bien conservée).

Largeur maxima, m. 0. 0008.

L'animal est de couleur brun.

[1] L. Camerano, "Gordiens du Musée Indien," *Records of the Indian Museum*, vol. II, Part II, pp. 113—117 (1908).

L'extrémité antérieure est assez effilée. L'extrémité postérieure est plus grossie avec l'ouverture cloacale terminale et elle apparait comme tronquée obliquement.

Les aréoles de la cuticule extérieure (largeur 12 a 20 micromillimètres) sont un peu élevées, leur contour est presque rond. Parmis ces aréoles il y a des nombreuses formations réfringentes (largeur 5 micromillimètres) réunies deux par deux, qui donnent à la cuticule un aspect tout à fait caractéristique. Dans la ligue de separations, très petite, des deux formations on observe un petit tubercule réfringent.

Parachordodes kaschgaricus, Camer.

Shembaganur, Palni Hills, 6300 ft., Madura district, Madras Presidency. (*Major F. Wall, I.M.S.*).

♂ Longeur, m. 0. 220. Largeur maxima, m. 0. 001.
Coleur noirâtre.

Parachordodes pustulosus, Baird.

Silcuri, Cachar, Assam.

♀ Longeur, m. 0. 440. Largeur maxima m. 0. 0015.

Paragordius stylosus (Linstow).

Delhi, Punjab.

♀ Longeur, m. 0. 142. Largeur maxima, m. 0. 001.
Couleur du corps brun clair. Le collier noir est peu marqué.

Gordius doriae, Camer.

Somaswar, 4700 ft., Almora district, Western Himalayas. (*R. Hodgart*).

♀ Longeur, m. 0. 195. Largeur maxima, m. 0. 001.
Le corps est de couleur brun clair. Le collier noir est bien marqué.

Gordius fulgur, Baird.

"From a tank at Badarpur, Assam (*B. Basu*). Local name *shut shanchar*. Supposed to be very poisonous."

♀ Longeur, m. 0. 550. Largeur maxima m. 0. 001.

XX. PRELIMINARY NOTE ON A NEW TORTOISE FROM SOUTH INDIA.

By J. R. HENDERSON, *M.B., F.L.S., Superintendent, Madras Government Museum.*

The tortoise which forms the subject of this note was obtained in Cochin State, on the Malabar coast, in October 1911, while I was engaged on a collecting tour in the dense State Forests, at a distance of about twenty miles from Chalakudi, the starting point of the forest tramway service. The Kadars, a jungle tribe who brought the first specimen to me, stated that it lived in the forest, inhabiting a short underground burrow and that it did not affect the neighbourhood of water, a fact borne out by the absence of webbed digits. In addition to this specimen, a male apparently mature, which is described below, I subsequently obtained through the kindness of Mr. G. R. Grubb, M.A., M.I.C.E., Chalakudi, a second young example, but a Museum collector dispatched to the forests in March last was unable to find any others, so the species does not appear to be common. *Testudo travancorica*, Boulenger, is common in the same neighbourhood and I obtained a number of specimens. Both examples of the new species have been kept alive for over six months, during which time they have lived entirely on vegetable food. They have not shown any special partiality for water and when handled they do not emit an offensive odour as in the case of *G. trijuga*.

I have followed Stejneger and Siebenrock in substituting the earlier name *Geoemyda* for *Nicoria*, the latter being adopted by Boulenger in the volume on Reptilia in the Fauna of India series. As pointed out by Stejneger (Proc. Biol. Soc. Washington, XV, p. 237, 1902) the type of *Geoemyda* (Gray, 1834) is *G. spengleri*, and the same species was subsequently taken by Gray as the type of his genus *Nicoria* (1855).

GEOEMYDA SILVATICA, n. sp.

Carapace moderately depressed, tricarinate, with the median keel much more prominent than the lateral ones; the greatest height at the level of the posterior margin of the first vertebral shield. Vertebral shields broader than long, except the last in which the length and breadth are almost equal; vertebrals, particularly the first, wider than the costals. Nuchal longer than broad. Plastron of moderate width. Abdominal shields larger than the pectorals. The longest median suture is that between the

abdominals, but the one between the pectorals is only slightly shorter; the median sutures between the femorals and between the anals are sub-equal. No axillary or inguinal shields. Upper jaw with a median hook. Digits without a distinct web. Claws and limb tubercles well developed.

	mm.
Length of carapace (median line) ..	119
Greatest width of carapace	83
Length of plastron (median line) ..	98
Length of hind lobe of plastron ..	30
Width of hind lobe of plastron ..	53
Width of bridge	36
Depth of shell	45

The following are the colours in the living male specimen. Carapace, including the keels, uniformly black or almost dark bronze. Plastron dull yellow, with two spots on each bridge. Anterior portion of the head, including the upper and lower jaws, bright yellow with a red spot on the summit of the snout. Posterior portion of the head and also the neck brown. Iris red and a tinge of the same colour on the upper eyelid. Limbs and tail black.

Locality.—Near Kavalai in the Cochin State Forests, inhabiting dense forest, at an elevation of about 1500 feet above sea level.

The new species is most nearly related to *G. tricarinata*, Blyth, a terrestrial tortoise occurring in Bengal and Assam, with which it agrees in the imperfectly webbed digits and yellow plastron, but in the latter the carapace is much more convex, the three keels are yellow, the upper jaw is not hooked and there are other well-marked differences. *G. trijuga* (Schweigger) the only other member of the genus hitherto met with in India, of which I obtained the striking variety described by Anderson as var. *coronata* (Anat. Zool. Researches, Yunnan, p. 729, 1878) at Chalakudi, is an aquatic species with many points of difference. In *G. spengleri* (Gmelin) from Japan, China, Borneo and Sumatra, which agrees with the new species in its depressed carapace and hooked upper jaw, the digits are webbed and the margins of the carapace are strongly serrated.

XXI. ON A NEW SPECIES OF BRANCHIODRILUS AND CERTAIN OTHER AQUATIC OLIGOCHAETA, WITH REMARKS ON CEPHALIZATION IN THE NAIDIDAE.

By J. STEPHENSON, *M.B., D.Sc. (Lond.), Major, I.M.S., Professor of Biology, Government College, Lahore.*

(Plates xi—xii.)

I received in November 1911 a tube of small aquatic Oligochaeta, sent to the Indian Museum from Madras by Prof. K. Ramunni Menon. The tube contained eight specimens, of which however one was a fragment incomplete at both ends. In one case the animal was in process of dividing asexually; none possessed sexual organs.

The worm belongs to the group of gilled Oligochaetes, and is closely related to the two Naids described, one by Bourne (4) under the name of *Chaetobranchus semperi* from Madras, and one by myself (15) as *Lahoria hortensis* from Lahore. Since gilled Oligochaeta are interesting on account of their rarity, and since the present form gives occasion for some remarks on the "cephalization" of the Naididae, I describe it here as far as possible in detail. My remarks go under four heads:—(1) Anatomy, (2) Asexual reproduction, (3) Systematic position, (4) Cephalization in the Naididae. It is to be remembered that I have only had the opportunity of examining preserved specimens.

(1) *Anatomy.*

In length the worms were from 8 to 15 mm.; they were brownish in colour; the two longest consisted each of 130 segments, plus a number of minute and scarcely differentiated segments in process of formation at the posterior end; another specimen had 77 segments with again a similar region of newly forming segments posteriorly. The gills were in most specimens just visible to the naked eye as processes on the anterior portion of the body. The prostomium was short and rounded. Succeeding the mouth was a short prebranchial region, which will be considered more fully below.

Gills.—The gills are elongated hollow evaginations of the body-wall; as in the related forms mentioned above, they contain a vascular loop, and, in the anterior portion of the body, the capillary dorsal setae also. Since they correspond in position with the dorsal setal bundles, they form a dorso-lateral series on each side. They diminish in size posteriorly, and the long dorsal setae are then no longer enclosed in them.

In the specimens in which the gills were best developed they were, in the most anterior segments, about ·54 mm. in length; but exact measurements are difficult, owing to their being somewhat curled and twisted; in the next succeeding segments, where they are longest, they were ·72 mm. long, or about 2—2½ times the diameter of the body in this region. In other specimens they were frequently not so long,—about ·27 mm., or equal to the diameter of the body.

Some idea of the progressive diminution in size may be obtained from the following data:—in an animal of 130 segments, the gills at the 40th segment were small finger-like lobes, at the 50th large tubercles, at the 60th small tubercles, and beyond this absent. In another specimen of 130 segments, they disappeared at the 76th segment; in one of 87 segments, at the 67th; they were present, as tubercles only, on the 73rd and 56th segments of two animals whose posterior ends had been destroyed at these levels respectively; and in another specimen they were quite small finger-like lobes on the 17th, and disappeared altogether beyond the 24th segment. Behind the region of the gills, in these preserved specimens, the series is continued as a pushing out of the body-wall, which is raised round the base of the dorsal setal bundles into small pointed conical elevations; but these are merely such as would be produced by a contraction of the muscles of the setal sac pushing out the bundles of setae, and indeed may have been so produced at the moment of fixation.

Pigmentation.—As in the related forms the anterior end of the body is markedly pigmented (pl. xi, figs. 1, 2, 3). The pigment occurs as irregular blotches on the prostomium and prebranchial region; behind this it has a fairly definite segmental arrangement, as irregular bands extending over the dorsal and lateral surfaces, but leaving the ventral surface free; the bands are formed of a number of irregular spots or blotches, which may or may not be confluent. The pigment may be very slight in amount and scattered in its distribution; in any case it fades away after the first few segments, e.g., beyond the 8th, 12th, or 13th.

Pigment also usually, but not always, occurs on the gills,—not all over them, but in streaks along their lateral aspects (pl. xi, fig. 1). The pigmentation of the gills corresponds roughly, as regards number of segments, to that of the body.

The pigment appears to be located in peritoneal cells lining the body-wall, and to be of the same nature as that of the chloragogen cells; similar cells invest the dorsal vessel as far forward as the second gill, and sometimes some of the lateral loops also [v. *inf.*, and cf. Bourne (4), and his fig. 3].

Setae.—The dorsal setal bundles begin with the gills; the setae are of two kinds, long and short. The long ('capillary') are straight, smooth, tapering gradually to a very fine point, and, where they are free from the gills and can be measured, in length commonly about 330 μ. The shorter ('needle') setae have typically the form shown in fig. 1; the distal curve and the

extremely slender extremity are (in preserved specimens) with difficulty visible with the ordinary high power, and an immersion lens is necessary to appreciate them. These setae are about 100μ long, and are closely applied to the proximal part of the shaft of the longer seta, the distal curved end of the short seta appearing to fit round the shaft of the longer. The point of the short seta may project slightly above the surface of the body in the middle and posterior regions of the animal's length.

In the most anterior part of the body, where the gills are longest, the setae are entirely enclosed in the gill processes. Here each bundle consists of two hair setae, or sometimes of only one; if there are two, one is much longer than the other. The hair setae are here much slenderer than they are posteriorly. This is the condition in the first 12, 13, 18, 26 or 27 gilled segments.

In the next succeeding region of the body the gills are becoming shorter, and the hair setae project freely and are no

FIG. 1.—*Branchiodrilus menoni*; dorsal needle-seta; × about 375.

longer contained in the gills. The bundles are composed of one hair and one needle. The transition from a thin to a thick type of hair seta is marked, and quite sudden. The needle has apparently not the typical shape described above; it is straighter, almost or quite without the distal curve, but it narrows rapidly to a fine point, like the curved form.

In the middle and posterior regions of the body the dorsal bundles consist of one hair and one needle, of the typical forms described above. Occasionally two needles occur in a bundle.

The ventral setae of the branchial and posterior regions of the body may be separated into two forms, though the distinction is not a hard and fast one, since intermediate shapes occur; neither is the distribution of the two forms fixed.

The one form, the more numerous, which may be designated the 'posterior,' is distinguished by a comparatively stout shaft, often a somewhat greater length, a nodulus distal to the middle of the shaft, and by having the prongs of the fork equal in length or the distal prong slightly longer (fig. 2). In length they measure

110 to 139 μ (proximal to nodulus : distal to nodulus : : 61 : 49. or 82 : 57). The other or 'anterior' type is slenderer throughout, the prongs, especially the distal prong, also longer and slenderer; the distal prong is $1\frac{1}{2}$ times as long as the proximal, while the

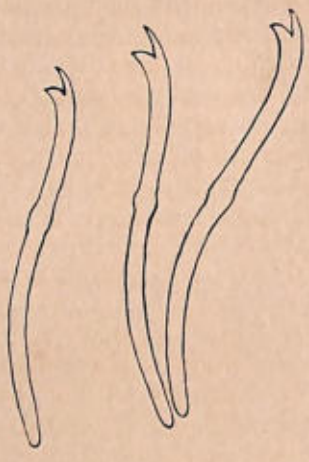


FIG. 2.—*Branchiodrilus menoni*; setae of the posterior ventral type; × 375.

nodulus is at the middle of the shaft or somewhat proximal (fig. 3). In length they measure 100 to 116 μ (proximal to nodulus : distal to nodulus : : 57 : 57, or 55 : 61). In both types the distal prong is only about half as thick at its base as the proximal.

The 'anterior' type occurs on a comparatively small number

FIG. 3.—*Branchiodrilus menoni*; setae of the anterior ventral type; × 375.

of the anterior segments of the body, the posterior type on the remainder; but there is no defined limit to their distribution. Thus well-marked 'anterior' setae may be found on segment xiv, and even behind this; or nearly all the ventral setae in the body may be of the 'posterior' type. The change from 'anterior' to 'posterior' is in any case not a sudden one, and may apparently

take place at a different level on the two sides of the same animal.

As to the number of ventral setae per bundle, this is usually three, and I have never seen more except in the one instance shown in pl. xi, fig. 4, where one of the bundles has four. Posteriorly there may be only two; and in some of the anterior segments also there may only be two. Very commonly in the anterior segments there were two fully formed setae, along with a half-formed seta, of which the proximal end was wanting,—as if it were still in process of formation, or perhaps rather as if its formation had been permanently arrested at this stage (cf. pl. xi, fig. 4).

Prebranchial region.—The region between the first gill and the mouth is in this species peculiar in several respects, and seems to merit special description. It may be recalled that in Bourne's worm dorsal and ventral setae begin at the same level (segment ii), the interval between mouth and first setae being equal, according to his figure, to about a single body segment; cephalization is therefore limited to the first segment. In the allied worm previously described by me there is a considerable interval between mouth and first gills; in this interval are situated the four first ventral setal bundles (exceptionally only three) but no dorsal setae; the gills and dorsal setae, therefore, begin on the sixth segment, and the first five segments are 'cephalized.'

In the specimens now under discussion, there is a moderate interval between the mouth and the level of the first gill, equal on the average (cf. pl. xi, figs. 1, 2 and 3) to the diameter of the body at the latter situation. No distinct external annulation could be made out in this interval; and the pigmentation was not segmentally arranged. The most curious point however is the varying distribution of ventral setae in this region.

The setae are always, when present, of a type distinct from those in the rest of the body. In their general proportions they resemble the 'anterior' setae, but are considerably shorter (77 to 87μ), remarkably slender, with delicate prongs, and a nodulus proximal to the middle of the shaft (proximal : distal : : 36 : 41, or 41 : 46).

Their distribution was as follows. In one specimen (pl. xi, fig. 1) there were four bundles of such setae in the prebranchial region; in another three (pl. xi, fig. 2); the condition in these specimens (except for the small size of the prebranchial setae) was therefore the same as in the related species previously described by me. In a third specimen there were on one side two setal bundles, of only one seta each, the anterior of the two being the longer; on the other side there was, near the mouth, a single bundle of two setae; the prostomium in this specimen was fairly well formed, and the prebranchial region of considerable extent; i.e. considering the manner in which asexual division takes place in this form (v. *inf.*), this specimen had probably been leading a free existence for some time. In a fourth there was on one side a single bundle, of one seta only, situated nearer to the first gill than to the

The buccal cavity is tubular, and is succeeded by the pharynx, a portion of the tube which possesses a strongly ciliated and laterally extended dorsal diverticulum, the cells lining which are markedly columnar; while the ventral wall of the pharynx is composed of flatter and more irregular cells (pl. xi, fig. 5). The pharynx extends backwards to include the first gilled segment; the diverticulum then flattens out and disappears. The oesophagus is strongly ciliated; there is no stomach,—indeed, beyond the pharynx, the tube can scarcely be differentiated into distinct regions.

The dorsal vessel is, for by far the greater part of its extent, dorsal in name only; it runs for the most part on the left of the intestine (pl. xi, figs. 2, 6); it is invested by chloragogen cells and pigment cells as far forward as the interval between first and second gills; here it becomes dorsal, and loses its investment.

The present species does not stand alone in the matter of the aberrant course of the dorsal vessel. I have ascertained, from an examination of my specimens, that *B. hortensis* is similar in this respect, though the fact was not noted in my original account of this worm. It is known also to be the case in the various species of the genus *Dero* (Naididae), and in *Branchiura sowerbyi* (Tubificidae) (1, 13); and I have found it also in the Tubificid worm I have described (13) as *Limnodrilus socialis*. One peculiarity common to all these forms is that they possess specialized respiratory arrangements;—*Dero*, *Branchiura*, and *Branchiodrilus* possess branchiae, while *Limnodrilus socialis* has a well-developed integumentary blood plexus in the posterior part of its body, and during life is incessantly waving this posterior end in the water; but as to what connection there is between such specialized respiratory arrangements and a lateral or ventrolateral position of the dorsal vessel I am not clear.

There is a large giant fibre on the dorsal surface of the ventral cord, looking in sections like a large empty tube (pl. xi, fig. 6).

(2) *Asexual Reproduction.*

One specimen only was dividing asexually (pl. xi, fig. 4); and here a fragment only of the posterior animal was present. The whole specimen consists of 87 segments in the anterior animal, and nine segments of the posterior. Though apparently nearly ready for detachment, there is as yet no differentiation of a head in the hinder zooid, no mouth, and no new setae, no newly formed segments, nor any region intervening between the first gilled segment and the anterior end of the body; the gills however have formed, and the characteristic pigmentation of the anterior region is beginning to appear. At the posterior end of the anterior animal there is an appearance suggestive of the approaching rapid formation of a budding zone,—a slight opacity, and an irregular fine transverse streaking, more especially on the ventral half of the body.

The condition is therefore to be compared with what occurs in Bourne's *Chaetobranchus*, where there is no budding zone, and the process of division resembles rather a simple fission of the animal into two. It is to be contrasted in this respect with the species I found at Lahore, where a regular budding zone is formed, as in *Nais*, *Chaetogaster*, etc. Further, the present form agrees with Bourne's in the fact that asexual reproduction is apparently a comparatively rare occurrence; Bourne, out of a large number, found only a few specimens dividing; whereas in many species of Naididae it seems to be rather the exception than the rule to find an animal which is not preparing to divide.

It would appear from the specimen undergoing division (pl. xi, fig. 4),—if I am right in supposing that a separation of the two individuals was here not far off,—that a considerable amount of the development of the head has still to be gone through after fission is completed. This is confirmed by the actual condition of two of the free-living specimens examined (the fourth and sixth; cf. *ant.*, under the description of the prebranchial region).

Can this inference be used to explain the remarkable variations in the distribution of the prebranchial setae? In other words, can we suppose that all specimens which show fewer than four pairs of ventral setal bundles in front of the gills have recently been separated, and have not yet completed the development of the anterior end,—and that the production of the full number of setal bundles will follow in time? Would the specimens described above have developed, in all cases, four bundles of ventral setae in the prebranchial region if they had been left alive?

This seems quite possible with regard to such specimens as the fourth and sixth of the foregoing description; here the other structures of the anterior end—prostomium etc.—were also incomplete, and it is quite possible that the setae might, later, have developed along with these.

It does not seem very probable with regard to some of the other specimens. For example, in that represented in pl. xi, fig. 3, the seventh of the previous description, the prostomium, mouth, and other features of the anterior end are well developed, yet the ventral setae are wanting; had they been going to develop, there would have been at least some signs of them. The same may be said with regard to the fifth. And in the specimen with three well-developed setal bundles in the prebranchial region (pl. xi, fig. 2) there would probably have been some sign of a fourth if a fourth had ever been going to develop. Again, asexual reproduction apparently here, as in Bourne's worm, does not occur with any great frequency; hence the chances are very much against six out of these seven specimens having been very recently separated, as the above explanation would demand.

The matter may therefore be summed up as follows:—In the present form the process of asexual reproduction is accompanied by the formation of only the rudiment of a budding zone; separation of the two resulting individuals takes place early;

and a considerable portion of the process of differentiation of the head is completed after separation. In this differentiation, the formation of the setal bundles sometimes lags behind that of the other structures, and the number of setal bundles formed varies considerably. Not infrequently, it would appear, none are formed; and the maximum number of four is perhaps comparatively seldom produced.

(3) *Systematic Position.*

Though closely related to the worm which I have described as *Lahoria hortensis*, the present species is not identical with it; and the more restricted distribution of the gills in the form under discussion, the details of asexual reproduction, certain differences in the form of the setae, and the smaller number of these in both dorsal and ventral bundles, are sufficient to distinguish it.

With regard to Bourne's *Chaetobranchus semperi* the agreement is in many respects closer. Thus Bourne gives identically the same number of segments (130) which I counted in the best developed specimens of the present batch; the details of pigmentation correspond in the two; the number and distribution of the gills is about the same; the details of asexual reproduction are strikingly similar, and different from what is usual in other Naididae; and finally both were taken in the same locality.

On the other hand there are several points of difference. To begin with the less important, the length of Bourne's worm appears to have been greater, though some of the apparent difference is no doubt due to contraction of the preserved specimens; the setae did not begin to project freely so soon in Bourne's specimens (about the 30th segment), as in mine (13th to 28th); and, to judge from Bourne's figure, the position of the mouth is different in the two, the prostomium being considerably longer, and the prebranchial region somewhat shorter in Bourne's specimens than in those now under discussion. Further and more important differences are found in the characters of the setae; though those of the two forms have a general resemblance, this does not extend to details (compare, for example, the dorsal needles of the present form with the sickle-shaped dorsal setae of *Chaetobranchus semperi*); and a marked distinction is found in the numbers of setae per bundle, both in the dorsal and ventral series. Lastly there is the fact that in the present form there may be as many as four pairs of ventral setal bundles between the first gills and the mouth.

In my present specimens, it is only in a minority that well-formed setal bundles are developed between the first gills and the mouth; and had I received a smaller number of the worms, say two or three only, it is not improbable that such examples would have been wanting altogether; in which case, in view of the many and detailed points of similarity, it is not unlikely that I should have recorded the present find as a rediscovery

of Bourne's worm. It does not seem possible, on the other hand, that Bourne should have overlooked the occasional occurrence of prebranchial ventral setae, since he "secured numerous specimens of *Chaetobranchus*" and (with regard to the mode of asexual reproduction at least) "examined a very large number of individuals."

The two forms are therefore to be regarded as distinct, and I accordingly propose for the one herein described the specific name *menoni*. It seems however impossible, merely on the ground of a (far from constant) difference with regard to the prebranchial setae, to deny a close genetic relationship between the two. They must undoubtedly be regarded as belonging to the same genus.

For the generic name *Chaetobranchus*, which, since it is the name which Bourne used, has been employed above in referring to the worm described by him, Michaelsen (8) substituted *Branchiodrilus*, *Chaetobranchus* having been previously used for a fish. The new worm thus becomes *Branchiodrilus menoni*.

If however these two species are ranked under the same genus, so must be the form from Lahore described by me as *Lahoria hortensis* (15); since the reason for separating this latter as a distinct genus from Bourne's worm was the same difference with regard to the prebranchial setae which occurs or may occur in *B. menoni*; i.e. the fact that four (or three) pairs of ventral setal bundles may occur in front of the first gills, or rather (which comes to the same thing) in front of the first dorsal setae.

The genus therefore now comprises three species, and genus and species will be defined as follows:—

Brachiodrilus Mchlsn. (= *Chaetobranchus*—Bourne):

Prostomium rounded. A pair of dorso-laterally placed branchial processes on many or most of the body-segments, beginning immediately or a short distance behind the mouth. Ventral setae crotchet shaped, forked distally. Dorsal setae beginning in the same segment as the gills, of two kinds, capillary and needles; the former, in a number of the anterior segments, enclosed in the gills.

1. **B. semperi** (Bourne).

Length 38-50 mm., diam. ·5 mm., segments 130. Branchial processes begin in the segment behind the mouth; at first are about four times as long as the diameter of the body, then decreasing in length and disappearing at the 60th—70th segment. Dorsal setal bundles consist of two or three capillary setae, longer in the anterior, shorter in the posterior segments, and two or three short sickle-shaped setae, the latter wanting in the anterior segments. Capillary setae of dorsal bundles all enclosed in the branchial processes in about the first 30 segments, some so enclosed in about the next 30, thenceforward all free. Ventral

bundles of 4-6 setae, the distal prong of which is the longer in the most anterior segments, the proximal being the longer in the remaining segments. No stomach. Lymph corpuscles rounded, with numerous olive-green granules. Asexual reproduction without the previous formation of a budding zone.

2. **B. menoni** sp. nov.

Length (preserved) 8-15 mm., segments up to 130. A short prebranchial region between first gills and mouth, which may or may not possess a series of pairs of ventral setal bundles (up to 4 pairs). Gills diminishing in size posteriorly, and ending some distance in front of hinder end; longest gills 2½ times as long as diameter of body. Dorsal setal bundles anteriorly of one or two hair setae; in the middle and posterior parts of the body of one hair and one needle seta, the latter somewhat bayonet-shaped, tapering to a fine point. The hair setae of the anterior bundles enclosed in the gills; becoming free before the 30th segment Ventral bundles usually of 3, sometimes of 2, setae; anteriorly slenderer, distal prong longer, nodulus proximal to middle of shaft or about its centre; further back the setae are stouter, distal prong approximately equal to or a little longer than proximal, nodulus distal to middle. No stomach. Asexual reproduction without or almost without previous formation of a budding zone.

3. **B. hortensis** (Stephenson) (=*Lahoria hortensis*).

Length 16—25 mm., diam. ·5—·75 mm., segments 90-120. Gills and dorsal setae begin on sixth (occasionally fifth) segment. Gills diminishing in size posteriorly, ending just in front of hinder end of animal; longest gills 3-4 times as long as diameter of body. Dorsal setal bundles of capillary and needle setae, not more than two of each per bundle; contained within the gills for the first 40—50 segments, then one hair seta of each bundle free; needle setae straight, pointed. Ventral bundles of 4—5 setae, distal prong slightly longer than proximal, and much thinner at its base. No stomach. A budding zone formed during asexual division.

4. *On Cephalization in the Naididae.*

Cephalization means the formation of a head; to quote from Beddard (2), "Lankester has applied this expression to the specialization of the anterior region of the body so frequently seen among the Oligochaeta." This specialization shows itself perhaps most prominently in the distribution of the setae;—" all Oligochaeta show cephalization as regards the first segment of the body, which never possesses setae." The Naididae which (except *Chaetogaster*) have regularly ventral setae in all segments from the second onwards, frequently lack dorsal setae in a number of the anterior segments, and there are thus in these cases

a number (usually four, i.e. segments ii—v) of segments which have ventral but no dorsal setae. It is frequently found moreover, e.g. in the genus *Nais*, that the ventral setae of these 'cephalized' segments are different in type from the succeeding ones; thus the distal of the two prongs of the forked end may be relatively longer, and the nodulus situated proximal, instead of distal, to the middle of the shaft.

Other systems or organs are concerned. Beddard instances septa and nephridia, which may be absent from the anterior segments. In addition I may adduce pigmentation; the cephalized segments may be lighter in colour, or the pigment may be differently arranged, as compared with the following segments. Chloragogen cells are absent from the alimentary tract in the cephalized segments. The gills of *Branchiodrilus hortensis* are similarly absent from this region.

The next point which I wish to bring forward is that this cephalization is related in the Naididae to the manner of asexual division, and to the production, between two separating individuals, of a budding zone. When one of the Naididae divides asexually, the usual procedure is that at some spot near the middle of the length of the animal a rapid production of new segments takes place; of these segments the larger number go to form the tail end of the anterior, the smaller number to form the head of the posterior, of the two resulting animals. This head commonly consists of five segments, with a prostomium, all newly formed; i.e., it corresponds to the number of cephalized segments as determined by the examination of free-living specimens. In other words these segments, produced in the budding zone, and representing the head of the (subsequently to be detached) animal, want the dorsal setae, and frequently have the ventral setae modified; they are commonly, at first at least, less pigmented (as are also the newly formed segments at the posterior end of the anterior animal); they contain no chloragogen cells, have no nephridia, and in *Branchiodrilus hortensis* are without gills.

Since the predominant mode of reproduction in the Naididae is the asexual, by fission,—sexual reproduction being a comparatively, or absolutely, rare occurrence,—by far the larger number of individuals of a species existing at any time will have been produced asexually, and *the cephalized segments will be those which have been produced in a zone of budding.*[1]

[1] This point with regard to the budding zone has not apparently received much attention from students of the Naididae and (in the somewhat scanty literature at my disposal) I cannot find any references as to how many of the segments produced in the budding zone go to the anterior end of the posterior animal in the different genera. My own observations on the genera *Chaetogaster*, *Nais*, *Slavina*, *Stylaria*, *Aulophorus* and *Branchiodrilus* show that the rule just stated holds for these (in *Chaetogaster*, where there are no dorsal setae, cephalization is marked by the regular series of ventral setae beginning only in the sixth segment); and it apparently holds also for *Aeolosoma* (fam. Aeolosomatidae), where the process is similar. It is to be noted however that *Pristina* is a remarkable exception; here no fewer than seven of the anterior segments are formed in the budding zone, though dorsal setae begin on the second segment and cephalization is therefore confined to the first.

From this it follows, that variations or irregularities in the process of budding will give rise to corresponding variations or irregularities in the degree and form of cephalization.

That the budding zone varies in position has been known for some time. It is usual, following Bourne (5), to denote by *n* the number of segments of the original animal behind which the budding zone appears, and though Bourne thought at first that *n* would be found to be constant for each species, it now appears that in a large number of species at least it varies within somewhat wide limits (for examples, *cf.* Benham (3), Piguet (11), Stephenson (16) (*Stylaria lacustris*).[1]

Variations in position of the budding zone would not necessarily affect the number of cephalized segments; the point has been mentioned, because variations in one respect prepare us to look for variations in other respects. Such have been noted in *Nais communis* by Piguet (11):—" à diverses reprises, j'ai trouvé un certain nombre d'exemplaires qui n'avaient que 4 segments avant celui où débutent les soies dorsales et les cellules chloragogénes (normalement, le 6me). J'ai d'abord pensé à une régénération incomplète après mutilation; mais tous ces individus avaient la région antèrieure absolument normale, sauf que leur 5me segment étail l'homologue du 6me des autres. Il faut donc supposer que le bourgeonnement produit quelquefois, accidentellement peut-être, des spécimens ayant, dans la region du pharynx et de l'oesophage, un segment de moins que les autres." The fact that in *Branchiodrilus hortensis* there may be either four or five cephalized segments (15) belongs here also. And in *Slavina punjabensis* I found (14) a number of irregularities in the results of the budding process;—incomplete differentiation of the head, an eye wanting on one side, fewer setal bundles, and these containing fewer setae than normal;—which might perhaps be partly explained by supposing that separation of the two individuals had taken place before the differentiation of the head had been completed, and that this differentiation would follow after, instead of as usual coming before, the separation. But it is perhaps equally likely that these irregularities were destined to endure.

This brings us to the condition in *B. menoni*. We have here before us a number of variations in the characters of the anterior end of the animal, especially in the numbers of the ventral setal bundles in front of the gills (or of the first dorsal setae). As to how this is related to the process of asexual reproduction, and how far these variations may be due merely to a delayed differentiation of the newly formed head, see the section on Asexual Reproduction. Referring to the discussion there for support, it will be sufficient now to state that *in* B. menoni *we have a species which varies within wide limits in regard to cephalization, as manifested especially in the setal distribution.*

[1] In the Aeolosomatidae however and in the genus *Chaetogaster*, in which cases the number of body segments is small, *n* would seem to be fixed for each species, according to observations on all the species that have come under my notice.

The importance of a right estimate of the value of cephalization, as marked by the want of correspondence in the anterior limits of the dorsal and ventral setae, is apparent when we call to mind that this is one of the characters by which the genera of the Naididae are discriminated. Thus the segment on which the dorsal setae begin (reckoning the first segment with ventral setae as the second of the animal's body) figures as a diagnostic mark of genera in Vejdovsky (17, p. 25), and in Michaelsen (8, p. 17). The extent anteriorly of the dorsal setae is the chief, if not the only, distinction between the genera *Naidium* and *Nais*. To quote from a former paper (15) :—"Beddard (2, p. 281), merging together a number of genera of other authors under the one name *Nais*, does so largely because they 'agree in the important fact that the first five segments are cephalized,—that the dorsal setae do not commence until the sixth segment,' and by implication would exclude from the genus any form which did not show this cephalization. Similarly *Pristina* and *Naidium* are united by him on the ground of the absence of this feature. Bourne (5) also believed that the number of cephalized segments is constant for the genus, and thought it probable that *Dero furcata*, possessing four achaetous dorsal segments, should on this account be removed from the genus, since the other members of it have five such segments." And specially with regard to *Branchiodrilus*, "the presence of dorsal setae on all segments from the second onwards is mentioned as a feature in the generic diagnosis of *Branchiodrilus* in Bourne's original paper (4), in Beddard's monograph of the Oligochaeta (2), and by Michaelsen (8)."

It is therefore evident that a distinction such as that which obtains between *Branchiodrilus semperi* and *B. hortensis*, where the dorsal setae begin on the second and sixth segments respectively, is held by most authorities as a ground for a generic separation. Holding this view myself, I accordingly separated the Lahore species as a distinct genus, *Lahoria*, though I thought it "perhaps worth while asking whether a cephalization which affects only the setal distribution (for the absence of gills on segments ii—v of the present form [i.e. *B. hortensis*] is evidently correlated with the absence of the setae which are necessary to stiffen them) has the systematic value hitherto generally attributed to it."

It is to be added that the above view, of the absolute value of a different anterior extent of the dorsal setae as a generic character, has not always been strictly maintained. Thus Michaelsen (8) unites into one genus *Paranais* three species known at various times as *Naidium naidina*, *Paranais littoralis*, and *Uncinais uncinata*, though their dorsal setae begin respectively on the second, fifth, and sixth segments. And in a recent paper (9) the same author prefers to include my *Lahoria hortensis* as a species of *Branchiodrilus* (as I do in the present paper), allowing the numerous close structural resemblances to over-ride the somewhat artificial distinction based on the distribution of the dorsal setae.

With the discovery of *B. menoni* the case becomes stronger. I was in doubt at first as to whether it would not be advisable to unite it with Bourne's worm under the same species, *B. semperi*; since the points of structural agreement are many, and in some cases extend into detail; and there can at least be little doubt of a close genetic connection. Yet, allowing the usual value to cephalization, the difference between some specimens of *B. menoni* and *B. semperi* would be generic; and indeed the same might be said of specimens of *B. menoni* alone, when compared one with another.

The conclusion to be drawn is that *the degree of cephalization in the Naididae is correlated with the behaviour of the segments of the budding zone,*[1] *and that variations in both, of considerable extent, may occur within the same species. The form of cephalization which is characterized by the absence of dorsal setae from a number of the anterior segments of the body has been evolved repeatedly, in different groups of the Naididae, and at different times. The degree of cephalization is not necessarily a generic character, since differing degrees of cephalization may coexist with a remarkable similarity in general organization.*

One point of a more speculative nature remains. In the case of *Branchiodrilus hortensis*, which usually has five prebranchial segments, specimens are occasionally met with which possess only four such segments; in these cases the first gilled segment would seem to be homologous throughout, i.e. the sixth segment of some individuals is homologous with the fifth of others. Similarly, according to Piguet, in *Nais communis* (v. *ant.*):—"mais tous ces individus (i.e. those with only four segments in front of that on which the dorsal setae began) avaient la région antérieure absolument normale, sauf que leur 5me segment était l'homologue du 6me des autres."

Similar considerations must be extended to *Branchiodrilus menoni*; the first gilled segment is homologous, throughout the individuals of the species, though these individuals vary as regards the number of segments intercalated in front of this fixed point and behind the mouth.

But while some specimens of *B. menoni* agree in the arrangement of their segments (as determined by the setal bundles) with *B. semperi*, others agree with *B. hortensis*. It follows that the first gilled segment is homologous in these two species, i.e. segment vi of *B. hortensis* is homologous with segment ii of *B. semperi*.

If this is the case, then we must infer that the same holds generally in the Naididae, and that the segment immediately succeeding those produced in the budding zone,—usually, but not always, that on which the dorsal setae begin,—is homologous thoughout the group.

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1 Compare however what was said previously (footnote p. 230) regarding *Pristina*.

As to whether this would lead to difficulties with regard to the homologies of the genital organs or not I cannot say. It would be interesting to have details of the budding process and of the position of the genital organs in *Naidium*, where the dorsal setae begin on the second segment; but these are lacking. The above views would not lead to any difficulties in the case of *Pristina*; here the testes are in segment vii, the ovaries in viii, i.e. the genital organs are displaced two segments backwards as compared with other genera. But the segments contributed to the animal's head from the budding zone are also more numerous than usual, seven instead of five, and therefore the testes are still in the last segment to be added from the budding zone, as in *Nais* and other genera.

II.

Branchiura sowerbyi, Bedd.

This interesting worm, belonging to that small group of Oligochaeta which possess gills, was first described by Beddard (1) in 1892 from specimens obtained from the mud of the *Victoria regia* tank in the Royal Botanical Society's Gardens in London; of these specimens only one was sexually mature, and this furnished the material for his description of the genital organs. No more was heard of this worm till 1908, when Michaelsen (7) found specimens, among them several sexually mature, in a warm water tank of the Botanical Gardens at Hamburg; Michaelsen's account deals exclusively with the genital system, in which he finds a number of differences as compared with Beddard's description. L. Perrier (10) shortly afterwards notified the discovery of numerous specimens in the Rhone, but did not add any anatomical details. Lastly in 1911 I (13) found the worm in a nullah near Lahore in the Punjab; I was able to add a number of anatomical facts to those recorded by Beddard, but none of my specimens were sexually mature.

I have since then received specimens from two sources. In May 1911 Mr. Gravely of the Indian Museum sent me a tube containing living specimens of the worm taken in Calcutta; they were obtained from mud in an earthenware basin containing aquatic plants planted in mud and water in the Museum garden. It is noteworthy that the worms were put into the tube on the 12th May, and were received by post in Lahore at 4.30 p.m. on the evening of the 15th; the tube was opened immediately, and the worms were found to be still quite lively. The mean temperature at Lahore for the 24 hours was at this date 90°, the maximum in the shade 106°F, and the temperatures must certainly have been higher in a railway van coming from the south.

A few observations were made on the movements of the living worm. As remarked above, they were quite active. The posterior part of the body was at times held quite still while the

anterior part was wriggling; the movements of the posterior part, when these occurred, were either irregular wrigglings or regular undulating movements. The gills in these specimens showed no movements of their own when the tail was at rest. The worms manifested a sharp and sudden response to a touch with a needle; they contracted somewhat, and then as a rule remained quite motionless for a short time, subsequently resuming their movements.

As to their external characters, the gill region was short; in one case well developed gills ceased suddenly a little distance in front of the hinder end, and behind this point there were only tubercles,—about a dozen in both dorsal and ventral series, the two or three most posterior being slightly larger than the rest; this peculiarity was possibly due to previous injury. On holding the tube up to the light and looking through it the gills were invisible to the naked eye in the living animal on account of their transparency; their length was not greater than the diameter of the body. The length of the animals was from $1\frac{3}{4}$ to 2 inches when extended, and their breadth 1 mm. or more. One specimen exhibited genital organs, as described below.

Again in November 1911 I received from the Indian Museum a tube of these worms, preserved, which had been taken in Madras in the mud from the *Victoria regia* tank in the Agrihorticultural Society's gardens, in September-October, 1907, by Prof. K. Ramunni Menon. The specimens were in a bad state of preservation, and consisted of 18 fragments, of sizes from 25 to 2 mm., mostly small; these had apparently belonged originally to two worms, of which neither showed sexual organs. The peculiarity about these specimens was that they were constricted, in transverse section, so as to show a somewhat figure-of-eight appearance; but the dorsal, and still more the ventral, surface was flattened, the ventral surface, in the region in front of the gills, giving the appearance of a flat sole.

The occurrence of a sexual specimen among the worms received from Calcutta offers the opportunity of adding a few remarks on the genital organs. The differences between the descriptions given by Beddard and by Michaelsen are very considerable. As briefly as possible, the chief of these are as follows:—Michaelsen finds that the vas deferens enters the proximal expanded portion of the atrium very obliquely through the wall of the latter, nearly but not quite at its rounded extremity; this portion of the atrium is lined by long columnar epithelium, surrounded by a voluminous investment of glandular cells, and encroaches posteriorly, where the vas deferens joins it, on segment xii. It merges anteriorly into the middle region of the atrium, which is narrower, undergoes several irregular windings, and before becoming the distal region of the atrium is joined by the paratrium. The distal region of the atrium is again wider, is bent at its upper end like a hook, but its main portion passes vertically downwards to the male aperture. The paratrium is a long

diverticulum from the middle region of the atrium, closely bound up with the atrium for some distance near its origin, then separating from it though still running parallel; it extends back through the whole extent of segment xii, has an insignificant lumen, and is, like the proximal portion of the atrium, covered with a thick layer of glandular cells. A special ovoid coelomic sac encloses the distal section of the atrium and so much of its middle section and of the paratrium as are bound up together. The spermathecae consist of a duct with an expanded spherical ampulla.

Beddard on the other hand shows the vas deferens as joining the atrium about the middle of the length of the latter. The internal half of the atrium has thus the appearance of being a diverticulum of the male efferent canal; it is a large ovoid sac, with a considerable lumen and a voluminous investment of gland cells of peritoneal origin. The distal half of the atrium, below the junction of the vas deferens, is tubular, and is surrounded by a considerable muscular investment. The spermathecae are pear-shaped.

The differences briefly indicated above might possibly be explained, according to Michaelsen, in one or more of three ways. First, Beddard's specimen might not have been fully mature; but this explanation is in any case not by itself sufficient, and moreover the clitellum was well developed in Beddard's specimen, and the spermathecae contained spermatozoa. Or Beddard may have been misled, owing to the scantiness of his material, and the difficulty of working out a complete description from one specimen only; in this case it may have happened that Beddard has overlooked the paratrium, and mistaken the relation of vas deferens to atrium. Lastly, the specimens of the two observers may have belonged to different species; this however Michaelsen thinks very unlikely, since if the above differences do actually exist they are not of specific but of generic importance.

The sexual specimen from Calcutta, mentioned above, was pretty certainly not fully mature; in the sections, ripe spermatozoa are indeed seen entering the seminal funnel, and the sperm sac extends as far backwards as segment xiv; but the clitellum is indistinguishable, the spermathecae contain no spermatozoa, and there is no ovisac with contained ova. But in the circumstances above mentioned, the examination of other sexual specimens of this worm is a matter of some interest and importance; and the present specimen has probably this advantage, that it will at least indicate whether the differences in the two already published accounts are or are not due to the first of Michaelsen's suppositions, —i.e. to Beddard's having worked on an immature specimen.

Briefly, the Calcutta specimen agrees with Michaelsen's description in all essential points; and a full account would therefore be quite superfluous. It will only be necessary to refer to the figures appended, and to mention the characters in which the present specimen differs from Michaelsen's account.

(i) The atrium and paratrium are confined to segment xi, and do not encroach on xii.

(ii) The proximal part of the atrium is a spherical sac, sharply marked off from the middle portion, and lined by cubical, not columnar, epithelium (pl. xii, figs. 1, 4).

(iii) There is no bulky covering of gland cells surrounding either atrium or paratrium (pl. xii, figs. 1—4).

(iv) The lower portion of the paratrium runs side by side with the middle region of the atrium in a common sheath (pl. xii, fig. 2), as in Michaelsen's specimens, but their lumina never unite, and open separately into the distal section of the atrium (pl. xii, fig. 3).

(v) The combined atrium and paratrium undergo fewer windings in the coelomic sac than is described by Michaelsen.

(vi) The distal section of the atrium is straight throughout, not hooked at its dorsal extremity (pl. xii, fig. 5).

(vii) The spermathecae are small, egg-shaped, with thick walls and small lumen.

(viii) The female efferent apparatus is not described by Michaelsen Beddard describes an oviduct opening on the furrow between segments xi and xii. I find an ovarian funnel on septum 11/12 (pl. xii, fig. 1), which leads to the exterior by a short oviduct opening on segment xii, a little distance behind the level of septum 11/12.

I think it probable that most, if not all, the differences between the Hamburg specimens and the present one are to be referred to their being in different stages of development. And since the present specimen is presumably at a less rather than a more advanced stage of development than that described by Beddard, and since nevertheless it shows a fairly close agreement with Michaelsen's description, it does not seem likely that the discrepancies in the accounts of Beddard and Michaelsen are due to differences in the degree of maturity of their respective specimens. The explanation of those discrepancies is therefore to be sought in one of the other directions indicated by Michaelsen.

III.

Limnodrilus socialis, Stephenson.

The above worm was recently described by me (13) from Lahore, where it is common. I have twice received specimens alive from Mr. Gravely of the Indian Museum; the first occasion was in March 1911, the worms having been taken in a masonry drain at Belgatchia near Calcutta, the second in May 1911, when a tube of these worms, taken within the precincts of the Museum, was received at the same time and under the same conditions as the *Branchiura sowerbyi* previously mentioned.

Since the shape of the cerebral ganglion is largely used for purposes of discrimination and identification, I append a sketch of it, from a specimen in which it was well seen (fig. 4).

IV.

Enchytraeus indicus, sp. nov.

I received from the Indian Museum in October last a small tube of worms collected by Mr. S. P. Agharkar, of the Elphinstone College, Bombay, in the neighbourhood of that city. Mr. Agharkar's note concerning the specimens is as follows:—"Oligochaete found in egg membranes of the common pond snail *Ampullaria*. They were found in the eggs of this snail which I collected on August 18th. The eggs were kept in a moist place for hatching, and on the 6th September, 1911, the young snails came out one by one. In some of these eggs, instead of the young snail, I found this worm. In other cases however it was found in the membrane surrounding the young snail."

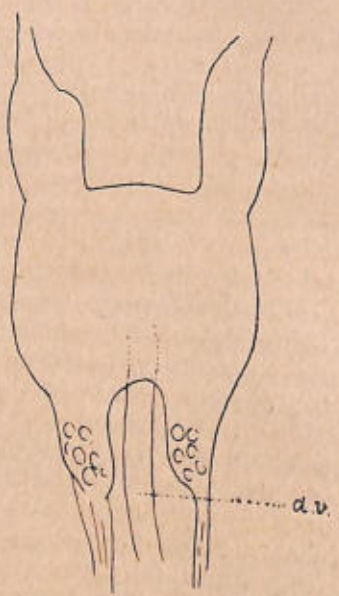

Fig. 4.—*Limnodrilus socialis*; cerebral ganglion, from above. *d.v.*, dorsal vessel.

The tube contained six specimens, of which one was very small, in a good state of preservation.

External characters.—The length was about 4 mm., the colour brownish; number of segments 31. The prostomium was short and bluntly conical; there was a head-pore between prostomium and first segment. The clitellum embraced segments xii—xiii; it was absent however from the median portion of the ventral surface of these segments.

The *setae* are of the type which is ordinarily found in the genus,—shaft straight with however a slight proximal curve, without nodulus, gently swollen towards the free extremity, and pointed at the end. In length they are approximately 50μ. The

ventral series are three per bundle in segments ii—xi, absent in xii and two per bundle behind this. The dorsal series are two per bundle throughout.

The *alimentary canal* begins in a tubular buccal cavity lined by low, approximately cubical, epithelium. The pharynx succeeds, and is in turn followed by the ciliated oesophagus, narrow as far as segment vi, a little wider in vii and viii; its calibre finally increases in xiv where the tube becomes the intestine; the cilia are specially long in segments vii—xi. Three pairs of septal glands are present, in segments iv, v and vi; their position would perhaps be more accurately described by saying that they are in close connection with septa 4/5, 5/6 and 6/7, which split to enclose them; the posterior pair of glands are united ventrally underneath the oesophagus. Peptonephridia are present as narrow coiled tubes in segment iv.

The *dorsal vessel* begins in segment xiii apparently, or at dissepiment 12/13. It divides just behind the level of the mouth; the two divisions unite again ventrally, probably in segment v, to form the ventral vessel.

The *nephridia* are of the compact type, with a small anteseptal portion and a pear-shaped postseptal; the latter twice as long as the anteseptal, the broad end anterior, the narrow end continued into the duct, which passes downwards and backwards. The duct is about half as long as the postseptal portion, and duct and postseptal together are about twice as long as broad. The first nephridium is in segment v.

The *cerebral ganglion* is large, in segment ii, and has the dorsal vessel closely applied to it underneath. From sections it appears to be slightly convex behind, or at any rate not indented.

Reproductive organs.—The testes are in xi, attached to septum 10/11; there are no sperm-sacs. The funnels are in xi; they are much smaller than is usual in the family, and do not diverge very greatly from the ordinary form; thus there is a small open funnel-like mouth, which is succeeded by a portion of the tube composed of columnar, clear and mucous-looking cells (cf. pl. xii, fig. 6, drawn from a specimen in cedar oil). The vas deferens passes through septum 11/12, is coiled in the anterior part of segment xii, but straight in its posterior portion; it is very narrow, its diameter being 7-8μ. The penial body, in the posterior part of xii, is spherical, has a diameter of 40-45μ, and opens on the surface by a wide aperture (pl. xii, fig. 6).

The ovary is attached to septum 11/12. Ova are found in all segments from viii to xii inclusive; segment xii may be largely filled by them (pl. xii, fig. 6). The funnel is a backward depression of septum 12/13 on each side, at its ventral attachment to the body-wall, whence the short narrow oviduct leads directly to the exterior.

The spermathecae open to the exterior in the intersegmental groove 4/5; the ampulla of each is small, approximately spherical or ovoid, in diameter about 30μ; it probably communicates with

the oesophagus, though my preparations do not show the actual opening. The duct is several times as long as the ampulla, and is bent once or twice in its course ; in diameter it is ·11-12μ.

I may add a few remarks on two of the above characters. The first is the penial body. The Enchytraeidae possess in general glandular structures surrounding the external end of the vas deferens, but differ among themselves in the disposition of the gland-cells ; in some cases there are a number of separate aggregates of these cells, opening on the surface of the body around the male aperture, while in other cases the whole of the gland-cells are compacted into a spherical, ovoid, or reniform penial body, surrounding the last part of the vas deferens. Eisen (6) proposes this distinction as a means of separating the Enchytraeidae into two subfamilies, the Lumbricillinae which have, and the Enchytraeinae which have not, a penial body. I have shown however (12) that the representative genera of the subfamilies, *Lumbricillus* and *Enchytraeus*, are connected by a number of forms which have a more or less intermediate position ; and that in particular a penial body occurs in more than one species of *Enchytraeus*. It is interesting to find that this is the case in the present species also.

The second point is the condition of the seminal funnel. Its general form in the Enchytraeidae is described by the word ' barrel-shaped,' and this form is occasioned by the excessive elongation of the cells composing the first part of the duct ; at the same time the cells become clear and stain only slightly, due presumably to the formation within them of a mucous substance. In the present species the funnel is small, and the change in the cells comparatively slight ; the condition is therefore intermediate between that usual in other families and that which is characteristic of the Enchytraeidae.

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PLATE XI.

Explanation of Figures.

FIG. 1. *Branchiodrilus menoni*; anterior end of a specimen with four ventral setal bundles in prebranchial region; no ventral setal bundle is to be made out in the segment of the first gill; the first gill has apparently been damaged; × 85.

FIG. 2. *Branchiodrilus menoni*; anterior end of a specimen with three ventral setal bundles in prebranchial region; the second gil lhas been damaged; the dorsal vessel is seen on the left side of the oesophagus; × 150.

FIG. 3. *Branchiodrilus menoni*; anterior end of a specimen with no ventral setae in prebranchial region; none could be seen in the first gilled segment either; × 85.

FIG. 4. *Branchiodrilus menoni*; a specimen in which asexual division is taking place, and is apparently nearly completed; ×68.

FIG. 5. *Branchiodrilus menoni*; transverse section of the prebranchial region, showing structure of pharynx and position of pigment cells. The specimen is that shown in fig. 1; ×150.

FIG. 6. *Branchiodrilus menoni*; transverse section through the sixth gill, showing position of blood-vessels, pigment cells, etc.; same specimen as fig. 4; ×150.

Alim., alimentary canal; *chl.*, chloragogen cells (much resembling pigment cells); *c. m.*, circular muscular layer; *d. v.*, dorsal vessel, *ep.*, surface epithelium; *g.*, gill; *l. v.* lateral commissural vessel; *l. m.*, longitudinal muscular layer; *pig.*, pigment cells in various situations; *ph.*, pharynx; *v. n. c.*, ventral nerve cord (the apparently empty space dorsal to it in fig. 6 is the giant fibre); *v. v.*, ventral vessel.

All the figures drawn with Zeiss's Abbe's drawing apparatus. The two sections (figs. 5 and 6) are seen from their front face; hence left and right are reversed.

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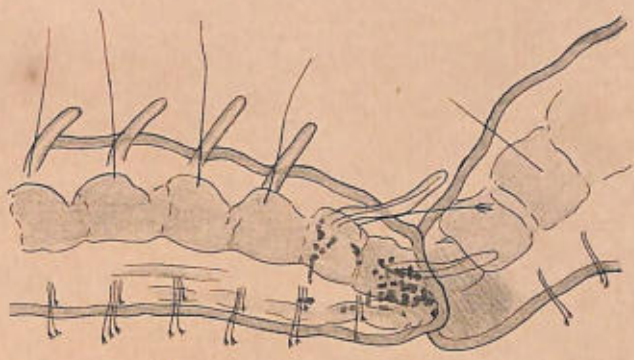

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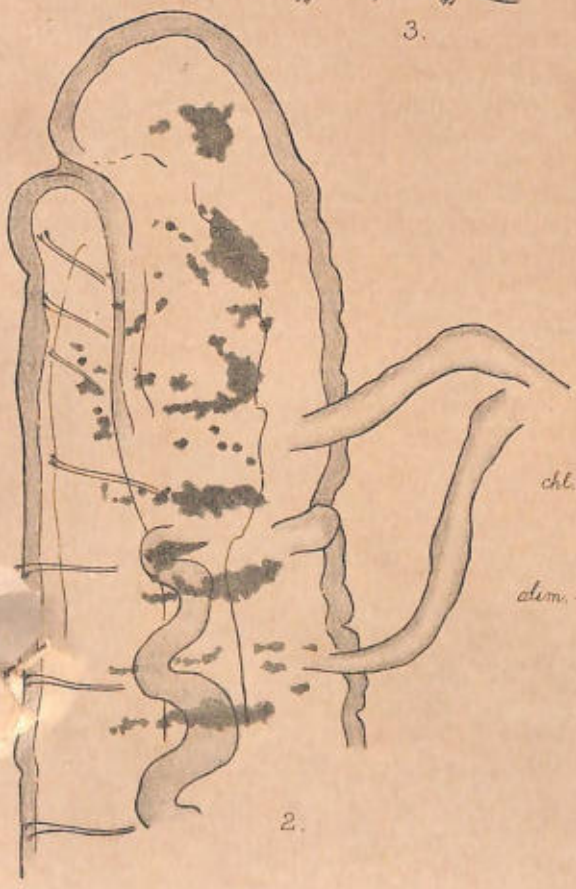

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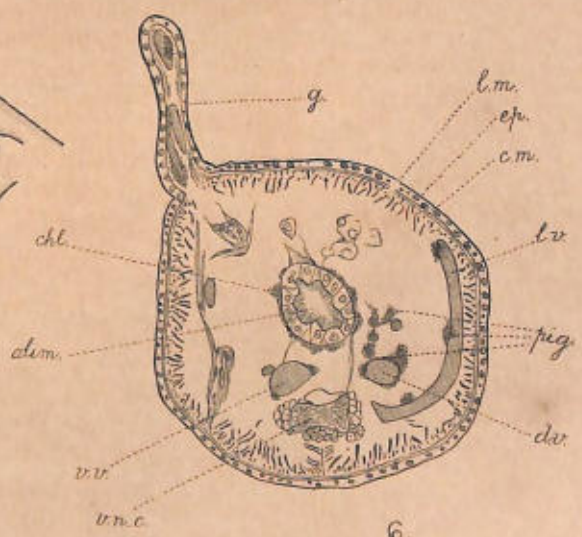

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PLATE XII.

Explanation of Figures.

FIG. 1. *Branchiura sowerbyi*; oblique section through posterior portion of segment xi; × 120.

FIG. 2. *Branchiura sowerbyi*; section through middle portion of atrium with paratrium; × 410.

FIG. 3. *Branchiura sowerbyi*; section through upper portion of coelomic sac, showing junction of paratrium and middle region of atrium with distal portion of atrium; × 330.

FIG. 4. *Branchiura sowerbyi*; section through proximal region of atrium and paratrium outside coelomic sac; × 240.

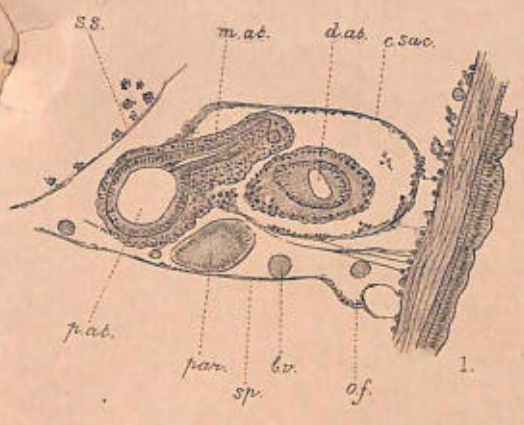
FIG. 5. *Branchiura sowerbyi*; vertical section through coelomic sac and distal region of atrium; × 95.

The above five figures drawn by Abbe's drawing apparatus from a series of longitudinal sections through the anterior end of a single specimen; the sections pass pretty accurately through the distal portion of the atrium on one side (fig. 5), but obliquely on the other (fig. 1).

B. v., blood-vessel; *c. sac.*, wall of coelomic sac; *d. at.*, distal portion of atrium; *d. w.*, dorsal body-wall; *m. at.*, middle portion of atrium; *o. f.*, ovarian funnel; *par.*, paratrium; *p. at.*, proximal portion of atrium; *per.*, peritoneal cells round proximal portion of atrium, corresponding to the glandular cells of other observers; *sp.*, septum 11/12; *s. s.*, sperm sac; *v. def.*, vas deferens; *v. w.*, ventral body-wall; *x*, at upper end of distal portion of atrium, indicates the place where, in a neighbouring section, the paratrium and middle portion of atrium enter; ♂ male aperture.

FIG. 6. *Enchytraeus indicus*; segments xi and xii, from a specimen mounted whole in cedar oil.

Clit., clitellum; *f.*, seminal funnel; *ov.*, ova; *pen.*, penial body; *s.*, seta; *t.*, testis.



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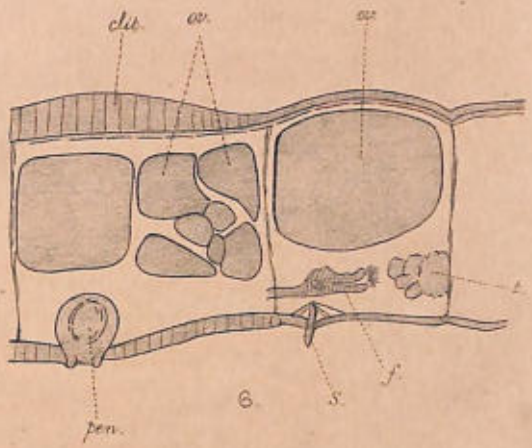

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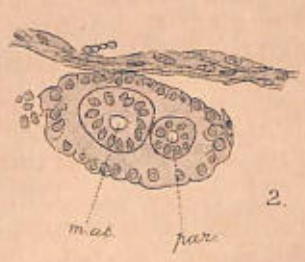

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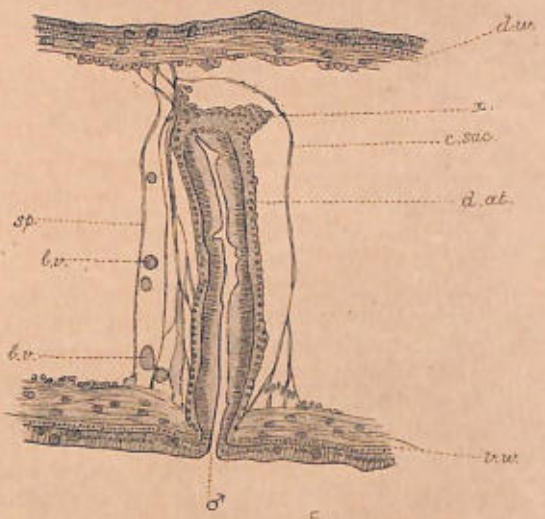

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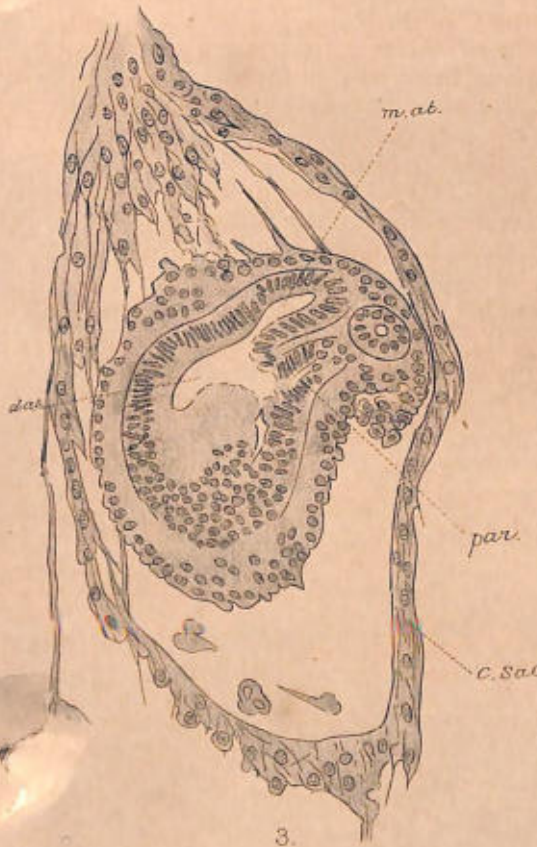

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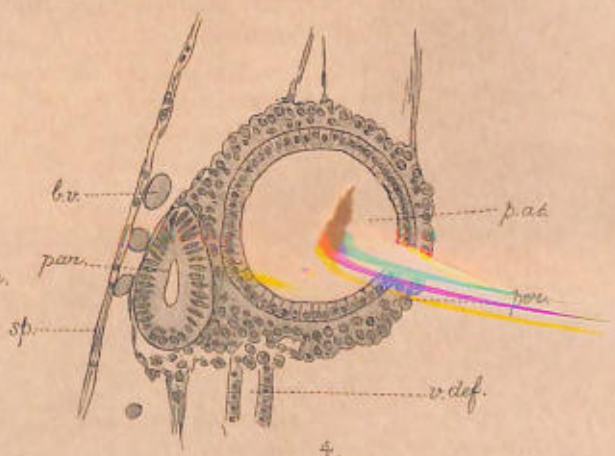

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J. Stephenson, del.

A. C. Chowdhary, lith.

PLATE XII.

Explanation of Figures.

FIG. 1. *Branchiura sowerbyi*; oblique section through posterior portion of segment xi; × 120.

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FIG. 3. *Branchiura sowerbyi*; section through upper portion of coelomic sac, showing junction of paratrium and middle region of atrium with distal portion of atrium; × 330.

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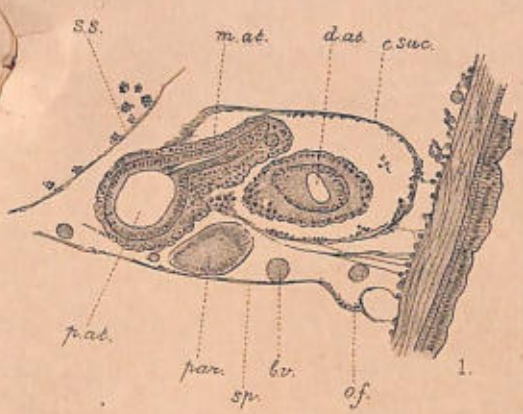
FIG. 6. *Enchytraeus indicus*; segments xi and xii, from a specimen mounted whole in cedar oil.

Clit., clitellum; *f.*, seminal funnel; *ov.*, ova; *pen.*, penial body; *s.*, seta; *t.*, testis.



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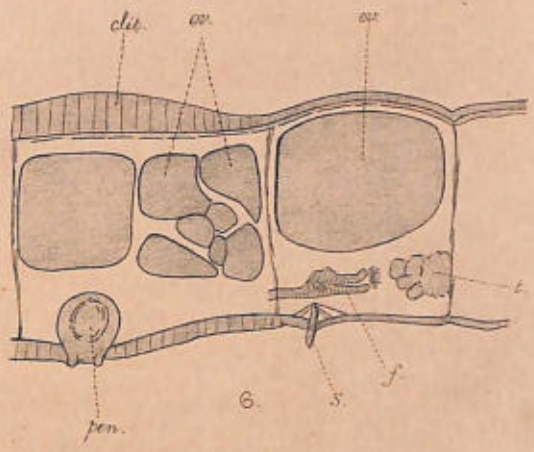

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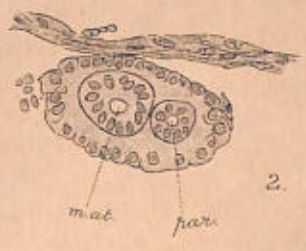

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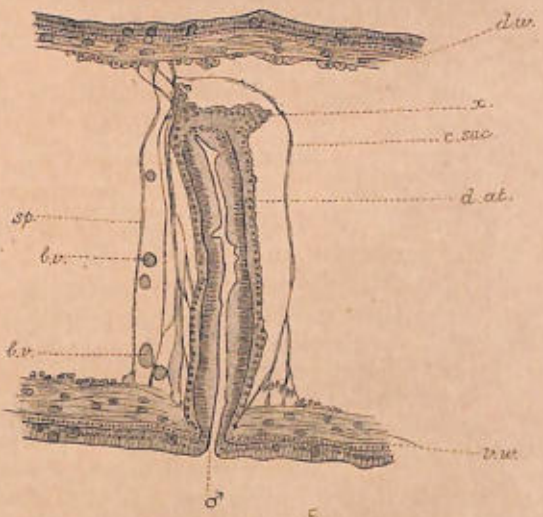

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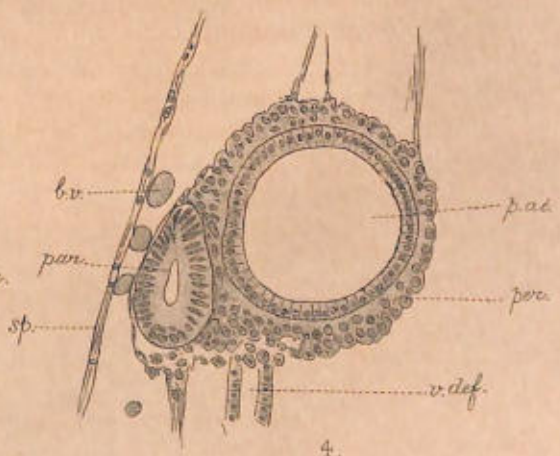

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J. Stephenson, del. A. C. Chowdhary, lith.

XXII. FAUNA SYMBIOTICA INDICA.

No. 4.—*CARIDINICOLA*, A NEW TYPE OF TEMNOCEPHALOIDEA.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

The object of the present note is to give a concise systematic description of an interesting symbiotic flatworm and to state what little is known of its habits. In preparing the description I have been indebted to the assistance of Mr. F. H. Gravely, who will, I hope, publish before very long a detailed anatomical account of the Temnocephaloidea represented in the collection of the Indian Museum and will discuss the morphology of the species described below.

I. *SYSTEMATIC.*

Class TEMNOCEPHALOIDEA.

It is perhaps doubtful whether the members of the so-called class Temnocephaloidea are sufficiently distinct from the Trematoda to be given that rank, and the peculiar little worm discussed in this paper is in many respects intermediate between the two "classes." For the present, however, the recognized classification may be accepted as convenient.

The Temnocephaloidea or Temnocephala, whatever their precise rank, are small parasitic flatworms with tentacles at the anterior end of the body and a large ventral sucker at the posterior extremity. They have a capacious sack-shaped alimentary canal with an anterior mouth but without a posterior aperture. The external surface is clothed with a delicate chitinous cuticle but in some cases bears cilia on certain parts of the body. Immediately below the cuticle there is a definite epidermis, in which, however, cell-walls do not occur. The genital organs lie behind or on the ventral surface of the alimentary canal in the posterior part of the body; the genital pore is situated near the posterior extremity or in the middle of the ventral surface.

A single species (*Scutariella didactyla*)[1] has been found in Europe but the group as a whole is characteristic of tropical and subtropical, or at any rate southern countries. It apparently has its headquarters in Australia, but is also found in New Zealand, in Malaysia and in S. America. Only one Indian species [Wood-Mason (12)] has hitherto been identified,[2] namely *Temnocephala semperi*, Weber, which is common on freshwater

[1] Mrázek, *Sitz. K. Böhm. Gesellsch. Wiss. Prag* 1907, p. 1, pl.

[2] Mr. Gravely has recently identified specimens after comparison with some of Prof. Max Weber's original examples from Java.

crabs of the genus *Potamon* (especially *P. manii*, Rathbun) in hill-streams in parts of Tenasserim.

The Temnocephaloidea appear to be confined to fresh water and to live, without exception, symbiotic rather than parasitic lives. In habits they are predaceous, but they invariably attach themselves to a host which they can conveniently employ as a beast of burden and a stalking-horse in the pursuit of their prey. Each species affects a single host or a group of closely allied hosts. Most of the Temnocephaloidea are found attached to Decapod Crustacea; the Australian species inhabit the gill-chamber of crayfish; the Malayo-Burman *Temnocephala semperi* lives on the ventral surface of crabs; one S. American form attaches itself to equatic tortoises, while another penetrates within the pulmonary chamber of the Gastropod *Ampullaria*. The species to be discussed in this paper, like the allied European form, is associated with small prawns of the family Atyidae.

The Temnocephaloidea may conveniently be divided into three families as follows:—

I. At least four anterior tentacles; posterior sucker circular; alimentary canal much shorter than body, with the genital organs posterior to it.

A. No lateral tentacles; no anterior sucker; pulsatile excretory pouches present .. .. Temnocephalidae.

B. Lateral as well as anterior tentacles; an anterior sucker in front of the mouth; no pulsatile excretory pouches.. .. Actinodactylellidae.

II. Only two anterior tentacles; anterior margin of posterior sucker cleft; alimentary canal extending to posterior extremity, with the genital organs on its ventral surface; no pulsatile excretory pouches .. .. Scutariellidae.

The third family appears to be considerably more remote from the two first than either of the latter is from the other, but it has not hitherto been recognized as distinct. It consists of two allied genera, *Scutariella*, Mrázek, and *Caridinicola*, gen. nov. The former is known from a single species from Montenegro; the latter from a single Indian species. The family may therefore be said to agree with most of the secondary divisions in the Temnocephaloidea in consisting almost of a minimum of forms. Only 5 genera (*Temnocephala*, *Craspedella*, *Actinodactylella*, *Scutariella* and *Caradinicola*) are known in the "Class" and of these *Temnocephala* is the only genus that is not monotypic, while the Temnocephalidae is the only family hitherto recognized that includes more than one genus, *Craspedella* as well as *Temnocephala* belonging to it.

Fam. SCUTARIELLIDAE, nov.

The two species included in this family are both minute, flattened, more or less ovoid or shield-shaped organisms associated with little freshwater prawns of the family Atyidae. They differ from all other known Temnocephaloidea in the following characters:—

(1) There are only two anterior tentacles, which differ in structure and function from those of *Temnocephala*.
(2) The posterior sucker is cleft anteriorly in such a way that it becomes either heart-shaped or horseshoe-shaped.
(3) There are no external cilia on any part of the body.
(4) The alimentary canal extends backwards to the posterior extremity.
(5) The genital organs lie beneath instead of behind the alimentary canal and the genital pore is situated in the middle of the ventral surface.

In the absence of lateral tentacles the Scutariellidae agree with the Temnocephalidae but they resemble *Actinodactylella*, Maxwell (7, 8) in the absence of pulsating excretory pouches and in the arrangement of the genital organs. The external cuticle is minutely ringed.

CARIDINICOLA, gen. nov.

The mouth is almost precisely terminal and the whole pharynx can be extruded in the form of a proboscis. The tentacles arise on the dorsal surface, one on either side of the mouth. At the base of each tentacle, on the ventral surface, there is a small sucker. The posterior sucker is horseshoe-shaped. The excretory system opens on either side by a pore on the lateral margin almost on a level with the eyes. There are two testes on either side, a larger and more conspicuous external and anterior testis and a smaller inner and internal one. The penis is armed with chitin and directed from right to left; the ovary resembles that of *Temnocephala* in structure and lies a little to the left of the middle line; the vitellarium does not cover the dorsal surface of the alimentary canal. Each tentacle has a large ganglion at its base. An elongated gland runs along each side of the anterior part of the body towards the tip of the tentacle.

Type, *Caridinicola indica*, nov.

Distribution.—The Ganges and the Mahanaddi rivers, eastern India.[1]

CARIDINICOLA INDICA, sp. nov.

External characters.—The animal is highly contractile and almost protean in form, but is always flattened dorso-ventrally, more or less produced at the anterior end and truncate posteriorly.

[1] Since this was written Mr. Gravely has obtained specimens of *Caridinicola* on *Caridina sumatrensis* in the Western Ghats.

When normally contracted it resembles a median longitudinal section of a cone in outline. In length an adult individual can extend instantaneously from 0·5 mm. to 2·0 mm. The integument is colourless and transparent and the rings on the cuticle very narrow. The tentacles are extremely short and have a bluntly rounded tip; they are soft and apparently devoid of cuticle; when the animal is fully extended they have the appearance of being mounted on short peduncles. The mouth opens between them at the base of a depression which becomes crateriform when the proboscis is fully retracted and the whole animal fully extended. There are two eyes situated on the anterior half of the dorsal surface some distance behind the base of the tentacles; the eyes are directed forwards and outwards; they are black in colour.

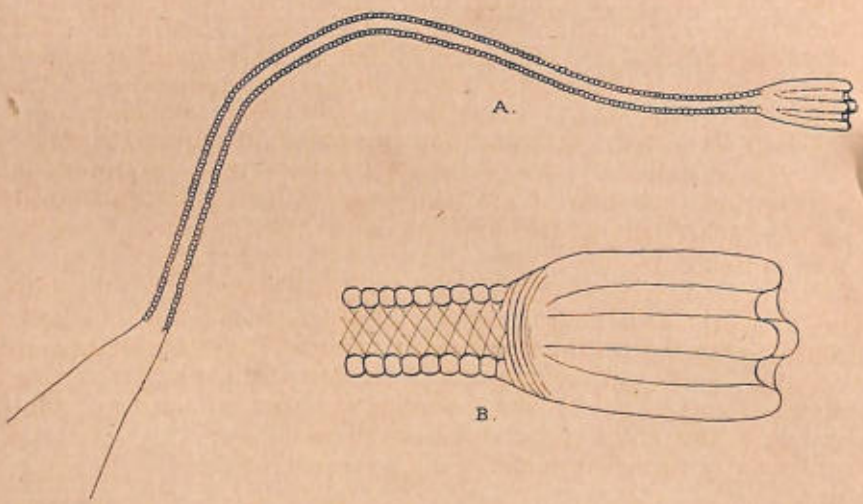

FIG. 1.—Chitinous armature of intromittent organ of *Caridinicola indica*.
A.—The entire armature, very highly magnified.
B.—The terminal cup, still more highly magnified. The stem or intermediate portion and the basal funnel are represented in optical section.

When the animal is fully contracted the posterior sucker sometimes becomes almost heart-shaped, but as a rule it resembles the figure formed by a straight line the extremities of which are curved upwards through the greater part of a circle, the distance apart of the incomplete circle thus formed varying with the state of contraction of the animal.

Alimentary canal.—The mouth opens into an elongate cylindrical but highly muscular pharynx (oesophagus) which can be thrust out bodily to nearly half the length of the animal. The tip of this organ is surrounded by a circle of minute prominences on each of which a sense-organ provided with a minute chitinous tooth is situated; the whole ring is folded inwards when the proboscis is retracted. Strong, almost transverse retractor muscles, are

attached to the base of the pharynx. The intestine is rather longer and much more bulky than the pharynx; it is indistinctly sacculated at its anterior end.

Genitalia.—Only the penis need be described here. The chitinous part of this organ (fig. 1) consists of three regions:—(1) a proximal, funnel-shaped base, (2) an elongate cylindrical stem and (3) a cup-shaped apex. The basal funnel occupies about $\frac{1}{8}$ of the length of the whole structure and has a perfectly smooth external surface; it is almost twice as long as its basal diameter. The stem is about 34 times as long as its own transverse diameter, maintains the same diameter throughout its length, is circular in cross-section and occupies $\frac{6}{8}$ of the whole structure. It is ornamented externally with minute rounded prominences with which it is closely covered, the prominences forming parallel transverse rings round it. The terminal cup is about $1\frac{1}{2}$ times as long as broad and only about $\frac{1}{10}$ the length of the stem. Its sides, which are nearly parallel, are supported by four equidistant vertical bars, each of which is about equal in breadth to the space which separates it from the next bar. At the rim of the cup the bars project upwards for a short distance, their tips being bluntly rounded.[1]

Excretory system.—A pore which I believe to be excretory is situated on each side of the body close to the edge of the dorsal surface and a little posterior to the eye. These pores are easily seen in living specimens.

Eggs.—The eggs are nearly circular as seen from the side but broadly oval as seen from above. Each is provided with a stalk considerably shorter than its own diameter. They are somewhat variable in size but measure on an average about 0·24 × 0·19 mm. in dorsal view. The external covering is chitinous but very thin and quite smooth; it has a distinct yellowish tinge.

Type (a specimen mounted in glycerine) No. Z.E.V. $\frac{3000}{7}$, Ind. Mus.

Localities, etc.—River Mahanaddi and canal opening thereinto at Cuttack and R. Mahanaddi at Sambalpur, Orissa (February and March); river Ganges near Rajmehal, Bengal (March) (*B. L. Chaudhuri*).

Hosts.—*Caridina propinqua*, de Man (4) and *C. sumatrensis*, Bouvier (3).

II.—BIOLOGICAL.

The first specimens of *Caridinicola* were found attached to antennae of prawns of the genus *Caridina* taken at Cuttack in February and preserved in spirit. Others were discovered loose in the same bottle. They were, naturally enough, mistaken for small leeches by my assistant who was sorting out the contents of the bottle. As the species was evidently one of considerable interest, I took the opportunity to revisit Cuttack last March and found the worm abundant in the gill-chambers of *C. propinqua*,

[1] These details can only be seen with the aid of an oil-immersion lens after the specimen has been treated with caustic potash.

which swarmed among water-weeds at the edge of the Mahanaddi and also in a canal at the same place. Loose specimens were subsequently found in bottles of *Caridina sumatrensis* from Sambalpur in Orissa and Rajmehal in Bengal.

In the river and canal at Cuttack small Decapod and Schizopod Crustacea are extremely abundant. At least three species of *Caridina* (*C. nilotica*, Roux) (*s.l.*), *C. propinqua*, de Man, and *C. sumatrensis*, Bouvier, occur among weeds at the edge, and also numerous small (mostly immature) Palaemonidae; while the water is often full of large shoals of the little estuarine Mysidae *Potamomysis assimilis* and *Macropsis orientalis*, Tattersall (10).

In spite of a careful search, I did not find *Caridinicola* on any species of *Palaemon* or Mysidae at Cuttack or on *Caridina nilotica*. I cannot, however, be sure that it did not occur on *C. sumatrensis*, although all the specimens of *Caridina* on which I know that I took it are assigned by Mr. Kemp to *C. propinqua*; for the immature individuals of the two prawns resemble one another very closely.

I have not been able to find *Caridinicola* on *Caridina propinqua* in the neighbourhood of Calcutta, but this may be due to the fact that the prawn in this district is only found in distinctly brackish water, whereas the water of the Mahanaddi at Cuttack is very nearly, if not quite, fresh. That of the Mahanaddi at Sambalpur and of the Ganges at Rajmehal is of course quite fresh. Nothing is yet known of the distribution of *Caridina propinqua*, which has hitherto been recorded only from the Ganges delta, but it is very closely related indeed to *C. fossarum*, Heller, from Persia, and it is probable that closely allied forms extend all over the territory intermediate between that country and Lower Bengal. *C. sumatrensis* appears to be distributed over a considerable part of the Oriental Region.

The host of *Scutariella* is *Atyaephyra desmarestii*, the only non-cavernicolous European Atyid.

The habitual position of *Caridinicola* on its host is inside the gill-chamber, in which it lies attached to the gills. In most cases it can be readily detected in this position with the aid of a low-power microscope by an external examination of the prawn, whose integument is rarely pigmented so deeply as to render the operculum opaque. If the water in which the prawn is living, however becomes foul or if any noxious substance is added to it, the worm immediately emerges from the anterior end of the chamber and makes its way rapidly along the antenna or antennule. After gesticulating wildly in a manner that will be described presently, it then makes off in search of a new environment, being by no means wholly dependent on the prawn for the power of locomotion. For this reason very few specimens can be found on prawns which have been kept in captivity for more than a few hours, unless precautions are taken to keep the water fresh.

Caridinicola, though not markedly gregarious, is usually found in parties of two or three and, so far as my observations go,

such parties are usually confined to one gill-chamber, that on the other side of the prawn remaining vacant.

The eggs are attached to the gill-filaments of the host and are apparently deserted by their parent before they hatch. I found numerous examples far advanced in development at the beginning of March. There are as a rule not more than half a dozen on one host.

The food of *Caridinicola* consists mainly if not entirely of minute Protozoa and Protophyta. The contents of the alimentary canal as a rule consists of a brownish granular substance, probably excretory and containing large numbers of Diatom and Desmid skeletons. The tests of Rhizopod Protozoa are often present also in considerable numbers.

Prey is evidently captured by means of the pharynx, which can, as already stated, be thrust out bodily in the form of a pro-

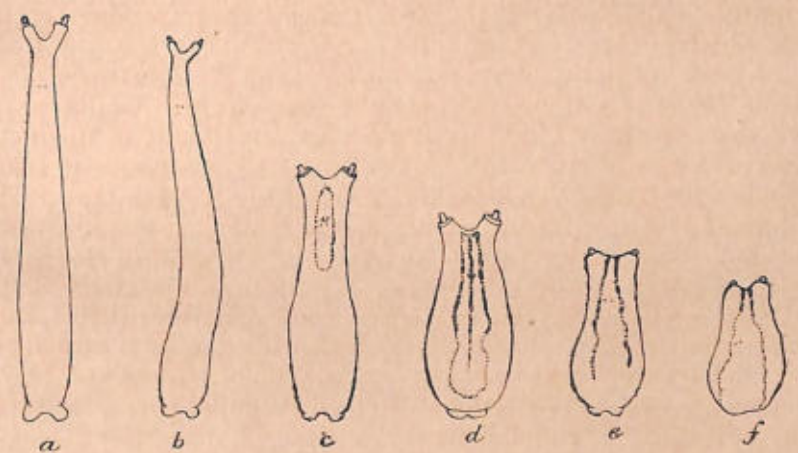

FIG. 2.—A single individual of *Caridinicola indica* in different stages of contraction.

boscis. I have not been so fortunate as to see the process, but Babu Abohya Charan Chowdhary, the Museum draftsman, tells me that while he was drawing the sketches reproduced in fig. 2, he saw the worm suddenly shoot out its proboscis and seize therewith a "small insect" which was running past. The proboscis was then rapidly withdrawn. The "small insect" was probably an Infusorian. The animal can easily be induced to extrude its proboscis by the exercise of pressure. Apparently the extrusion takes place more readily when the whole body is in a state of moderate contraction and is brought about by lateral contraction of the muscles of the body-wall, which are very well developed, aided by those of the organ itself. Retraction is affected by means of the retractor muscles situated at the base of the oesophagus. Doubtless the sense-organs surrounding the mouth enable the animal to decide whether the prey captured should be swallowed

or rejected, while the little teeth with which they are provided assist in its retention.

When *Caridinicola* is undisturbed in the gill-chamber of its host it habitually remains with its body in a state of moderate retraction, approximately as in fig. 2 *d*. The posterior sucker is firmly fixed to a gill-filament and the body is arched upwards and forwards in such a way that the eyes look directly forwards and outwards, the anterior extremity being bent considerably downwards. If any disturbance occurs, however, the animal immediately straightens itself and elongates its body to the utmost. Such attitudes as those shown in fig. 2 *a* and *b* are only adopted just before it begins to move forwards. Apparently the rule that it emerges from the anterior end of the gill-chamber is absolute, and it invariably escapes *viâ* the antenna or antennule. As soon as it reaches the filamentous part of one of these appendages it stays its course and remains for some little time with the peculiar posterior sucker clasped round the hair like structure. The body is stretched to the utmost and moves rapidly upwards and downwards and from side to side, often gyrating almost as if on a pivot; but the sucker retains a firm hold. The tentacles during these evolutions exhibit curious twitching movements apparently neither correlated in the case of the two tentacles nor rhythmical. At length the *Caridinicola* releases hold of its host and drops to the bottom or onto a convenient weed. It seems probable that it habitually deserts its host at night, for I found it difficult to procure specimens on *Caridina* in the Mahanaddi early in the morning.

Progression is effected by means of "looping." The body is first held upright and stretched to the greatest possible length. The anterior extremity is then bent downwards and the surface along which progression is to be effected touched gently by the tentacles with their characteristic twitching movements. The two little anterior suckers next take hold, and the posterior sucker is released, drawn forward to a position immediately behind that occupied by them and then affixed again. The animal is now in readiness for a new move forwards.

Taking the above-stated observations into consideration, it seems probable that the tentacles are, as their structure would suggest, primarily of use as sensory organs. They seem to play no other part in progression than that of testing the ground before the anterior suckers attach themselves to it. They have, I think, another function, namely that of finding the right host. I noticed that if a *Caridinicola* were removed from its host and placed in a dish of water in which a *Caridina* of the right species was present, it immediately stood up in the water on its posterior extremity and, after twisting about in all directions and flicking its tentacles, finally directed them in the direction of the *Caridina* and then moved rapidly towards it. This happened whether the *Caridina* was dead or alive; indeed, even if it were torn in pieces, the little worm appeared to be attracted by the fragments and attached itself to one of them.

The eyes probably serve another purpose. As the worm sits in the gill-chamber of its host, they are, as I have already stated, directed straight in front of it. The current of water that flows constantly through the gill-chamber must bring in many of the little organisms on which *Caridinicola* feeds, and it is reasonable to assume that it catches these organisms by means of its protrusible pharynx. In order to do so, however, it must first become aware of their presence. There is every probability that it does so by seeing them, for the walls of the gill-chamber of *Caridina propinqua* are of glassy transparency and offer hardly any obstacle to the passage of light, while even those of *C. sumatrensis*, although they are as a rule much more densely pigmented, are by no means opaque.

SUMMARY.

1. The new genus *Caridinicola* constitutes with *Scutariella*, Mrázek, a family of "Temnocephaloidea" of which the latter is the type.

2. The family Scutariellidae is distinguished from other families of the group, among other characters, by the fact that the intestine extends to the posterior end of the body and that the genital organs, therefore, lie on its ventral surface instead of posterior to it.

3. *Caridinicola* is distinguished from *Scutariella* by the possession of a pair of small anterior suckers, by the terminal position of the mouth and by the peculiar shape of the posterior sucker.

4. *Caridinicola indica* is found only in association with certain species of the Atyid genus *Caridina*, namely *C. propinqua*, de Man, and *C. sumatrensis*, Bouvier.

5. It captures its prey by means of a protrusible pharynx or oesophagus.

6. Its tentacles are sense-organs and are apparently employed in testing the nature of the surface along which the animal is moving and also in finding the host.

7. The eyes are probably used for the detection of prey.

8. Progression is affected by "looping."

In conclusion I must again express my indebtedness to Mr Gravely and also to Mr. Stanley Kemp, who has given me great assistance in identifying the hosts of *Caridinicola indica*.

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XXIII. PRELIMINARY DESCRIPTION OF A FRESHWATER MEDUSA FROM THE BOMBAY PRESIDENCY.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

Mr. F. H. Gravely of the Indian Museum and Mr. S. P. Agharkar of the Elphinstone College, Bombay, have recently obtained many specimens of the medusa referred to on p. 144, vol. lxxxvii of *Nature*. The following preliminary description is based on an examination of these specimens, which are several hundreds in number and come from the Yenna and Koyna valleys in the Satara district of the Bombay Presidency.

LIMNOCNIDA INDICA, sp. nov.

This medusa is closely allied to *L. tanganicae* (Bohm)[1] and *L. rhodesiae*, Boulenger,[2] but differs from both in the arrangement of its tentacles and sense-organs.

Dimensions.—The smallest specimen (fig. 1) I have seen is about 1·75 mm. in diameter and has probably been, at any rate when in a state of contraction, at least as deep as broad. Full-grown medusæ are 15 mm. in diameter and almost three times as broad as deep.

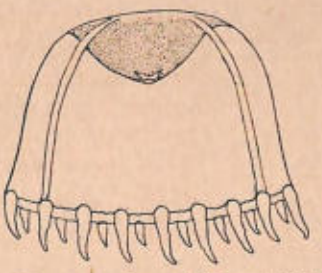

FIG. 1.—Young medusa of *Limnocnida indica*.

Umbrella.—The umbrella is very shallow and almost flat on the dorsal surface in the adult; in the young it is distinctly flattened above but not so broadly as in the adult.

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1 Günther (R.T.), *Ann. Mag. Nat. Hist.* (6) xi, p. 269 (1893); *Quart. Journ. Micro. Sci.* xxxvi, p. 271 (1894); *P.Z.S.*, 1907 (ii), p. 643; Browne in Graham Kerr's *The Work of John Samuel Budgett*, p. 471 (1907); Boulenger (C.L.), *Quart. Journ. Micro. Sci.* lvii, p. 83 (1911).

2 Boulenger (C.L.); *tom. cit.*, p. 427 (1912).

Manubrium.—The manubrium in most of Mr. Gravely's and Mr. Agharkar's specimens has the saucer-like form characteristic of the genus, consisting merely of a shallow ring and opening nearly as wide as the velum. In some few adult individuals, however, it is in a more or less contracted condition, while in one young one (fig. 1) its margin has been drawn together in such a way as to close the mouth almost completely, leaving only a minute star-shaped aperture. Mr. Gravely informs me that even the largest medusæ are quite capable of keeping their mouths closed, so long as they are in good health.

Gonads.—The gonads surround the manubrium as in other members of the genus. In the male the testis forms a uniform opaque white ring, but in the female the ring is grooved vertically at frequent intervals so that it has a crimped appearance. The grooves extend from the upper part of the manubrium downwards

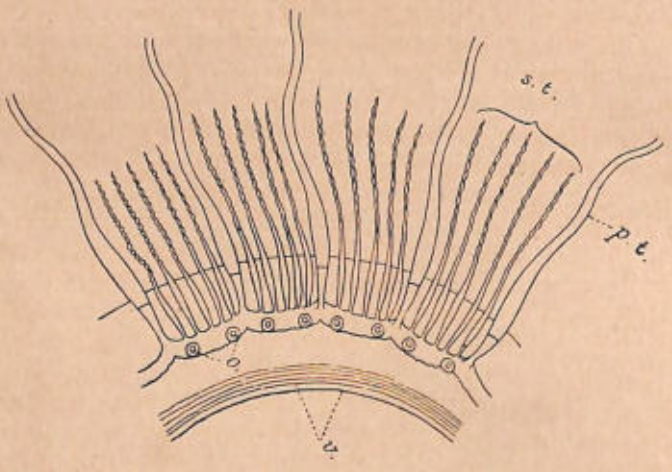


FIG. 2.—Tentacles and sense-organs as seen from below, o.=otocyst; p. t.=primary tentacle; s.t.=secondary tentacle; v.=velum.

but do not reach its distal margin. They do not form distinct loculi in the ovary, for the ova, which are arranged horizontally, extend across them. A number of minute greenish cells (possibly symbiotic algae) exist in the outer covering of the ovary and give it a faint yellowish tinge. The eggs are very small; when ripe and apparently just about to be emitted from the ovary they are circular and from 0·04 to 0·06 mm. in diameter. At an earlier stage they are produced and pointed at one side.

Tentacles.—The tentacles appear, at any rate in the adult, to have a much more definite arrangement (fig. 2) than is the case either in *L. tanganicæ* or *L. rhodesiae*. In general structure they agree with the tentacles of these species. They may be divided at sight into two series that may be called primary and secondary; those of each series having a distinctive structure, position and number. The primary tentacles are much stouter at the base and

also much longer than the secondary ones. They extend upwards from the base through the jelly of the bell for a short distance and on emergence therefrom lie parallel to its external surface, each in a shallow groove, for about twice the distance for which they are enclosed in the jelly. This groove extends to the edge of the umbrella. On its termination the tentacle bends outwards and upwards and then downwards. At the point at which it does so there is only a very slight prominence on the surface of the umbrella. The base of the primary tentacle is both constricted from side to side and flattened dorso-ventrally. On the dorsal surface, where it is in contact with the mesogloea below the ectoderm of the bell, its endoderm contains numerous small polygonal cells of a yellowish colour due to their thickened walls.

The secondary tentacles are not only much shorter but also more nearly cylindrical and equal than the primary ones. They project practically straight out from their base, which is not, or only to a very slight extent, enclosed in the jelly.

The full number of tentacles is 384. Every primary tentacle is followed by five secondary ones arranged in a straight line with their bases a little further from the velum.[1] There are thus 64 series of six tentacles each, each consisting of one primary and five secondary tentacles. The radial tentacles are followed by five secondary tentacles just as other primary tentacles are.

It might be possible to divide the primary tentacles into several series by their length and in the adult medusa the radials are distinctly longer than the others; but the differences in this respect are slight and apparently unimportant. In the young medusa 1·75 mm. in diameter only two series can be distinguished and the radial tentacles are very little if at all longer than the others. At this stage there are 24 primary tentacles and each is followed by a single secondary one, which is distinguished not only by its smaller size but also by being placed a little lower on the edge of the bell as seen from the side or above.

Sense-organs.—The otocysts are comparatively large, at least equallying the base of the largest tentacles in diameter. They also have a very definite arrangement in the adult. Every set of five secondary tentacles has two otocysts at its base and these two are separated from the next pair by the base of a primary tentacle and by an outward emargination of the inner edge of the ring of thickened tissue at the base of the tentacles. It is always quite clear, in well-preserved specimens, that the otocysts are not situated at the base of the primary tentacles and are not surrounded by anything like a tentacular bulb. In the young medusa already alluded to there are only three fully formed otocysts in each quadrant, *i.e.*, only twelve in all; while in an older medusa measuring 3·25 mm. in diameter there are five in each quadrant.

1 Owing to the fact that the base of the primary tentacle is embedded in the jelly, this tentacle, unless a very careful examination is made from below, has the *appearance* of arising *further* from the velum than the secondary tentacle.

In the adult medusa the total number is 128. The sense-organs have the structure characteristic of *Limnocnida*.

Nematocysts.—The nematocysts resemble those of other species of *Limnocnida* both in shape and in arrangement. Round the margin of the bell they form a "nettle-band," in which they are found in various stages of development, always lie parallel to the external surface and never possess cnidocils. In the basal part of the primary tentacles they have the same position and still lack cnidocils. In this region they are very numerous. From a point a short distance beyond that at which the tentacle projects from the edge of the bell, however, they are arranged in very definite papillae. In these they stand out almost vertically from the surface and are provided with cnidocils. On the distal part of the tentacle the papillæ are arranged in transverse rings round it, each ring consisting of four papillae. On the secondary tentacles the papillae extend nearly to the base

Types (many specimens from Medha, Yenna valley, between Mahableshwar and Satara). No. Z.E.V. $^{5\,1}/_{7\,3}$ Ind. Mus. (*F. H. Gravely*: May, 1912).

Distribution.—Pools in streams in the Western Ghats that finally enter tributaries of the Kistna river, Satara district, Bombay Presidency.

On the manubrium of specimens from Tambi in the Koyna valley I found numerous examples of the Infusorian *Trichodina pediculus*, Ehrenberg, a species which in Europe lives symbiotically on *Hydra* and other aquatic organisms.

XXIV. ON A NEW GENUS OF INDIAN THRIPS (THYSANOPTERA) INJURIOUS TO TURMERIC.

By RICHARD S. BAGNALL, *F.L.S.*, *F.E.S.*

(Plate vii.)

Through the kindness of Dr. N. Annandale I am able to describe the following interesting species of Thrips which was submitted to me with other Indian material in 1909. The specimens were collected more than thirty years ago, and on that account are not in such good condition as one would wish. I have however made a greatly enlarged drawing which shows the chief features of both sexes, and whilst the following description is a very complete one, considering the fragmentary state of the material, I hope later to have the pleasure of examining some newly collected specimens and thus be enabled to more accurately describe and figure certain parts.

Apart from its economic importance the species is one of considerable interest. It belongs to the sub-order Terebrantia and in certain features, such as the general character of the head and prothorax and the form of the antennæ, it would appear to be closely related to the genus *Heliothrips*, but a number of strong and peculiar characters (italicized in the generic description) are of such importance, I consider, as to render it advisable to place the genus into, at least, a sub-family of its own, the Panchaetothripinae.

Dr. Annandale has sent me the following transcription of the reference to the specimens, which appeared in the "Indian Museum Notes," Vol. 1, 1889–1891—Entomology Notes—by E. C. Cotes, p. 109:—

"Specimens were received on 21st May, 1889, from the Board of Revenue, Madras, through the Superintendent, Government Central Museum, Madras. *Sutta thegulu*, small black-winged insect, frequently jumps from one place to another. This attacks the plant when two months old. The leaves become rolled up, greenish in colour, turning pale yellow, and the leaves gradually become dry. This spoils the turmeric crop, and rhizomes are not developed. Eggs are also deposited on the back of the leaves. *Sutta thegulu* is considered to be a severe form of attack."

Order THYSANOPTERA.

Suborder Terebrantia.

Fam. THRIPIDAE, Hal.

Sub-fam. *PANCHAETOTHRIPINAE*, mihi.

Gen. Panchaetothrips, nov.

Head short and strongly transverse, *posteriorly strongly chitinized in the form of a raised collar*; frons depressed; cheeks roundly contracted before collar. Eyes prominent and protruding, ocelli present. *Antennæ* long, eight-jointed, joints three and four very long and slender, five and six broadly united, the style bristle-like with the eighth joint much longer than the penultimate. Maxillary palpi long and slender, three-jointed. Prothorax strongly transverse, without prominent bristles. Pterothorax large. Wings present, not reticulated; spines on fore-wing exceptionally long and strong; *fore-vein apparently merged with costa, and hind-vein obsolete.*

Abdomen broadly ovate, *depressed and margined laterally; tenth segment in the female cylindrical and almost closed ventrally; Ovipositor very long and slender, almost straight. Anal spines exceptionally long and strong.*

Type *Panchaetothrips indicus*, mihi.

Panchaetothrips indicus, sp. nov.

♀ Length 1·3 mm. Length of last abdominal segment about 0·25 mm. Colour brown or yellow-brown, the pterothorax, the last abdominal segment and often the hind part of body darker; sides of pterothorax shaded with grey. Fore-tibiæ yellow at apex, intermediate and hind femora yellowish basally and apically, and the tibiae lighter at knees and shaded thence from brown to clear yellow at apex; all tarsi yellow. First antennal joint yellowish-brown, second concolorous with head, joints three to five clear yellow, almost white, shaded with light brown at tips; apical joints light brown.

Surface of head lightly reticulated, most strongly laterally and in the space between each posterior ocellus and eye; transversely striated below collar. Strongly transverse, widest across eyes; space between eyes almost three times the width of an eye; frons slightly produced, separating the basal antennal joints and having the apex narrowly emarginate. Forehead depressed from about a line drawn across the anterior fifth of the eyes; cheeks slightly rounded and thence strongly narrowed basally to collar which is apparently raised laterally and dorsally. Eyes large, prominent and very coarsely facetted; ocelli rather large, oviform; anterior

ocellus forwardly directed, placed in centre of forehead on a line drawn through the anterior fifth of eyes; posterior pair on a line drawn through the posterior third of eyes, the space separating them being as great as that between each ocellus and eye. Mouth-cone reaching across prosternum. Maxillary palpi three-jointed, long and slender. Antennæ widely separated at base, more than three times as long as the head; first joint short, cylindrical and narrower than the second; second widest at middle where it is about as broad as long, slightly narrowed distally and truncate at apex; third and fourth extremely slender, almost spindle-formed; fifth slightly stouter and broadly jointed to the sixth which is roundly narrowed apically; seventh styliform, parallel sided, and eighth continued in the form of a bristle. Relative lengths of joints:—6, 12, 24, 19·5, 17, 10, 5, 15. In one specimen the fourth joint is only very little shorter than the preceding.

Prothorax strongly transverse, without any conspicuous spines; surface finely and irregularly striated transversely. Pterothorax large; mesothorax roundly widened to juncture with the metathorax which has the sides roundly narrowed to the base of abdomen. Both meso- and metathorax laterally convex and with the surface reticulated. Surface of all the legs similarly reticulated; hind pair much longer than the others. Tibia of each hind leg furnished with a series of minute bristles for practically the whole length of the inner margin. Wings strong and reaching to the last abdominal segment; fore-wing narrowing rather unevenly from the basal fourth; basal part with a series of four long strong bristles on the fore-margin, the third being the longest, and a series of ten very long and strong spines on the costa, the last of which is the shortest. There are three spines on the basal part of the fore-vein; this vein appears to be carried to the extreme tip in the form of a thickened fore-margin, and is furnished in the apical half with six spines. There is one short and one long spine just under the first costal spine, but there appears to be no trace whatever of a hind-vein nor of any spines set on a line corresponding with such a vein. The fore-fringe is poorly developed whilst the cilia of the hind-fringe are closely spaced, long and slightly wavy. The hind-wing has the median vein well-developed, and the hairs of the fore-fringe are much shorter and more widely spaced than those on the hind margin.

The abdomen is strongly depressed and margined laterally; and excluding the last segment is broadly oval, in some specimens circular. Towards the apex the posterior angles of the segments are produced into overlapping spinous processes. The last segment is very large and elongated in the form of a tube, bearing at its apex four long and two shorter spines, all of which are exceptionally stout. The apex of the ninth segment is furnished with a series of long, stout spines, the longest over-reaching the tip of the last segment; the eighth is furnished at its posterior margin with similar but short spines. Ovipositor very long and slender, almost straight.

♂. Smaller and narrower, end of abdomen and genital armature as shown in plate vii, figure 2. Sternites two to six with an elongated chitinous thickening.

Habitat.—India; on the leaves of turmeric (*Curcuma longa*), Madras, 1889.

EXPLANATION OF PLATE VII.

FIG. 1.—*Panchætothrips indicus* gen. et sp. nov. ♀ × 85.

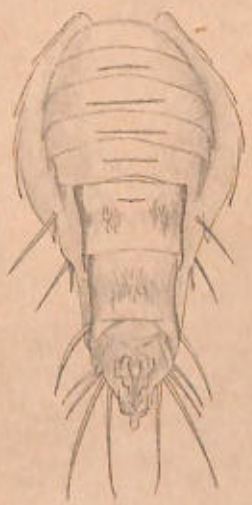
,, 2. ,, ,, abdomen of ♂ × 85.

,, 3. ,, ,, ovipositor, ♀ × 85.

,, 4. ,, ,, maxillary palpus × about 400.

,, 5. ,, ,, end of right antenna × about 150.

1.



2.

3.

4.

5.

R. S. Bagnall, del. D. Bagchi, lith.

PANCHAETOTHRIPS INDICUS, Bagnall, sp. nov.

XXV. THE AQUATIC CHELONIA OF THE MAHANADDI AND ITS TRIBUTARIES.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent, Indian Museum.*

The smaller streams that join to form the Mahanaddi (literally the "Great River") rise in various mountain-ranges in the Central Provinces of India and their united waters flow eastwards through Orissa to the Bay of Bengal, which they reach by several mouths. The Mahanaddi river-system is thus, on the eastern side, the most northerly system of any importance in Peninsular India properly so called, that is to say India south of the Ganges and the Indus. From the Gangetic system it is not separated either by any great distance or by any very important natural barrier; the most northerly mouth of the Mahanaddi is hardly more than 100 miles south of that of the R. Hughli, and there are neither mountain-ranges nor deserts between them.

Almost all that is known of the aquatic chelonia of the Mahanaddi river-system is contained in a paper by the late Dr. W. T. Blanford published in the *Journal of the Asiatic Society of Bengal* in 1870 and entitled "Notes on some Reptilia and Amphibia from Central India." In preparing my recent account of the Indian Trionychidae (*Rec. Ind. Mus.*, VII, pp. 151-180) I had before me most of the specimens of that family collected by Dr. Blanford but was unable, for lack of further material, to add much to what he had written. Now, however, thanks to the assistance given me by Mrs. F. deMonte of Cuttack in Orissa, Mr. T. Southwell, Deputy Director of Fisheries, Bengal, and Mr. B. L. Chaudhuri of the Indian Museum, it has become possible to deal in a more satisfactory manner both with Dr. Blanford's specimens and with those that have recently been acquired. Even so, I have only been able to prove the existence in the Mahanaddi and its tributaries of four aquatic tortoises, although at least eleven species that may be called strictly aquatic haunt the waters of the Ganges. These eleven species are the following:—

Trionyx gangeticus	Trionychidae.	*Hardella thurgi*	Testudinidae.
Trionyx hurum		*Batagur baska*	
Emyda granosa		*Kachuga lineata*	
Pelochelys cantoris		*Kachuga dhongoka*	
Chitra indica		*Kachuga smithii*	
		Kachuga tectum	

It is probable that at least three of the Gangetic Testudinidae also occur in the Mahanaddi system, viz., *Kachuga lineata*, *K. dhongoka* and *Batagur baska*. Of the first I have examined a young specimen taken by the late Dr. W. T. Blanford[1] in the lower reaches of the Godaveri, while the second is represented in the Indian Museum by quite typical examples from the Nerbadda and from Hyderabad, and the third by a skull from the Godaveri. Of the four forms, moreover, of which specimens have actually been obtained from the Mahanaddi, three are so closely related to Gangetic forms that they may be regarded merely as subspecies or local races thereof. The distribution of the fourth is still very imperfectly known; it may occur in the upper reaches of the Ganges.

The following are the four tortoises actually known to live in the Mahanaddi:—

Trionychidae.	Testudinidae.
Trionyx gangeticus mahanaddicus, subsp. nov.	*Kachuga tectum intermedia.*
Trionyx leithii.	
Emyda granosa intermedia.	

The type specimens of all except *Trionyx leithii* are in the collection of the Indian Museum.

Fam. TRIONYCHIDAE.

Trionyx gangeticus mahanaddicus, subsp. nov.

Trionyx gangeticus, Cuv. var. (*partim*), Blanford, *J.A.S.B.* (2) XXXIX, p. 344 (1870).

Trionyx gangeticus, Annandale, *Rec. Ind. Mus.* VII, Addenda Nos. 16781, 16791, 16792, 1087-8, p. 180, pl. v, fig. 2 (1912).

Closely allied as the Mahanaddi *Trionyx* is to the typical *T. gangeticus* I now think, after examining a fully adult specimen, that it must be recognized as a distinct race. It may be defined as follows:—

Costal plates eight pairs, the last well developed and in contact in the middle line; two neurals between the first pair of costals; plates coarsely pitted and vermiculate. Epiplastra narrowly separated in front of the entoplastron, which forms an obtuse angle; existing plastral callosities very large, but no entoplastral callosity. Plastron as in *T. gangeticus*.

Head moderate; snout (on skull) considerably longer than orbit; interorbital region, in the adult, a little narrower than the nasal fossa; postorbital arch about half as wide as greatest diameter of orbit; mandible with inner edge strongly raised,

[1] Identified by Dr. Blanford as "*Batagur ellioti*?", J.A.S.B. (2) 1879, p. 110.

forming a sharp ridge, which sends off a short triangular tubercle at the symphysis; *immediately in front of this tubercle a deep transverse semi-circular depression; diameter of mandible at symphysis equal to or a little less than greatest diameter of orbit; a faint longitudinal ridge in this region; alveolar part of the lower jaw relatively shorter than in* T. gangeticus; *coronal bone more nearly vertical; both jaws, in adult, less blunt at the tip.* Branchial skeleton as in *T. gangeticus.*

Dorsal surface of carapace pale olive without radiating lines in the young; in the adult, dark olive with pale yellowish vermiculate veinings over the bony carapace and a more or less distinct marbling on the margin; dorsal surface of limbs and neck dark olive, the anterior part of the latter marbled with dull yellow; *head yellowish olive* in old individuals, green in young ones; on the vertex behind the eyes two broad, dark olive ∧-shaped bars of irregular outline and often more or less interrupted; a straight but otherwise similar bar running obliquely on each side from behind the eye to near the gape; *numerous dark-olive spots of different sizes between and behind the bars, between the eyes, on the snout and the sides of the head; these spots growing relatively larger with age*; the whole ventral surface greyish white.

Distribution.—Hasdo river (tributary of the upper Mahanaddi), Bilaspur district, Central Provinces; Sambalpur and Cuttack, Orissa.

Type.—Skeleton (skin of head in spirit): No. 17014 in the Indian Museum Register of Reptiles, etc.

I have examined four individuals in the flesh and after preservation, as well as the two young skulls obtained by Dr. Blanford in the Hasdo river; three of my specimens were obtained by Mrs. F. deMonte from fishermen at Cuttack, which is situated at the upper end of the Mahanaddi delta, while the fourth was taken at Sambalpur, some distance higher up the river, by Mr. B. L. Chaudhuri. In skull-characters the six individuals agree closely, allowance being made for differences in age. It is evident that in this race pigmentation increases with age, the opposite being the case in that of the Ganges; for the young specimens are stated by Dr. Blanford to have had no dark markings on the carapace and apparently only a dark veining on the head, while the largest individual examined (the type) was much darker than others of smaller size. The entire disk of this individual (a male) was 70 cm. long by 55 cm. broad, while the bony carapace was 38 cm. by 46 cm.

It is evident that Dr. Blanford was dealing with two distinct species in writing the description cited above, for the very young individuals to which he referred as being ocellate on the back actually represent not the new subspecies but *T. leithii*, Gray. The skull of that species is narrower than that of either form of *T. gangeticus*, the symphysis of the lower jaw longer and the inner edge of the mandible without any trace of a ridge.

The following are the measurements of four skulls of *T. gangeticus mahanaddicus*:—

	No. 17014.	No. 16790.	No. 16912	No. 1088.
Length	100 mm.	102 mm.	87 mm.	65 mm.
Greatest breadth ..	97 ,,	73 ,,	65 ,,	44 ,,
Length of snout ..	29 ,,	27 ,,	24 ,,	17 ,,
Length of orbit ..	18 ,,	15 ,,	15 ,,	13 ,,
Width of postorbital arch	8 ,,	7 ,,	8 ,,	4 ,,
Interorbital width ..	13 ,,	13 ,,	15 ,,	..
Width of nasal aperture	17 ,,	16 ,,	15 ,,	..
Length of mandibular symphysis .	18 ,,	16 ,,	14 ,,	..

No. 1088 is one of Dr. Blanford's specimens from the Hasdo river in the Central Provinces; the other skulls are from Orissa. The length of the skull is measured in each case from the tip of the snout to that of the articular condyle.

Trionyx leithii (Gray) (1870).

Aspilus cariniferus (*partim*), Gray, *Suppl. Cat. Sch. Rept.* I, p. 101 (1870).

Trionyx gangeticus, Cuv. var. (*partim*), Blanford, *J. A. S. B.* (2) XXXIX, p. 344 (1870)

Trionyx leithii and *gangeticus* (*partim*), Gray, *P. Z. S.* 1873, pp. 49 and 47, fig. 3 (p 48), pl. viii.

Trionyx sp. ?, Blanford, *J. A. S. B.* (2) XLVIII, p. 110 (1879).

Trionyx leithii, Boulenger, *Cat. Chel. Brit. Mus.*, p. 249 (1889) and *Faun. Brit. Ind.* Rept., p. 12; Annandale, *Rec. Ind. Mus.* VII, pp. 159, 160, fig. 2 (1912).

Young specimens of this species were obtained by the late Dr. W. T. Blanford in the Hasdo river. The species is also known from the Western Ghats and the Godaveri, Kistna and Nelambar rivers and is said to occur in the Indus or the Upper Ganges.

Emyda granosa intermedia, Annandale.

Emyda vittata ? Peters, Blanford, *J. A. S. B.* (2) XXXIX, p. 343 (1870).

Emyda vittata, *id.*, *ibid.* XLVIII, p. 111 (1879): Annandale, *Rec. Ind. Mus.* I, p. 397 (1907).

Emyda granosa intermedia, *id. ibid.* VII, pp. 171, 172, pl. VI, fig. 3 (1912).

I have recently examined several additional specimens from Cuttack and Sambalpur. They agree well with the type, except that one old male has the shell olive-brown instead of olive-green.

The dark reticulation is, however, well marked on its disk. The disk of my largest specimen (a female) measures 306 × 270 mm. The race is apparently found all over central and eastern India from the headwaters of the Mahanaddi to the mouth of the Godaveri.

Fam. TESTUDINIDAE.

KACHUGA TECTUM INTERMEDIA (Blanford).

Emys (*Pangshura*) *tectum*, Bell var. *intermedia*, Blanford, *J.A.S.B.* (2) XXXIX, p. 339, pl. xiv.

Pangshura tecta var. *intermedia*, *id.*, *ibid.* XLVIII, p. 110.

Kachuga intermedia, Boulenger, *Faun. Brit. Ind.* Rept., p. 43.

This form is very common both at Cuttack and at Sambalpur; I have examined a large series of living examples as well as many skeletons and skulls. So far as I can discover, there is no *constant* structural difference between it and the *K. tectum* of the Ganges, although in the great majority of individuals the second neural plate is much shorter. I have, however, seen individuals of *intermedia* in which it was no longer than is usual in *tectum*, and of the true *tectum* in which it was just as short as it is in *intermedia*; nor is the outline of its posterior margin by any means constant in either race. The coloration of the two races is, however, always different, at any rate in fresh or well preserved specimens, and in young individuals of *intermedia* the carapace is never so deep in the middle as it is in the Gangetic race. The carapace of *intermedia* is always much paler than it is in the true *tectum* and instead of the posterior part of the head being occupied by a broad V-shaped red or orange mark, it is for the most part of the same dull olive as the snout. There is always a conspicuous red spot behind each tympanum and sometimes less distinct and paler red marks can be detected on the top of the head behind the eyes. There are no spots on the dorsal surface of the limbs, but the thighs and often the upper arms are striped with pale olive. In the true *tectum* it is noteworthy that the V-shaped red or orange mark on the head is occasionally broken up into a coronal of spots.

The shell of the largest specimen of the race *intermedia* that I have measured is 260 mm. long by 245 mm. wide, the measurements being taken along the curves. I cannot distinguish the skulls of the two races.

It is probable that the race *intermedia* occurs all over the river-systems of the Mahanaddi and the Godaveri and that the typical *tectum*[1] is confined to those of the Indus, the Ganges and the Brahmaputra. Several specimens from the Godaveri in the collection of the Indian Museum were labelled "*tectum*" by the late Dr. J. Anderson, but a close comparison has assured me that

[1] Siebenrock regards *Pangshura cochinchinensis*, Tirant, as a synonym of *K. tectum*: see Tirant, *Etudes Div. Miss. Pavie* III, p. 494, and Siebenrock, *Zool. Jahrb.* Suppl. X, 1909, p. 454.

they actually represent the southern race, the colour of the carapace being quite distinct. It is probable moreover, that other herpetologists, misled by the belief that in *intermedia* the second neural plate is always transverse, may have identified specimens incorrectly. Mr. Boulenger records specimens of *K. tectum* from the Cuttack river and the Deccan (*Cat. Chel. Brit. Mus.*, p. 59), but both in his "Catalogue" and in the "Fauna" he states that the recent distribution of *K. tectum* is the "Ganges and Indus systems." In this I think he is right, for *K. cochinchinensis* (Tirant) probably represents a distinct race, as that of the Upper Brahmaputra may also do.

XXVI. ON A SMALL COLLECTION OF RECENT CRINOIDS FROM THE INDIAN OCEAN.

By AUSTIN H. CLARK, *B.A., F.R.G.S.*

Some time after the completion of my report[1] upon the Crinoids collected by the "Investigator" I received a few additional specimens which had escaped notice when that collection was sent to me.

In order that the published records of the large and important collection belonging to the Indian Museum may be complete these specimens are listed here.

One of the items of interest brought to light by the study of this material is the discovery of a new species of *Oligometra* allied to the Australian *O. adeonæ*, in the Andaman Islands. Up to a few weeks ago *O. adeonæ* in North Australia and the Aru Islands and *O. thetidis* in New South Wales were supposed to represent a somewhat anomalous type of the genus peculiar to Australia; but very recently a related species, *O. marginata*, has been described from Solor Strait in the Lesser Sunda Islands, where it was dredged by the Dutch steamship "Siboga." Not only does this new species greatly increase the known geographical range of this curious group, but it possesses an additional interest in being intermediate in its characters between this group within the genus *Oligometra* and the species of the genus *Prometra*, furnishing new evidence of the very close inter-relationships between all of the genera comprised within the family Colobometridæ.

Almost equally interesting is the new species of *Zygometra* herein described. Although not greatly different from *Z. comata*, which occurs from the Mergui Archipelago to the Philippine Islands, it appears to be quite distinct, and it appears to occupy a habitat considerably to the westward of that of any other species of the family.

Family COMASTERIDÆ.

Subfamily *CAPILLASTERINÆ*.

CAPILLASTER SENTOSA (P. H. Carpenter).

8° 51′ 30″ *N. lat.*, 81° 11′ 52″ *E. long.*; 28 *fathoms*.—One small broken specimen.

[1] Echinoderma of the Indian Museum, Part VII, Crinoidea. Calcutta, 1912.

Family ZYGOMETRIDÆ.

Zygometra andromeda, sp. nov.

The centrodorsal is thin discoidal, the bare dorsal pole large, slightly concave, finely granular, 2·5 mm. in diameter.

The cirri are XXI, 27-30 (usually the latter), 13 mm. to 15 mm. long; the longest segments are about one-third broader than long; dorsal spines, which are long and sharp, are developed from the eighth or ninth segment onward.

The arms are about twenty-five in number, 50 mm. to 55 mm. long; the division series and arms resemble those of *Z. comata*, but the distal edges of the radials and the proximal and distal edges of the ossicles of the division series and, to a lesser extent, of the first two brachials, are thickened and everted, this eversion being finely scalloped or tuberculated so that the edges of the ossicles appear beaded; the summit of the eversion may be smooth, but is usually very finely spinous; the flattened lateral edges of the ossicles of the division series and the first two brachials are very finely spinous; the dorsal surface is unmodified; the distal edge of the first syzygial pair bears a row of small rounded obscure tubercles, and there is usually a similar, but less evident row at the syzygial line. Beyond the fourth brachial the arms are smooth, resembling those of *Z. comata*.

P_1 is composed of twenty-four segments and is 9·5 mm. long.

Locality.—India.

Eudiocrinus minor, A. H. Clark.

Andaman Islands.—One specimen, with arms 35 mm. long.

Family HIMEROMETRIDÆ.

Heterometra reynaudii (J. Müller).

India.—Two specimens; one of these has twenty arms about 65 mm. long; one IIBr 2, and nine IIBr 4 (3+4) series are present; the other has twelve arms 25 mm. long; there are 15—18 cirrus segments of which the fifth or sixth and following bear dorsal spines.

? *India.*—Two very small specimens; one of these has ten arms 15 mm. long; the cirri are XI., the longest with 17 segments of which the ninth and following bear dorsal spines, the shorter with 12 segments, none of which bear dorsal spines; the other individual is also ten armed; the longest cirri are 10 mm. long with 22 segments, dorsal spines being developed from the seventh onward; the smallest cirri are 2·5 mm. long with 9 segments, quite without dorsal spines, and exactly resembling the cirri of young examples of *Antedon bifida*.

HETEROMETRA PULCHRA, A. H. Clark.

Arrakan Coast. - Two small broken specimens.

Family STEPHANOMETRIDÆ.

STEPHANOMETRA INDICA (E. A. Smith).

8° 51′ 30″ *N. lat.*, 81° 11′ 52″ *E. long.*; 28 *fathoms.*—Two specimens; P_1 has fifteen segments.

Family MARIAMETRIDÆ.

DICHROMETRA PROTECTUS (Lütken).

India.—One specimen with thirty arms.

Family COLOBOMETRIDÆ.

DECAMETRA MOEBIUSI, A. H. Clark.

? *India.*—One specimen.

COLOBOMETRA DISCOLOR, A. H. Clark.

Off Table Island, Andamans; 15-35 *fathoms.*—One specimen.

PROMETRA BREVICIRRA, A. H. Clark.

? *India.*—One specimen.

OLIGOMETRA INTERMEDIA, sp. nov.

The centrodorsal is small, discoidal, the dorsal pole flat, papillose, 0·8 mm. in diameter.

The cirri are very short, very stout, and strongly curved, IX, 10-11, 2·5 mm. long; the earlier segments are broader than long, but the sixth and following are about as broad as long; the second segment has the distal dorsal edge produced and finely spinous, this becoming on the fourth a median transverse ridge with prominent lateral angles which project slightly beyond the lateral profile of the segment and encroach slightly on the lateral surface; on the outer segments this transverse ridge becomes narrower and partially resolves itself into paired transversely elongate spines, at the same time moving to a position proximal to median; here there may be an eversion of the median part of the distal dorsal edge of the segments so that the segments may present more or less of the "bidentate" appearance characteristic of *O. adeonæ* and *O. marginata.*

The ten arms are about 18 mm. long; the division series and arms in general resemble those of *O. serripinna*, but the ossicles of the IBr series and the first brachials have broad and prominent ventrolateral processes as in the species of *Stephanometra.*

P_4 is absent; P_1 is 2·5 mm. long with eight segments, and is the longest and stiffest pinnule on the arm, though it is not especially stout; the first segment is half again as broad as long, the second is about as long as broad, the third is twice as long as broad, the fourth and fifth are between two and one half and three times as long as broad; the following rapidly decrease in size; the third and following bear long and prominent spines at the prismatic angles which after the fourth are very conspicuous; P_2 is 2 mm. long with eight segments, exactly resembling P_1; P_3 is small and slender, about 1 mm. long with about eight segments; the following pinnules are weak and delicate, not tapering so rapidly as P_3.

Locality.—Andaman Islands.

OLIGOMETRA SERRIPINNA (P. H. Carpenter).

"Investigator" Station No. 95; 15-25 *fathoms.*—One specimen; the synarthrial tubercles and the processes on the lower pinnules are strongly marked.

Arrakan Coast.—One small and immature specimen.

Family TROPIOMETRIDÆ.

TROPIOMETRA ENCRINUS, A. H. Clark.

Sadras.—One specimen.

Family ANTEDONIDÆ.

Subfamily *ZENOMETRINÆ.*

PSATHYROMETRA MAJOR, A. H. Clark.

"Investigator" Station No. 115; 188-220 *fathoms.*—One small specimen; there are four or five cirrus sockets in the outer columns.

PSATHYROMETRA MIRA, A. H. Clark.

West of Alleppey, Travancore (9° 34′ 57″ *N. lat.*, 75° 36′ 30″ *E. long*); 406 *fathoms.*—One specimen, not quite mature, and one typical specimen.

Thirteen miles south by west from North Sentinel Island, Andamans; 130-250 *fathoms.*—One small specimen.

Seven miles south-east by south from Ross Island; 265 *fathoms.*—One small specimen.

PSATHYROMETRA INUSITATA, A. H. Clark.

Seven miles south-east by south from Ross Island; 265 *fathoms.*—One small specimen.

Family PENTAMETROCRINIDÆ.

PENTAMETROCRINUS VARIANS (P. H. Carpenter).

"*Investigator*" *Station No.* 114; 922 *fathoms.*—One small specimen.

XXVII. CONTRIBUTIONS TO THE FAUNA OF YUNNAN BASED ON COLLECTIONS MADE BY J. COGGIN BROWN, B.Sc., 1909-1910.

PART VIII.—EARTHWORMS.

By J. STEPHENSON, *D.Sc., Major, I.M.S., Professor of Biology, Government College, Lahore.*

I received from the Indian Museum in November, 1911, four tubes containing earthworms, collected by Mr. J. Coggin Brown of the Geological Survey of India, in Yunnan and the Shan States. Of these one tube contained a single specimen, which, owing to its being sexually quite immature, was unidentifiable. The rest were all species of *Pheretima*.

PHERETIMA BROWNI, sp. nov.

A large number of specimens, all in a bad state of preservation, owing apparently to the whole of the specimens having been placed in far too small a quantity of preservative fluid.

Tengyueh, Yunnan.

EXTERNAL CHARACTERS.—*Length* 4 inches; maximum *breadth* 3 mm.; *segments* about 108. *Colour* dark brown, often with a purple tinge.

Prostomium small, prolobous.

First *dorsal pore* in the intersegmental furrow $^{11}/_{12}$.

Clitellum xiv—xvi=3; no trace of annulation and no setæ visible on the clitellum.

Male apertures on segment xviii, nearly one-third of the circumference apart, with 12 setæ intervening. The apertures are large, and are not situated on papillæ

Female aperture median, anteriorly in segment xiv.

Spermathecal apertures in furrows $^{7}/_{8}$ and $^{8}/_{9}$.

No *genital papillæ* or other special marks.

The *setæ* form a ring which is closed ventrally, and almost closed dorsally; the setæ are a little closer together ventrally than laterally and dorsally, and those of segments iv—ix are enlarged. Numbers of setæ:—$^{23}/_{v}$, $^{34}/_{ix}$, ca. $^{41}/_{xiii}$, $^{44}/_{xix}$.

INTERNAL ANATOMY.—The *septa* are so softened that it is impossible to tell which are thickened, probably $^{6}/_{7}$ and $^{7}/_{8}$, possibly also $^{10}/_{11}$ and $^{11}/_{12}$ are stouter than the rest; and $^{8}/_{9}$ is probably absent.

The *gizzard* occupies segments viii—ix. The *intestine* begins in xv. There are a pair of *intestinal diverticula* in xxvi; these are elongated, conical, without secondary projections; they extend forwards through segments xxv—xxiii.

The last *heart* is in segment xiii.

The *seminal funnels* are in x and xi, enclosed in small testicular sacs; the sacs of each pair are separate, not conjoined across the middle line. The *seminal vesicles* are paired, of moderate size, in segments xi and xii.

The *prostates* are of moderate size, and flattened against the body-wall; each consists of two principal lobes, one anterior, the other posterior to the origin of the duct; both lobes are divided up into numerous lobules.

The *spermathecæ* possess an irregularly shaped, roughly ovoid ampulla, with a broad short duct. The diverticulum arises from near the distal end of the duct; it is variable, often coiled, thin and narrow for the most part, and dilated at its internal end; when uncoiled it is about equal in length to the ampulla or somewhat shorter.

PHERETIMA DIVERGENS (Mchlsn.) var. YUNNANENSIS var. nov.

A single specimen, in a tube along with *P. hawayana*.

Tengyueh, Yunnan.

EXTERNAL CHARACTERS.—*Length* 3¾ inches; *breadth* 3 mm., *segments* 108, *colour* yellowish brown.

Prostomium epilobous $^1/_3$.

No *dorsal pores* visible in front of clitellum.

Clitellum includes segment xiv—xvi=3; there are a few setæ ventrally on xvi, otherwise the clitellum is without setæ.

Male apertures on segment xviii, at an interval of nearly one-third of the circumference, in the line of the ring of setæ. About 12 setæ intervene between the apertures; there are however no setæ immediately to the inner side of these latter.

Female aperture a minute pore, mid-ventrally on xiv.

Spermathecal apertures small, in intersegmental furrows $^5/_6$, $^6/_7$, $^7/_8$, $^8/_9$ (on right side only those in $^5/_6$ and $^6/_7$ visible). The interval between the apertures of opposite sides is equal to about 11 or 12 setæ.

Genital papillæ are present on segments vii, viii and ix, in pairs, on the anterior part of the segment between the setal ring and the anterior boundary of the segment; the interval between the papillæ of each pair is equal to 7 or 8 setæ.

Midventrally, in the line of the setal rings of vi—ix and xi—xiii, there are appearances which might possibly represent faintly marked copulatory areas, but more probably are due to post-mortem changes, or to the specimen having been rubbed.

The *setæ* form closed rings. Those on the anterior segments as far back as vii or viii are enlarged somewhat, but not markedly. The intervals between the setæ are approximately the same all

round the ring. The following numbers were counted:—ca. $^{86}/_{vii}$, ca. $^{47}/_{xiii}$, $^{46}/_{xvii}$, and 50—56 in the middle region of the body.

INTERNAL ANATOMY.—*Septa* $^{5}/_{6}$, $^{6}/_{7}$, $^{7}/_{8}$ are moderately thickened, $^{8}/_{9}$ and $^{9}/_{10}$ are absent, $^{10}/_{11}$ and $^{11}/_{12}$ considerably thickened, $^{12}/_{13}$ and $^{13}/_{14}$ slightly so.

The *gizzard* occupies segments viii—ix. The *intestine* begins in xvi; there is a well-marked typhlosole. A pair of large conical *intestinal diverticula* originate in xxvi.

The last *heart* is situated in segment xiii; '*blood glands*' are present, a pair in each segment, along the course of the dorsal vessel on the intestine, as in *P. posthuma*.

The *nephridial system* is micronephric; the nephridia are very minute, scattered over the internal surface of the body-wall.

Testes and *seminal funnels* are enclosed in testicular sacs, of moderate size, paired, quite separate from each other, in segments x and xi. The two *vasa deferentia* of each side unite into one at the posterior boundary of xi.

The *seminal vesicles*, in segments xi and xii, are paired, of com-

FIG. 1.—Spermatheca of *Pheretima divergens* var. *yunnanensis*.

paratively small size, irregularly lobulated, with in every case a fairly distinct mesially projecting lobe.

Prostates are absent. The terminal portion of the male duct on each side is much thickened and looped.

The *spermathecæ* (fig. 1) are in four pairs, corresponding to furrows $^{5}/_{6}$—$^{8}/_{9}$. The ampullæ are of an inverted pear-shape (the broader end below), the duct is thick and short,—one-third the length of the ampulla. From the distal end of the duct arises the diverticulum, thin and tubular for most of its extent but swollen at its proximal end; the length of the diverticulum varies; it is mostly $^{1}/_{2}$—$^{3}/_{4}$ as long as the ampullla and duct; the figure was drawn from one of the organs where it was even longer than the upper of these limits. In the case of the most posterior pair of spermathecæ in the specimen here described, the swollen end of the diverticulum was more rounded, and not so elongated as in the rest.

Corresponding to the papillæ on segments vii, viii, and ix, there are seen on the inner side of the body wall small *accessory glands*, white and tuft-like; sessile on the body-wall (ix), or with a short thick duct (vii), or consisting of two minute tufts (viii).

The present species has not so far been recorded from India. Since in the specimen here described there are certain fairly well marked differences from the typical form,—in size, in the presence of setæ on the clitellum, in the details of the spermathecal apparatus,—it appears advisable to describe it as a separate variety.

The figure of the spermathecal apparatus may be compared with that given in the original description of the worm (Michaelsen, Arch. für Naturgesch., vol. 58, 1892), the gizzard is there said to occupy segments ix—x, and the hearts to be situated in segments x—xii.

Pheretima hawayana (Rosa).

This species has been previously described under a number of different names (*cf.* Beddard, Proc. Zool. Soc. Lond., 1900, p. 645), from many different countries. The species is apparently a variable one, and one form, previously described separately as *P. barbadensis* (Bedd.), but included in *P. hawayana* by Beddard in the paper just referred to, is considered by Michaelsen to have the value of a subspecies (Michaelsen, Mem. Ind. Mus., vol. 1, No. 3, 1909, p. 187).

I give a fairly complete description of the specimens in the present collection, since they are of interest from the fact that they are in some ways intermediate between the typical form of *P. hawayana* and the subspecies *barbadensis*, and hence help to confirm Beddard's view as to the specific identify of the two.

Six specimens, in a tube with a single specimen of *P. divergens* var. *yunnanensis*.

Tengyueh, Yunnan.

External characters.—*Length* 2—4 inches; *breadth* 3—4 mm.; *segments* 88—90. *Colour* of most of the specimens a dirty yellowish brown.

Prostomium epilobous $^1/_2$; sometimes with a transverse fissure in addition completing the anterior boundary of segment i, *i.e.* a combined prolobus and epilobous condition.

First *dorsal pore* in intersegmental furrow $^{10}/_{11}$.

Clitellum includes segments xiv—xvi=3; without setæ.

Male pores on xviii, $^2/_7$ of the circumference apart on small or very small papillæ.

Female pore on xiv, mid-ventral, in a transversely extended depression.

Spermathecal apertures three pairs, in furrows $^5/_6$, $^6/_7$, $^7/_8$.

Genital papillæ, etc.—Internal to the male apertures on segment xviii, and either in the same transverse line with them or at a slightly posterior level, were a number of small pigmented spots, either one or two on each side. These had, except in one case, the character of depressions; in only the one exception was the spot a papilla. When more than one spot was present, they were separate, not fused.

In one specimen a pair of small papillæ, each with a darker centre, was present on the posterior part of segment vii, nearly in the groove $^{7}/_{8}$ and slightly median to the position of the spermathecal apertures.

The *setæ* formed an unbroken ring; they were slightly closer together ventrally than dorsally; those of segments iii—viii were enlarged. The following numbers were counted:—^{44}/ix, ^{49}/xi, ^{56}/xii, ^{54}/xix, ^{56}/xxvii.

INTERNAL ANATOMY.—*Septa* $^{5}/_{6}$ and $^{6}/_{7}$ moderately thick, $^{7}/_{8}$ considerably thickened, $^{8}/_{9}$ and $^{9}/_{10}$ absent, $^{10}/_{11}$—$^{12}/_{13}$ somewhat thickened.

Intestinal diverticula small, conical, originating in segment xxvii; in one specimen there were one (right side) or four (left) small rounded secondary diverticula on the ventral border of the primary diverticula.

Small *testicular sacs*, completely separated, in x and xi; *vesiculæ seminales*, irregularly lobulated in xi and xii.

Prostates large, in six segments (xvii—xxii), divided up into a corresponding number of lobes by the septa. A thick yellow duct, with an S-shaped curve, rises from the middle portion of the gland in segment xix, the vas deferens joins the gland anterior to, but near, the origin of the prostatic duct.

Accessory prostates correspond in position to the genital spots on segment xviii.

The *spermathecæ* are three pairs; the ampulla is ovoid in shape, narrowing gently to the duct, which is of considerable length, three-quarters as long as the ampulla. The diverticulum is often coiled; it is a narrow tube which when uncoiled equals the ampulla in length in some cases, while in others it is only two-thirds or one-half as long.

An *accessory gland* was present on each side in the specimen which possessed the papillæ posteriorly on segment vii; the glands corresponded in position with these papillæ, and were sessile on the inner face of the body-wall.

Remarks.—Writing of Beddard's inclusion of *P. barbadensis* with *P. hawayana* Michaelsen says:—"I am not yet quite convinced that this view is correct. Till now I have not seen a specimen—and I have examined many—which aroused any doubt as to whether it should be placed in the typical form or in the subsp. *barbadensis*. In the generally more robust typical form with stronger setæ in the anterior part of the body the papillæ near the male pores are always united at each side, occupying an oblong oval area medial from the male pores and mostly somewhat oblique. In the subsp. *barbadensis* the papillæ near the male pores are scattered, partly very near the male pores, partly near the median ventral line."

In the present specimens the dark spots near the male apertures had as a rule the character of slight depressions rather than of papillæ; they were not confluent, and in this respect resembled the papillæ of the subsp. *barbadensis* rather than those

of the typical form. But the setæ of the anterior segments were stronger than those of the remaining segments, which Michaelsen, in the passage just quoted, gives as a characteristic of the typical form.

In the '*Tierreich*' (Oligochaeta, 1900) Michaelsen describes the two forms as separate species. In the fact that the setæ are disposed in an unbroken chain, and that the clitellum occupies the whole of three segments, the present form agrees with *P. barbadensis*; while in having secondary diverticula from the intestinal cæca, and a curved prostatic duct, it resembles *P. hawayana*. Occupying thus an intermediate position, it serves to confirm Beddard's view of the unity of these two species.

Pheretima posthuma (L. Vaill.).

A number of specimens, mostly mature.
Ye-nan-Gyaung, Magwe, N. Shan States, Upper Burma.

XXVIII. A CATALOGUE OF THE ASIATIC NAIADES IN THE COLLECTION OF THE INDIAN MUSEUM, CALCUTTA, WITH DESCRIPTIONS OF NEW SPECIES.

By H. B. PRESTON, *F.Z.S.*

Plate VIII.

In compiling the following catalogue the scheme generally followed is that used by Mr. C. T. Simpson in his valuable work "Synopsis of the Naiades, or Pearly Freshwater Mussels"[1]; occasionally however the author, after examining the large series of specimens not only in the Indian, but also in the British Museum, has had to deviate from that system, but as far as possible Simpson's work has been incorporated in the present catalogue.

The author's thanks are especially due to Mr. Edgar A. Smith, I.S.O., of the British Museum, whose unrivalled knowledge and great courtesy in placing specimens in his hands for examination have largely helped him in his labour.

Three extra-Indian species are figured in the plate that accompanies this catalogue: the new Indian forms here described will be figured later in a volume of the "Fauna of British India."

Fam. UNIONIDAE.

Subfam. *UNIONINAE*, Swainson, 1840.

Gen. **Hyriopsis**, Conrad, 1853

1. **Hyriopsis bialatus**, Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 579,=*Unio delphinus*, Grunner, Arch. für Naturg., I, 1841, p. 276, pl. ix, figs. 1, 1*a-c*,=*Margaron* (*Unio*) *delphinus*, Lea, Syn., 1852, p. 19; 1870, p. 28,=*Unio megapterus*, Morelet, J. de Conch., XXI, 1863, p. 159.

Siam (Russel coll.), Reg. Nos. $\frac{2342}{1}$, $\frac{3032}{1}$; Pahang River, Malay Peninsula (Dr. Cantor), Reg. No. $\frac{1891}{1}$; Cambodia, Reg. No. $\frac{2238}{1}$.

2. **Hyriopsis cumingii** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 579,=*Unio cumingii*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1852, p. 54; Lea, Jl. Ac. Nat. Sci. Philad., IV, 1860, p. 240, pl. xxxv,, fig. 120,=*Margaron* (*Unio*) *cumingii*, Lea, Syn., 1852, p. 19; 1870, p. 28.

Shanghai Market, Reg. No. $\frac{1930}{1}$; Shanghai, Reg. No. $\frac{693}{1}$.

1 Proc. U.S. Nat. Mus., Washington, D.C., XXII, 1900, pp. 501—1044.

3. **Hyriopsis myersianus** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 580,=*Unio myersianus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 92; Jl. Ac. Nat. Sci., III, 1857, p. 290; Obs., VI, 1857, p. 10, pl. xxii, fig. 2,=*Margaron* (*Unio*) *myersianus*, Lea, Syn., 1870, p. 28,=*Unio housei*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 92; Jl. Ac. Nat. Sci. Philad., III, 1858, p. 291, pl. xxiii, fig. 3,=*Margaron* (*Unio*) *housei*, Lea, Syn., 1870, p. 28.

Cambodia, Reg. No. $\frac{1998}{1}$; Pitsanuloke, N. Siam (H. W. Biggie), Reg. No. $\frac{1447}{1}$.

4. **Hyriopsis schlegeli** (von Martens), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 581,=*Unio schlegeli*, von Martens, Mal. Blatt., VII, 1861, p. 55; Kobelt, Abh. Senck. Nat. Ges., XI, 1879, p. 421, pl. xiv,=*Barbala schlegeli*, Paetel, Conch. Sam., III, 1890, p. 175.

Lake Biwa, Japan (J. Anderson), Reg. Nos. $\frac{524}{1}$, $\frac{525}{1}$, $\frac{526}{1}$, and $\frac{527}{1}$.

Gen. **Chamberlainia**, Simpson, 1900.

5. **Chamberlainia hainesiana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 582,=*Unio hainesianus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 92; Jl. Ac. Nat. Sci Philad., III, 1857, p. 289, pl. xxi, fig. 1,=*Margaron* (*Unio*) *hainesianus*, Lea, Syn., 1870, p. 28,=*Unio imperialis*, Morelet, Rev. et Mag. Zool., XIV, 1862, p. 480.

Siam (*ex coll.* Richtofen), Reg. Nos. $\frac{5161}{1}$ and $\frac{630}{1}$.

Gen. **Cristaria**, Schumacher, 1817.

Subgen. **Cristaria**, Schumacher, 1817.

6. **Cristaria plicata** (Leach), von Ihering, Abh. Senck. Nat. Ges., XVIII, 1893, p. 147; Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, pp. 583—584,=*Dipsas plicatus*, Leach, Zool. Miscell., I, 1815, p. 120, pl. iii,=*Mytilus plicatus*, Solander in Gray, Ann. of Phil., IX, 1825, p. 27,=*Appius plicatus*, Gray in Menke, Syn. Meth. Moll., 1830, p. 106,=*Margarita* (*Dipsas*) *plicatus*, Lea, Syn., 1836, p. 47; 1838, p. 28,=*Margaron* (*Dipsas*) *plicatus*, Lea, Syn., 1852, p. 46; 1870, p. 74,=*Unio plicatus*, Sowerby, Conch. Icon., XVII, 1868, pl. liv, fig. 280,=*Dipsas plicatus*, Troschel, Arch. für Naturg., XIII, 1874, p. 272; Kobelt, Abh. Senck. Nat. Ges., XI, 1879, p. 429, pls. xv—xvii, xviii, fig. 1, =*Barbala plicata*, H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 501, pl. cxvii, figs. 4, 4*a*,=*Anodonta plicata*, Schrenck, Reis. und F. Am. Lande, II, 1867, p. 704, pl. xxvii, fig. 4,=*Anodonta* (*Dipsas*) *plicata*, Clessin, Conch. Cab. Ano., 1876, p. 240, pl. xxi, figs. 1, 2,=*Cristaria tuberculata*, Schumacher, Ess. Nouv. Syst., 1817, p. 140, pl. xx, fig. 2,=*Anodonta dipsas*, Blainville, Man. Mal., 1825, p. 538, pl. lxvi, fig. 2,=*Symphanota bialata*, Lea, Tr. Am. Phil. Soc., 1830, p. 445, pl. xiv, fig. 24,=*Unio bialata*, Hanley, Test. Moll., 1842, p. 219; Biv. Shells, 1843, p. 214, pl.

xxii, fig. 4,=*Barbala bialata*, Chenu, Mas., 1859, p. 145, fig. 717,=*Unio bialatus*, Deshayes, Tr. Elem. Conch., 1839, p. 19, pl. xxxi, fig. 3,=*Anodonta magnifica*, Clessin, Conch. Cab. Ano., 1870, p. 123, pl. xxxv, fig. 1,=*Dipsas occidentalis*, Heude, Conch. Fl. Nank., IX, 1885, pl. xlvi,=*Barbala occidentalis*, Paetel, Conch. Sam., III, 1890, p. 175,=*Barbala plicatula*, Paetel, Conch. Sam., III, 1890, p. 175.

Cambodia, Reg. No. 5033; Lake Biwa, Japan (J. Anderson), Reg. Nos. $\frac{532}{1}$, $\frac{530}{1}$, $\frac{531}{1}$, $\frac{532}{1}$; Shanghai, Reg. No. $\frac{602}{1}$.

7. **Cristaria bellua** (Morelet), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, 1900, p. 584,=*Anodonta bellua*, Morelet, Rev. et Mag. Zool., XVIII, 1866, p. 167; Ser. Conch., IV, 1875, p. 331.

Cambodia, Reg. No. $\frac{5062}{1}$.

8. **Cristaria herculea** (Middendorff), von Ihering, Abh. Senck. Nat. Ges., XVIII, 1893, p. 146; Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 584,=*Anodonta herculea*, Middendorff, Bull. Phys. Math. Ac. St. Pet., VI, 1848, p. 303; Sib. Reise, II, 1851, p. 278, pl. xxi, fig. 5, xxii, figs. 1, 2, xxvi, figs. 1, 2,=*Anodonta* (*Dipsas*) *herculea*, Clessin, Conch. Cab. Ano., 1875, p. 175, pl. lix, figs. 1, 2,=*Barbala herculea*, Paetel, Conch. Sam., III, 1890, p. 175,=*Dipsas plicata* var. *clessini*, Kobelt pars, Abh. Senck. Nat. Ges., XI, 1879, p. 429, pl. xv?=*Craspedodonta smaragdina*, Anton, Verz. der Conch., 1839, p. 16, No. 592; Clessin, Conch. Cab. Ano., 1875, p. 93, pl. xxvii, fig. 2.

Amur region, Reg. No. $\frac{1078}{1}$; Lena River, E. Siberia, Reg. No. $\frac{831}{1}$.

Subgen. **Plethholophus**, Simpson, 1900.

9. **Plethholophus swinhoei** (H. Adams), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 586,=*Unio swinhoei*, H. Adams, Proc. Zool. Soc. London, 1866, p. 319; Sowerby, Conch. Icon., XVI, pl. xlii, fig. 232,=*Anodonta swinhoei*, H. Adams, Proc. Zool. Soc. London, 1866, p. 446; Clessin, Conch. Cab. Ano., 1876, p. 125, pl. lxxv, fig. 6,=*Anodon swinhoei*, Sowerby, Conch. Icon., XVI, 1868, pl. xxvii, fig. 108,=*Margaron* (*Unio*) *swinhoei*, Lea, Syn., 1870, p. 45.

Canton, Reg. Nos. $\frac{1800}{1}$, $\frac{5067}{1}$; Formosa, Reg. No. $\frac{5171}{1}$.

10. **Plethholophus reiniana** (von. Martens), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 585; von. Martens, Jahrb. Mal. Ges., II, 1875, p. 136, pl. iii, fig. 4,= ?*Dipsas reiniana*, Kobelt, Abh. Senck. Nat. Ges., XI, 1879, p. 432, pl. xii, fig. 4. xxi, fig. 2,=*Anodonta reiniana*, von Ihering, Abh. Senck. Nat. Ges., XVIII, 1893, p. 147,=*Barbala reiniana*, Paetel, Conch. Sam., III, 1890, p. 175.

Lake Biwa, Japan (J. Anderson), Reg. No. $\frac{533}{1}$.

Gen. **Lepidodesma**, Simpson, 1896.

11. **Lepidodesma languilati** (Heude), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, pp. 586 and 587,=*Unio*

languilati, Heude, J. de Conch., XXII, 1874, p. 116; Conch. fluv. Nank., 1875, Pt. I, pl. vii,=*Lepidodesma languilati*, Simpson, Proc. U.S. Nat. Mus., XVIII, 1896, p. 311.=*Cristaria megadesma*, von Martens, S.B. Nat. Fr., 1875, p. 3; Mal. Bl., XXVI, 1875, p. 187,=*Barbala megadesma*, Paetel, Conch. Sam., III, 1890, p. 175.

China, Reg. No. $\frac{83.3}{1}$.

Gen. **Pilsbryoconcha**, Simpson, 1900.

12. **Pilsbryoconcha exilis** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 587,=*Anodonta exilis*, Lea, Tr. Am. Phil. Soc., VI, 1839, p. 81, pl. xxii, fig. 68,=*Margarita* (*Anodonta*) *exilis*, Lea, Syn., 1838, p. 32,=*Anodon exilis*, Catlow and Reeve, Conch. Nom., 1845, p. 66,=*Margaron* (*Anodonta*) *exilis*, Lea, Syn., 1852, p. 51; 1870, p 82,=*Monocondylaea exilis*, Paetel, Conch. Sam., III, 1890, p. 174,=*Anodonta siliqua*, Küster? Conch. Cab. Ano., 1852, p. 57, pl. xiv, fig. 5,=*Anodonta polita*, Mouss., L. and Süss. Moll., Java, 1849, p. 98, pl. xix, figs. 2 and 3,=*Margaron* (*Anodonta*) *polita*, Lea, Syn., 1852, p. 53,=*Anodon politus*, Sowerby, Conch. Icon., XVII, 1867, pl. xii, fig. 36,=*Monocondylaea compressa*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 190; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 30, pl. xi, fig. 29,=*Pseudodon compressa*, Conrad, Am. Jl. Conch., I, 1865, p. 213,=*Margaron* (*Monocondylaea*) *compressa*, Lea, Syn., 1870, p. 73,=*Spatha compressa*, Paetel, Conch. Sam., III, 1890, p. 188,=*Anodon javana*, Sowerby, Conch Icon., XVII, 1867, pl. xi, fig. 33,=*Anodon gracilis*, Sowerby? Conch. Icon., XVII, 1867, pl. xiv, fig. 45,=*Anodon kellctti*, Sowerby? Conch. Icon., XVII, 1867, pl. xix, fig. 71,=*Anodonta sempervivens*, Deshayes, Nouv. Arch. de Mus., X, 1874, p. 120, pl. v, figs. 4, 5.

Java, Reg. No. $\frac{80.3.3}{1}$.

Gen. **Anodonta** (Bruguiere em.), Lamarck, 1799.

13. **Anodonta woodiana**, Lea,=*Symphanota woodiana*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 42, pl. v, fig. 13,=*Margarita* (*Anodonta*) *woodiana*, Lea, Syn., 1836, p. 48; 1838 p. 29,=*Anodon woodiana*, Catlow and Reeve, Conch. Nom., 1845, p. 68; Sowerby, Conch. Icon., XVII, 1870, pl. xxxvi, fig. 149,=*Anodonta woodiana*, Hanley, Test. Moll., 1842, p. 215; Biv. Shells, 1843, p 315; H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 503; Clessin, Conch. Cab. Ano., 1875, p 146, pl. xlviii, figs. 1, 2,=*Margaron* (*Anodonta*) *woodiana*, Lea, Syn., 1852, p. 47; 1870, p. 75,=*Symphanota magnifica*, Lea, Tr Am. Phil. Soc., V, 1834, p. 42, pl. v, fig. 14,=*Margarita* (*Anodonta*) *magnifica*, Lea, Syn., 1836, p. 48; 1838, p. 29,=*Anodonta magnifica*, Hanley, Test. Moll., 1842, p. 215; Biv. Shells, 1843, p. 215; H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 503; Chem. Man., 1859, II, p. 156, fig. 719,=*Anodon magnifica*, Catlow and Reeve, Conch. Nom., 1845, p. 67; Sowerby, Conch. Icon., XVII, 1870, pl. xxv, fig. 96,=*Margaron* (*Anodonta*) *magnifica*, Lea, Syn., 1852, p. 47; 1870, p. 75,= ?*Anodonta aurata*, Küster, Conch. Cab. Ano., 1853,

p. 30, pl. vi, fig. 2,=*Anodon rotundatus*, Swainson, Ex. Conch., 2nd Ed., 1841, pl. xxxvii,=*Anodon gibbum*, Benson, Jl. As. Soc. Beng., XXIV, 1855, p. 135,=*Anodon gibba*, Sowerby, Conch. Icon., XVII, 1867, pl. vi, fig. 13; Heude, Conch. Fl. Nank., VII, 1881, pl. li, fig. 95,=*Margaron* (*Anodonta*) *gibba*, Lea, Syn. 1870, p. 81; von Martens, Nov. Conch., IV, 1876, p. 159, pl. cxxxvi, figs. 6, 7,=*Anodonta gibba*, Clessin, Conch. Cab. Ano., 1875, p. 181, pl. lx, fig. 4,=*Anodon tricostatus*, Sowerby, Conch. Icon., XVII, 1870, pl. xxv, fig. 98,=*Anodonta edulis*, Heude, J. de Conch., XXII, 1874, p. 117,=*Anodon edulis*, Heude, Conch. Fl. Nank., I, 1875, pl. viii, fig. 18,=*Anodonta edulis*, Paetel, Conch. Sam., III, 1890, p. 179,=*Anodon securiformis*, Heude, Conch. Fl. Nank., III, 1877, pl. xviii, fig. 39,=*Anodonta securiformis*, Paetel, Conch. Sam., III, 1890, p 107,=*Anodon nigricans*, Heude, Conch. Fl. Nank., III, 1877, pl. xix, fig. 41,=*Anodonta nigricans*, Paetel, Conch Sam., III, 1890, p. 182,=*Anodon piscatorum*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxvi, fig. 56,=*Anodon elliptica*, Heude, Conch. Fl. Nank., IV 1878, pl. xxvii, fig. 58 =*Anodon fusca*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxviii, fig. 59,=*Anodon frinianum*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxviii, fig. 60,=*Anodon joreti*, Heude, Conch. Fl. Nank., IV, 187·, pl. xxix, fig. 62,=*Anodon striata*,, Heude, Conch. Fl. Nank., IV, 1878, pl. xxx, fig. 63,=*Anodonta striata*, Paetel, Conch. Sam., III, 1890, p. 185,=*Anodon pacifica*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxxii, fig. 66,=*Anodon tumida*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxv, fig. 69,=*Anodonta tumida*, Paetel, Conch. Sam., III, 1890, p. 186,=*Anodon subtetragona*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxvi, fig. 70,=*Anodon lineata*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxvi, fig. 71,=*Anodonta lineata*, Paetel, Conch. Sam., III, 1890, p. 181, =*Anodon irregularis*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxvii, fig. 73,=*Anodonta irregularis*, Paetel, Conch. Sam., III, 1890, p. 180,=*Anodon melanochlorea*, Heude, Conch. Fl. Nank., 1879, pl. xxxviii, fig. 74,=*Anodonta melanochlorea*, Paetel, Conch. Sam., III, 1890, p. 182,=*Anodon agricolarum*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxix, fig. 75,=*Anodonta agricolarum*, Paetel, Conch. Sam., III, 1890, p. 176,=*Anodon mingorum*, Heude, Conch. Fl. Nank., V, 1879, pl. xl, fig. 77,= *Anodonta mingorum*, Paetel, Conch. Sam., III, 1890, p. 182,= *Anodon bigibba*, Heude, Conch. Fl. Nank., VI, 1880, pl. xli, fig. 78,=*Anodonta bigibba*, Paetel, Conch. Sam., III, 1890, p. 177, =*Anodon despecta*, Heude, Conch. Fl. Nank., V, 1880, pl. xli, fig. 79,=*Anodon obtusa*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlii, fig. 80,=*Anodon navicula*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlii, fig. 81,=*Anodonta navicula*, Paetel, Conch. Sam., III, 1890, p. 182,=*Anodon orbicularis*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlii, fig. 82,=*Anodonta orbicularis*, Paetel, Conch. Sam., III, 1890, p. 182,=*Anodon limosa*, Heude, Conch. Fl. Nank., VI, 1880, pl. xliii, fig. 83,=*Anodonta limosa*, Paetel, Conch. Sam., III, 1890, p. 181,=*Anodon livida*, Heude, Conch.

Fl. Nank., 1880, pl. xliii, fig. 84,=*Anodonta livida*, Paetel, Conch. Sam., III, 1890, p. 181,=*Anodon castanea*, Heude, Conch. Fl. Nank., 1880, pl. xliii, fig. 85,=*Anodonta castanea*, Paetel, Conch. Sam., III, 1890, p. 177,=*Anodon minuta*, Heude, Conch. Fl. Nank., VI, 1880, pl. xliv, fig. 86,=*Anodonta minuta*, Paetel, Conch. Sam., III, 1890, p. 182,=*Anodon succinea*, Heude, Conch. Fl. Nank., VI, 1880, pl. xliv, fig. 87,=*Anodonta succinea*, Paetel, Conch. Sam., III, 1890, p. 185,=*Anodon chiniana*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlv, fig. 88,=*Anodonta, chiniana*, Paetel, Conch. Sam., III, 1890, p. 177,=*Anodonta scaphydium*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlvi, fig. 89,=*Anodonta scaphidium*, Paetel, Conch. Sam., III, 1890, p. 184, =*Anodon puerorum*, Heude, Conch. Fl. Nank., VII, 1880, pl. xlvii, fig. 90,=*Anodonta puerorum*, Paetel, Conch. Sam., III, 1890, p. 183,=*Anodon indecora*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlviii, fig. 91,=*Anodonta indecora*, Paetel, Conch. Sam., III, 1890, p. 180,=*Anodon sorini*, Heude, Conch. Fl Nank., VII, 1881, pl. xlix, fig. 92,=*Anodonta sorini*, Paetel, Conch. Sam., III, 1890, p. 185,=*Anodon rosea*, Heude, Conch. Fl. Nank., VII, 1881, pl. l, fig. 93,=*Anodonta rosea*, Paetel, Conch. Sam., VII, 1890, p. 184,=*Anodon aubreyi*, Heude, Conch. Fl. Nank., VII, 1881, pl. lii, fig. 97,=*Anodonta aubreyi*, Paetel, Conch. Sam., III, 1890, p. 176,=*Anodon confusa*, Heude, Conch. Fl. Nank., VII, 1881, pl. liii, fig. 99,=*Anodonta confusa*, Paetel, Conch. Sam., III, 1890, p. 178,=*Anodon obtusata*, Heude, Conch. Fl. Nank., VII, 1881, pl. liv, fig 100,=*Anodon rubella*, Heude, Conch. Fl. Nank., VII, 1881, pl. liv, fig. 100 bis,=*Anodonta rubella*, Paetel, Conch. Sam., III, 1890, p. 184,=*Anodon pulchella*, Heude, Conch. Fl. Nank, VII, 1881, pl. lv, fig. 101,=*Anodonta pulchella*, Paetel, Conch. Sam., III, 1890, p. 183,=*Anodon florida*, Heude, Conch. Fl. Nank., VII, 1881, pl. lv, fig. 102,=*Anodonta florida*, Paetel, Conch. Sam., III, 1890, p. 179,=*Anodonta retusa*, Heude, Jl. de Conch., XXXII, 1884, p. 20,=*Anodon intermerata*, Heude, Conch. Fl. Nank., IX, 1885, pl. lxvii, fig. 130,=*Anodonta intermerata*, Paetel, Conch. Sam., III, 1890, p. 180,=*Anodon filippiana*, Heude, Conch. Fl. Nank., IX, 1885, pl. lxviii, fig 131,=*Anodonta filippiana*, Paetel, Conch. Sam., III, 1890, p. 183, =*Anodon fantozatiana*, Heude, Conch. Fl. Nank., IX, 1885, pl. lxix, fig. 132,=*Anodonta fantozatiana*, Paetel, Conch. Sam., III, 1890, p. 179.

Canton River, Reg. Nos. $\frac{4941}{1}$, $\frac{4942}{1}$; Shanghai, Reg. Nos $\frac{5032}{1}$, $\frac{5058}{1}$, $\frac{5032}{1}$, $\frac{607}{1}$, $\frac{5178}{1}$, $\frac{604}{1}$, $\frac{606}{1}$; N. China, Reg. No. $\frac{5231}{1}$; Zinzay, N. China, Reg. No. $\frac{5165}{1}$.

14. **Anodonta** sp. ? A single, malformed specimen. Kandahar, Reg. No. $\frac{4948}{1}$.

Gen. **Gabilliotia**, Servain, 1890.

15. **Gabilliotia euphratica** (Bourguignat), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 650,=*Unio euphraticus*,

Bourguignat, Test. Nov., 1852, p. 28; Cat. Rais., 1853, pl. iv, figs. 1—3,=*Pseudodon euphratica*, Conrad, Am. Jl. Conch. I, 1865, p. 233,=*Margaritana euphratica*, von Martens, Vorderas. Conch., 1874; Kobelt, Icon., new ed., II, 1886, p. 26, pl. xlv, fig. 266,=*Leguminaia euphratica*, Westerlund, Faun. Pal., II, Pt. 7, 1890, p. 188,=*Unio churchillianus*, Sowerby, Conch. Icon., XVI, 1868, pl. xcvi, fig. 526.

Bagdad, Reg. No. $\frac{1952}{1}$.

Gen. **Solenaia**, Conrad, 1868.

16. **Solenaia soleniformis** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 656,=*Anodonta soleniformis*, Benson, Journ. As. Soc. Beng., V, 1836, p. 750,=*Spatha soleniformis*, Hanley and Theobald, Conch. Ind., pl. ix, fig. 1,=*Mycetopus soleniformis*, Fischer, Jl. de Conch., XXXVIII, 1890, p. 94,=*Margaron* (*Unio*) *bensoni*, Lea, Syn., 1870, p. 57,=*Mycetopus bensonianus*, Paetel, Conch. Sam. III, 1890, p. 186.

Cachar, Reg. Nos. $\frac{4790}{1}$, $\frac{5059}{1}$, $\frac{5060}{1}$.

Gen. **Margaritana**, Schumacher, 1817.

17. **Margaritana margaritifera** (Linnaeus), Schumacher, Ess. Nouv. Syst., I, 1817, p. 124, pl. x, fig. 4; Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 674—677, etc.,=*Mya margaritifera*, Lister, Hist. Anim. Ang. App., 1865, pl. i, fig. 1, etc.,=*Mya margaritifera, testa ovali oblonga, etc.*,—Möller, Zool. Danicae, 1776, p. 245; Chemnitz, Conch. Cab. VI, 1782, p. 15, pl. i, fig. 5, =*Baphiae margaritifera*, Meuschen, Mus. Gevers., 1787, p. 472,=*Unio margaritifera*, Drapernaud, Tab. Moll. Fr., 1801, p. 107; Hist. Moll. Fr., 1806, p. 132, pl. x, figs. 17—19, pl. xi, fig. 5? etc.,=*Alasmodonta margaritifera*, Conrad, New F. W. Shells, 1834, p. 72,=*Margarita* (*Margaritana*) *margaritifera*, Lea, Syn., 1836, p. 45; 1838, p. 28,=*Margaron* (*Margaritana*) *margaritifera*, Lea, Syn., 1852, p. 43; 1870, p. 69,=*Baphia margaritifera*, H. & A. Adams, Gen. Rec. Moll., II, 1857, p. 499; III, pl. cxvii, figs. 2, 2*a*,=*Unio margaritiferus*, Retzius, Dis. S. Hist. Nat., 1788, p 16; Spengler, Skriv. Nat. Selsk., III, 1793, p. 52; Turton, Conch. Ins. Brit., 1822, p. 241, pl. xvi, fig. 1,=*Alasmodon margaritiferus*, Brown, I. & F. W. Conch., 1836, p. 112, pl. xxi, fig. 13, pl. xxii, figs. 1, 3,=*Margaritana margaritiferus*, Westerlund, Faun. Pal., II, Pt. 7, 1890, p. 184,=*Alasmodon margaritiferum*, Fleming, Hist. Brit. Moll., 1828, p. 417,=*Unio margaritifer* var. *minor*, Rossmässler, Icon., Pt. 2, 1835, p. 19, pl. ix, fig. 129,=*Unio margaritifer*, Küster, Conch. Cab., 1856, p. 130, pls. xxxviii, xxxix,=*Unio* (*Margaritana*) *margaritifera*, Schrenck, Reis. und F. in Amur Lande, II, 1867? p. 700,=*Unio auricularius*, Spengler, Skriv. Nat. Selsk., III, 1793, p. 44,=*Unio elongata*, Lamarck, An. sans. Vert., VI, 1819, p. 70,=*Damaris elongata*, Leach, Syn. Moll. Gt. Brit., 1852, p. 322,=*Margaritana elongata*, Westerlund,

Faun. Pal., II, Pt. 7, 1890, p. 185; Locard, Coq. de Fr., 1893, p. 149, fig. 162,=*Unio elongatus*, Nilsson, Hist. Moll. Swec., 1822, p. 16; Sowerby, Conch. Icon., XVI, 1868, pl. lxxvi, fig. 397,=*Alasmodonta arcuata*, Barnes, Am. Jl. Sci., VI, 1823, p. 227, pl. xii, fig. 20,=*Mya arcuata*, Eaton, Zool. Text book, 1826, p. 222, =*Alasmodon arcuata*, Stimpson, Shells of New Eng., 1851, p. 15; Küster, Conch. Cab., 1856, p. 293, pl. xxxix, fig. 1,=*Unio sinuata*, C. Pfeiffer, Nat. Deutsch L. & W. Moll., Pt. 2, 1825, p. 33, pl. vii, fig. 4,=*Unio roissyi*, Michaud, Comp. Hist. Moll. Fr., 1831, p. 112, pl. xvi, fig. 28,=*Margaritana roissyi*, Westerlund, Faun. Pal., II, Pt. 7, 1890, p. 186,=*Unio tristis*, Morelet, Moll. Portugal, 1845, p. 107, pl. xiii, fig. 2,=*Margarita* (*Unio*) *crassiamus*, Lea, Syn., 1836, p. 40; 1838, p. 26,=*Unio* (*Alasmodonta*) *dahuricus*, Middendorff, Bull. Phys. Math. Ac. St. Petersb., IX, 1850, p. ?; Sib. Reise, II, 1851, p. 275, pl. xxvi, figs. 3, 5, =*Unio dahuricus*, Middendorff, L. & S. Moll. Sib., 1859, p. 26,= *Unio* (*Margaritana*) *dahurica*, Kobelt, Abh. Senck. Nat. Ges., XI, 1875, p. 427; Kobelt, Faun. Jap. Ext., 1879, p. 143, pl. xiii, figs. 1, 2,= *Alasmodon falcata*, Gould, Proc. Boston. Soc. Nat. Hist., III, 1850, p. 294; Otia Conch., 1862, p. 87; U. S. Expl. Exp. XII, 1852, p. 433, figs. 545, 545*a*, 545*b*,=*Unio falcatus*, Sowerby, Conch. Icon., XVI, 1868, pl. lxxv, fig. 390,=*Unio* (*Alasmodonta*) *complanatus*, Middendorff, Sib. Reise, II, 1851, Pt. I, p. 273, pl. xxvii, figs. 1—6,=*Margaritana complanata*, Westerlund, Fauna Pal., II, Pt. 7, 1890, p. 187,=*Alasmodon yubaensis*, Trask, Proc. Cal. Acad. Sci., I, 1855, p. 30,=*Margaritana raveneliana*, Chenu, Man., 1859, II, p. 144, fig. 714.

Chitose, Yezo, Japan (J. Anderson), Reg. No. $\frac{23b}{1}$.

Gen. **Unio**, Retzius, 1788.

18. **Unio mussolianus**, Küster, Conch. Cab. Unio., 1861, p. 244, pl. lxxxii, fig. 1,=*Unio bourguignatianus*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 189; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 54, pl. xviii, fig. 51,=*Margaron* (*Unio*) *bourguignatianus*, Lea, Syn., 1870, p. 39,=*Unio rasus*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 189; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 50, pl. xvii, fig. 47,=*Margaron* (*Unio*) *rasus*, Lea, Syn., 1870, p. 58,=*Unio mosulensis*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 190; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 52, pl. xvii, fig. 49,=*Margaron* (*Unio*) *mosulensis*, Lea, Syn., 1870, p. 48,= *Margaritana mosulensis*, Paetel, Conch. Sam., III, 1890, p. 173.

River Tigris, Reg. No. $\frac{23a}{1}$.

19. **Unio modiola**, sp. n. (Pl. viii, figs. 1, 2.)

Shell elongately oblong, somewhat curved, solid, covered with a chocolate coloured, laminiferous periostracum, both valves concentrically striate; umbones large, but not prominent, somewhat coarsely corrugate; dorsal margin slightly arched; ventral margin curvedly excavated in the median posterior region; anterior side somewhat produced, rounded above, sloping below; posterior

side produced, rounded; cardinal teeth rather anteriorly situate, triangular, erect; lateral teeth anteriorly very short, posteriorly elongate and abruptly terminating; anterior adductor scars deeply impressed; posterior scars slight; interior of shell very slightly iridescent, sculptured with fine irregular ridges somewhat resembling the marks of coarse finger prints.

Long. 45, lat. 86 mm.

Hab.—River Tigris, Reg. No. $\frac{24.3.3}{1}$ [Type].

20. **Unio mongolicus,** Middendorff, Sib. Reise, II, 1851 p. 277, pl. xxvii, figs. 7, 8.

Upper Indus, Reg. No. $\frac{5.9.5.4}{1}$.

21. **Unio tigridis,** Bourguignat, Test. Nov. Saul., 1852, p. 30 Cat. Rais. Moll., 1853, p. 77, pl. iv, figs. 7, 9,=*Unio truncatus,* Swainson, Zool. Ill., 2nd Ser., I, 1829, pl. x,=*Margarita* (*Unio*) *truncatus,* Lea, Syn., 1836, p. 21; 1838, p. 18,=*Margaron* (*Unio*) *truncatus,* Lea, Syn., 1852, p. 26; 1870, p. 39,=*Unio dignatus,* Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 189: Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 51, pl. xvii, fig. 48,=*Margaron* (*Unio*) *dignatus,* Lea, Syn., 1870, p. 39,=*Margaron* (*Unio*) *tigris,* Lea, Syn., 1870, p. 39,=? *Unio kisonis,* Kobelt, Icon., 1st sup., 1895, p. 17, pl. vii, figs. 2, 3.

River Tigris, Asiatic Turkey, Reg. No. $\frac{6.2.3}{1}$.

22. **Unio terminalis,** Bourguignat, Test. Noviss., 1852, p. 31; Cat. Rais. Moll., 1853, p. 76, pl. iii, figs. 4—6 etc.,= *Margaron* (*Unio*) *terminalis,* Lea, Syn., 1870, p. 39.

Jordan Valley, Reg. No. $\frac{4.7.2.4}{1}$.

23. **Unio ascia,** Hanley, Rec. Biv. Shells, 1856, p. 385, pl. xxiii, fig. 20.

Penang, Reg. No. $\frac{4.9.5.5}{1}$.

24. **Unio perakensis,** sp. n. (Pl. viii, figs. 5, 6.)

Shell closely allied to *Unio pressirostris,*[1] Von Martens, of which it may ultimately prove to be a variety, but differing from that species in its less cuneate form and larger size, in its less contracted anterior side and more obtuse and sloping posterior side.

Long. 31, lat. 85·5, diam. 21 mm.

Hab.—Perak, Reg. No. $\frac{8.1.6}{1}$ [Type].

Gen. **Shistodesmus,** Simpson, 1900.

25. **Shistodesmus lampreyanus** (Baird and Adams), Simpson, Syn. Naides, Proc. U. S. Nat. Mus., XXII, p. 804,= *Unio* (*Dysnomia*) *lampreyanus,* Baird and Adams, Proc. Zool. Soc. London, 1867, p. 491, pl. xxvi, figs. 2, 2*a*,=*Margaron* (*Unio*) *lampreyanus* Lea, Syn., 1870, p. 30.

Shanghai, Reg. No. $\frac{6.9.8}{1}$.

1 Nachrichtsbl. d. D. Malak. Ges., 1900, p. 14.

Subfam. *HYRINAE*, Swainson.

Gen. **Nodularia**, Conrad, 1853.

Sec. Lanceolaria, Conrad, 1853.

26. **Nodularia (Lanceolaria) oxyrynchus** (Mart.), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 807,=*Unio oxyrynchus*, Martens, Mal. Blatt. VII, 1861, p. 57; Kobelt, Abh. Senck. Nat. Ges. XL, 1879, p. 420, pl. xiii, figs. 3, 4.

Japan, Reg. No. $\frac{5223}{1}$.

Sec. Nodularia, Conrad, 1853.

27. **Nodularia (Nodularia) douglasiae** (Gray), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 808; Griff. An. King. XII, 1833, (p. 601, index 1834), pl. xxi, fig. 2,=*Unio murchisonianus*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 33, pl. iii, fig. 6; Obs., I, 1834, p. 145, pl. iii, fig. 6,=*Margarita* (*Unio*) *murchisonianus*, Lea, Syn., 1836, p. 14; 1838, p. 14,=*Margaron* (*Unio*) *murchisonianus*, Lea, Syn., 1852, p. 21; 1870, p. 32,=*Unio osbecki*, Phil. Zeits. für Mal., 1845, p. 164; Conch., III, Pt. II, p. 45, pl. iii, fig. 1,=*Margaron* (*Unio*) *osbecki*, Lea, Syn., 1852, p. 21; 1870, p. 32,=*Unio nux-persicus*, Dunker, Zeits. für Mal., 1848, p. 83; Musgrave, Phot. Conch., 1863, pl. i, fig. 10,=*Margaron* (*Unio*) *nux-persicus*, Lea, Syn., 1870, p. 32,=*Unio sculptus*, Deshayes, Bull. Nouv. Arch. Mus., IX, 1873, p. 9, pl. i, figs. 3, 3a,=*Unio dactylinus*, Heude, Conch Fl. Nank., 1885, pl. lxv,= ?*Unio pictorum* var. *longirostris*, West, Kong. sv. vet. Ak. Hand., XIV, No. 12, p. 74,=*Unio schrencki*, West,=*Unio abbreviatus*, West.

Ningpo, China, Reg. No. $\frac{5227}{1}$; Shanghai, Reg. No. $\frac{2561}{1}$; N. China, Reg. No. $\frac{5166}{1}$; China, Reg. No. $\frac{605}{1}$.

27*a*. Var. **shanghaiensis**, Lea,=*Unio shanghaiensis*, Lea, Proc. Ac. Nat. Sci. Philad., III, 1859, p. 153; Jl. Ac. Nat. Sci. Philad., IV, 1860, p. 242, pl. xxxvi, fig. 121.

Shanghai, Reg. No. $\frac{2555}{1}$; Chinkiang, China, Reg. No. $\frac{5226}{1}$.

28. **Nodularia (Nodularia) caerulea** (Lea), Simpson, Syn. Naides, Proc. U.S. Nat. Mus., XXII, p. 811,=*Unio caeruleus*, Lea, Tr. Am. Phil. Soc., IV, p. 95, pl. xiii, fig. 25; Obs., I, p. 105, pl. xiii, fig. 25,=*Margarita* (*Unio*) *caeruleus*, Lea, Syn., 1836, p. 20,=*Margaron* (*Unio*) *caeruleus*, Lea, Syn., 1852, p. 30; 1870, p. 47,=*Unio gerbidoni*, Eydoux, Guer. Mag., 1838, p. 9, pl. cxviii, figs. 2, 2a, 2b; Hanley and Theobald, Conch. Ind., 1876, p. 6, pl. xii, fig. 2,=*Unio substriatus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93; Obs. VI, 1857, p. 20, pl. xxvi, fig. 14,=*Margaron* (*Unio*) *substriatus*, Lea, Syn., 1870, p. 47,=*Unio humilis*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93; Obs., VI, 1857, p. 16, pl. xxvi, fig. 10,=*Margaron* (*Unio*) *humilis*, Lea, Syn., 1870, p. 32,=*Unio corrianus*, Küster, Conch. Cab. Unio., 1861, p. 229, pl. lxvii, fig. 5,=*Unio leioma*, Benson, Ann. Mag. Nat. Hist., 1862, p. 192; Hanley and Theobald, Conch. Ind.,

1876, p. 6, pl. xii, fig. 5,=*Unio pilatus*, Lea, Proc. Ac. Nat. Sci., Philad., X 1866, p. 133; Jl. Ac Nat. Sci., Philad., VI, 1868, p. 181, pl. xxxviii, fig. 95,=*Margaron* (*Unio*) *pilatus*, Lea. Syn., 1870, p. 47,=*Unio evitatus*, Lea, Proc. Ac. Nat. Sci., Philad., X, 1868, p. 133; Jl. Ac. Nat. Sci., Philad., VI, 1868, p. 279, pl. xxxviii, fig. 92,=*Margaron* (*Unio*) *cristatus*, Lea, Syn., 1870, p. 47,=*Unio trirostris*, Sowerby, Conch. Icon., XVI, pl. lxv, fig. 331.

Saharanpur, United Provinces, Reg. Nos. 51/1 and 51/1; Sind, Reg. Nos. 51/1 and from a jheel near Rohri, Sukkur Dist., Reg. Nos. 51/1 and 51/1; Rajputana, Reg. No. 50/1; Singpal Garhi, Nepal, Reg. No. 51/1; Kockh(?) Reg. No. 50/1; Rampur, Reg. No. 50/1; Calcutta, Reg. Nos. 51/1, 47/1 (W. Theobold), 51/1, 51/1, 51/1, 50/1, 51/1 (G. Nevill); Belgachia, Calcutta, and Maidan tank (N. Annandale), Reg. Nos. 47/1, 47/1 and 47/1; Siliguri, Reg. No. 48/1; Patna, Reg. No. 21/1; Phenchooganj, Central Sylhet, Reg No. 48/1; Barrack River, Silchar, Reg. No. 48/1; Darjeeling (R. Carter), Reg. No. 52/1; Ballygunge, near Calcutta, Reg. No. 49/1; Jamalpur, Reg. No. 50/1; Sambalpur, Bengal, Reg. No. 52/1; Bagh, Central India (W. T. Blanford), Reg. No. 52/1; Nerbudda, Central Provinces (W. T. Blanford), Reg. No. 52/1; Lower Nerbudda, Central Provinces, Reg. Nos. 51/1 and Burwani, 51/1; Hazrapur, Bengal, Reg. No. 52/1; Rajmahal, Bengal (W. T. Blanford), Reg. No. 52/1; Manbhoom, Bengal, Reg. Nos. 51/1 and 50/1; River Dukkaree, Umballa, Punjab Dist., Reg. No. 52/1; Bhagulpur, Bengal (Capt. Sherwill), Reg. No. 52/1; Poonasa, Central India (W. T. Blanford), Reg. No. 52/1.

28*a*. Var. **gaudichaudii** (Eydoux),=*Unio gaudichaudii*, Eydoux, Mag. de Zool., 1838. Cl. V, p. 10, pl. cxviii, fig. 3,=*Margaron* (*Unio*) *gaudichaudii*, Lea, Syn., 1850, p 32; 1870, p 50.

Dacca, Bengal, Reg. No 51/1; Bengal (Laidley), Reg. No. 52/1.

28*b*. Var. **keraudreni** (Eydoux),=*Unio keraudreni*, Eydoux, Mag. de Zool., 1838, Cl. V, p. 8, pl. cxviii, fig. 1,=*Margaron* (*Unio*) *keraudreni*, Lea, Syn., 1852, p. 30; 1870, p. 46.

Damuda, Bengal (W. T. Blanford), Reg. No. 51/1; Chandernagore, Bengal, Reg No. 51/1.

29. **Nodularia (Nodularia) shurtleffiana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio shurtleffianus*, Lea, Proc. Ac Nat. Sci., Philad., VIII, 1856, p. 94; Obs., VI, p. 22, pl. xxvii, fig 17; Jl. Ac. Nat. Sci., Philad., III, p. 302,=*Margaron* (*Unio*) *shurtleffianus*, Lea, Syn., 1870, p. 32.

Myadong, Burma, Reg. No. 52/1; Shuaygoomyo, Burma, Reg. No. 52/1; Putna, Mirzapur Dist., U P. (R. Hodgart), Reg. No. 50/1; Lucknow (Museum Collector), Reg. No. 52/1, (S. Kemp) Reg. Nos. 51/1 and 51/1.

30. **Nodularia (Nodularia) occata** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio occatus*, Lea, Proc. Ac. Nat. Sci., Philad., IV, 1860, p. 307; Jl. Ac. Nat. Sci., Philad., VI, 1863, p. 398, pl. 1, fig. 304; Obs., X, 1863, p. 34, pl. 1,

fig. 304,=*Margaron* (*Unio*) *occatus*, Lea, Syn., 1870, p. 31,=*Unio macilentus*, Benson, Ann. Mag. Nat. Hist., Ser. 3, 1862, p. 187; Hanley and Theobald, Conch. Ind., p. 5, pl. x, figs. 2, 4; p. 62, pl. cliv, fig. 5,=*Unio rugosus*, Hanley and Theobald, Conch. Ind., p. 62, pl. cliv, fig 3.

Saharanpur, Reg. No. $\frac{2053}{1}$; Phenchooganj, Sylhet, Reg. No. $\frac{5140}{1}$; Barrack River, Cachar, Reg. No. $\frac{5046}{1}$; Cachar, Reg. No. $\frac{2562}{1}$; Myadong, Upper Burma, Reg. No. $\frac{6092}{1}$; North-East Cachar, Reg. No. $\frac{5156}{1}$; Pegu, Burma (W. Theobald), Reg. No. $\frac{6093}{1}$ and $\frac{5188}{1}$; Saharunpur, United Provinces (J. Wood-Mason), Reg. No. $\frac{5207}{1}$; Wurda, Central Provinces (W. T. Blanford), Reg. No. $\frac{5205}{1}$; Bhamo, Upper Burma, Reg. No. $\frac{5198}{1}$; Calcutta (G. Nevill), Reg. No. $\frac{6094}{1}$.

31. **Nodularia (Nodularia) pachysoma** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio pachysoma*, Benson, Ann. Mag. Nat. Hist., X, 1862, p. 186; Hanley and Theobald, Conch. Ind., 1876, p. 6, pl. xii, fig. 1,=*Margaron* (*Unio*) *pachysoma*, Lea, Syn., 1870, p. 63,=*Unio pachystoma*, Paetel, Conch. Sam., III, 1890, p. 162.

Sawaddy, Burma (J. Anderson), Reg. No. $\frac{2415}{1}$; Burma (W. Theobald), Reg. No. $\frac{5155}{1}$; Assam (Robinson), Reg. No. $\frac{5160}{1}$; Irrawaddy (J. Anderson), Reg. No. $\frac{5200}{1}$; Calcutta, Reg. Nos. $\frac{6095}{1}$ and (N. Annandale) $\frac{5742}{1}$; Berhampur (R. E. Lloyd), Reg. No. $\frac{5747}{1}$.

32. **Nodularia (Nodularia) chaudhurii**, sp. n.

Shell small, rather thin, elongately ovate, pale olive, covered with a finely laminiferous periostracum; both valves concentrically striate, sculptured with irregular, minute, nodulous, radiate ridges which appear posteriorly as regular corrugations; umbones small, somewhat prominent; dorsal margin slightly arched; ventral margin straight; anterior side produced, rounded; posterior side bluntly rostrate, abruptly sloping above and below; hinge-teeth elongate, anteriorly projecting; anterior scars deep, roundly triangular; posterior scars scarcely impressed; interior of shell iridescent, nacreous, posteriorly corrugate.

Long. 12·75; lat. 23 mm.

Hab.—Upper Burma, Reg. No. $\frac{2555}{1}$ [Type].

33. **Nodularia (Nodularia) bonneaudi** (Eydoux), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio bonneaudi*, Eydoux, Mag. de Zool., 1838, pl. 119, figs. 1, 1a; Hanley and Theobald, Cat. L. and F. W. Shells, Brit. Ind., pp. 48, 49; Hanley and Theobald, Conch. Ind., pl. x, fig. 6,=*Margaron* (*Unio*) *bonneaudi*, Lea, Syn., 1852, p. 32; 1870, p. 50.

Pegu Reg. Nos. $\frac{2576}{1}$, $\frac{5101}{1}$, $\frac{2425}{1}$, $\frac{5096}{1}$; Shuaygoomyo, Burma, Reg. Nos $\frac{5179}{1}$ and (W. T. Blanford) $\frac{5216}{1}$; Zayleyman, Upper Burma (J. Anderson), Reg. No. $\frac{5202}{1}$; Cachar, Reg. No. $\frac{5185}{1}$; Bhamo, Reg. Nos. $\frac{5197}{1}$ and (J. Anderson) $\frac{5134}{1}$; Tenasserim (W. T. Blanford), Reg. No. $\frac{5210}{1}$; Myadong, Upper Burma, Reg. Nos.

$\frac{5180}{1}$, $\frac{5233}{1}$; Irrawaddy River at Sagaing (J. Coggin Brown), Reg. Nos. $\frac{4739}{1}$ to $\frac{4741}{1}$.

34. **Nodularia (Nodularia) andersoniana** (Nevill),=*Unio andersonianus*, Nevill, Jl. As. Soc. Beng., XLVI, 1877, p. 40; Yunnan Exp., pl lxxx, fig. 9.

Barrack River, Silchar; Reg. No. $\frac{1870}{1}$; Assam, Reg. No. $\frac{2462}{1}$; Myadong, Upper Burma (J. Anderson), Reg. Nos. $\frac{5192}{1}$ [Type] and $\frac{5217}{1}$, $\frac{5191}{1}$; Siliguri, N. Bengal, Reg. No. $\frac{5225}{1}$.

35. **Nodularia (Nodularia) pugio** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 814,=*Unio pugio*, Benson, Ann. Mag. Nat. Hist., Ser. 3, X, p. 193; Sowerby, Conch. Icon., pl. xcv, fig. 516.

Pegu, Reg. Nos. $\frac{5025}{1}$ and (W. Theobald) $\frac{5170}{1}$; Myadong, Upper Burma (J. Anderson), Reg. No. $\frac{5213}{1}$; Sawaddy, Burma, Reg. No. $\frac{5193}{1}$; Tenasserim, Lower Burma (W. T. Blanford), Reg. No. $\frac{5210}{1}$; Zayleyman (J. Anderson), Reg. No. $\frac{5205}{1}$; Arakan, Reg. No. $\frac{5030}{1}$.

36. **Nodularia (Nodularia) crispata** (Gould), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 815,=*Unio crispata*, Gould, Proc. Bost. Soc. Nat. Hist., I, 1843, p. 141; Otia Conch., 1862, p. 191,=*Unio crispatus*, Catlow and Reeve, Conch. Nom., 1845, p. 58; Hanley and Theobald, Conch. Ind., 1876, p. 21, pl. xlv, fig. 1,=*Margaron* (*Unio*) *crispatus*, Lea, Syn., 1870, p. 32,=*Unio scobinatus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93; Obs., VI, 1857, p. 19, pl. xxvi, fig. 13,=*Margaron* (*Unio*) *scobinatus*, Lea, Syn., 1870, p. 32,=*Unio mandarinus*, Morelet, J. de Conch., XII, 1863, p. 159,=*Unio pellis-lacerti*, Morelet, J. de Conch., XIII, 1865, p. 22; Sowerby, Conch. Icon., XVI, 1868, pl. lxxxvi, fig. 457,=*Unio venustus*, Morelet, J. de Conch., XIV, 1866, p. 63,=*Unio oblatus*, Lea, Syn., 1870, p. 64.

Siam, Reg. Nos. $\frac{2332}{1}$ and $\frac{4732}{1}$; Battambang, Cambodia, Reg. No. $\frac{5028}{1}$; Bhamo, Reg. No. $\frac{3858}{1}$.

37. **Nodularia (Nodularia) scobina** (Hanley), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 816,=*Unio scobina*, Hanley, Rec. Biv., p. 382, pl. xxiii, fig. 40; Hanley and Theobald, Cat. L. and F. W. Shells Brit. Ind., p. 49; Hanley and Theobald, Conch. Ind., pl. xlvi, fig. 2.

Sibsagar, Assam (S. E. Peel), Reg. No. $\frac{2554}{1}$.

38. **Nodularia (Nodularia) ingallsiana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 816,=*Unio ingallsianus*, Lea, Tr. Am. Phil. Soc., X, pl. xxiv, fig. 41; Obs., V, 1852, p. 38, pl. xxiv, fig. 41,=*Margaron* (*Unio*) *ingallsianus*, Lea, Syn., 1852, p. 36; 1870, p. 58.

Cambodia, Reg. No. $\frac{5031}{1}$; Siam, Reg. No. $\frac{2550}{1}$.

39. **Nodularia (Nodularia) pazii** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 816,=*Unio pazii*, Lea, Proc. Ac. Nat. Sci., Philad., VI, 1862, p. 176; Jl. Ac. Nat. Sci., Philad.,

VI, p. 61, pl. xxi, fig. 60; Obs., XI, p. 65, pl. xxi, fig. 60,= *Margaron (Unio) pazii*, Lea, Syn., 1870, p. 39.

China, Reg. No. $\frac{624}{1}$.

40. **Nodularia (Nodularia) olivaria** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 817,=*Unio olivarius*, Lea, Tr. Am. Phil. Soc., IV, p. 108, pl. xvi, fig. 38; Obs., I, p. 118, pl. xvi, fig. 33; Hanley and Theobald, Conch. Ind., p. 5, pl. x, fig. 1,=*Margarita (Unio) olivarius*, Lea, Syn., 1836, p. 26; 1838, p. 20; 1852, p. 30; 1870, p. 47,=*Unio pumilio*, Küster, Conch. Cab. Unio, 1862, p. 268, pl. xc, fig. 7.

Assam, Reg. Nos. $\frac{2472}{1}$, $\frac{5150}{1}$; Saharanpur, Reg. Nos. $\frac{2415}{1}$ and $\frac{3221}{1}$; East Cachar (Museum Collector), Reg. No. $\frac{2206}{1}$; Moradabad, United Provinces (Laidlay), Reg. No. $\frac{5150}{1}$; North-East Cachar, Reg. No. $\frac{6097}{1}$; Raniganj, Bengal, Reg. No. $\frac{5152}{1}$.

41. **Nodularia (Nodularia) theobaldi** (Nevill, MS.), sp. n.

Shell ovately rectangular, very slightly curved, gaping anteriorly, moderately solid, concentrically striate, covered with a dark, olivaceous periostracum; umbones small, not prominent; dorsal margin somewhat arched, ventral margin slightly excavated in the median region, otherwise straight; anterior side slightly produced and somewhat sharply rounded; posterior side very obtusely rostrate, steeply sloping above, then sharply rounded and again sloping inwards below. Cardinal teeth in right valve roughly triangular, jagged, somewhat inwardly projecting, fitting between two teeth in the left valve which are roughened and of which the anterior is rather broad and massive; lateral teeth in both valves elongate and nearly straight; anterior scars somewhat deeply excavated especially above; posterior scars ovate, lightly impressed; interior of shell nacreous, shading from pale flesh colour to bluish iridescent especially towards the posterior margin.

Long. 34, lat. 60, diam. 19 mm.

Hab.—Manipur, Assam, Reg. Nos. $\frac{1710}{1}$ [Type], $\frac{2478}{1}$.

42. **Nodularia (Nodularia) pecten**, sp. n. (Pl. viii, figs. 3, 4.)

Shell elongately ovate, rather thin, covered with a finely laminiferous periostracum of a pale bluish green colour shading to yellowish green towards the margins, finely concentrically striate and posteriorly ribbed, especially on the left valve; umbones rather small, moderately prominent; dorsal margin very slightly arched; ventral margin gently curved; anterior side rounded; posterior side obtusely rostrate below, sloping above; hinge-teeth in both valves weak, anteriorly erect in right valve, sinuous and almost twisted in the left; posterior teeth nearly straight, moderately elongate; adductor scars scarcely perceptible; interior of shell pearly.

Long. 19, lat. 33·5, diam. 12 mm.

Hab.—Pitsanuloke, N. Siam, Reg. No. $\frac{5084}{1}$ [Type].

The author follows Simpson in placing this and the next two species in the Section *Nodularia*, though, owing to the very

different texture of the shells, it is somewhat difficult to understand his reasons for so placing them.

43. **Nodularia (Nodularia) nuttalliana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 817,=*Unio nuttallianus*, Lea, Proc. Ac. Nat. Sci., Philad., VIII, 1856, p. 103; Obs., VI, 1857, p. 30, pl. xxx, fig. 25; Jl. Ac. Nat. Sci., Philad., 1858, Ser. 2, III, p. 310, pl. xxx, fig. 25; Hanley and Theobald, Conch. Ind., p. 19, pl. xli, figs. 5, 6,=*Margaron (Unio) nuttallianus*, Lea, Syn., 1870, p. 74.

Assam, Reg. No. $\frac{5930}{1}$; Cachar, Reg. No. $\frac{5156}{1}$.

44. **Nodularia (Nodularia) involuta** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 817,=*Unio involutus*, (Benson), Hanley, Rec. Biv. Shells, 1856, p. 385, pl. xxiii, fig. 19; Hanley and Theobald, Conch. Ind., p. 19, pl. xli, fig. 2.

Sylhet, Reg. No. $\frac{5157}{1}$.

Sec. RADIATULA, Simpson, 1900.

45. **Nodularia (Radiatula) crispisulcata** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 820,=*Unio crispisulcatus* Lea, Ann. Mag. Nat. Hist., X, 1862, p. 193; Sowerby, Conch. Icon., XVI, 1866, pl. xlix, fig. 262,=*Margaron (Unio) crispisulcatus*, Lea, Syn., 1870, p. 149.

Irrawaddy near Thayetmyo (Asiatic Society of Bengal), Reg. No. $\frac{2557}{1}$; Pegu (J. Anderson), Reg. No. $\frac{4737}{1}$; Pegu, Reg. No. $\frac{5152}{1}$; Pegu, Reg. No. $\frac{6095}{1}$.

46. **Nodularia (Radiatula) lima**, Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 820.=*Unio radula* (Benson), Hanley, Rec. Biv. Shells, Supp., 1856, p. 382, pl. xxiii, fig. 41; Hanley and Theobald, Conch. Ind., p. 5, pl. x, fig. 3,=*Dysonomia radula*, Rochebrune, Bull. Soc. Phil., VI, 1882, p. 42.

Siliguri, N. Bengal, Reg. Nos. $\frac{2560}{1}$, $\frac{4733}{1}$, $\frac{5568}{1}$; Sikkim, Reg. No. $\frac{2526}{1}$.

46*a*. Var. **siliguriensis**, Preston,=*Unio siliguriensis*, Preston, Rec. Ind. Mus., Calcutta, II, Pt. 1, p. 47.

Siliguri, Reg. No. $\frac{6099}{1}$. [Type.]

Having now had an opportunity of examining a good series of *N. lima*, a shell which had previously been inaccessible to me, I have no hesitation in reducing *U. siliguriensis* to a variety of that species.

Gen. **Physunio**, Simpson, 1900.

Sec. PHYSUNIO, Simpson, 1900.

47. **Physunio (Physunio) gravidus** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 830,=*Unio gravidus*, Lea, Proc. Ac. Nat. Sci., Philad., VIII, 1856, p. 93; Obs., VI, 1857, p. 12, pl. xxiv, fig. 5; Jl. Ac. Nat. Sci., Philad., III, 1858, p. 292, pl. xxiv, fig. 5,=*Margaron (Unio) gravidus*, Lea, Syn., 1870, p. 28,=*Lampsilis gravidus*, Rochebrune, Bull. Soc. Phil, VI,

1882, p. 43,=*Unio abnormis*, Morelet, Rev. et Mag., XIV, 1862, p. 480,=*Unio superbus*, Sowerby, Conch. Icon., XVI, pl. lix, fig. 295.

Cambodia, Reg. No. $\frac{1993}{1}$; Siam, Reg. No. $\frac{2577}{1}$; Pitsanuloke, N. Siam (H. W. Biggie), Reg. No. $\frac{1410}{1}$.

48. **Physunio (Physunio) micropterus** (Morelet), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 831,=*Unio micropterus*, Morelet, J. de Conch., XIV, 1866, p. 63; Ser. Conch., IV, 1875, p. 349, pl. xv, fig. 7.

Cambodia, Reg. No. $\frac{1997}{1}$.

Gen. **Dalliella**, Simpson, 1900.

49. **Daliella purpurea** (Valenciennes), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 832,=*Anodonta purpurea*, Valenciennes, Rec. Obs. Zool., II, 1853, p. 236, pl. xlviii *bis*, figs. 3, 3*a*, 3*b*,=*Margarita* (*Anodonta*) *purpurea*, Lea, Syn., 1836, p. 51; 1838, p. 30,=*Anodon purpurea*, Catlow and Reeve, Conch. Nom., 1845, p. 67,=*Margaron* (*Anodonta*) *purpurea*, Lea, Syn., 1852, p. 50; 1870, p. 79,=*Anodonta burroughiana*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 105, pl. xvi, fig. 49; Obs., I, 1834, p. 217, pl. xvi, fig. 49,=*Margaron* (*Anodonta*) *burroughiana*, Lea, Syn., 1870, p. 81,=*Anodon burroughianus*, Sowerby, Conch. Icon., XVII, pl. xxvii, fig. 103,=*Margarita* (*Unio*) *bengalensis*, Lea, Syn., 1836, p. 26; 1838, p. 20,=*Unio bengalensis* Lea Tr. Am. Phil. Soc., VI, 1838, p. 3, pl. ii fig. 3; Obs., II, 1838 p. 3, pl. ii, fig. 3,=*Margaron* (*Unio*) *bengalensis* Lea, Syn., 1852, p. 30; 1870, p. 47,=*Anodon bengalensis*, Sowerby, Conch. Icon., XVII, pl. xiv, fig. 49,=*Anodonta bengalensis*, Clessin, Conch Cab. Ano., 1876, p. 173, pl. lvii, fig. 1,=*Unio verecundus* Gould, Proc. Bost. Soc. Nat. Hist., III, 1850, p. 295; U. S. Expl. Exp., XII, 1852, p. 431, figs. 541, 541*a*, 541*b*, 541*c*,=*Unio mauritianus*, Lea, Proc. Ac. Nat. Sci. Philad., III, 1859, p. 152; Jl. Ac. Nat. Sci., Philad., IV, 1860, p. 257, pl. xl, fig. 138,=*Margaron* (*Unio*) *mauritianus*, Lea, Syn., 1870, p. 42,= ?*Anodonta heldii*, Küster, Conch. Cab. Ano., 1873, p. 64, pl. xix, fig. 1 =*Anodonta chinensis*, Küster?

Manila, Reg. Nos. $\frac{5027}{1}$, $\frac{5028}{1}$, $\frac{5029}{1}$; Luzon, Reg. No. $\frac{5061}{1}$.

50. **Dalliella subcrassa** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 833,=*Anodonta subcrassa*, Lea, Proc. Zool. Soc., London, 1850, p. 198; Ann. Mag. Nat. Hist., VIII, 1851, p. 495; Jl. Ac. Nat. Sci., Philad., IV, 1859, p. 236, pl. xxxiii, fig. 115,=*Margaron* (*Anodonta*) *subcrassa*, Lea, Syn., 1852, p. 51; 1870, p. 81,=*Anodon subcrassa*, Sowerby, Conch. Icon., XVII, 1867, pl. xiii, fig. 42.

Philippines, Reg. No. $\frac{618}{1}$.

51. **Dalliella insularis** (Drouet), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 834,=*Pseudodon insularis*, Drouet, Rev. Biol. Fr., VI, 1894, p. 217 fig 2.

Sarawak, Reg. No. $\frac{1977}{1}$.

Gen. **Pseudodon**, Gould, 1844.

Sec. TRIGONODON, Conrad, 1865.

52. **Pseudodon (Trigonodon) crebristriatus** (Anthony), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 835,=*Monocondylaea crebristriata*, Anthony, Am. Jl. Conch., I, 1865, p. 205, pl. xviii, fig. 1,=*Trigonodon crebristriata*, Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Margaron* (*Monocondylaea*) *crebristriata*, Lea, Syn., 1870, p. 72,=*Unio crebristriatus*, Sowerby Conch. Icon., XVI, 1868, pl. xcv, fig. 517,=*Pseudodon crebristriatum*, Hanley and Theobald, Conch. Ind., p. 5, pl. ix, fig. 3,=*Unio vondembuschi*, Sowerby Conch. Icon., XVI, pl. xcv, fig. 518.

Pegu, Reg. Nos. $\frac{1699}{1}$ and $\frac{2031}{1}$.

52*a*. Var. **curvata**, var. n.

Shell having the ventral margin more curved, and generally less ovate in shape than in the typical form.

Hab.—Pegu, Reg. Nos. $\frac{1699}{1}$ [Type], $\frac{2133}{1}$.

52*b*. Var. **peguensis** (Anthony),=*Monocondylaea peguensis*, Anthony, Am. Jl. Conch., I, 1865, p. 205, pl. xviii, fig. 2,=*Margaron* (*Monocondylaea*) *peguensis*, Lea, Syn., 1870, p. 73,=*Pseudodon crebristriatum* var. *peguensis*, Hanley and Theobald, Conch. Ind., 1876, p. 5, pl. ix, fig. 5.

Zayleyman, Reg. No. $\frac{2573}{1}$.

Sec. PSEUDODON, Gould, 1884.

53. **Pseudodon (Pseudodon) vondembuschiana** (Lea), Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Margaritana vondembuschiana*, Lea, Proc Am. Phil Soc., I, 1840, p. 288; Tr. Am. Phil. Soc., VIII, 1842, pl. xviii, fig. 39; Obs., III, 1842, p. 60, pl. xviii, fig. 39,=*Margaron* (*Monocondylaea*) *vondembuschiana*, Lea, Syn., 1852, p. 45; 1870, p. 73,=*Monocondylaea vondembuschiana*, H. and A. Adams, Gen. Rec. Moll., II, 1858, p. 501,=*Monodontina buschiana*, Conrad, Proc. Ac. Nat. Sci., Philad., VI 1853, pp. 269, 449,=*Unio vonbuschea*, Sowerby, Conch. Icon., XVI, 1866, pl. li, fig. 269,=*Alasmodonta crispata*, Mousson, L. and Süss. W. Moll. Java, 1849, p. 97, pl. xviii, figs. 1, 2,=*Margaritana crispata*, Paetel, Conch. Sam., III, 1890, p. 173,=*Monocondylaea planulata*, Lea, Proc. Ac. Sci., Philad., XI, 1859, p. 187; Jl. Ac. Nat. Sci., Philad., IV, 1859, p. 262, pl. xlii, fig. 142; Obs., VII, 1860, p. 80, pl. xlii, fig. 142,=*Pseudodon planulata*, Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Microcondylaea planulata*, Paetel, Conch. Sam., III, 1890, p. 175,=*Margaron* (*Monocondylaea*) *planulata*, Lea, Syn., 1870, p. 73,=*Margaritana fragilis*, Küster, Conch. Cab. Unio, 1862, p. 295, pl. xcviii, fig. 2,=*Microcondylaea fragilis*, Paetel, Conch. Sam., III, 1890, p. 175,=*Monocondylaea rhombica*, Küster, Conch. Cab. Unio, 1862, p. 304, pl. c, fig. 7.

Sarawak, Reg. Nos., $\frac{5038}{1}$, $\frac{5163}{1}$.

54. **Pseudodon (Pseudodon) inoscularis** (Gould), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p 837,=*Anodon inoscularis*, Gould, Proc. Bost Soc. Nat. Hist., I, 1844, p. 160; Hanley and Theobald, Conch. Ind., p. 5, pl. ix, fig. 2,=*Margaron* (*Monocondylaea*) *inoscularis*, Lea, Syn., 1870, p. 73,=*Margaritana inoscularis*, Paetel, Conch. Sam., 1890, III, p. 173.

Tenasserim River, Reg. No. $\frac{1987}{1}$; Tenasserim, Reg. No. $\frac{1996}{1}$.

55. **Pseudodon (Pseudodon) cumingii** (Lea), Conrad, Am. Jl. Conch, I, 1865, p 233,=*Anondonta cumingii*, Lea, Proc. Zool. Soc., London, 1850, p. 199; Ann. Mag. Nat. Hist., VIII, 1851, p. 495; Musgrave in Hanley's Phot Conch., 1863, pl. i, fig. 6,=*Margaron* (*Monocondylaea*) *cumingii*, Lea, Syn., 1852, p. 50, 1870, p. 73,=*Monocondylaea cumingii*, Lea, Jl. Ac. Nat Sci., Philad., IV, 1860, p. 235, pl. xxxiii, fig. 114; Obs., VII, 1860, p. 53, pl. xxxiii, fig. 114,=*Anodon cumingii*, Reeve, Conch. Icon., XVII, 1870, pl. xxxi, fig. 122,=*Microcondylaea cumingii*, Clessin, Conch. Cab. Ano., 1876, p. 259; pl. lxxxiii, figs. 3, 4,=*Pseudodus cumingii*, de Morgan, Bull. Soc. Zool. de Fr., X, 1885, p. 422

Cambodia, Reg. Nos. $\frac{1999}{1}$ and $\frac{1951}{1}$; Philippines (W. Theobald), Reg. No. $\frac{614}{1}$.

56. **Pseudodon (Pseudodon) tumidus** (Morelet), Simpson, Syn. Naiades, Proc. U.S. Nat Mus., XXII, p 837,=*Monocondylus tumidus*, Morelet, Jl. de, Conch., XIV, 1866, p. 62; Mabille, Rev. Zool., XXIII, 1872, p. 51, pl. v, figs 6, 7.

Upper Cambodia, Reg. No. $\frac{1995}{1}$.

57. **Pseudodon (Pseudodon) salwenianus** (Gould), Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Anodon salwenianus*, Gould, Proc. Bost. Soc. Nat. Hist., I, 1844, p. 160,=*Anodonta salweniana*, Gould, Otia Conch., 1862, p. 193,=*Monocondylaea salweniana*, Paetel, Conch. Sam., III, 1890, p. 174,=*Unio salweniana*, Sowerby, Conch. Icon., XVI, 1868, pl. xciv, fig. 513,=*Margaron* (*Monocondylaea*) *salweniana*, Lea, Syn., 1870, p. 72,=*Pseudodon salwenianum*, Hanley and Theobald, Conch. Ind., p. 5, pl. ix, fig. 4.

Tenasserim River, Reg. Nos. $\frac{1977}{1}$, $\frac{1993}{1}$ and $\frac{1997}{1}$; Burma, Reg. Nos. $\frac{5049}{1}$ and $\frac{5040}{1}$.

58. **Pseudodon (Pseudodon) cambodjensis** (Petit), Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Monocondylaea cambodjensis*, Petit, Jl. de Conch., VI, 1865, p. 122,=*Margaron* (*Monocondylaea*) *cambodjensis*, Lea, Syn., 1870, p. 72.

Cambodia, Battambang, Reg. No. $\frac{1996}{1}$; Cochin China, Reg. No. $\frac{5050}{1}$.

59. **Pseudodon (Pseudodon) ava** (Theobald), Simpson, Syn., Naiades, Proc. U.S. Nat. Mus., XXII, p. 839,=*Monocondylaea ava*, Theobald, Jl. As. Soc. Beng., XLII, 1873, pt. II, p. 209, pl. xvii, fig. 15.

Mandalay (J. Anderson), Reg. No. $\frac{1957}{1}$.

Gen. **Parreysia**, Conrad, 1853.

Subgen. **Parreysia**, Conrad, 1853.

60. **Parreysia corrugata** (Müller), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 841,=*Mya corrugata*, Müller, Verm. Terr. et Fluv., 1774, Pt. 2, p. 214; Besch. Ges. Nat. Ber., IV, 1779, p. 56, pl. iiib, figs. 7, 8,=*Unio corrugata*, Lamarck, An. sans Vert., VI, 1819, p. 79; Deshayes, Enc. Méth., II, 1827, p. 584, pl. ccxlviii, fig. 8,=*Unio* (*Potamida*) *corrugata*, Swainson, Tr. on Mal., 1840, p. 268, fig 51; p. 281, fig. 57,=*Unio rugosus*, Küster, Conch. Cab. Unio., 1862, p. 290, pl. xcvii, fig. 5,=*Unio corrugata*, Retzius, Diss. Hist. Nat., 1778, p. 18; Spengler, Skriv. Selsk. Nat., III, 1793, p. 68; Hanley, Test. Moll., 1842, p. 197; Biv. Shells, 1843, p. 197; Hanley and Theobald, Conch. Ind., 1876, p. 21, pl. xlv, figs. 2—5, etc.,=*Margarita* (*Unio*) *corrugatus*, Lea, Syn., 1836, p. 29; 1838, p. 21,=*Margaron* (*Unio*) *corrugatus*, Lea, Syn., 1852, p. 20; 1870, p. 30,=*Mya spuria*, Gmelin, Syst. Nat., 13th Ed., 1788, p. 3222,=*Mya gaditana*, Schreibers, Versuch., 1793,=*Unio multidentatus*, Philippi, Conch., III, 1847, p. 46, pl. iii, fig. 4,=*Margaron* (*Unio*) *multidentatus*, Lea, Syn., 1870, p. 50,=*Unio fulmineus*, Philippi, Conch., III, 1847, p. 46, pl. iii, figs. 5, 6,=*Unio lutens*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93,=*Unio luteus*, Lea, Jl. Ac. Nat. Sci. Philad., III, 1857, p. 291, pl. xxiv, fig. 4,=*Margaron* (*Unio*) *luteus*, Lea Syn., 1870, p. 46,= ?*Unio semirugatus*, Chemnitz, Ill. Conch., 1858 pl. xii, figs. 2, 2*a*,=*Unio merodabensis*, Küster, Conch. Cab Unio, 1861, p. 233, pl. lxxviii, fig. 4,=*Unio tennenti*, Hanley and Theobald, Conch. Ind., p. 22, pl. xlv, figs. 7—9.

Garchiroti Tahsil, Chanda, C. P., Reg. No. $\frac{5143}{1}$; River Dukkaree, near Umballa, Reg. No. $\frac{5145}{1}$; Ceylon (Asiatic Society of Bengal), Reg. No. $\frac{2500}{1}$; Séwan, close to the Indus, Reg. No. 2514; Gudur, Madras Presidency (G. H. Tipper), Reg. No. 5113, and a stream two miles north of Gudur (G. H. Tipper), Reg. Nos. $\frac{5112}{1}$ and $\frac{5114}{1}$; Madras, Reg. No. $\frac{2493}{1}$; Manbhoom, Reg. No. $\frac{2506}{1}$; Patna, Reg. Nos. $\frac{2503}{1}$ and $\frac{2507}{1}$; Berhampore, Murshidabad Dist., (S. W. Kemp), Reg. No. $\frac{5087}{1}$; Brahmapuri Tahsil, Chanda, C. P., Reg. No. $\frac{5141}{1}$; Bangalore, Mysore State, Reg. No. $\frac{2474}{1}$; Phenchooganj, Sylhet, Reg. No. $\frac{2959}{1}$; Loc.? (Asiatic Society of Bengal), Reg. No $\frac{2530}{1}$; Singpal Garki, Nepal (R. Hodgart), $\frac{6096}{1}$ Arrah, Reg. No. $\frac{5161}{1}$; Orissa, Reg. No. $\frac{2515}{1}$; Muzafferpore (I. H. Burkill), Reg. No. $\frac{5141}{1}$; Puri, Orissa, Reg. No. $\frac{2516}{1}$; Putna, Mirzapur Dist., U.P. (R Hodgart), Reg. No. $\frac{6100}{1}$.

60*a*. Var. **fragilis**, Hanley and Theobald, Conch. Ind., p. 21, pl. xlv, fig. 4.

Puri, Orissa, Reg. No. $\frac{2516}{1}$.

60*b*. Var. **laevirostris** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842,=*Unio laevirostris*, Benson, Ann. Mag. Nat. Hist., 1862, p. 192; Jl. As. Soc. Beng., 1862,

XXXV, p. 144,=*Unio corrugatus* var. *laevirostris*, Hanley and Theobald, Conch. Ind., 1876, p. 21, pl. xliv, figs. 5, 6.

Chittagong Hills, Reg. Nos. 25/1 and 24/1; Sadya, N. E. Assam, Reg. No. 24/1; Loc.? (Asiatic Society of Bengal), Reg. No. 25/1; Arrah, Reg. No. 91/1.

60*c*. Var. **nagpoorensis** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842; Hanley and Theobald, Conch. Ind., p. 21, pl. xlv, fig. 3,=*Unio nagpoorensis*, Lea, Proc. Ac. Nat. Sci., Philad., 1859 (1860), p. 331; Jl. Ac. Nat. Sci., Philad., IV, 1860, p. 270, pl. xlv, fig. 150; Obs., VII, 1860, p. 88, pl. xlv, fig. 150,=*Margaron* (*Unio*) *nagpoorensis*, Lea, Syn., 1870, p. 38.

Poona, Reg. No. 15/1; a stream two miles north of Gudur, Madras Presidency (G. H. Tipper), Reg. No. 31/1; Godavery River, Reg. No. 24/1.

61. **Parreysia wynegungaensis** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842,=*Unio wynegungaensis*, Lea, Proc. Ac. Nat. Sci., Philad., 1859 (1860), p. 331; Obs. Unio., VII, p. 89, pl. xlv, fig. 151; Sowerby, Conch. Icon., Unio., pl. xvi, fig. 339,=*Unio wynegungaensis*, Hanley and Theobald, Cat. L. and F. W. Shells Brit. Ind.,=*Margaron* (*Unio*) *wynegungaensis*, Lea, Syn., 1870, p. 50.

Ortalai River, Reg. No. 23/1; Damuda (W. T. Blanford), Reg. No. 24/1; Surat, Reg. No. 24/1; Sambalpur, Reg. No. 24/1; Godavery River (W. T. Blanford), Reg. Nos. 17/1, 21/1; from the little 'nuddy' at Barod, about 130 miles S.W. of Sepree, Reg. No. 81/1; Assam (*ex coll.* Robinson), Reg. No. 25/1.

62. **Parreysia favidens** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842,=*Mya spuria*, Wood, Ind. Test., 1825, p. 12, pl. ii, fig. 35*a*,=*Unio favidens*, Benson, Ann. Mag. Nat. Hist., X, 1862, p. 188; Hanley and Theobald, Conch. Ind., 1876, p. 6, pl. xi, fig. 1,=*Margaron* (*Unio*) *favidens*, Lea, Syn., 1870, p. 38,=*Unio favidens*, Paetel, Conch. Sam., III, 1890, p. 152,=*Unio trirostris*, Musgrave in Hanley's Phot. Conch., 1863, pl. ii, fig. 9,=*Unio tripartitus*, Lea, Proc. Ac. Nat. Sci., Philad., VII, 1863, p. 190; Jl. Ac. Nat. Sci., Philad., VI, p. 57, pl. xix, fig. 55,=*Margaron* (*Unio*) *tripartitus*, Lea, Syn., 1870, p. 35,=*Unio favidens* var. *marcens*, Benson, Ann. Mag. Nat. Hist., X, 1862, p. 188,=*Unio marcens*, Hanley and Theobald, Conch. Ind., 1876, p. 19, pl. xlii, figs. 4—6.

Moradabad (Asiatic Society of Bengal), Reg. No 21/1; River Indus, Reg. No. 24/1; Barrack River, Silchar, Reg. Nos. 18/1, 18/1, 18/1, 24/1; Rajputana, Reg. No. 24/1; Berhampur, Reg. No. 24/1; Dacca, Reg. Nos. 14/1 and 25/1; Bengal, Reg. No. 23/1; Loc.? (Asiatic Society of Bengal), Reg. No. 25/1; Cachar, Reg. No. 24/1; E. Cachar, Reg. Nos. 25/1, 25/1, 24/1; Barrack River, Sylhet, Reg. No 24/1; Tezpur, Reg. Nos. 23/1 and 2 /1; "West of Ranigunge," Reg. No. 23/1; Assam, Reg. No. 24/1; Poona, Reg. No. 30/1; Karnul, Madras, Reg. No. 25/1; Calcutta (J. Wood-Mason) Reg.

No. $\frac{2485}{1}$, also Reg. No. $\frac{4708}{1}$; Seven Tanks, Calcutta, Reg. No. $\frac{2533}{1}$; Arrah, Reg. Nos. $\frac{2317}{1}$ and $\frac{4851}{1}$; Rajmahal, Reg. No. $\frac{2470}{1}$; Hazrapur, Reg. No. $\frac{2498}{1}$; Ranigunge, Reg. No. $\frac{4894}{1}$; Sunderbunds, Reg. No. $\frac{2488}{1}$; Phenchooganj, Central Sylhet (a variety), Reg. No. $\frac{4860}{1}$.

62*a*. Var. **pinax** (Benson), Hanley and Theobald, Conch. Ind., p. 6, pl. x, fig. 2,=*Unio pinax*, Benson, Ann. Mag. Nat. Hist., 1862, p. 192; Jl. As. Soc. Beng., XXXV, 1866, p. 144.

Loc? (Asiatic Society of Bengal), Reg. No. $\frac{2447}{1}$; Arrah, Reg. No. $\frac{6102}{1}$.

62*b*. Var. **plagiosoma** (Benson), Hanley and Theobald, Conch. Ind., p. 6, pl. xi, fig. 3,=*Unio plagiosoma*, Benson, Ann. Mag. Nat. Hist., X, p. 191; Jl. As. Soc. Beng., XXXV, 1866, p. 144.

Patna, Reg. No. $\frac{5107}{1}$; Langlai, Assam, Reg. Nos. $\frac{2378}{1}$ and $\frac{2480}{1}$; Alipur, Calcutta (J. Anderson), Reg. No. $\frac{2524}{1}$; Birbhum (J. Wood-Mason), Reg. No. $\frac{2484}{1}$.

62*c*. Var. **chrysis** (Benson), Ann. Mag. Nat. Hist., Ser. 3, X, p. 189; Hanley and Theobald, Conch. Ind., pl. xli, fig. 3.

Patna, Reg. No. $\frac{2450}{1}$.

62*d*. Var. **deltae** (Benson), Ann. Mag. Nat. Hist., Ser. 3, X, p. 189; Hanley and Theobald, Conch. Ind., pl. xlii, fig. 2.

Hazrapur, Reg. Nos. $\frac{2505}{1}$ and $\frac{5102}{1}$; Calcutta, Reg. No. $\frac{2461}{1}$.

62*e*. Var. **irridula** (Benson), Ann. Mag. Nat. Hist., Ser. 3, X, p. 189.

Bengal, Reg. No. $\frac{2451}{1}$; Damuda, Reg. No. $\frac{6103}{1}$; Manbhoom, Reg. No. $\frac{2481}{1}$; Gunduk (Asiatic Society of Bengal), Reg. No. $\frac{2510}{1}$; Ranigunge, Reg. No. $\frac{2492}{1}$; Patna, Reg No. $\frac{2453}{1}$.

62*f*. Var. **assamensis** (Nevill, MS.), var. n.

Shell more convex than the typical form, the dorsal margin is rather less posteriorly angled, the anterior side more rounded and the posterior slightly more nasute.

Hab.—Digong, Reg. No. $\frac{2479}{1}$ [Type]; Assam, Reg. Nos. $\frac{2504}{1}$, $\frac{2511}{1}$ and $\frac{2488}{1}$; Arrah (Asiatic Society of Bengal), Reg. No. $\frac{2516}{1}$; Sylhet, Reg. No. $\frac{2456}{1}$.

63. **Parreysia smaragdites** (Benson),=*Unio smaragdites*, Benson, Ann. Mag. Nat. Hist., 1862, X, p. 190.

Bhamo, Upper Burma (J. Anderson), Reg. Nos. $\frac{2457}{1}$, $\frac{4705}{1}$; Zayleyman Upper Burma (J. Anderson), Reg. No. $\frac{2448}{1}$; Zayleyman, Reg. No. $\frac{5099}{1}$; Loc? (J. Anderson) Reg. No. $\frac{5100}{1}$.

64. **Parreysia bhamoensis** (Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 843,=*Unio bhamoensis*, Theobald, Jl. As. Soc. Beng., XLII, 1873, Pt. 2, p. 207, pl. xvii, fig. 1,=*Unio mandelayensis*, Theobald, Jl As. Soc. Beng., XLII, Pt. 2, p. 208, pl. xvii, fig. 2.

Mandalay, Upper Burma, Reg. Nos. $\frac{5095}{1}$ and (J. Anderson) $\frac{2471}{1}$; Sheinmagah, Upper Burma, Reg. No. $\frac{2569}{1}$; Irrawaddy

River at Sagaing (J. Coggin Brown), Reg. Nos. 47/1—58; Zayleyman, Upper Burma (J. Anderson), Reg. No. 2870/1.

65. **Parreysia pernodulosa**, sp. n.

Shell small, ovate, dark brown; both valves sculptured anteriorly with coarse, corrugate ridges which become more nodulous and irregular in the median and posterior regions; umbones rather large; dorsal margin rapidly sloping anteriorly, slightly sloping posteriorly; ventral margin somewhat rounded; anterior side rather contracted, sharply rounded; posterior side broad, very gently rounded; cardinal teeth very anteriorly situate, in right valve squarish, bearing two elongate grooves; in left valve large, jagged, split into three portions, between each of which occur two deep notches, the middle portion, or that between the two notches, being by far the smallest: at the base of the anterior portion is situated a smaller, jagged tooth which is obliquely grooved in the centre; lateral teeth in both valves posteriorly, elongately arched, grooved down the whole length; anterior scars very deep; posterior scars elongate, but not well marked; interior of shell pale bluish, nacreous.

Long. 15·5; lat. 20·5 mm.

Hab.—Zayleyman, Upper Burma (J. Anderson), Reg. No. 6104/1 [Type].

66. **Parreysia feddeni** (Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 843,=*Unio feddeni*, Theobald, Jl. As. Soc. Beng., XLII. Pt. 2, p. 208, pl. xvii, fig. 3; Hanley and Theobald, Cat. L. and F. W. Shells, Brit. Ind., p. 48.

Pem Ganga, Reg. No. 2310/1 (*ex coll.* W. T. Blanford).

67. **Parreysia daccaensis**, sp. n.

Shell differing from *P. feddeni*, Theobald, in its much larger size, more ponderous form and more elongately ovate shape, it is much darker in colour, being of a dark blackish brown instead of the greenish yellow shade of that species, the shell is much more coarsely, concentrically striate and is also considerably malleated, while *P. feddeni* is almost smooth in texture; the umbones in the present species are, though larger, far less prominent, but the system of hinge teeth is the same.

Long. 47; lat. 76·5, diam. 29 mm.

Hab.—Dacca, Reg. No. 6105/1 [Type].

68. **Parreysia tavoyensis** (Gould), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 843,=*Unio tavoyensis*, Gould, Proc. Bost. Soc. Nat. Hist., 1843, p. 140; Küster, Conch. Cab. Unio., 1856, p. 166, pl. xlviii, fig. 2, etc,=*Margaron* (*Unio*) *tavoyensis*, Lea, Syn., 1870, p. 31,=*Unio savoyensis* Paetel, Conch. Sam., III, 1890, p. 166,=*Unio parma*, Benson, Sowerby, Conch. Icon., XVI, 1868, pl. xcv, fig. 514; Hanley and Theobald, Conch. Ind., p. 61, pl. cliv, fig. 1.

Tavoy, Reg. Nos. 2366/1, 4703/1, and 2543/1; Pegu, Reg. Nos. 2431/1, 2567/1, and 2522/1; Arakan, Reg. No. 2505/1; Tenasserim, Burma (W. T. Blanford), Reg. No. 2581/1; Mandalay, Reg. No. 2504/1.

68*a*. Var. **triembolus** (Benson), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 844,=*Unio triembolus*, Benson, Jl. As. Soc. Beng., XXXV, 1855, p. 144; Ann. Mag. Nat. Hist., X, 1862, p. 190; Hanley and Theobald, Conch. Ind., p. 43, pl. cvii, fig. 2,=*Unio houngdaranicus*, Tapparone-Canefri, Ann. Mus. Civ. Genova, VII, 1889. p. 341.

Cachar, Reg. No. $\frac{2}{1}\frac{4}{1}\frac{5}{1}\frac{2}{1}$; Barrack River, Silchar, Reg. No. $\frac{1}{1}\frac{8}{1}\frac{0}{1}\frac{6}{1}$; Loc? (Asiatic Society of Bengal), Reg. No. $\frac{2}{1}\frac{4}{1}\frac{5}{1}\frac{8}{1}$; Calcutta, Reg. No. $\frac{2}{1}\frac{4}{1}\frac{5}{1}\frac{1}{1}$.

69. **Parreysia rajahensis** (Lea), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 844,=*Unio rajahensis*, Lea, Proc. Am. Phil. Soc., II, 1841, p. 30; Tr. Am. Phil. Soc., VIII, 1842, p. 289, pl. xxiii, fig 53; Obs., III, 1842, p. 77, pl. xxiii, fig. 53,=*Margaron* (*Unio*) *rajahensis*, Lea, Syn., 1852, p. 25; 1870, p. 38, =*Unio indicus*, Sowerby, Conch. Icon., XVI, 1866, pl. xl, fig. 222; Hanley and Theobald, Conch. Ind., p. 43, pl. cvii, fig. 1,=*Margaron* (*Unio*) *indicus*, Lea, Syn., 1870, p. 31.

Nerbudda River, Reg. No. $\frac{2}{1}\frac{4}{1}\frac{7}{1}\frac{3}{1}$; Poona, Reg. No. $\frac{1}{1}\frac{3}{1}\frac{1}{1}\frac{2}{1}$; Nerbudda R. (W. Theobald), Reg. No. $\frac{1}{1}\frac{7}{1}\frac{1}{1}\frac{2}{1}$; Nerbudda R., Reg. No. $\frac{2}{1}\frac{8}{1}\frac{1}{1}\frac{8}{1}$, (W. T. Blanford); "from the soil of the Ran Kach," Reg. No. $\frac{2}{1}\frac{0}{1}\frac{0}{1}\frac{2}{1}$; from 130 miles S. W. of Sepree, Reg. No. $\frac{5}{1}\frac{1}{1}\frac{3}{1}\frac{3}{1}$; Sahibgunge, Reg. No. $\frac{2}{1}\frac{4}{1}\frac{7}{1}\frac{1}{1}$.

70. **Parreysia corbis** (Hanley), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845,=*Unio corbis*, Benson in Hanley's Rec. Biv. Shells, 1856, pl. xxiii, fig. 43; Hanley and Theobald, Conch. Ind., p. 22, pl. xlv, fig. 10,=*Margaron* (*Unio*) *corbis*, Lea, Syn., 1870, p. 50.

Assam, Reg. No. $\frac{5}{1}\frac{1}{1}\frac{2}{1}\frac{3}{1}$.

71. **Parreysia burmanus** (Blanford), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845,=*Unio burmanus*, Blanford, Proc. Zool. Soc., London, 1869, p. 450,=*Unio birmanus*, Hanley and Theobald, Conch. Ind., p. 19, pl. xlii, fig. 11.

Bhamo, Reg. Nos. $\frac{5}{1}\frac{2}{1}\frac{3}{1}\frac{2}{1}$ [Type], $\frac{2}{1}\frac{5}{1}\frac{1}{1}\frac{8}{1}$, $\frac{1}{1}\frac{5}{1}\frac{0}{1}\frac{3}{1}$, $\frac{2}{1}\frac{5}{1}\frac{3}{1}\frac{0}{1}$ (J. Anderson), $\frac{1}{1}\frac{7}{1}\frac{0}{1}\frac{9}{1}$.

72. **Parreysia sikkimensis** (Lea), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845,=*Unio sikkimensis*, Lea, Proc. Ac. Nat. Sci. Philad., III, 1859, p. 151; Jl. Acad. Nat Sci., IV, 1859, p. 251; Obs., VII, 1860, p. 69, pl. xxxix, fig. 131,=*Margaron* (*Unio*) *sikkimensis*, Lea, Syn., 1870, p. 64.

Sikkim, Reg. No. $\frac{2}{1}\frac{4}{1}\frac{3}{1}\frac{1}{1}$; Sibsagar, Assam, Reg. Nos. $\frac{2}{1}\frac{5}{1}\frac{0}{1}\frac{5}{1}$ and $\frac{1}{1}\frac{7}{1}\frac{1}{1}\frac{8}{1}$ (S. E. Peal.); Siliguri, Reg. No. $\frac{5}{1}\frac{1}{1}\frac{0}{1}\frac{2}{1}$; Namtsik, Dihing, Reg. No. $\frac{5}{1}\frac{0}{1}\frac{7}{1}\frac{0}{1}$; Cachar, Reg. No. $\frac{2}{1}\frac{4}{1}\frac{0}{1}\frac{2}{1}$.

73. **Parreysia gowhattensis** (Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845,=*Unio gowhattensis*, Theobald, Jl. As. Soc. Beng., XLII, 1873, Pt. 2, p. 208, pl. xvii, fig. 4.

Gowhatty (=Gauhati), Assam (Museum Collector), Reg. No. $\frac{4}{1}\frac{7}{1}\frac{1}{1}\frac{6}{1}$; Gowhatty, Reg. Nos. $\frac{2}{1}\frac{4}{1}\frac{7}{1}\frac{5}{1}$ and $\frac{2}{1}\frac{5}{1}\frac{5}{1}\frac{5}{1}$.

74. **Parreysia annandalei**, sp. n.

Shell oval, convex, moderately solid, coarsely concentrically ribbed, covered with a thin, smooth, brownish-olivaceous periostracum; umbones rather small, not prominent; dorsal margin arched; ventral margin considerably rounded; anterior side slightly produced and rather sharply rounded; posterior side very bluntly sub-rostrate; cardinal teeth two in each valve, somewhat anteriorly situate, rather coarse, corrugated; lateral teeth strong, curved; anterior scars rather small, very deeply excavated; posterior scars also small, ovate, deeply impressed; interior of shell whitish, iridescent.

Long. 29, lat. 41, diam. 20 mm.

Hab.—Gowhatty, Reg. No. $\frac{2420}{1}$ [Type].

75. **Parreysia perconvexa**, sp. n.

Shell ovate, slightly curved, very convex, solid, but much eroded, where intact covered with a dark blackish brown periostracum; umbones moderately large; dorsal margin sloping in an anterior direction; ventral margin slightly curved posteriorly; anterior side gently rounded; posterior side slightly and very bluntly produced, rounded; cardinal teeth very anteriorly situate with upper surface multi-ridged and supported in each valve by an enormous column-like callus thickening of the shell; lateral teeth coarse, rather short, curved; anterior muscular scars of great depth; posterior scars subcircular, well impressed; interior of shell very pale greenish white.

Long. 37, lat. 55, diam. 33 mm.

Hab.—Nangyong Lake, Reg. No. $\frac{3050}{1}$ [Type].

Gen. **Lamellidens**, Simpson, 1900.

Subgen. **Lamellidens**, Simpson, 1900.

76. **Lamellidens marginalis** (Lamarck), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 854,=*Unio marginalis*, Lamarck, An. sans Vert., VI, 1819, p. 79; Deshayes, Enc. Méth., II, 1827, p. 151, pl. ccxlvii, fig. 1,=*Die breite Mahler-Muschel aus Grönland*, Schröter, Flusse., 1779, p. 181, pl. ix, fig. 1,=? *Unio groenlandicus*, Mörch, Am. Jl. Conch., IV, 1868, p. 38,=? *Unio testudinarius*, Spengler, Skriv. Selsk. Nat., III, 1793, p. 65,=?*Unio truncatus*, Spengler, Skriv. Selsk. Nat., III, 1793, p. 65=*Margarita* (*Unio*) *marginalis*, Lea, Syn., 1836, p 37; 1838, p. 24, =*Margaron* (*Unio*) *marginalis*, Lea, Syn., 1852, p. 38; 1870, p. 60,=*Unio anodontina*, Lamarck, An. sans Vert., VI, 1819, p. 80,=*Unio anodontinus*, Küster, Conch. Cab. Unio., 1861, p. 240, pl. lxxx, fig. 15,=*Symphynota bilineata*, Lea, Tr. Am. Phil. Soc., IV, 1831, p. 98, pl. xi, fig. 19; Obs. I, 1834, p. 108, pl. xi, fig. 19,=*Margarita* (*Unio*) *bilineatus*, Lea, Syn., 1836, p. 38; 1838, p. 25,=*Unio bilineatus*, Hanley, Test. Moll., 1842, p. 207; Biv. Shells, 1843, p. 207, pl. xxi, fig. 30,=*Margaron* (*Unio*)

Singbhoom, Reg. No. $\frac{4880}{1}$; Chittagong, Reg. No. $\frac{4877}{1}$; Arrah Reg. No. $\frac{4885}{1}$; Burma, Reg. No. $\frac{2593}{1}$; Hazrapur, Reg. No. $\frac{4879}{1}$; Rangoon, Reg. No. $\frac{5106}{1}$; Bhamo, Upper Burma (J. Anderson), Reg. No. $\frac{2535}{1}$; Tank near Bangalore, Reg. No. $\frac{5012}{1}$; Tezpur, Reg. No. $\frac{2530}{1}$; Dacca, Reg. No. $\frac{4891}{1}$; Toungoo, Burma, Reg. No. $\frac{2437}{1}$; Bhagalpur (Capt. Sherwill), Reg. No. $\frac{4876}{1}$; "a stream two miles north of Guddur, Madras Presidency" (G. H. Tipper), Reg. Nos. $\frac{5110}{1}$, $\frac{5115}{1}$; "from the little 'nuddy' at Barod, S. W. of Sepree, about 130 miles," Reg. Nos. $\frac{5039}{1}$, $\frac{5091}{1}$; "from a jheel near Rohri, Sind," Reg. No. $\frac{4988}{1}$; Irrigation Channels, Seistan, Reg. Nos. $\frac{3241}{1}$ and $\frac{4814}{1}$; Poona, Reg. Nos. $\frac{5095}{1}$ and $\frac{5078}{1}$; Karnul District, Madras, Reg. Nos. $\frac{5047}{1}$ and $\frac{5038}{1}$; Calcutta, Reg. Nos. $\frac{4887}{1}$, $\frac{4886}{1}$ (distorted specimens), $\frac{4896}{1}$ (very young specimens); Belgachia, Calcutta (N. Annandale), Reg. Nos. $\frac{4730}{1}$, $\frac{4732}{1}$; Loc? (Indian Tanks), Reg. Nos. $\frac{4730}{1}$ and $\frac{5109}{1}$; Patna, Reg. No. $\frac{4900}{1}$; Bandardaha, Berhampur, Bengal (B. L. Chaudhuri), Reg. No. $\frac{5234}{1}$; Silcuri, Reg. No. $\frac{4864}{1}$; Barrack River, Silchar, Reg. No. $\frac{5047}{1}$; E. Cachar, Reg. No. $\frac{4899}{1}$; Igatpuri, Western Ghats (Museum Collector), young specimens, Reg. No. $\frac{4704}{1}$; Putna, Mirzapur District, U. P. (R. Hodgart), Reg. No. $\frac{4750}{1}$.

76*a*. Var. **obesus** (Hanley and Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 855,=*Unio marginalis* var. *obesa*, Hanley and Theobald, Conch. Ind., p. 20, pl. xliii, fig. 3,= ?*Unio corrianus*, Sowerby, Conch. Icon., XVI, 1868, pl. lxxvii, fig. 41.

Chittagong, Reg. No. $\frac{5034}{1}$; Silchar, Cachar, Reg. No. $\frac{4881}{1}$; Toungoo, Burma, Reg. No. $\frac{2530}{1}$.

76*b*. Var. **tricolor** (Hanley and Theobald), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 855,=*Unio tricolor*, Küster, Conch. Cab. Unio., 1856, p. 156, pl. xlv, fig. 1,=*Unio marginalis* var. *tricolor*, Hanley and Theobald, Conch. Ind., p. 20, pl. xliii, fig. 5.

Shuaygoomyo, Reg. No. $\frac{2532}{1}$; Manbhoom, Reg. No. $\frac{4893}{1}$.

76*c*. Var. **candaharicus** (Hutton),=*Lamellidens marginalis* var. *candaharicus* (Hanley and Theobald), in Simpson's Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 855,=*Unio marginalis* var. *candaharica*, Hanley and Theobald, Conch. Ind., p. 20, pl. xliii, fig. 4,=*Unio marginalis* var. *kandaharica*, Hutton, in Theobald's Cat. L. and F. W. Shells, Brit. Ind., p. 46,=*Unio candaharicus*, Hutton, Jl. As. Soc. Beng., XVIII, Pt. 2, 1850, p. 660.

Kandahar (Hutton), Reg. No. $\frac{4991}{1}$; Kandahar, Reg. No. $\frac{4733}{1}$.

76*d*. Var. **thwaitesi**, Lea,=*Lamellidens thwaitesi*, Lea, in Simpson's Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 856,=*Unio thwaitesi*, Lea, Proc. Ac. Nat. Sci., Philad., III, 1859, p. 152; Jl. Acad. Nat. Sci., Philad., IV, 1860, p. 246, pl. xxxvii, fig. 125, =*Margaron* (*Unio*) *thwaitesi*, Lea, Syn., 1870, p. 41,=*Unio consobrinus*, Hanley and Theobald, Conch. Icon., p. 19, pl. xli, fig. 7.

Ceylon, Reg. Nos. $\frac{5043}{1}$, $\frac{4718}{1}$; Colombo, Reg. No. $\frac{4954}{1}$.

76*e*. Var. **consobrinus**, Lea,=*Lamellidens consobrinus*, Lea, in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus , XXII, p. 856,=*Unio consobrinus*, Lea, Proc. Ac. Nat. Sci., Philad., III, 1859, p. 331; Jl. Ac. Nat. Sci., Philad., 1860, p. 272, pl. xlv, fig. 152; Obs., VII, 1860, p. 90, pl. xlv, fig. 152,=*Margaron* (*Unio*) *consobrinus*, Lea, Syn., 1870, p. 46,=*Unio corbeti*, Deschamps, Bull. Soc. Zool. Fr., XVII, 1892, p. 68, fig.

Assam, Reg. No. $\frac{1}{1895}$; Poona, Reg. No. $\frac{1}{1883}$; Dacca, Reg. No. $\frac{1}{1892}$.

76*f*. Var. **lamellatus**, Lea,=*Lamellidens lamellatus*, Lea, in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 856,=*Unio lamellatus*, Lea, Tr. Am. Phil. Soc., VI, 1838, p. 19, pl. vi, fig. 16; Obs., II, 1838, p. 19, pl. vi, fig. 16,=*Margarita* (*Unio*) *lamellatus*, Lea, Syn., 1836, p. 26; 1838, p. 20,=*Margaron* (*Unio*) *lamellatus*, Lea, Syn., 1852, p. 29; 1870, p. 46,=*Unio layardii*, Lea, Proc. Ac. Sci., Philad., III, 1859, p. 153; Jl. Ac. Nat. Sci., Philad., IV, 1860, p. 243, pl. xxxvi, fig. 22,=*Margaron* (*Unio*) *layardii*, Lea, Syn., 1870, p. 46.

Upper Burma, Reg. No. $\frac{1}{2444}$; Calcutta, Reg. No. $\frac{1}{1888}$; Mandalay, Reg. Nos. $\frac{1}{1731}$ and $\frac{1}{2510}$; Pegu, Reg. No. $\frac{1}{2550}$; Bhamo (J. Anderson), Reg. No. $\frac{1}{2525}$; Matale, Ceylon, Reg. No. $\frac{1}{1880}$.

After a careful examination of a long series of this shell the author is unable to consider it other than a mere variety of *L. marginalis*.

76*g*. Var. **scutum**, Sowerby,=*Lamellidens scutum*, Sowerby, in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus , XXII, p. 857,=*Unio scutum*, Sowerby, Conch. Icon., 1868, XVI, pl. xciv, fig. 510; Hanley and Theobald, Conch. Ind. p. 22, pl. xlvi, fig. 1.

Tenasserim, Burma, Reg. No. $\frac{1}{1880}$; Rangoon (N. Annandale), Reg. No. $\frac{1}{1731}$.

76*h*. Var. **corrianus**, Lea,=*Lamellidens corrianus*, Lea, in Simpson's Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 857,=*Unio corrianus*, Lea, Tr. Am. Phil. Soc., VI, 1834, p. 65, pl. ix, fig. 25; Obs., I, 1834, p. 177, pl. ix, fig. 25,=*Margarita* (*Unio*) *corrianus*, Lea, Syn , 1836, p. 38; 1838, p. 25,=*Margaron* (*Unio*) *corrianus*, Lea, Syn., 1852, p 38; 1870, p. 61.

Sibsagar, Assam (S. E. Peel), Reg. No. $\frac{1}{1889}$; Calcutta, Reg. Nos. $\frac{1}{1884}$, $\frac{1}{1911}$, $\frac{1}{1887}$ and $\frac{1}{1710}$; Pegu (W. T. Blanford), Reg. Nos. $\frac{1}{1888}$ and $\frac{1}{2550}$; Balagunge, Central Sylhet, Reg. No. $\frac{1}{1865}$; Burma, Reg. No. $\frac{1}{2527}$; Zayleyman, Upper Burma (J. Anderson), Reg. No. $\frac{1}{1875}$; Madras, Reg. No. $\frac{1}{3000}$; Berhampur, Murshidabad District, Bengal (S. W. Kemp), Reg. No. $\frac{1}{3035}$; Sambalpur, Reg. No. $\frac{1}{1902}$.

76*i*. Var. **generosus**, Gould,=*Lamellidens generosus* (Gould) in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 857,=*Unio generosus*, Gould Proc. Bost. Soc Nat. Hist., 1847, p. 220; Hanley and Theobald, Conch. Ind., p. 22, pl. xlvi, fig. 4,=*Unio generosus* var. *angustior*, Hanley and Theobald, Conch. Ind ,

p. 22, pl. xlvi, fig. 7,=*Margaron* (*Unio*) *generosus*, Lea, Syn., 1870, p. 29,=?*Unio lamellatus*, Sowerby, Conch. Icon., XVI, 1868, pl. xciv, fig. 511.

Myadong, Upper Burma (J. Anderson), Reg. No. $\frac{2531}{1}$; Mandalay (N. Annandale), Reg. Nos. $\frac{1783-89}{1}$; Bhamo (J. Coggin Brown), Reg. No. $\frac{1736}{1}$.

76j. Var. **jenkinsianus** (Benson),=*Lamellidens jenkinsianus*, (Benson) in Simpson's Syn. Naiades, Proc. U S. Nat. Mus., XXII, p. 857,=*Unio jenkinsianus*, Benson, Ann. Mag. Nat. Hist., Ser. 3, X, p. 185; Hanley and Theobald, Conch. Ind., pl. xli, fig. 4.

Upper Assam, Reg. No. $\frac{2446}{1}$; Sylhet, Reg. No. $\frac{2037}{1}$; Upper Bramaputra (F. Stoliczka), Reg. No. $\frac{1874}{1}$; Bhagalpur (Capt. Sherwill), Reg. No. $\frac{1878}{1}$.

76k. Var. **zonatus**, Deshayes,=*Unio zonatus*, Deshayes, Enc. Méth. Vers., II, p. 587; Hanley and Theobald, Conch. Ind., pl. xliv, fig. 2.

Rangoon, Reg. No. $\frac{2066}{1}$.

76l. Var. **sublamellatus** (Nevill, MS.) var. n.

An elongate, somewhat rostrate form, having the hinge teeth rather less developed.

Hab.—Burma (W. Theobald), Reg. No. $\frac{1711}{1}$ [Type].

76m. Var. **sawaddyensis** (Nevill, MS.) var. n.

Shell much more ovate and convex than the typical form, having the dorsal margin more arched and posteriorly ascending, the ventral margin and anterior side more rounded, and the posterior side produced and roundedly rostrate.

Hab.—Sawaddy River (Asiatic Society of Bengal), Reg. No. $\frac{2541}{1}$ [Type]; Bhamo (J. Anderson), Reg. No. $\frac{1704}{1}$; Sawaddy, Tengling Stream (J. Anderson), Reg. Nos $\frac{2535}{1}$ and $\frac{2539}{1}$; Shuaygoomya, Upper Burma (J. Anderson), Reg. No. $\frac{2532}{1}$; Mandalay, Upper Burma (N. Annandale), Reg. Nos. $\frac{1790-94}{1}$.

77. **Lamellidens narainporensis**, sp. n.

Shell cuneate, moderately convex, posteriorly rostrate, dark reddish brown, covered, towards the margins, with a finely laminiferous periostracum, marked with concentric lines of growth, bearing two carinae on each valve running from the umbones in a dorsally posterior direction; umbones small, not prominent, somewhat coarsely corrugated; dorsal margin very gently arched; ventral margin scarcely rounded in the anterior and median regions, slightly curved posteriorly; anterior side abruptly rounded; posterior side sloping above, then angled and very abruptly descending; cardinal tooth in left valve obtusely triangular, erect, absent in right valve; lateral teeth anteriorly short, deeply grooved and projecting in right valve, erect and jagged in the left, posteriorly moderately elongate and bifurcated in both valves; anterior scars rather circular, deep; posterior scars lightly impressed; interior of shell pale flesh colour shading to iridescent bluish white, very minutely granulate.

Long. 35, lat. 84 mm.

Hab.—Narainpore Bhil, Murshidabad District, Bengal (C. J. Robertson Milne), Reg. No. $\frac{5056}{1}$ [Type].

78. **Lamellidens nongyangensis**, sp. n.

Shell very elongately ovate, inflated, covered with a blackish brown, finely laminiferous periostracum, concentrically marked with rather coarse lines of growth; dorsal margin anteriorly somewhat straight, posteriorly arched above, sloping and slightly excavated below; ventral margin scarcely rounded; anterior side abruptly descending; posterior side rostrate, obtusely rounded; cardinal teeth very anteriorly situate, triangular, erect; lateral teeth elongate, also erect, terminating posteriorly in an abrupt slope; anterior scars deeply marked; posterior scars lightly impressed; interior of shell flesh-coloured shading to bluish, iridescent, minutely pitted and granulate.

Long. 45, lat. 94 mm.

Hab.—Nongyang Lake, South of Patkai, Reg. No. $\frac{5048}{1}$ [Type].

79. **Lamellidens phenchooganjensis**, sp. n.

Shell very elongately ovate, posteriorly obtusely rostrate, dark blackish brown, sculptured with fine concentric striae, crossed, especially in the anterior median region, by fine, slightly distant, transverse, radiate striae, thus presenting a minutely wrinkled appearance; umbones flattened, much eroded; dorsal margin anteriorly gently sloping, posteriorly more rapidly sloping in a slight curve; ventral margin scarcely rounded; anterior side angled above, gently rounded below; posterior side produced, angularly rounded; hinge teeth very elongate, somewhat fine; anterior scars ovate, moderately impressed; posterior scars roughly triangular, not well impressed; interior of shell shading from pale brown to bluish, nacreous, marked, especially towards the anterior ventral region, with very shallow radiate furrows.

Long. 42, lat. 86 mm.

Hab.—Phenchooganj, Central Sylhet, Reg. No. $\frac{5058}{1}$ [Type].

80. **Lamellidens mainwaringi** (Nevill, MS.) sp. n.

Shell rather small, cuneate, covered with a finely laminiferous periostracum; both valves marked with rather fine, concentric and finer, transverse, radiate, scratch-like striae; dorsal margin anteriorly gradually sloping, posteriorly arched and more rapidly descending; ventral margin somewhat straight; anterior side rounded; posterior side angled above and below, somewhat obliquely and obtusely rostrate; hinge-teeth well developed, moderately short; anterior adductor scar deeply impressed, posterior scar somewhat roughly triangular, well impressed; interior of shell bluish iridescent, rather granulate.

Long. 25·5, lat. 50 mm.

Hab.—Siliguri, Reg. Nos. $\frac{5018}{1}$ [Type], $\frac{5861}{1}$, $\frac{5102}{1}$; Namtsik, Dihang, Reg. No. $\frac{5070}{1}$.

Genus **Trapezoideus**, Simpson, 1900.

81. **Trapezoideus foliaceus** (Gould), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 858,=*Unio foliacea*, Gould, Proc. Bost. Nat. Hist. Soc., I, 1843, p. 141,=*Unio foliaceus*, Catlow and Reeve, Conch. Nom., 1845, p. 59; Hanley and Theobald, Conch. Ind., p. 19, pl. xlii, fig. 3,=*Margaron* (*Unio*) *foliaceus*, Lea, Syn., 1852, p. 39; 1870, p. 62,=*Unio peguensis*, Anthony, Am. Jl. Conch., I, 1865, p. 351, pl. xxv, fig. 2; Sowerby, Conch. Icon., XVI, 1868, pl. xcv, fig. 519,=*Margaron* (*Unio*) *peguensis*, Lea, Syn., 1870, p. 51.

Bhamo (J. Anderson), Reg. No. $\frac{87.07}{1}$; Pegu (W. T. Blanford), Reg. No. $\frac{85.70}{1}$; Pegu, Reg. No. $\frac{80.36}{1}$.

81*a*. Var. **zayleymanensis** (Nevill, MS.), var. n.

Shell thinner and smaller than the typical form, more produced anteriorly and much more obtuse posteriorly, the slight curve in the ventral margin is also absent.

Hab.—Bhamo (J. Anderson), Reg. No. $\frac{85.78}{1}$ [Type]; also from Bhamo, Reg. No. $\frac{85.78}{1}$; Zayleyman (J. Anderson), Reg. No. $\frac{85.78}{1}$.

82. **Trapezoideus misellus** (Morelet), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 859,=*Unio misellus*, Morelet, Jl. de Conch. XIII, 1865, p. 21; Ser Conch., IV, 1875, p. 341, pl. xiv, fig. 2,=*Unio siamensis*, Lea, Proc. Ac. Nat. Sci., Philad., X. 1866, p. 133, Jl. Ac. Nat. Sci., Philad., VI, 1868, p. 279, pl. xxxviii, fig. 93; Obs., XII, 1869, p. 39, pl. xxxviii, fig. 93, =*Margaron* (*Unio*) *siamensis*, Lea, Syn., 1870, p. 57.

Tenasserim, Lower Burma, Reg. No. $\frac{80.74}{1}$; Irrawaddy River at Sagaing (J. Coggin Brown), Reg. Nos. $\frac{87.89}{1}$—4.

82*a*. Var. **subclathratus**, von Martens, Arch. für Naturg., p. 44, pl. vi, fig. 3.

Sheinmagah, Shwebo Dist., Burma, Reg. No. $\frac{85.63}{1}$.

83. **Trapezoideus pallegoixi** (Sowerby), Simpson, Syn. Naiades, Proc U. S. Nat Mus., XXII, p. 859,=*Anodon pallegoixi*, Sowerby, Conch. Icon., XVII, 1867, pl. xvii, fig. 17,=*Anodonta pallegoixi*, Clessin, Conch. Cab. Ano., 1876, p. 210, pl. lxiv, fig. 6.

Siam, Reg. No. $\frac{80.01}{1}$.

84. **Trapezoideus exolescens** (Gould), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 859,=*Unio exolescens*, Gould, Proc. Bost. Soc. Nat. Hist., 1843, p. 141; Hanley and Theobald, Conch. Ind., p. 43, pl. cvii, fig. 5,=*Margaron* (*Unio*) *exolescens*, Lea, Syn., 1852, p. 32; 1870, p. 51.

Bhamo, Reg. No. $\frac{85.65}{1}$.

Genus **Arconaia**, Conrad, 1865.

85. **Arconaia lanceolata** (Lea), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 860,=*Triquetra lanceolata*, Lea, Proc. Ac. Nat. Sci., Philad., VIII, 1856, p. 79,=*Hyria lanceolata*, Lea,

Proc. Ac. Nat. Sci., Philad., 1856, p. 300,=*Arconaia lanceolata*, Conrad, Am. Jl. Conch., I, 1865, p. 234,=*Triquetra contorta*, Lea, Proc. Ac. Nat. Sci., Philad., VIII, 1856, p. 300; Obs., VI, 1857, p. 39, pl. xxxiii, fig. 33,=*Hyria contorta*, Sowerby, Conch. Icon., XVII, 1869, pl. i, figs. 2*a*, 2*b*,=*Margaron* (*Triquetra*) *contorta*, Lea, Syn., 1870, p. 26,=*Unio contortus*, Heude, Conch. Fluv, Nank., 1877, pl. xv, fig. 31.

Lake Tungling, China, Reg. No. $\frac{1878}{5}$.

Photo. by A. C. Chowdhury

1.

3.

4.

2.

5.

6.

1, 2. Unio modiola. 3, 4. Nodularia (Nodularia) pecten. 5, 6. Unio perakensis.

Engraved by Derby

MISCELLANEA.

GENERAL.

MALARIA MORTALITY IN THE FRINGE AREA OF CALCUTTA.—On p. 98 of Mr. C. A. Paiva's "Materials for a Survey of the Mosquitoes of Calcutta" (Rec. Ind. Mus , vii, 1912, pp. 93—98) it is stated that, as far as Calcutta is concerned, malaria is most common in the fringe area. Dr. Pearse, Calcutta Health Officer, writes informing us that, so far as can be judged from the death-rate per 1,000 from the disease, this had just ceased to be the case when the survey was instituted. He attributes the improvement largely to the drainage scheme commenced in 1909, and observes that "since 1908 the fringe area has compared very favourably with the eastern and southern wards of the city." Mr. Paiva tells me, moreover, that his record of adult malaria-carrying mosquitoes from this area is based on specimens collected prior to the initiation of the mosquito survey.

F. H. GRAVELY.

INSECTS.

ON THE LARVAL HABITS OF *Toxorhynchites immisericors*.—In Mr. Brunetti's supplementary Catalogue of Oriental Culicidæ (Rec. Ind. Mus., vol. iv, No. x) I find a statement attributed to me with which I am not entirely in agreement.

On page 436, under *Toxorhynchites immisericors*, I am represented as asserting that "the larvæ prey first upon those of their own race before proceeding to devour those of other species," and again "Mr. E. E. Green thought it eats its own species first."

I was puzzled, for some time, to understand how or where I could have said anything to give rise to this impression, until—on looking through my early paper on the life history of this insect ('Spolia Zeylanica,' vol. ii, pp. 159 to 164)—I found the following sentences:—"Confirmation of the supposed carnivorous habit was soon forthcoming: firstly, by the rapid disappearance of most of the young larvæ while the remainder waxed fat, and secondly, by the detection of one larva in the act of devouring a comrade the same size as itself." . . . . . "Though well supplied

with *Culex* larvæ, the young *Toxorhynchites* continued to prey upon each other until but a single survivor remained in each vessel. Having a habit of backing blindly about in the water, they sooner or later come within reach of the jaws of their companions."

As these remarks appear to be susceptible of an interpretation that was never intended by their author, I should like to take this opportunity of explaining them more fully.

With regard to the earlier paragraph, until their carnivorous proclivities had been definitely proved, the newly-hatched larvæ were crowded together in a single vessel, without those of any other species. They had therefore no choice but to devour each other—or starve.

In the second paragraph, I thought that the concluding sentence sufficiently explained the disappearance of the *Toxorhynchites* in spite of the presence of other *Culex* larvæ.

My experience was certainly not that of Mr. Paiva, who found "that the larva will devour that of any other species, if present, before attacking those of its own kind."

I do not, for a moment, suppose that *Toxorhynchites* larvæ prefer to feed upon members of their own species; but I am equally doubtful of their preference for those of other species. I am inclined to believe that it is a matter of complete indifference to them and that the choice of prey is guided simply by opportunity. Their jaws instinctively close upon any wriggling creature that comes within reach—be it one of their own or an alien race. The more sluggish habit of the *Toxorhynchites* renders it a more easy prey, especially when combined with its habit of backing about on the surface of the water.

The fact remains that, in any restricted collection of water—such as the cup of a broken bamboo stem, it is seldom that more than a single fully-developed *Toxorhynchites* larva can be found, amongst a crowd of other Culicid larvæ.

E. Ernest Green.

Peradeniya, 15*th May*, 1912.

CRUSTACEA.

East Asiatic species of *Apus*.—When writing my notes on this subject (Rec. Ind. Mus., vi, 1911, p. 357) I was unable to give any references to *Apus granarius*, Simon. For the following I am indebted to Dr. W. T. Calman:—

Apus granarius, Simon, Ann. Soc. entom. France, ii, 1886, p. 446, and G. O. Sars, Ann. Mus. Zool. St. Petersburg, vi, 1901, p. 133, pl. i, pl. ii, figs. 1—12.

The species was first described from specimens found in the neighbourhood of Pekin, while the examples subsequently examined by Sars were obtained at several localities in Eastern Mongolia.

I have recently had opportunity of consulting Packard's full description of *Apus himalayanus* (Hayden's Ann. Rep. U. S. Geol. Survey for 1873, Washington, 1874, p. 327, pl. xvi, figs. 5, 5*a*), but I am still not convinced that the form is really distinct from *A. cancriformis*.

STANLEY KEMP.

XXIX. NOTES ON THE SURFACE-LIVING COPEPODA OF THE BAY OF BENGAL, I AND II.

By R. B. SEYMOUR-SEWELL, *B.A., Capt., I.M.S., Surgeon-Naturalist to the Marine Survey of India, and Offg. Professor of Biology, Calcutta Medical College.*

(Plates xiv—xxiv).

INTRODUCTION.

Up to the present time, our knowledge of the species and distribution of surface-living Copepoda in the Bay of Bengal is confined to a paper by the late Mr. I. C. Thompson, who worked out a collection made by Captain Wyse of the S. S. "Johannesburg" during a voyage from Delagoa Bay to Calcutta ("Report on two collections of Tropical and more northerly Plankton." I. C. Thompson, F.L.S., *Trans. Liverpool Biol. Soc.*, vol. xiv, 1899-1900). Several extensive collections have, however, been made in neighbouring waters and the results are contained in the following papers:—

(1) The Siboga collection, from the region between Borneo on the west and New Guinea on the east. The Copepoda of the "Siboga" Expedition. A. Scott. Leyden, 1909.

(2) The collection made by Professor Herdman around Ceylon and worked out by I. C. Thompson and A. Scott. The Ceylon Pearl Oyster Fisheries and Marine Biology, pt. i, 1903. London.

(3) The collection made by Professor S. Gardiner in the Maldive and Laccadive Archipelagoes and worked out by Dr Wolfenden. The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, 1903-1906. Cambridge.

In addition to these I must mention other minor collections described in the following papers:—

(4) Giesbrecht: Ueber pelagischen Copepoden des Rothen Meeres: Zoologische Jahrbucher, Syst. Abth., Band ix, 1897. Jena.

(5) Cleve: Planktonic organisms from the Indian Ocean and Malay Archipelago. Kong Sv. Vet. Akad. Handlingar, Bd. 35, No. 5, 1901-02. Stockholm.

(6) A. Scott: Some Red Sea and Indian Ocean Copepoda. Trans. Liverpool Biol. Soc., vol. xvi, 1902 Liverpool.

(7) Cleve: Record of a voyage made by Thorild Wulff to and from Bombay. Arkiv for Zoologi, Band i, 1903-04. Stockholm.

During the early months of 1911 and again in November of the same year the R.I.M.S. "Investigator" was carrying out a survey of the coast of Burma, and advantage was taken of the opportunity thus offered to make a collection of the free-living Copepoda that frequent the surface waters of this region.

There was also in the Indian Museum a large collection made some years previously by the "Investigator" in the region of the coast off Chittagong; these collections have been worked out and the results are embodied in the following paper.

For purposes of convenience I have divided the collections into two series, the first comprises those from the Chittagong region and the Rangoon River estuary, while the second deals with the collections made further south in the neighbourhood of the Moscos Islands and the mouth of Tavoy River.

I.—The Gymnoplea of the Chittagong and Rangoon River Estuaries; with notes on the application of "Brooks' Law" to the Copepoda and evidence of Dimorphism in this group of Crustacea.

As regards the collection from the Chittagong region there is unfortunately no indication of how the collection was made, and whether or not it is composed of the results from several surface trawls or only a single one, nor is there anything to indicate at what time of the year it was taken; it is probable however that the collection was made in 1903 during the months of January to March as that was, I believe, the last occasion on which the R.I.M.S. "Investigator" was surveying in that locality.

The collection from the Rangoon River estuary was made on three consecutive nights by means of a surface tow-net allowed to drift with the tide. The resulting catch was extremely copious, though subsequent examination showed that the actual number of species represented was small; but this lack of variety was amply compensated by the fact that out of a total of seven (or possibly eight) species five were new to science and as regards the *Labidocera euchaeta*, Giesbrecht, not only was the corresponding male, hitherto unknown, present in large numbers, but a probably dimorphic form was also obtained. The main bulk of the collection consisted of large numbers of *Acrocalanus inermis*, sp nov. and *Labidocera euchaeta*, Giesbrecht, in various stages of development, and a study of these forms and the various changes that take place during the growth of these two species has led to results of very considerable interest. So many external factors such as temperature, salinity, or food supply, may possibly produce varia-

tion in the developmental changes that it is only in such cases as this, where a large number of stages can be obtained at the same time and place, that one is able with comparative ease to carry out investigations regarding the laws of development. The locality where the collection was made is situated at the mouth of the river close to the fairway buoy ("Investigator" station 394, 16° 16′ 00″ N., 96° 21′ 00″ E., 13-xi-1911), and hydrometer readings showed that the density of the water was very low, the average reading being 1002.

In the following table I have given a list of the Copepoda (Gymnoplea) present in the two collections, and a comparison of the two faunas indicates that the collection from Chittagong was probably made further out to sea, where there was greater admixture of the estuarine and truly marine forms than in the Rangoon River estuary.

RANGOON RIVER ESTUARY.	OFF CHITTAGONG.
Acartia spinicauda, Giesbrecht.	*Acartia spinicauda*, Giesbrecht.
Acartia tortaniformis, sp. nov.	*Acartia tortaniformis*, sp. nov.
Acrocalanus inermis, sp. nov.	*Acrocalanus gibber* (Giesbrecht).
Centropages alcocki, sp. nov.	*Acrocalanus inermis*, sp. nov.
Labidocera euchaeta, Giesbrecht.	*Canthocalanus pauper* (Giesbrecht).
Paracalanus dubia, sp. nov.	*Candacia bradyi*, Scott.
Pseudodiaptomus binghami, sp. nov.	*Centropages notoceras*, Cleve,[1] (? = *dorsispinatus*, Scott and Thompson).
	Centropages furcatus (Dana).
	Centropages orsinii, Giesbrecht.
	Centropages tenuiremis, Thompson and Scott.
	Eucalanus monachus, Giesbrecht.
	Euchaeta concinna, Dana.
	Labidocera acuta (Dana).
	Labidocera euchaeta, Giesbrecht.
	Labidocera kröyeri (G. Brady).
	Labidocera minuta, Giesbrecht.
	Paracalanus aculeatus, Giesbrecht.
	Paracalanus serratipes, sp. nov.
	Pontella andersoni, sp. nov.
	Pontellopsis regalis (Dana).
	Undinula vulgaris (Dana).

[1] I am somewhat doubtful about these species. Cleve apparently considered them synonymous, but both accounts differ in certain details and a consideration of the matter will be found below, in the second paper dealing with the Copepoda from the Moscos region.

I have embodied the results obtained in the following paper and for the sake of convenience I have divided it into two parts dealing respectively with the developmental changes in certain species and with a full description of the new forms obtained.

1. DEVELOPMENT.

From time to time results have been published showing that in certain members of the Crustacea the animal during the course of its development, as each succeeding growth-moult takes place, increases in size by a definite proportion.

W. K. Brooks (1886, p. 105) was the first to show that such a mathematical relationship existed between the successive larval stages of the Stomatopoda.

Hadley (1906) has shown that a similar condition of affairs is met with in the American lobster, *Homarus americanus*, Milne Edwards. Unfortunately I have not been able to see this paper, but Herrick (1911, p. 362), in his work on the natural history of this animal, has reprinted Hadley's results. In the table given he shows that during the earlier moults the growth-factor is 1·18 and that after the 17th moult this gradually diminishes.

Fowler (1909) has also shown that in all probability the same condition of affairs exists in the case of *Carcinus maenas*, but his chief contribution deals with a group of the Ostracoda, the Halocypridae. He has shown that here also, at each successive moult, there appears to be a definite increase in the size of the animal and he has formulated the following law which he proposes to call "Brooks' Law," that "during early growth each stage increases at each moult by a fixed percentage of its length, which is approximately constant for the species and sex." By applying this law, he has shown that as far as this group of the Ostracoda are concerned, it would appear highly probable that every species possesses two dimorphic forms corresponding to the two final sexually mature stages.

With a view to testing whether the Copepoda followed the same law, I carried out a number of measurements of the various stages in the species *Labidocera euchaeta*, Giesbrecht, *Acrocalanus inermis*, sp. nov., and *Pontella andersoni*, sp. nov. The measurement taken was the total length from the most anterior part of the head to the tip of the furcal rami, and the results were plotted out as shown in the following text-figures, the females being to the left and the males to the right of the middle line.

(*a*) **Labidocera euchaeta**, Giesbrecht.

In this species I have been able to obtain a fairly extensive series of measurements, covering six successive stages of growth in the female and four in the male. Of these stages, stage 2 and all below it undoubtedly were those of *Labidocera euchaeta*, but as regards stage 1, I was for some time of opinion that I was here deal-

ing with a new species; but on measuring these examples and plotting the results obtained with those of the undoubted examples of *L. euchaeta*, I found that they formed a mathematically exact continuation of the series. As, in addition, these examples have only been obtained in association with large numbers of *L. euchaeta*, and a prolonged search has failed to reveal any immature forms other than those of *L. euchaeta* that could correspond with this type, I have come to the conclusion that we have here in the Copepoda an exactly similar state of affairs to that which has been shown by Fowler to exist among the Ostracoda (Halocypridae). The actual measurements of all the examples in each group are shown in text-figure I.

It is at once evident that the different measurements fall into a series of groups, each having a normal curve of variation, and although the extremes of variation of successive groups may to some extent overlap yet each shows a very definite mean.

Taking first the growth stages of the female, the mean length measurement at each successive moult is given below and for purposes of comparison I have also given the lengths calculated from the smallest stage by multiplying each stage by the growth-factor.

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 6	0·593	0·593	1·4
,, 5	0·844	0·830	1·4
,, 4	1·168	1·162	1·4
,, 3	1·620	1·627	1·27
,, 2	2·054	2·066	1·27
,, 1	2·639	2·624	

From the above it would appear that during the early moults the growth-factor is 1·4, whereas in the last two moults this factor falls to 1·27.

This drop in the factor is of some interest inasmuch as it has not been found to exist in the Ostracoda, though it undoubtedly is a feature in the growth stages of some of the higher Crustacea.

Turning now to the consideration of the males I found that, previous to stage 4, it was quite impossible to differentiate between the two sexes, and hence the growth moults can only be studied from that point.

The mean length-measurements of the various stages of the male are as follows, and here again I have given the calculated measurement for comparison.

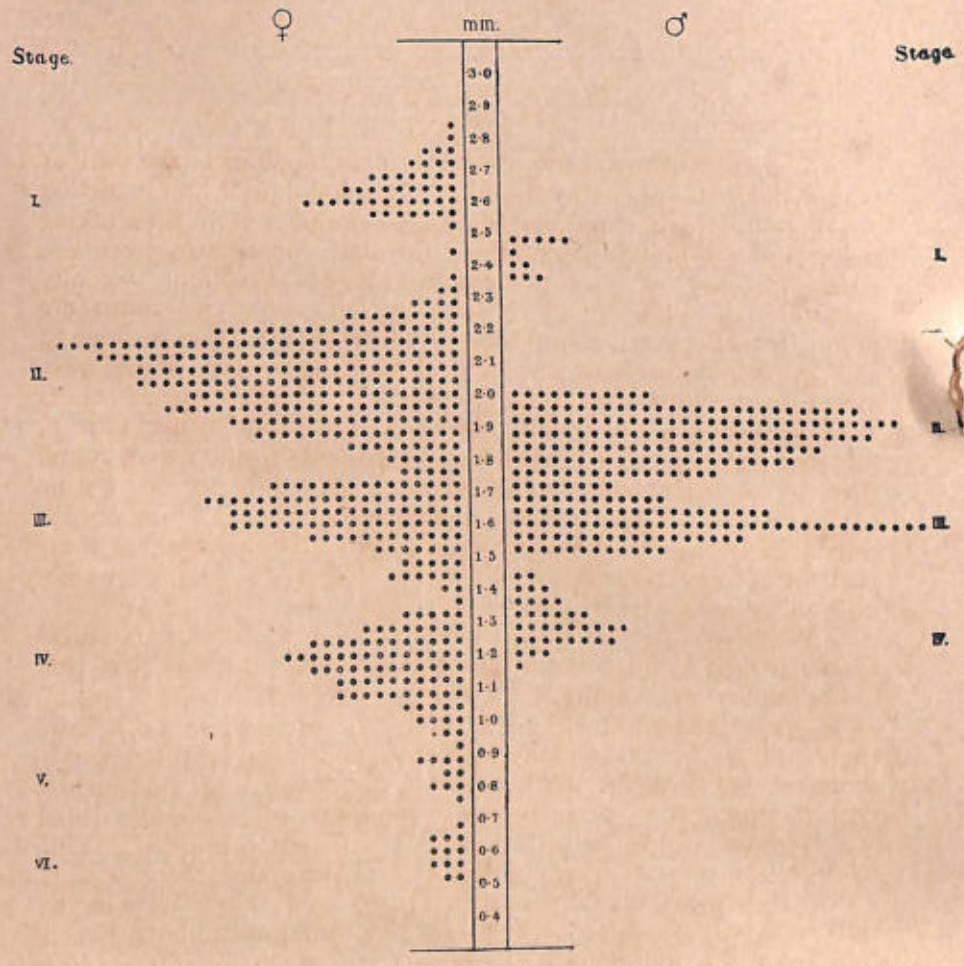


FIG. 1.—Measurements of 808 specimens (500 ♀ : 308 ♂) of *Labidocera euchaeta* from the Rangoon River Estuary.

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·844	0·844	1·5
,, 4	1·295	1·266	1·5 or 1·27
,, 3	1·611	1·608	1·5
,, 2	1·880	1·899	....
,, 1	2·429	2·412	....

At first sight the observed length measurements of the various stages did not appear to fit into "Brooks' Law," but a further study revealed the fact that at stage 4 we have a division taking place and an individual may go through one of two processes, either he may at once proceed to stage 2 becoming sexually mature in a single moult or he may have an extra immature moult, reaching stage 3, and then by a final moult attain to stage 1. The growth-factor between stages 5 and 4 is 1·5, and at the next moult some with the same growth-factor reach stage 2, others have an intermediate moult, the growth-factor of which is 1·27, (i.e. the same as that for the final two moults in the females) and then by a final moult having again a growth-factor of 1·5 he reaches stage 1. The number of examples of stage 1 was always considerably less than that of stage 2, and it is possible that these two forms may be seasonal dimorphic forms, the one a summer and the other a winter form.

As regards the structural characters of these various stages I have given a detailed description below; suffice it to say here that in both males and females, the last two stages only (stages 1 and 2), as in the Halocypridae, are sexually mature and in both cases there are, as I have already indicated, considerable differences in structure between the invididuals of the two groups, so much so that if only a few specimens had been met with I should without any hesitation have described them as different species. This difference was most marked in the case of the males, those of stage 2, which become sexually mature direct from stage 4, being totally different as regards their grasping antennae and 5th pair of legs from the individuals of stage 1, in which an intermediate moult is carried out.

In order to check the results, I carried out a further series of measurements on specimens obtained in a tow-netting taken off Chittagong (approximately 620 miles away) in which the same forms were present. I obtained exactly similar results, and the measurements found are shown in text-figure II.

In the table below I have again given the average length-measurements of the various stages, as found, and the calculated size for reference.

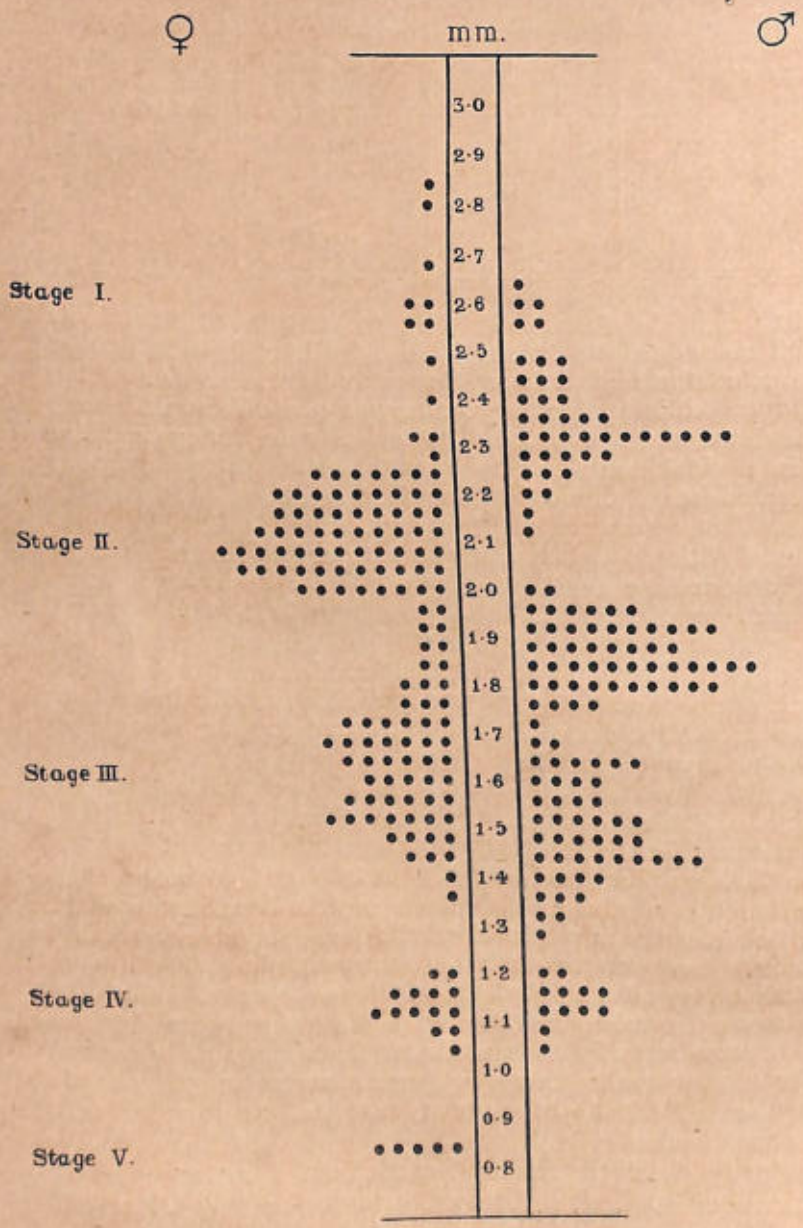


FIG. 2.—Measurements of 303 specimens (153 ♀ : 150 ♂) of *Labidocera euchaeta* from Chittagong.

♀

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·840	0·840	1·4
,, 4	1·131	1·176	1·4
,, 3	1·620	1·646	1·27
,, 2	2·114	2·090	1·27
,, 1	2·640	2·654	....

♂

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5 .. .	0·84	0·84	1·5
,, 4	1·137	1·26	1·5 or 1·27
,, 3	1·502	1·60	1·5
,, 2	1·868	1·89	....
,, 1	2·342	2·40	....

Here again we find exactly the same growth factors and the same dimorphic condition in the males, and from this it would appear by no means improbable that the growth factors remain constant for a given species under altered conditions, variations in the food-supply, etc., merely causing changes in the number of moults carried out in any given period of time.

(*b*) **Acrocalanus inermis,** sp. nov.

A considerable number of examples (367) were measured and the results obtained were plotted out as before (text-figure III).

In this species I was only able to obtain a series of four growth stages in each sex and the final sexual stage, stage 1, was not represented; but so far as these moults go they confirm the results obtained in the previous species.

In the female the observed and calculated sizes for the various moults agree even more closely than in *Labidocera cuchaeta.*

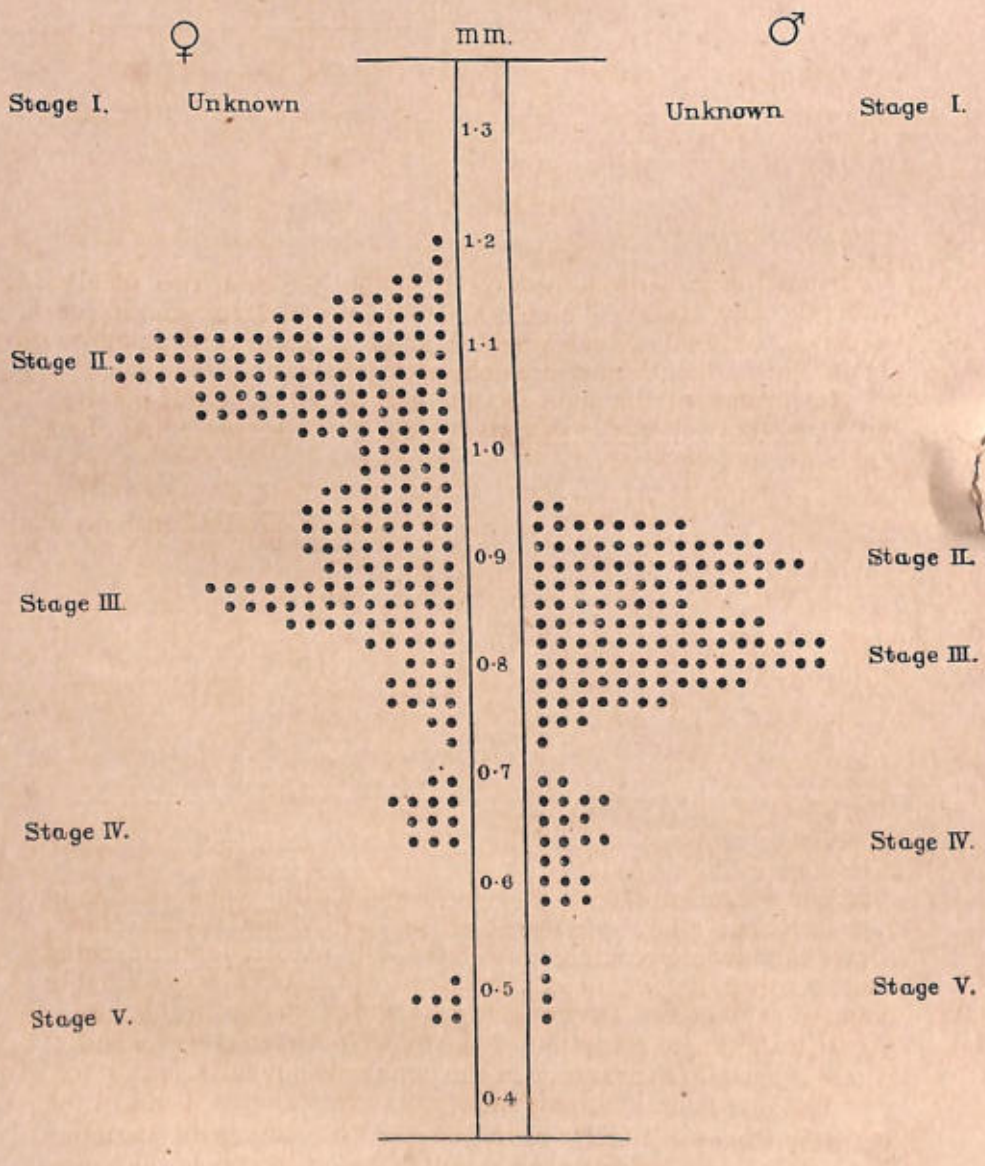


FIG. 3.—Measurements of 367 specimens (222 ♀ : 145 ♂) of *Acrocalanus inermis*, sp. nov.

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·49	0·49	1·355
,, 4	0·66	0·664	1·355
,, 3	0·90	0·900	1·208
,, 2	1·08	1·087	1·208
,, 1	Unknown	1·313	....

Here the growth-factors are 1·355 for the first two moults, while the last observed moult had a factor of 1·208 and in consequence the final sexual stage or stage 1, at present unknown, should have a length measurement of 1·313.

In the case of the male also the last sexual stage was missing, but the observed and calculated sizes for the preceding four stages are as follows :—

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·51	0·51	1·3
,, 4	0·63	0·66	1·3 or 1·208
,, 3	0·81	0·80	1·3
,, 2	0·86	0·86	....
,, 1	Unknown	1·04	....

The stage growths here follow exactly the same rule as in *Labidocera euchaeta*. At stage 4 we get a division taking place; some individuals becoming at once sexually mature and reaching stage 2, others having an extra moult to stage 3 before presumably doing so at stage 1. The characteristic growth-factor in this case is 1·3 with the single exception of the moult between stages 4 and 3, where it again is the same as in the final female moults, *viz.*, 1·208.

The text-figure does not show any very definite demarcation between stages 2 and 3, owing to the two curves of variation overlapping to a considerable extent; these two stages, however, can be easily recognized by their structural characters (*vide infra*).

(*c*) **Pontella andersoni**, sp. nov.

A fairly large number of individuals of this species were obtained from the tow-netting taken off Chittagong. I have, how-

ever, only been able to obtain three definite growth stages in either sex and although these follow "Brooks' Law" closely yet, as regards the female stages, this species differs in one respect from those of the other species measured.

The actual measurements are plotted out in text-figure IV, but owing to insufficient numbers the last stage of the female and the first of the male do not form very distinct groups.

The average sizes of each group, as found from the actual measurements and those calculated from the smallest stage obtained, are given below :—

♀

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 4	1·991	1·99	1·29
,, 3	2·575	2·57	1·29
,, 2	3·34	3·31	1·29
,, 1	Unknown	4·27	....

As in the case of the other species only specimens from stage 2 were sexually mature. A peculiarity of the growth of this species is that there is no diminution of the growth-factor for the last two moults.

In the case of all the other species that I have examined the growth-factor drops when stage 3 has been reached, and the last two sexual moults are characterized by a smaller increase in size, but here there is no indication of such a change.

In the case of the male also only the penultimate form was obtained. The table below shows the actual and calculated sizes of the various moult-stages.

♂

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 4	1·825	1·825	1·29 or 1·57
,, 3	2·343	2·354	1·57
,, 2	2·859	2·865	....
,, 1 .. .	Unknown	3·696	....

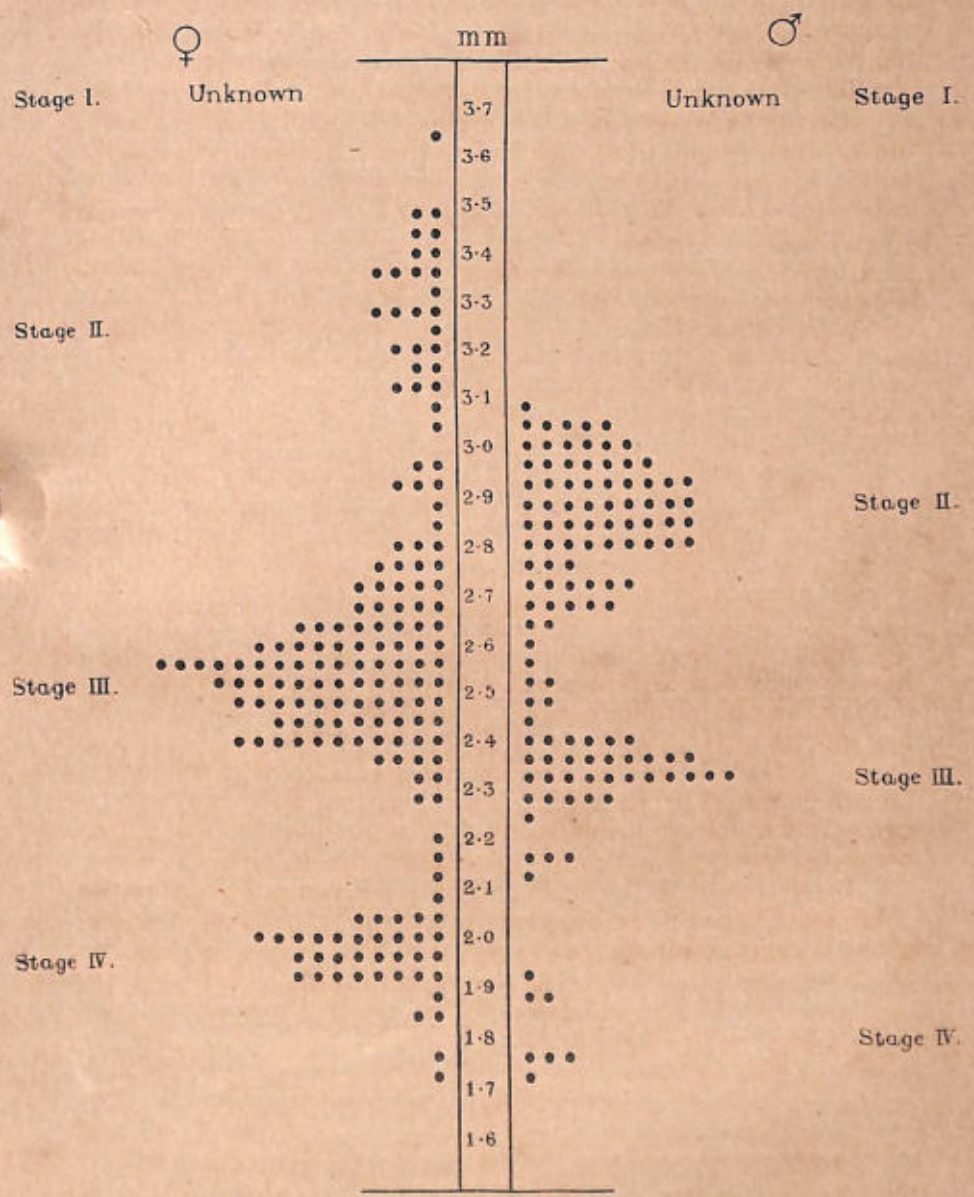


FIG. 4.—Measurements of 296 specimens (175 ♀ : 121 ♂) of *Pontella andersoni*, sp. nov.

As in the other cases we have two growth-factors for stage 4. Some individuals by a factor = 1·57 attain sexual maturity direct and reach stage 2, the remainder have a growth factor = 1·29 (the same as for the female) and thus reach stage 3, whence by a factor of 1·57 they should attain stage 1. Unfortunately no examples were obtained of this stage, but calculation shows that it should have a length of 3·69 mm., while the final stage of the female should be 4·2 mm. in length.

During the last few weeks a further series of tow-nettings has been received. These were taken in the region at the mouth of Tavoy River (*vide infra* plate xiv), and their chief interest and importance lies in the fact that they contain large numbers of *Paracalanus aculeatus* Giesbrecht, among which are numerous examples of the hitherto unknown male, a detailed description of which will, I hope, be published shortly.

A series of measurements of individuals of both sexes has been carried out and the results are given in text-figure V.

In the case of the female only two stages have at present been obtained, and these apparently correspond to the last immature stage (stage 3), and the first sexually mature form (stage 2); the members of this latter group correspond exactly with the description of *P. aculeatus* both as regards size and structure.

As is shown in the accompanying table, the growth-factor between these two stages is 1·284.

Paracalanus aculeatus ♀.	Observed size.	Growth-factor.
	mm.	
Stage 3 (?)	0·874	1·284.
,, 2 (?)	1·120	

The males fall into a series of four stages corresponding to stages 4 to 1. The individuals of stage 3 correspond exactly with the description given by Cleve (1901), so far as their structure is concerned, but are on the whole slightly smaller, measuring only 0·873 mm. as opposed to 1·1 mm. in his specimens.

Stage 2 corresponds exactly with the adult females, while stage 1 is slightly different, having a series of spines on the margin of the second joint of the exopod in the 2nd-4th pairs of legs.

The average measurements of these four stages are given below in the accompanying table.

Paracalanus aculeatus ♂.	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 4	0·667	0·667	1·45 or 1·284
,, 3	0·873	0·856	1·45
,, 2	0·996	0·967	....
,, 1	1·238	1·241	....

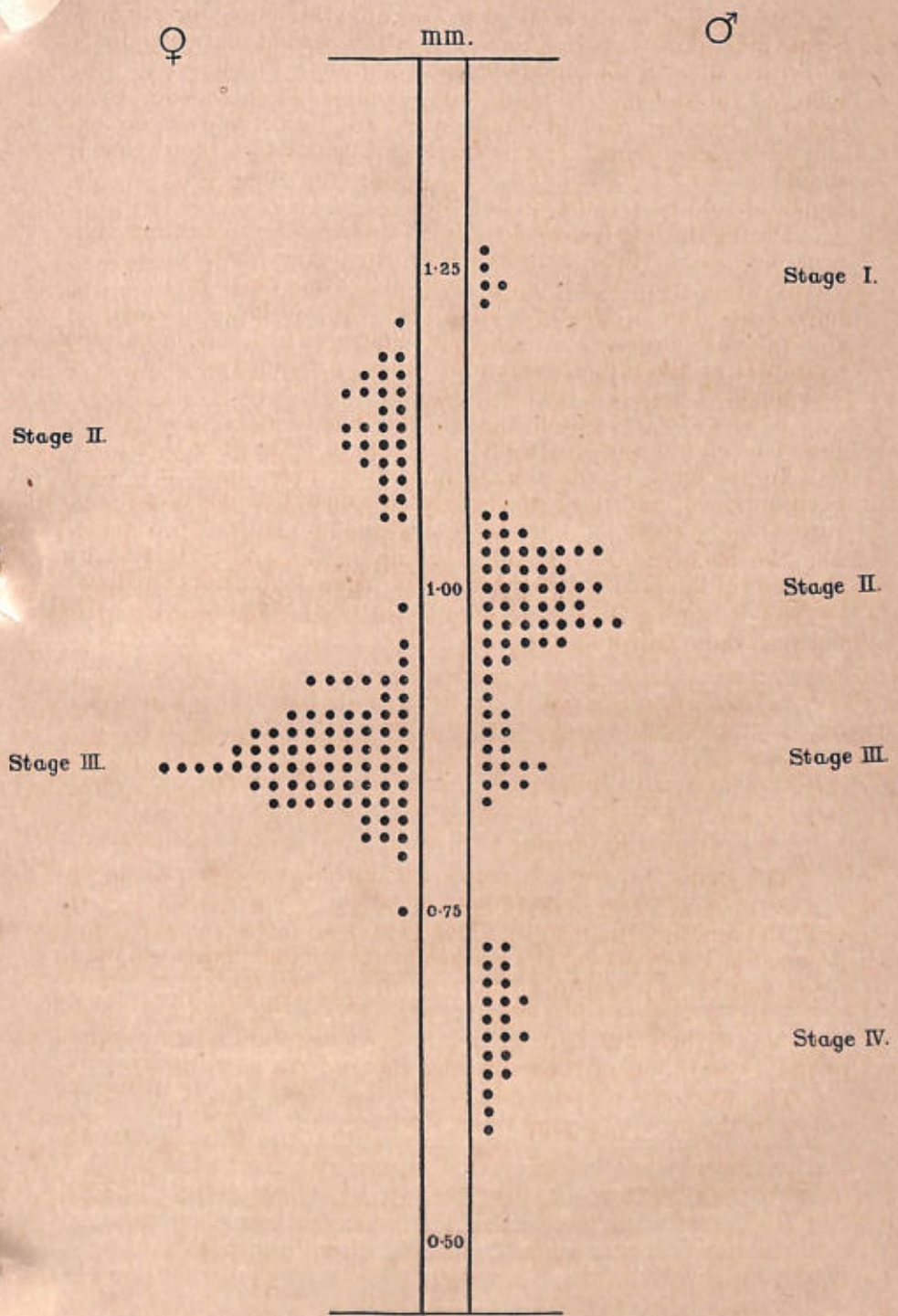


FIG. 5.—Measurements of 192 specimens (105 ♀ : 87 ♂) of *Paracalanus aculeatus* from Tavoy River Estuary.

Here again we see that from stage 4, an individual may either attain sexual maturity (stage 2) in a single moult having a growth-factor of 1·45, or may, by a moult with a growth the same as that of the female, *viz.*, 1·284, reach stage 3 and then become mature (stage 1) by a moult with the typical factor for the male =1·45.

From the above it would appear that under certain conditions we may get two dimorphic forms in any species of Copepod.

Dimorphism in certain groups of the Arthropoda and especially in the Insecta is comparatively common, and several instances have been reported from the Crustacea, among which I may make mention of the dimorphic males in *Pandalus montagui*, Leach (= *P. annulicomis*). This was first noted by Calman (1899) and has since been confirmed and explained by Wollebaek (1908).

In this case the dimorphism affects only the 1st pleopod of the male and is merely a breeding and non-breeding form, that is to say the dimorphism is seasonal and is of the "facultative" type.

Another example of facultative dimorphism in the Decapoda has been described by G. Smith (1906) in two species of *Inachus* (*I. scorpio* and *I. thoracicus*) in which the great chelae are affected.

The type of dimorphism which appears to be present in *Labidocera euchaeta*, *Paracalanus aculeatus*, and possibly in all the species of the Copepoda does not, however, follow either of the above cases, and we have apparently a "high" and a "low" form in both males and females.

As I have already mentioned in the case of *Labidocera euchaeta*, it would appear that in the females growth takes place by a series of moults which follow "Brooks' Law" and the last two stages are sexually mature, thus giving rise to a "high" and a "low" form, which differ from one another not only as regards size but also in respect to certain structural characters, which, however, as I shall subsequently show, are caused by a direct continuation of those changes which are undergone by the individual during the various moults from the later Copepodid stages to the "low" or 1st sexually-mature form. In this respect the dimorphism agrees exactly with that described by Fowler (*loc. cit.*) as occurring in the Ostracoda.

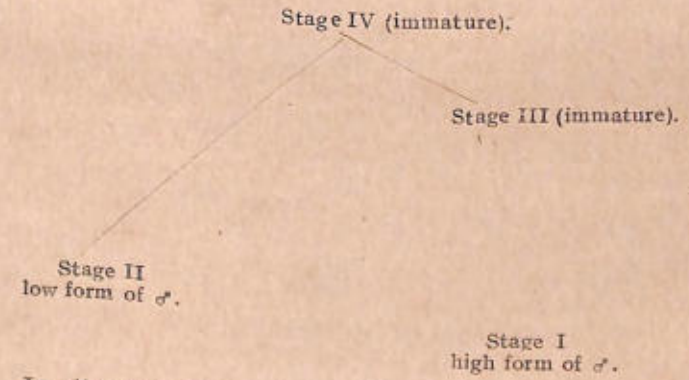
In the case of the males, however, the type of dimorphism is somewhat different and it would appear that the "low" sexually mature form (stage 2) does not directly give rise to the "high" form (stage 1). That is to say, the type of dimorphism is "definitive." Some factor, at present unknown but possibly seasonal, exercises an influence on a Copepodid form (stage 4) and determines which of the two forms shall be finally adopted by the individual.

It may possibly happen that when circumstances such as food supply, etc., are favourable, as in the summer season, the

Copepodid stage can become at once sexually mature and thus give rise to the "low" form (stage 2). Whereas, in unfavourable surroundings an extra Copepodid stage is passed before the individual attains to the "high" form (stage 1). At any rate, if any reliance can be placed on "Brooks' Law," it appears probable that stage 1 never develops direct from stage 2. A similar type of dimorphism has been described by G. Smith (1904) as occurring in a species of Isopod, *Gnathia maxillaris*. In this case, starting from a normal segmented larva, we may get the course of development passing through a small '*praniza*' (1—4 mm. in length) to a small adult (= the "low" form), or on the other hand we may get a larger '*praniza*' (= 5—8 mm. in length) which finally gives rise to a large adult (= "high" form), and in this case also it appears certain that the one form is never derived direct from the other.

In the only two species of Copepoda in which I have been able to investigate all the later stages of the life cycle, *viz.*, *Labidocera euchaeta* and *Paracalanus aculeatus*, the males follow an exactly similar course, and the results obtained in the case of the other species which I have investigated tend to show that this condition of affairs is universal.

We may summarize these changes in the male Copepod as follows:—



In all cases where they have been obtained, examples of stage 1 were much less common than those of stage 2 or 3, and it appears probable that only a few individuals undergo this final moult.

Finally it would appear at least possible that in many instances so-called "species" of Copepoda, which are at present believed to be distinct, are in reality merely high and low forms of one and the same species, and further investigation may necessitate a linking of pairs of species, as is the case at present in the Ostracoda (Halocypridae).

One extraordinary feature in the above dimorphism of the males is the sudden assumption by certain individuals from stage 4 of the female growth-factor.

That the development of the external sexual characters in the Crustacea is largely, if not entirely, dependent on the development of the gonads cannot be denied and, in consequence, any circumstance that retards the full development of either ovary or testes will materially affect the assumption of the respective sexual characters. If from parasitisation or any other cause the sexual development of these organs is retarded we should expect to find that in the Copepoda, as in other groups of the Crustacea, there would be a corresponding modification in the development of the sexual characters; but in such a case we should further expect that if at a future date the animal recovered and developed its sexual functions the external characters of the sex would be less specialized than in the normal individual.

In the present cases the exact reverse is found, for the individuals of stage 1 (the "high" form), in the development of which the female growth-factor makes its appearance, are, besides being altogether larger and finer specimens, also more highly developed as regards their sexual appendages, to wit the grasping antenna and the 5th pair of legs, than is the case with examples of stage 2, the "low" form, in whose development the growth-factor is of the male type throughout. Consequently it would appear highly improbable that we are dealing here with the result of infection by a parasite.

Wollebaek (1909) has recently published observations tending to show that in certain deep-sea Decapoda the individuals are normally hermaphrodite but, in the absence of any observations on the development and structure of the gonads in these various growth-stages, any speculation with regard to the possibility of a similar condition occurring among Copepoda cannot be attempted.

2. SYSTEMATIC.

Family *CALANIDAE.*

Genus **Paracalanus.**

Paracalanus dubia, sp. nov.

Pl. xv, figs. 1—5.

Numerous specimens of a female of a species of *Paracalanus* were present, and at first sight I was inclined to regard them as examples of *P. crassirostris* (Dahl), but a further examination has revealed several differences and I have been forced to conclude that I was dealing with a new form. I have, therefore, given it the name *P. dubia.*

Total length 0·74 mm.

The head and 1st thoracic segment are fused together; the forehead presents a well-developed rounded bulge anteriorly and

terminates in a bifid rostrum, composed of two short, stout, blunt processes.

The thorax presents only three free segments as, in addition to the 1st, the 4th and 5th segments are fused together.

The abdomen consists of four segments of which the 2nd and 3rd are quite short, closely resembling those of *P. crassirostris*. The 1st segment is symmetrical and presents a well-marked genital swelling ventrally. The furcal rami are symmetrical, twice as long as broad, and terminate in four setae of nearly equal length. The proportions of the segments and furca are 15 : 5 : 5 : 10 : 8.

The *1st antennae* reach to the middle of the abdomen; they are composed of 24 free joints having the following relative proportions:—

Segments—

1-2	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
20.	5.	4.	4.	4.	4.	4	4·5.	5.	5·5.	6.	6.	6.	6.	6.	6.	7.	8·5.	8·5.	8·5.	9.	10.	9.	10.

There is a transverse row of minute spines present on the posterior aspect of segments 2 to 9 inclusive.

The *2nd antennae and mouth parts* are similar to those of other members of the genus.

The *1st pair of legs*. The 1st basal segment bears several scattered delicate spines on its anterior surface. The 2nd basal bears an internal marginal seta. The exopodite consists of three segments, of which the 1st bears a small spine distally on its external margin. The 2nd is devoid of spines and the 3rd has the usual two marginal spines, and an end spine, which is extremely long and delicate and is equal in length to the whole exopodite. The endopodite consists of two segments, both devoid of spines.

The *2nd pair of legs*. The 1st basal carries an inner marginal seta and has delicate spines scattered over its anterior surface. The 2nd basal has no seta or spines. The 1st segment of the exopodite bears a corona of spines on its distal external border. The 2nd segment bears no spines in addition to the usual marginal one. The 3rd segment has a row of fine spinules, six to eight in number, on the proximal part of the margin and a corona of fine spines near the distal end; the terminal spine is nearly half as long again as the end segment. The endopodite is three-jointed and has a group of four long slender spines on the posterior aspect of the 2nd joint.

The *3rd and 4th pairs of legs*. In both there is a row of spinules on the proximal part of the margin of exopod 3, and a few on exopod 2, and the 2nd joint of the endopodite has a group of four spines on its posterior surface. The 3rd leg differs from the 4th, however, in that the 1st basal bears a few scattered spines on its anterior surface which are absent on the 4th leg.

The *5th pair of legs*. These are composed of two joints, the terminal joint bears two end spines, one long and the other quite short. The longer spine bears to the end joint the proportional lengths of 7 : 10, and the margin is serrated so that in reality it is

a saw rather than a spine. In addition there is a corona of spinules on the posterior aspect of the 2nd segment near the distal border.

As will be seen the points in which the present specimens differ from *P. crassirostris* are:—

1. The absence of spines on the margin of exopod 2 of the 2nd leg.
2. The absence of spines on the posterior aspect of exopod 3 of the 3rd and 4th legs.
3. The serrated saw on the 5th pair of legs.
4. The shorter terminal joint of the 1st antennae.

No corresponding males were found in the collection.

Paracalanus serratipes, sp. nov.

Pl. xv, figs. 6–10.

Several specimens were obtained off Chittagong associated with numerous specimens of the preceding species which they fairly closely resemble, especially as regards the proportions of the body and the 5th pair of legs; they differ, however, both as regards size and in the spinulation of the swimming legs.

As I have already pointed out, it would seem probable that for every species proper we have two forms, a first and a second sexual stage such as have been shown to exist among the Ostracoda, and I am inclined to think that this form may be the later sexual stage of *P. dubia*, but this is only a matter of opinion and I have therefore given it the above "specific" name.

♀ Total length 1·1 mm.

The body and abdomen were similar to *P. dubia* and the relative proportions of the latter were 22: 12: 11: 18: 10.

The *1st antennae* reach to the middle of the abdomen and consist of 23 free joints, the 1st and 2nd and the 8th and 9th segments being fused; the relative proportions of these joints are as follows:—

Segments—

1-2.	3.	4.	5.	6.	7.	8-9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
35.	11.	11.	12.	12.	12.	14.	8.	8.	10.	11.	12.	12.	12.	12.	12.	13.	13.	13.	15.	13.	15.	15.

Segments 2 to 9 inclusive all bear a transverse row of fine spines on their posterior surfaces close to the distal border, and on segments 10 to 24 there are longitudinal rows of spines as in *P. aculeatus*.

Practically the only difference between these two species, as regards the 1st antenna, is in the length of the end segment.

The *2nd antennae and mouth-parts* are as in other members of the genus.

The *1st pair of legs*. The 1st basal segment bears a few spines on its anterior surface. The exopodite is three-jointed and the 1st joint bears a small transverse row of spines on its distal

external margin, and the 2nd joint is devoid of spines. The endopodite is two-jointed and bears no spines; the last segment bears 5 setae.

The *2nd pair of legs*. There are no spines on the basal joints. The segments of the exopodite have the usual marginal and end spines, and in addition the 1st segment of the exopod bears a transverse row of spines on its outer and posterior aspect. The 2nd segment bears a slightly oblique row of 4 spines posteriorly and the 3rd segment bears a corona of spines on its posterior surface.

The *3rd and 4th pairs of legs* are almost exactly similar. There are no spines on the basal joints. The 1st segment of the exopod bears a row of spines on the outer and posterior surface distally in the 3rd leg; this is absent in the 4th. The 2nd joint has a row of 4 spines posteriorly, and the 3rd joint has a corona of fine spines in addition to the marginal row. The 2nd joint of the endopodite has a row of spines on its posterior aspect and a transverse corona of spines on its outer and anterior surface.

In the 2nd—4th legs the endopod bears 2 setae on its 2nd and 7 on its terminal joint.

The *5th pair of legs* is the same as in *P. dubia*, but in a few specimens a third small segment was intercalated between the usual two.

♂ Total length 1·1 mm.

The cephalo-thorax is the same as that of the female. The abdomen consists of five segments and its length is contained 2·5 times in that of the cephalo-thorax. The proportional lengths of abdominal segments and furca are 10 : 20 : 16 : 16 : 12 : 10.

The rostrum consists of two short stout spines.

The *1st antennae* reach a point a short distance behind the posterior border of the 5th thoracic segment. As usual in adult males of this genus the basal segments are fused together, so that there are only twenty joints present. The relative lengths are as follows:—

Segments—																				
1-2.	3-6.	7-8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
33.	45.	21.	5.	6.	7.	8.	8.	10.	9.	11.	11.	11.	10.	11.	10.	11.	11.	11.	8.

The *2nd antennae* resemble those of the male of *P. parvus*, and the exopodite terminates in a nipple-like projection.

The *1st pair of legs*. There appear to be no spines on the 1st basal joint; basal 2 as usual bears an internal seta. The 1st joint of the exopodite has no marginal spine, the 2nd carries a transverse row of small spines and the 3rd has a row of delicate spines on the proximal part of the external margin. The terminal spine is long and slender, being longer than the whole exopodite.

The *2nd—4th pairs of legs* are the same as in the female.

The *5th pair of legs*. As usual that of the left side is considerably the larger and possesses four segments in addition to the enlarged basal portion. The proportional lengths of these seg-

ments are 15: 18: 16: 12. The penultimate joint bears a distal spinous process and the last joint terminates in two processes of unequal length. The right leg has only three segments and terminates in two short processes.

These specimens very closely resemble *P. aculeatus*, especially as regards the spinulation of the legs, but they differ markedly in the length of the antennae and the structure of the 5th legs, and I conclude that they are a new species.

Note.—Since the above was written, other examples of this species have been obtained at the mouth of the Tavoy River, and it would appear probable that it is a regular inhabitant of estuarine waters in this region.

Genus **Acrocalanus.**

Acrocalanus inermis, sp. nov.

Pl. xvi, figs. 1—9.

As already mentioned a large number of specimens in various stages of development were obtained. As regards their general structure and appearance they agree very closely with other members of this genus; they have all five segments of the thorax separate; the 5th pair of legs is practically absent in the female and only the left one present in the male. They differ, however, in having no spines on the margins of the exopodite of any leg. I do not consider that this is sufficient ground for creating a new genus and propose to include this species under the name of *A. inermis*.

Stage 1. Unknown.

Stage 2.

♀ Total length 1·08 mm.

The head is separate from the 1st thoracic segment and terminates anteriorly, its bifid rostrum consisting of two sharply-pointed processes. The 4th and 5th thoracic segments are also separate and the posterior margin of the thorax is rounded and bears a row of small spines.

The abdomen consists of four segments and is contained 3 times in the length of the cephalo-thorax; the furcal rami are symmetrical and bear four terminal setae. The proportional lengths of the abdominal segments and furca are 24 : 14 : 11 : 18 : 12.

The *1st antennae* reach to the end of the furcal rami and consist of 23 separate joints; the 1st and 2nd segments are completely and the 8th and 9th partially fused together. The relative proportions are as follows :—

Segments—

1-2.	3.	4.	5.	6.	7.	8-9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25
35.	9.	9.	9.	9.	10.	15.	8.	8.	9.	10.	11.	11.	11.	11.	11	12.	12.	12.	10·5.	12.	11.	12

Each of the 1st six segments bears a transverse row of very small delicate spines.

In *the 2nd antenna* the endopodite and exopodite are of nearly equal length, the former consists of seven segments and the whole closely approximates to the condition found in *Paracalanus parvus.*

The *mandible* is armed with a row of powerful teeth; they are not quite symmetrical, that of the left side having a small extra cusp on the large 1st tooth.

The *maxilliped* resembles that of *A. pediger*, Claus (*vide* Cleve, 1901, pl. i, fig. 9).

The *1st pair of legs* consists of the usual 3-jointed exopod and 2-jointed endopod; the 1st segment of the exopod has no large marginal spine, but its place is taken by a short transverse row of small spinules; the 2nd joint is also devoid of spines but its outer border is fringed with long hairs; the 3rd joint has two marginal and a long terminal spine, this last being twice as long as the segment. The 1st basal joint bears no inner seta and is beset with short stiff hairs. The 2nd basal bears a long inner seta.

The *2nd pair of legs*. Both endopodite and exopodite are 3-jointed. The 1st joint of the exopod has a transverse row of short spines near its distal extremity and a well-marked marginal spine. The 2nd joint has a well-developed marginal spine and an oblique row of 4 long spines on its posterior aspect, but no spinules on its margin. The 3rd joint has 2 outer spines and a terminal spine but no marginal spinules, it also has a transverse row of delicate spinules distally. The 2nd joint of the endopod has a row of small spinules on its anterior surface and an oblique row of long delicate spines posteriorly.

The *3rd and 4th pairs of legs* resemble each other and are devoid of the marginal spinules that are present in other members of the genus.

The *5th pair of legs* is practically absent, being only represented by short rounded unsegmented processes.

♂ Total length 0·86 mm.

The abdomen consists of 5 segments having, together with the furcal rami, the following proportional lengths 5 : 8 : 6 : 6 : 6 : 5, the last three abdominal segments being of equal length.

The *1st antennae* resemble those of *A. gibber* and *A. gardineri* in that the first six segments are fused together to form a solid mass, separated by a constriction from the remainder of the segments. Segments 7 and 8 are also fused and the relative proportions of the joints are as follows:—

Segments—

1-6	7-8.	9.	10.	11.	12.	13.	14.	15.	16.	17	18.	19.	20.	21.	22.	23.	24.	25.
52.	14.	4·5.	5·5.	6.	6·5.	7·5.	7·5.	8.	9.	9.	9.	9·5.	10.	10.	9·5.	10·5.	10.	6.

The *2nd antennae* differ from those of the female in that the last segment of the exopodite ends in a stump devoid of bristles.

A *5th leg* is only present on the left side and resembles that of *A. gardineri* in that it is composed of a basal portion and four joints. The last joint bears two terminal processes, one long and the other short, and the penultimate joint also bears a terminal spine.

Immature forms :—

In the younger stages of development we find that the males and females closely resemble one another, practically the only difference being the presence of the 5th leg; neither of the antennae showing, as yet, distinctive male features.

Stage 3. In both sexes the abdomen consists of four segments having, together with the furcal rami, the following proportional lengths :—4 : 6 : 5 : 9 : 5.

The *1st and 2nd antennae* are of the female type and with the exception of the 5th leg in the male all the other mouth parts and appendages are as in the adult.

The *5th leg* of the male is short, reaching only to the 2nd basal joint of the 4th leg and consisting of a basal portion and three joints having the proportional lengths 6 : 5 : 13. The last joint bears 3 spines, two terminally and one midway along the margin, at which point it also shows a slight constriction. From its appearance it is evident that at the next moult it will divide into two, to form the last two segments of the adult leg.

There is a very close relationship between the two genera *Acrocalanus* and *Paracalanus* and, from the study of these immature forms of the present species and examples of so-called adults of other members of these genera, it would appear that in mature males we get certain sexual characters in both 1st and 2nd antennae as well as in the 5th leg.

In *Paracalanus parvus*, *Acrocalanus pediger*, and *A. gardineri*, as well as in the present species, in sexually mature males we find that (1) the 1st antenna has a marked tendency towards the coalescence of the basal segments, (2) the distal part of the end segment of the exopodite of the 2nd antenna is rounded and nipple-like and is devoid of setae, (3) the abdomen consists of five fully-separate segments, and (4) the left leg consists of a basal portion and 4 segments, of which the terminal bears two and the penultimate a single spinous process.

Males have also been described in the case of *A. longicornis*, *monachus* and *gracilis* and *Paracalanus aculeatus*, but in all cases they present only four completely-separate abdominal segments; the antennae are of the female type and the 5th leg has only three separate joints apart from the basal portion and the terminal joint bears three spines. I therefore entirely agree with Wolfenden (1906, p. 1002) that in these instances the males were immature and a comparison of these forms with stage 3 of the above species shows that they are of corresponding ages.

Both Wolfenden (1906) and Cleve (1901) have described forms which they took to be females in which a small 5th leg was present belonging to the following species, *Acrocalanus longicornis*. *A. gracilis*, and *A. gibber* (by Wolfenden) and *Acrocalanus pediger* (by Cleve), but I am inclined to regard most, if not all, of these examples as immature males corresponding to stages 3 and 4 as described above.

NOTE.—Since the above was written Grandori (1912) has published a description of a new genus and new species of Copepod (*Piezocalanus lagunaris*). This is very closely related to *Paracalanus* and *Acrocalanus* and it is interesting to note that in this form also the mature males present the above characters.

Family *CENTROPAGIDAE.*

Genus **Pseudodiaptomus.**

Pseudodiaptomus binghami, sp. nov.

Pl. xvii, figs. 8—11.

A single specimen of a female was found which, while undoubtedly belonging to this genus, yet presents certain characters which indicate that it belongs to a species hitherto undescribed.

♀ Total length 1·3 mm.

The head was fused with the 1st thoracic segment, and thoracic segments 4 and 5 were also fused together. The posterior border of the thorax is rounded and bears a small spine near the dorsal surface. Anteriorly the head terminates in a small bifid rostrum.

The abdomen consists of four segments of which the 1st is considerably the longest; their relative proportions together with the furcal rami being 45: 25: 30: 12: 28. The 1st segment has two transverse rows of minute spines on its dorsal surface and a row of spines round the dorsal half of its posterior border; there is also a small blunt projection on the ventral aspect, behind the genital opening. The 2nd and 3rd segments also have a row of spines on the dorsal part of the posterior margin. The furcal rami are symmetrical and bear 5 short setae, of which the third is considerably wider than the others and is spear-shaped.

The *1st antennae* unfortunately have their terminal segments missing, only 18 being present; the relative lengths of these are as follows:—

Segments—

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18.
17. 10. 5. 6. 6. 9. 5. 5. 7. 10. 11. 12. 13. 14. 14. 14. 12. 14.

The *2nd antennae and mouth parts* are of the usual type, but the terminal joint of the endopod of the 2nd antenna bears a row of sharp spines.

The exopodite and endopodite of the *1st—4th pairs of legs* are 3-jointed and only bear two spines on the external margin of the last segment of the exopodite. There is no spine on the 2nd joint of the exopodite of the 1st leg.

The *5th pair of legs* is symmetrical, each consists of three segments; the 2nd bears a spine at its outer distal angle and the third segment terminates in four spines, three of which are short, but the fourth is very long and curved, being longer than

the combined length of the last two segments. All the spines have serrated margins.

At first sight this specimen appeared to be an example of *Pseudodiaptomus lobipes*, Gurney (1907, p. 27, pl. 1, figs. 3—5), but a closer comparison revealed several differences as regards the serration of the spines on the 5th pair of legs and the spinulation of the 1st abdominal segment, and the furcal setae are entirely different.

Unfortunately Gurney's type specimens appear to have been lost by him and have never been deposited in the Indian Museum, but I have examined other specimens from the original locality and have come to the conclusion that the specimen is not identical. I therefore propose to give it the above name after Lt. A. Bingham, R.I.M., who for many years has been 1st Lieutenant on the R.I.M.S. "Investigator" and has personally assisted in the collection of much valuable marine material.

Genus **Centropages.**

Centropages alcocki, sp. nov.

Pl. xvii, figs. 1—7.

Numerous examples of both males and females were present.

♀ Total length 1·2 mm.

The head and 1st thoracic segment are separate as also are the last two thoracic segments. The posterior border of the last segment is rounded and near the ventral border presents a short backwardly directed spinous process. The head is rounded anteriorly and terminates in a small bifid rostrum.

The abdomen possesses three segments and is symmetrical, the proportional lengths of segments and furca being 35 : 22 : 20 : 15. The 1st segment bears on each side a clump of small needle-shaped spines. The furcal setae are 5 in number and of these the 2nd is about twice the length of the others.

The *1st antennae* are short and do not reach to the end of the thorax; the proportional lengths of the segments are as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
15.	9.	3.	4.	4.	4.	4.	5.	5.	6.	6.	9.	13	14.	15.	16.	16.	17.	15.	11.	11.	7.	7.	12.

There are no spines on any of the proximal segments.

The *2nd antennae and mouth-parts* closely resemble those of *C. typicus*.

The *1st—4th pairs of legs* in their general structure resemble those of other members of the genus, but the terminal spines of the exopods differ from those of other species in that the armature of the saw is composed of a series of coarse teeth separated by comparatively wide intervals, more nearly resembling the condition found in *Temora*. The spine on the 2nd joint of the exo-

pod of the *5th pair of legs* is simple and resembles that present in *C. typicus*.

♂ Total length 1·1 mm.

The head and thorax are as in the female; the abdomen consists of four segments and the furcal rami are symmetrical as in the female.

The *grasping antenna* has the knee-joint, as usual, between the 18th and 19th segments and the proportional lengths of the distal joints are as follows:—

13.	14.	15.	16.	17.	18.	19-21	22.	23.	24.
13.	15.	20.	20.	20.	32.	22.	20.	16.	12.

The 10th, 11th and 12th segments all bear a curved spine-like process on the anterior surface. The 17th segment bears a toothed-plate which is somewhat longer than the segment itself and is prolonged over the proximal part of the 18th segment. The toothed-plate on the 18th segment extends the whole length of the joint, that of the 19th segment bears teeth the whole length of the segment and is then produced as a spinous process beyond the distal extremity.

The *5th pair of legs* is as figured.

The shape of the last thoracic segment and the coarse saw on the exopodites of the legs serve to distinguish it from other members of the genus.

I have much pleasure in dedicating this species to Lt.-Col. A. Alcock, who for many years was Surgeon Naturalist and subsequently became the Superintendent of the Indian Museum.

Genus **Labidocera**.

Labidocera euchaeta, Giesbrecht.

Stage 1, Dimorph. 1, nov.

Pl. xviii, figs. 1—9.

♀ Total length 2·64 mm.

The head is separate from the 1st thoracic segment and is subdivided into two regions, an anterior and a posterior, by a deep groove that runs transversely across the dorsum, separating the part that carries the two antennae from that which bears the mouth-parts. The 4th and 5th thoracic segments are fused, and the posterior thoracic border is produced backwards in an angular process as in *L. wollastoni*. Anteriorly the head forms a prominent bulge terminating below in a pair of long retrorse rostral spines. There is no rostral lens but a ventral lens is present. Although well marked this forward bulge of the forehead is not so distinct as in the earlier stage (stage 2). Side hooks are absent.

The abdomen is composed of two joints only, the 2nd or posterior of which is very short. The furcal rami are symmetrical and the furcal setae are of practically equal length.

The *1st antennae* comprise 21 joints, the 7th and 8th segments being completely and the 10th and 11th partially fused. When fully extended they reach nearly to the end of the abdomen. The proportional lengths of the joints are as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7-8.	9.	10-11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23
51.	52.	11.	8.	7.	18.	30.	17.	37.	24.	25.	28.	38.	38.	45.	45.	30.	28.	28.	25.	25

The distal part of segment 2 and segments 3 to 14 are fringed posteriorly with long hair.

The *2nd antenna, mandible and maxillae* are of the usual type.

The *maxilliped* resembles that of other members of the genus, but is armed with a row of fine teeth down the margin of the 2nd basal joint.

The *1st pair of legs* is as figured. All the segments of the exopodite are fringed with fine hair and the terminal saw is long and slender, being over 1½ times the length of the last segment.

The *5th pair of legs* very closely resembles those of the preceding stage as described by Giesbrecht. In both cases there is no endopodite present; it differs, however, in having five spines on the margin of the exopodite instead of four. As we shall see later this increase in the number of spines appears to be connected with the progressive stages of development, the young immature forms only having three spines present.

♂ Total length 2·43 mm.

The general structure of the cephalo-thorax is the same as in the female, but the cephalic groove, described above, appears to be usually somewhat better marked. The rostrum resembles that of the female and has no lenses. A well-developed ventral lens is present.

The abdomen consists of 5 segments, of which the 5th is very small. The furcal rami are symmetrical, as in the female, and the proportional lengths of segments and furca are 5 : 6 : 6 : 4 : 1 : 6.

The *left 1st antenna* resembles that of the female, the proportional lengths of the joints being as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7-8.	9.	10-11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
45.	46.	9.	6·5.	7.	16.	27.	15.	35.	23.	23.	26.	38.	38.	45.	44.	30.	27.	27.	24.	24.

The *right 1st antenna*, as usual, forms a grasping organ, and the exact determination of the limits of the various segments in the proximal portion is a matter of considerable difficulty; as regards the distal segments the knee-joint is situated between segments 18 and 19 and the 19th to 21st segments are fused together.

The proportional lengths of the last 9 joints are as follows:—

14.	15.	16	17.	18.	19-21.	22.	23.	24.
31.	30.	45.	38.	78.	78.	32·5.	23.	23.

The 17th segment bears a prominent crest, which terminates distally in a sharp point; the 18th segment is armed with a toothed-plate, which is not produced proximally as in the earlier

stage; the teeth are lancet shaped and are larger in the centre than at the two ends. The 19th—21st segments bear a toothed plate, which extends nearly the whole length of the joint, and the 22nd segment is produced distally in a sharp process which extends nearly the whole length of the succeeding segment.

The *5th pair of legs.* The right forms a grasping organ; the proximal part of the claw is produced in a slender curved process and near the base of this is a single rounded tooth. The distal part of the claw is slender and has no teeth. The left leg has a short terminal joint, which bears a spine on its external margin and has three terminal processes; its inner border is thickly fringed with hair. The penultimate joint also bears a terminal spine at its distal external angle.

L. euchaeta. Stage 2, Dimorph. 2.

Pl. xix, figs. 1—3.

Giesbrecht, 1892, p. 446, pl. 23, fig. 31, and pl. 41, figs. 7-36.
Giesbrecht and Schmeil, 1898, p. 135.

The female of this stage was first described by Giesbrecht (1889). I have not been able to see his original description, but the specimens obtained by me agree almost exactly with the description and figures given by him in his work on the Copepoda of the Gulf of Naples (1892), and by Giesbrecht and Schmeil in the "Das Tierreich" (1898). It is therefore unnecessary for me to give a detailed description.

The head and 1st thoracic segment are separate and a faint groove indicates the division into the two parts of the cranial region, and the 5th thoracic segment is fused with the 4th and terminates posteriorly in an angular process; a point in which my specimens differ from the description is in the sharp forward bulge of the forehead. The rostral spines are long and slender. No rostral lenses are present, but there is a small ventral lens.

The abdomen has three segments and the furcal rami are asymmetrical, the left being smaller than the right, and the 2nd furcal seta is much longer than the others, more than three times their length and nearly 2½ times as long as the combined abdomen and furca.

The *1st antenna* is composed of 23 segments; their relative lengths are given below—

Segments—	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
	32.	38.	6.	5.	6.	9.	6.	19.	15.	12.	26.	24.	23.	30.	32.	29.	42.	41.	27.	27.	31.	31.	25.

It reaches back nearly to the posterior end of the furca.

The *5th pair of legs* has no separate endopodite, and the exopodite has a row of spines on its external margin and distal end.

♂ Total length 1·88 mm.

Numerous examples of males were obtained and they correspond very closely with the females as regards their general structure.

The cephalo thorax is the same as in the female.

The abdomen consists of 5 segments, of which the 3rd is the longest and the 5th very short; the relative proportions of abdominal segments and furca are 22 : 20 : 30 : 15 : 7: 22. The furcal rami in this sex are symmetrical.

The *grasping antenna* has the knee-joint between the 18th and 19th segments; the proportional lengths of the distal-joints are as follows :—

13-14.	15.	16.	17.	18.	19-21.	22.	23.	24-25.
23.	25.	45.	27.	47.	60.	38.	30.	23.

The 17th segment bears a spine very like that of *L. minuta*, and the toothed-plate of the 18th is longer than the segment itself and is produced proximally over the 17th. The 19th segment bears a row of six angular teeth which increase in size distally.

The *5th pair of legs* is as figured. The spine on the proximal segment of the claw in the right leg is short, and there is a small angular tooth near its base; the distal segment is broad and terminates in two setae. The left leg bears a terminal group of curved spine-like processes and is clothed in hair on its inner margin; the penultimate joint also has a distal spine.

L. euchaeta. Stage 3.

Pl. xix, figs. 4—7.

♀ As regards their general structure, the individuals of this stage do not show any very great differences from stage 2. The abdomen possesses the same three segments, but the furcal rami are symmetrical. The *antennae and mouth parts* are identical with those of the adult.

The *5th pair of legs* is short, only reaching to the end of the 1st basal joint of the 4th pair of legs; they are very similar in structure to those of stage 2.

♂ In the case of the male the cephalo-thorax is the same as in the adult. The abdomen, however, only possesses four segments; of these the 3rd is the longest as in the case of subsequent stages.

The *5th pair of legs* contains only two joints and presents a superficial resemblance to those of the female of the same stage; they are however considerably longer, reaching to the 2nd basal joint of the 4th leg, and are not quite symmetrical, that of the right side being the larger. The main difference in length from that of the female is due to the greater size of the distal joint; four spines are present, one about the middle of the external margin and a group of three distally; on a level with the single marginal spine there is a distinct constriction showing where, at the next moult, the division into two segments will occur.

L. euchaeta. Stage 4.

Pl. xix, figs. 8 and 9.

This is the earliest stage in which any definite difference between the two sexes could be made out, and here the only apparent sexual indication lay in the proportional length of the 5th legs; in the female they were short, reaching only to a point half-way or a trifle more along the 2nd abdominal segment, whereas in the male they reach well beyond the 2nd segment and in some cases half-way along the 3rd.

In both sexes the form of the legs were the same and consisted of two joints, the distal having only three spines, and in both sexes also the abdomen consists of three segments, of which the third is the longest.

From the above descriptions, it is seen that the two final stages (1 and 2) differ very considerably as regards certain characters; especially is this the case in the males, where the grasping antennae and the 5th pair of legs are entirely different.

In the females the differences are less marked, yet a study of the two sexes in these stages must, I think, convince anyone that they actually belong to each other and that we are not dealing with the female of one species and the male of another. For the purpose of reference I have tabulated below some of the main characters following the changes through the four final growth-moults.

	No. of joints in abdomen.		Head lenses.	1st antenna ♀.	5th leg ♀ exopod.
	♀	♂			
Stage 4 ..	3	3	No lenses ..	23 free segments	3 spines.
,, 3 ..	3	4	No lenses ..	23 free segments	4 spines.
,, 2 ..	3	5	No rostral lenses, small ventral lens.	23 free segments	4 spines.
,, 1 ..	2	5	No rostral lenses, ventral lens.	21 joints, segments 7 and 8, and 10 and 11 fused.	5 spines.

It is at once obvious that these differences are due to a progressive development through the various growth-moults. In all the above-mentioned instances there is a regular gradation such as could not be merely due to coincidence. There is no greater difference between stages 1 and 2 than there is between stage 2 and the sexually immature forms, stages 3 and 4, and I consider that this fact, combined with a study of the developmental moults, justifies me in concluding that these are dimorphic forms

and not distinct species or varieties. Incidentally it is interesting to note that in the female we get a fusion of the abdominal segments taking place, whereas in the male we have the exact reverse, the segments gradually increasing in number owing to division taking place.

Genus **Pontella**, G. Brady.

Pontella andersoni, sp. nov.

Pl. xx, figs. 1—6.

Numerous examples of both males and females were obtained; they differ from all previously described species, and I have given them the above name after Lt.-Col. A. R. S. Anderson, who was for many years Surgeon-Naturalist and is now Civil Surgeon at Chittagong, where the specimens were obtained.

♀ Total length 3·34 mm.

The head and 1st thoracic segment are separate, as are also the 4th and 5th thoracic segments. The posterior thoracic margin terminates in a sharp lateral spine. The forehead is rounded anteriorly and terminates in a strong bifid rostrum. There are no rostral lenses present. The back of the head is crossed by a strongly marked groove. Side hooks are present.

The abdomen consists of two segments, the 2nd of which is small and terminates in symmetrical furca. The 2nd pair of furcal setae are much longer than the others, about twice the length. The relative lengths of the segments and furca are 20 : 6 : 11. The 1st segment is barrrel-shaped and quite symmetrical.

The *1st antennae* do not reach to the end of the thorax. The segments have the following proportional lengths :—

Segments—

1.	2.	3.	4.	5.	6.	7.	8.	9	10.	11-12.	13.	14.	15.	16.	17.	18.	19	20.	21.	22.	23.	24.
50.	38.	11.	9.	13.	14.	12.	12.	20.	14.	39		24.	28	32.	41.	37.	43.	45.	34.	31.	32.	23.	28.

The 11th and 12th segments are partially fused and the posterior border of the proximal segments is fringed with hair.

The *2nd antennae, mandibles, and maxillae* are of the usual type. The *maxillipeds* show the usual seven joints and the 2nd joint is armed with a row of spines down the margin.

The *1st pair of legs* has the usual 3-jointed exopodite and endopodite, and the whole of the external margin of the former is fringed with hair. The spine on exopod 2 is long, reaching well beyond the base of the 1st spine on exopod 3. The terminal saw is longer than the combined lengths of the two end segments of the exopodite.

The *2nd—4th pairs of legs* are as usual.

The *5th pair of legs* consists of a single jointed exopodite and endopodite, the former being about twice the length of the latter. The exopodite bears five spines, a single one near the middle of the outer border and four close together at the distal end. The

endopodite is bifid, the external process being the longer of the two.

♂ Total length 2·86 mm.

The head and thorax resemble those of the female, with the exception that small rostral lenses are present.

The abdomen consists of five segments, of which the 3rd is the longest, the furcal rami are symmetrical and the proportional length of the segments and furca are 7 : 5 : 10 : 5 : 5 : 15.

The *left 1st antenna* resembles that of the female. The *right* forms the usual grasping apparatus. The knee-joint is between the 18th and 19th segments. The 17th segment is produced on its anterior surface as a low crest, terminating in a short spine distally. The 18th segment carries a toothed-plate, which is prolonged proximally for a short distance over the 17th segment, and is armed with a double row of fine teeth. The 19th segment bears two tooth-plates each armed with fine teeth, and is prolonged distally as a sharp spine. The proportional lengths of the end segments are as follows :—

13-14.	15.	16.	17.	18.	19-21.	22-25.
8.	8.	12.	5.	23.	20.	26.

The 9th—12th segments each carries a seta-like spine on the anterior border.

The *5th pair of legs* is as figured. Instead of a single process on the proximal segment of the claw, it bears two spines, and proximal to the spines are a pair of small knot-like projections on the margin. The distal segment is broad and ends in a blunt club-like protuberance. The left leg terminates in a long segment, bearing the usual spine and two processes terminally, and about two-thirds of the distance along its posterior surface arises a serrated spine.

P. andersoni. Stage 3.

Pl. xx, figs. 7—9.

♀ At this period of its existence the animal is as mentioned before, sexually immature, and in consequence we find that the abdomen consists of 3 segments, one more than in the mature female. As regards the appendages, these are for the most part the same as in the adult, and even in the case of the 5th pair of legs there is no very marked difference; the endopod is, however, a trifle shorter and its two terminal processes have not yet assumed their final delicate shape.

♂ In the male, as was pointed out in the case of *Labidocera euchaeta*, there are very considerable differences between this stage and the next.

The abdomen consists of 4 segments only, of which the third is the longest.

The *left 1st antenna* exactly resembles that of the female; the *right*, though quite unlike that of the adult, yet has begun to

alter in character and has assumed the form described by Brady (1883, p. 95, pl. xlv, fig. 11) in his *Pontella inermis*. The segments 12—16 form a spindle-shaped swelling, but the distal segments have not yet fused completely together, though segments 19—21 show signs of so doing, and there is no distinct knee-joint present. Segment 14 bears a long spinous process, and from the distal end of segment 19 a spinous process arises and extends to the end of segment 2, this is the future toothed-plate.

The *5th pair of legs* is symmetrical and consists of two segments only, the distal of which closely resembles the exopod of the female leg; there is no endopodite present. They reach to the end of the 2nd basal joint of the 4th leg and, as in the immature *Labidocera euchaeta*, are slightly constricted at the level of the first marginal spine, thus indicating where the division into two segments will occur at the next moult.

It is interesting to note that in stage 2, that is, in the first sexually mature stage of the males of both *Labidocera euchaeta* and *Pontella andersoni*, the terminal part of the claw of the 5th right leg is broad and stout and comparatively short, and it may be that this is one of the characteristics of this stage of development, the slender spinous-type of joint being developed only in stage 1.

Genus **Acartia.**

Acartia tortaniformis, sp. nov.

Pl. xxi, figs. 1—10.

Several examples of both sexes were obtained.

♀ Total length 1·4 mm.

The head and 1st thoracic segment are separate. Thoracic segments 4 and 5 are fused together and have a rounded posterior margin. Anteriorly the rostrum is absent, and the line of the forehead is continued round to the ventral surface, where it terminates in a hair-bearing ridge.

The abdomen is long and is contained 1½ times in the length of the cephalo-thorax; it contains 3 segments and a pair of furcal rami which are long, the proportions being 9 : 7 : 5 : 10. The 1st segment bears a row of spines transversely across its dorsal surface and scattered spines on the anterior half of its dorsal aspect. The furcal rami are symmetrical and terminate in four setae, the fifth arising from the external margin; the 2nd is longer than the others and is somewhat stouter at its base: this latter feature is however much more marked in the males. An accessory seta also arises from the dorsal surface.

The *1st antennae* reach to the beginning of the furcal rami; as usual it is difficult to determine the boundaries of the various segments in the proximal part; the proportional lengths of the segments are as follows:—

Segments—

1. 2-6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
10.	36.	12.	15.	3.	11.	11.	8.	19.	12.	12.	14.	21.	21.	25.	19.	19.	15.	20.	15.	5.

There are three groups of small triangular spines on the posterior surface of the proximal joints, and with the exception of the distal three segments, all the others bear transverse rows of spines posteriorly.

The *2nd antenna* is of a somewhat unusual type. The basal portion consists of the usual two segments; the 1st basal bears a single and the 2nd basal two setae, and the margins are fringed with hair. The endopodite appears to be fused with the second basal joint and bears a crown of seven setae. The exopodite consists of a single joint and bears 9 setae.

The *mandible* is furnished with four teeth, of which the 1st is separated from the remainder by a wide interval.

The *2nd maxilla* resembles that of other members of the genus.

The *maxilliped* presents a resemblance to that of other members of the genus *Acartia*; the 3rd joint bears four sharp spinous processes and the 2nd joint carries a row of 4 triangular teeth on the margin.

The *1st pair of legs*. The exopodite consists of three segments. There is no marginal spine on exopod 2; both exopod 1 and 2 carry a single seta on their inner margins and exopod 3 has a row of five. The terminal spine is long and slender and is not serrated for some distance along the shaft; the proportional lengths of the spine and the terminal segment are as 46 : 16. The endopodite has two joints, of which the proximal bears a pair and the distal six setae.

The *2nd—4th pairs of legs*. Each consists of a 3-jointed exopod and 2-jointed endopod. Each joint of the exopod bears a single marginal spine, and the end saw is very long and slender resembling that of the 1st leg. The 1st joint of the endopod bears 3 and the 2nd 6 setae.

The *5th pair of legs* is symmetrical and possesses a basal portion carrying a marginal bristle and a single-jointed exopodite and endopodite, of which the former is about twice the length of the latter and each is serrated.

♂ Total length 1·45 mm.

The cephalo-thorax resembles that of the female. The abdomen is composed of four segments.

The *right antenna* is modified to form a grasping organ. The knee-joint is situated between segments 18 and 19. The 17th segment bears a toothed-plate which is prolonged distally over the 18th segment, which bears a toothed-plate carrying numerous needle-like teeth, and distally has a pair of sharp fang-like teeth. The 19th segment bears two long spine-like tooth-plates armed with fine teeth on their anterior margins.

The *left antenna* resembles that of the female.

The *th pair of legs*. The left leg consists of three segments and the right of four, as in other members of the genus; arising from the basal joint of the right leg is a well-developed process, the endopodite.

This species is of considerable interest as it shows marked affinities on the one hand to the genus *Acartia* and on the other to the genus *Tortanus*; it forms, as it were, a distinct connection between these two genera, though on the whole, its structure is nearer that of *Acartia*. I propose therefore to give it the name *Acartia tortaniformis*.

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II.—The Gymnoplea of the S. Burma Coast and Moscos Island.

The regions of the coast of Burma in which the collections were made comprise (1) Hinzé Basin (lat. 14° 41′ 95″ N., long. 97° 53′ 00″ E.) and its neighbouring waters, and (2) the region extending from the Middle Moscos South Island (lat. 14° 15′ 95″ N.) on the north to the entrance of Tavoy River (lat. 13° 31′ 45″ N.) on the south, and from the coast line on the east to about latitude 97° 40′ 00″ on the west. Over the whole area the plankton was found to be abundant, especially during the later part of the season, *i.e.* March and early April, and the following diatoms were identified:—

Amphilonche belonoides.
Asterionella glacialis.
Asterionella challengerensis.
Asteromphalus hookeri.
Bacteriastrum delicatulum.
Bacteriastrum spirillum.
Bacteriastrum varians.
Chaetoceras criophilum.
Chaetoceras coarctatum.
Chaetoceras compressum.
Chaetoceras densum.
Chaetoceras dichaeta.
Chaetoceras didymum.
Chaetoceras diversum.
Chaetoceras furca.
Chaetoceras lorenzianum.
Climacodium biconcavum.
Climacodium frauenfeldianum.
Coscinodiscus centralis.
Coscinodiscus excentricus.
Coscinodiscus lineatus.
Eucampia zoodiacus.
Guinardia flaccida.
Hemiaulus hauckii.
Melosira borreri.
Nitzschia closterium.
Nitzschia lineola.
Nitzschia migrans.
Planktoniella sol.
Pyrocystis lunula.
Rhizosolenia alata.
Rhizosolenia arafurensis.
Rhizosolenia calcar avis.
Rhizosolenia robusta.
Rhizosolenia setigera.
Rhizosolenia shrubsolei.
Rhizosolenia stolterfothii.
Rhizosolenia styliformis.
Skeletonema costatum.
Thalassiosira antarctica.
Thalassiosira aurivillii.
Thalassiosira longissima.

It was soon seen, however, that although in the main the same diatoms were present in all the different parts of this region, in certain very definite areas the proportional distribution was extremely different, and this appeared to be constant during the whole of the two months in which the investigations were carried out. So striking were the differences that one could tell at a glance from which particular area the collection of plankton had been made. I was thus able to divide the region, from the Middle Moscos Islands to Tavoy River, into four areas, each differing from the other in their surface plankton, and in the accompanying map (pl. xiv) I have indicated, as nearly as possible, the limits of these areas.

Area I extends from the mainland to some distance west of the Middle Moscos Islands, and from there is continued southward along the coast in a narrow band. The diatom flora of

this area was composed, in the main, of large quantities of *Coscinodiscus* and *Thallasiosira*. In this respect it resembled the flora of the waters off Hinzé Basin, some 25 miles further to the north; but I am unable to state whether these areas were confluent as no observations were made in intermediate waters. The flora of Hinzé Basin itself agreed with that of area III and the estuary of Tavoy River.

Area II extends from the south point of the Middle Moscos South Island to the north of the South Moscos group and then splits into two; one band passes down on the west side of the Islands, but the main area is continued to the south, in a gradually decreasing band, as far as the coast. In this area the tow-nettings were extremely large and of a dark green colour and consisted very largely of a thread-like alga of the genus *Trichodesmium*; there were also present, in fairly large numbers, several species of the genus *Ceratium*, principally *C. tripos*, which occurred not only as single individuals but also in the chain form.

Area III extends in a band from the east of the South Moscos Islands down to the entrance to Tavoy River, where it becomes continuous with the estuarine plankton. Here again the tow-nettings were very copious and of a dark green colour. Diatoms were exceedingly abundant, the commonest forms being *Rhizosolenia* and *Chaetoceras*.

Area IV extends over the whole of the region lying to the west of the 20-fathom line. The tow-nettings were of a pale pink colour, thereby being in marked contrast to those obtained from the two preceding areas. In some respects the plankton here was very similar to that of area II in that it contained quantities of the alga *Trichodesmium*, but it differed very materially in the large number of *Radiolaria* that were present. As I have already mentioned, its eastern boundary corresponds fairly closely with the 20-fathom line, and it is possible that we are in reality dealing here with a continuation of area II, the differences being due solely to the increased depth of the water; but as, in addition to the differences above mentioned, it was found that there were certain differences in the Copepod fauna present in these two areas I have preferred to keep them separate.

One cannot help being struck by the manner in which these areas are arranged, in roughly parallel bands running approximately from north north-west to south south-east Along this part of the coast, the main trend of the ebb and flood tides is in this same direction, but it does not appear to me to be probable that tide alone could cause such a definite banded arrangement, and a much more likely explanation would be that we are here dealing with a slow though definite current of water moving down the coast from the north and carrying the plankton with it, and this view receives further support from a study of the physical conditions of the coast-line, where we see that the sand-banks at the mouth of Hinzé Basin and in Maungmagan Bay have a well-marked southerly trend, and at the south end of the

South Moscos South Island there is a very definite scouring out of the sea bed, the depth here suddenly increasing to over 20 fathoms. Such a current coming down from the more northerly region of the Bay of Bengal would also account for the presence in area II of the serial form of *Ceratium tripos*, a form which, it is generally stated, is only found well out to sea and remote from any land.

On the other hand, however, area III would appear to run in a direction exactly opposed to such a current, for this area is directly continuous with the region at the mouth of Tavoy River. There is no doubt that this area is largely influenced by tides, for on two occasions the ship while carrying out a line of soundings passed right across this region, and although the net was down the whole time, the type of plankton obtained was typically that of area II; on both occasions, however, the tide was on the ebb, and this would appear to indicate that during the flood tide this area is carried up from the south from the region of Tavoy River to the east of the South Moscos Islands, and on the ebb tide it again recedes, its place being taken by water from area II.

The variations in the tow-nettings of these four areas were, however, not confined merely to the diatom flora; marked differences were found to exist regarding the occurrence of various species of Copepoda. This was particularly well marked in the case of area I as compared with the remaining three areas, and in the following table I have endeavoured to indicate these differences as fully as possible, the frequency or the reverse of several species being shown in percentages of the total Copepod catch.

	Area I (5 localities).	Areas II and III (8 localities).	Area IV (2 localities).
CALANIDAE.			
Canthocalanus pauper	12·33% in one locality: less than 4% in all others.	From 6 to 29·5% in 5 of the 8 localities.	From 6 to 8%.
Undinula caroli ..	Less than 1% in all localities.	From 3 to 16% in five localities.	Less than 1%.
Eucalanus subcrassus	6·6% and 13·2% in two localities: less than 2·5% in all others.	From 8 to 22% in seven localities.	11% in both localities.
Acrocalanus longicornis.	Less than 1% ..	From 5 to 29·5% in six localities.	2% in both localities.
PONTELLIDAE.			
Labidocera acuta ..	From 19·8 to 59% in all localities.	From 5·4 to 8% in three localities: less than 3% in all others.	Less than 4%.

	Area I (5 localities).	Areas II and III (8 localities).	Area IV (2 localities).
Labidocera minuta ..	From 4·1 to 10·1% in two localities: less than 4% in others.	Less than 1% or absent.	1% or less.
Pontella spinipes ..	From 5·5 to 21·5% in three localities.	Absent ..	Less than 1% or absent.
Tortanus gracilis ..	Less than 1% or absent.	Less than 4% or absent.	From 6 to 9%.

In addition to the above, area IV differed from all the other areas in the presence—though only in very small numbers—of *Eucalanus attenuatus*, *Rhincalanus cornutus* and *Candacia truncata*, *C. aethiopica* and *C. pachydactyla*.

The Copepod fauna of this region of the Burma coast, considered as a whole, seems in many respects to be intermediate between that of the Arabian Sea and Ceylon on the one hand and the Malay Archipelago and its neighouring waters on the other; thus we find present such species as *Centropages dorsispinatus*, *Centropages tenuiremis* and *Labidocera pectinata*, and such variations as *Pontella danae* var. *ceylonica*, *Labidocera kroyeri* var. *stylifera* and the "*plumulosus*" variety of *Undinula vulgaris* and allied species, all of which have so far only been recorded from the west, and *Candacia discaudata*, *Calanopia thompsoni*, *Tortanus barbatus*, *Pontella princeps* and *Labidocera euchaeta*, which link the fauna of this region with that of the Malay Archipelago and Pacific Ocean on the east. In several instances the specimens obtained furnish interesting examples of "continuous" variation, being intermediate between specimens already known from regions on both sides or a further development of previously-described variations from Ceylon and the Arabian Sea; a more detailed account of these will be given under the different species.

In the following systematic notes I have dealt solely with the Gymnoplea. Of these 73 different species and varieties were obtained, two of the former being new to science, *Pseudodiaptomus hickmani* and *Pontella investigatoris*. In the table below I have given a list of these species and varieties and have indicated in the succeeding columns their presence or absence, so far as is at present known, from the neighbouring areas that have already been investigated.

		Red Sea (Giesbrecht, Cleve, A. Scott).	Arabian Sea (Cleve, A. Scott).	Maldive and Laccadive Archipelagoes (Wolfenden).	Around Ceylon (Thompson & Scott).	Malay Archipelago (Cleve).	Between Borneo and New Guinea (A. Scott).
1	*Calanus minor*		×	×	×	×	×
2	*Canthocalanus pauper*	×	×	×	×	×	×
3	,, ,, var. *plumulosus*, nov.						
4	*Undinula vulgaris*	×	×	×	×	×	×
5	,, ,, var. *plumulosus* ..			×			
6	,, *darwini*		×	×	×	×	×
7	,, *caroli*			×			×
8	,, ,, var. *plumulosus*, nov. ..						
9	*Eucalanus attenuatus*		×	×	×	×	
10	,, *crassus*	×	×	×	×	×	
11	,, *monachus*		×	×	×	×	×
12	,, *pileatus*			×	×		×
13	,, *subcrassus*	×	×	×	×	×	×
14	,, *subtenuis*	×	×	×	×	×	×
15	*Rhincalanus cornutus*	×	×	×	×	×	×
16	*Paracalanus aculeatus*	×	×	×		×	×
17	,, ,, var. *plumulosus* ..			×			
18	,, *parvus*	×	×	×	×	×	×
19	*Acrocalanus gardineri*			×			
20	,, *gibber*	×	×	×	×	×	×
21	,, *gracilis*	×	×	×	×	×	×
22	,, *inermis*						
23	,, *monachus*			×			×
24	,, *longicornis*		×	×	×	×	×
25	,, ,, var. *plumulosus*, nov.						
26	*Calocalanus pavo*	×	×	×	×	×	×
27	,, *plumulosus*	×	×	×	×	×	×
28	*Clausocalanus arcuicornis*		×	×	×	×	×
29	*Euchaeta concinna*			×	×	×	×
30	,, *marina*	×	×	×	×	×	×
31	*Scolecithrix danae*		×	×	×	×	×
32	*Centropages nolocerus*		×		×		
33	,, *furcatus*	×	×	×	×	×	×
34	,, *orsinii*	×	×	×	×	×	×
35	,, *tenuiremis*		×		×		
36	*Pseudodiaptomus aurivillii* ..		×		×	×	×
37	,, *hickmani*, sp. nov. ..						
38	*Temora discaudata*	×	×	×	×	×	×
39	,, *stylifera*	×	×	×	×	×	
40	,, *turbinata*				×		×
41	*Lucicutia flavicornis*	×	×	×	×	×	×
42	*Candacia æthiopica*		×		×		×
43	,, *bradyi*	×	×	×			×
44	,, *catula*	×	×	×	×	×	×
45	,, *discaudata*						×
46	,, *pachydactyla*		×	×	×	×	×
47	,, *truncata*	×	×	×	×		×
48	*Calanopia elliptica*	×	×	×	×	×	×
49	,, *minor*	×	×	×	×		×
50	,, *thompsoni*						×
51	*Labidocera acuta*	×	×	×	×	×	×
52	,, *euchaeta*						
53	,, *kroyeri*		×		×	×	×
54	,, ,, var. *bidens*, nov. ..						
55	,, ,, var. *burmanica*, nov. ..						

		Red Sea (Giesbrecht, Cleve, A. Scott).	Arabian Sea (Cleve, A. Scott).	Maldive and Laccadive Archipelagoes (Wolfenden).	Around Ceylon (Thompson & Scott).	Malay Archipelago (Cleve).	Between Borneo and New Guinea (A. Scott).
56	*Labidocera kroyeri* var. *stylifera*				×		
57	,, *minuta*	×	×	×	×	×	×
58	,, *pectinata*		×		×		
59	*Pontella andersoni*						
60	,, *dānae* var. *ceylonica* ..				×		
61	,, *investigatoris*, sp. nov. ..						
62	,, *princeps*				×		×
63	,, *securifer*			×	×		×
64	,, *spinipes*			×			
65	*Pontellopsis herdmani*				×		×(?)
66	,, *krämeri*	×		×			×
67	,, *regalis*		×			×	×
68	*Pontellina plumata*	×	×	×	×	×	×
69	*Acartia danae*			×			×
70	,, *erythraea*	×	×	×	×	×	×
71	,, *spinicauda*		×				×
72	*Tortanus barbatus*						×?
73	,, *gracilis*	×	×	×	×(?)	×	×

Family *CALANIDAE*.

Genus **Calanus**, Leach.

1. **Calanus minor** (Claus).

Occurrence: Localities B, E, F, K, N, P.[1]

On the whole, this species was comparatively rare; in only a single locality (F) was it present in comparative abundance. The specimens obtained are, with one exception, typical, and in size correspond to the measurement, as given by Scott, 1·7 mm. in length.

As regards colouration, the females usually showed a uniform faint red pigmentation, whereas the males were as a rule colourless.

In one specimen, a female, the 3rd and 4th legs of the left side were abnormal; instead of the usual three-jointed exopodite and endopodite, it consisted of a single paddle-shaped segment, bearing on its free margin a number of setae, 10 in the 3rd and 11

[1] These letters afford reference to the list of localities given at the end of the paper. All of them, with the exception of Q (Hinzé Basin), are also shown on the map.

in the 4th leg, in the latter the basipodite also presented at its distal external angle a short process carrying four teeth. Probably this abnormality was the result of some previous injury.

Genus **Canthocalanus**, Scott.

1. **Canthocalanus pauper** (Giesbrecht).

Calanus pauper, Giesbrecht and Schmeil, Das Tierreich, Lief. 6, p. 16, 1898.

Occurrence: Localities A, B, C, D, E, G, H, J, K, L, N, O, P, Q.

This species was almost invariably present all over the area of investigation, its maximum frequency of occurrence being obtained to the E. and S. E. of South Moscos South Island.

In point of size it agrees very closely with the figures given by Giesbrecht and Schmeil (*loc. cit*).

In this species also a single specimen, again a female, possessed an abnormal 4th leg right side. The endopodite was normal but the exopodite was composed of only two segments: the distal segment was paddle-shaped and carried one external marginal spine and six setae, the proximal segment carried a single seta but no spine.

2. **Canthocalanus pauper** (Giesbrecht) var. **plumulosus**, nov.

Occurrence: Localities H, K, M.

Seven specimens were obtained which presented, in varying degree, the plumose variation of the furcal setae. So far as I am aware the only previous record of this type of variation was given by Dr. Wolfenden, who found it in several closely allied species; in *Undinula* (*Calanus*) *vulgaris*, *Paracalanus aculeatus* and *Calocalanus pavo* bilaterally, and in *Euchirella bella* var. *indica* and *Euchaeta norvegica* [1] unilaterally, all his examples being obtained from the Maldive and Laccadive Archipelagoes.

As he points out, the variation is extremely irregular, only two, of the seven specimens obtained, being identical; the absence of feathering on the side branches of the plumose setae also agrees with his description of the variation as he found it in *Undinula vulgaris*.

It would appear that this type of variation is extremely local in its occurrence, for as will be seen later, almost all specimens showing it were obtained in the region round the South Moscos South Island.

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[1] Dr. Wolfenden gives a figure of the variation in this species (the Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, plate C, fig. 21), but I can find no mention of it in the text.

Genus **Undinula**, Scott.

Undina, Brady, *nom. præocc.*

1. **Undinula vulgaris** (Dana).

Occurrence: Localities B, D, E, F, G, H, K, L, M O, P.

Although widely distributed over the whole of the Middle and South Moscos regions, it was much more abundant over the region to the S. and E. of the South Moscos South Island.

In size it was as a rule rather below the average as given by Giesbrecht and Schmeil (*l.c.*, p. 17), varying from 1·9 to 2·3 mm. in length. A few specimens were obtained having the double spine on the left side of the last thoracic segment as figured by Giesbrecht (*Calanus vulgaris*: F. u. Fl. Gulf. Neap., xix, pl. 7, fig. 28).

2. **Undinula vulgaris** (Dana) var. **plumulosus** (Wolfenden).

Calanus vulgaris, Wolfenden, Notes on the Collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 994, pl. xcvi, figs. 21 and 22.

Occurrence: Localities K, L, Q.

This variety appears to be of comparatively infrequent occurrence, only four specimens being obtained. These, with a single exception from Hinzé Basin, were obtained in the same locality as *Canthocalanus pauper* var. *plumulosus*. They show the same irregularity in the number and arrangement of the plumose setae.

3. **Undinula darwini** (Lubbock).

Occurrence: Localities O and P.

This species appears to be very rare in the different areas investigated and very few specimens were obtained; all those examined were, with one exception, females.

4. **Undinula caroli** (Giesbrecht).

Calanus caroli, Giesbrecht, Atti. Acc. Lincei Rend., ser. 4, vol. 4, Sem. 2, p. 331 (1892).—F. u. Fl. Neapel, vol. 19, p. 91, t. viii, f. 36.

Calanus caroli, Wolfenden, Notes on the Collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 994.

Occurrence: Localities B, C, E, F, G, H, K, L, M, P, Q.

A large number of females were obtained, which agree in every particular with the description of the specimens obtained

by Wolfenden in the Maldive and Laccadive Archipelagoes; that is to say, they have no teeth on the external margin of the last segments of the 2nd or 3rd legs, and, in addition, the fine denticulation on the proximal segment of the basipodite of the 5th legs and the spines on the margin of the 1st and 2nd abdominal segments, which are met with in *U. darwini*, are absent in these specimens.

I agree with Wolfenden in thinking that these are probably the female *Undinula caroli*. No males were obtained.

5. **Undinula caroli** (Giesbrecht) var. **plumulosus**, nov.

Two specimens showing the plumose variation of the furcal setae were found in locality K.

Genus **Eucalanus**, Dana.

1. **Eucalanus attenuatus** (Dana).

A few specimens only were taken in localities O, P. They all differed slightly from the description given by Giesbrecht, in possessing a more pointed forehead. In this respect they much more nearly resembled *Eucalanus elongatus*.

2. **Eucalanus crassus**, Giesbrecht.

Occurrence: Localities D, E, L, M, O, P, Q.

A considerable variation in colouration was found to be present; in a few specimens the pigmentation was well marked and closely resembled the figure in Giesbrecht, the setae on the exopodite of the mandible being bright crimson; in the majority, however, all trace of pigmentation was absent.

The females were covered all over the posterior part of the cephalo-thorax and the 1st abdominal segment with short close-set hairs. In the males, however, this was not the case.

In one male specimen the 5th leg was found to terminate in two apical hairs, the distal end of the last segment being slightly bifid, and a specimen of a female was found in which a rudimentary 5th left leg was present; in structure this extra leg closely resembled that normally present in the male, though slightly smaller in size.

3. **Eucalanus monachus**, Giesbrecht.

Occurrence: Localities E, G, H, O, P.

This species was comparatively rare especially in locality H, in which only three specimens were obtained.

4. **Eucalanus pileatus**, Giesbrecht.

Occurrence: Localities J, L, M, P, Q.

This species also was not common, except in locality J where it formed 6% of the whole catch.

5. **Eucalanus subcrassus**, Giesbrecht.

Occurrence: Localities A, B, C, D, E, F, H, J, L, M, N, O, P, Q.

This species was one of the commonest; it was widely distributed over the whole area of investigation and was usually present in large numbers; in one locality (Q) it formed very nearly half the total catch.

6. **Eucalanus subtenuis**, Giesbrecht.

Occurrence: Locality Q.

The species was apparently absent over the whole of the Moscos Archipelago; a few specimens were obtained further north in Hinzé Basin (locality Q).

Genus **Rhincalanus**, Dana.

1. **Rhincalanus cornutus** (Dana).

This species appears to be extremely rare in this region, only two specimens were obtained from locality O and one from P.

Genus **Paracalanus**, Boeck.

1. **Paracalanus aculeatus**, Giesbrecht.

Occurrence: Localities A, D, E, G, J, K, L, N, O.

Although by no means common, this species of *Paracalanus* was fairly widely distributed.

2. **Paracalanus aculeatus**, Giesbrecht, var. **plumulosus**, Wolfenden.

Two specimens were obtained showing the plumose arrangement of the furcal setae, one each in localities G and P; in other respects they were identical with *P. aculeatus*.

3. **Paracalanus parvus** (Claus).

A few specimens were obtained in localities A, J and Q, but in all other localities this species appears to be absent.

Genus **Acrocalanus**, Giesbrecht.

1. **Acrocalanus longicornis**, Giesbrecht.

Occurrence: Localities A, F, G, H, K, L, M, N, O, P.

This species was fairly widely distributed and in certain regions (G, K, L, M) was exceedingly common.

In one specimen an unusual condition was present in the 4th right leg; the proximal "aussenranddorne" was missing on the

3rd joint of the exopodite and the coarse teeth on the proximal part gradually diminished in size and finally blended with the finer denticulations on the distal part of the margin, forming a continuous series.

2. **Acrocalanus longicornis**, Giesbrecht, var **plumulosus**, nov.

A single specimen was obtained from locality G, which showed a slight form of variation of this type, the 2nd seta of the left furcal appendage showing a single dichotomous branching.

3. **Acrocalanus gardineri**, Wolfenden.

A. gardineri, Wolfenden, Notes on the Collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 1004, pl. xcvii, figs. 5, 10, 14-21.

Occurrence: Localities M, N, Q.

Examples of this species were rare. Those that were obtained were all males and tallied with Wolfenden's description, with the exception that the 2nd basal segment of the 5th leg was in all cases much shorter than the 1st, not longer, as he describes it.

4. **Acrocalanus gibber**, Giesbrecht.

Occurrence: Localities D, E, H, J, K, L, N, O, P.

This species was fairly widely distributed, and in certain localities, notably D, H, K, was quite common.

5. **Acrocalanus gracilis**, Giesbrecht.

Occurrence: Localities C, G, H, J, M, N.

With the exception of localities H, N, in which it formed 10—11% of the total catch, it occurred only in comparatively small numbers. It was also less widely distributed than the preceding species.

6. **Acrocalanus monachus**, Giesbrecht.

Only a single specimen was obtained from locality G.

Genus **Calocalanus**, Giesbrecht.

1. **Calocalanus pavo** (Dana).

Occurrence: Localities D, E, O.

With the exception of a single specimen found in D, all those obtained came from E and O, where the species was comparatively common.

2. **Calocalanus plumulosus** (Claus).

A single female was obtained in locality O.

Genus **Clausocalanus**, Giesbrecht.

1. **Clausocalanus arcuicornis** (Dana).

Occurrence : Localities J, O, P.

Only a few specimens were obtained in each of the above localities and the species was apparently absent in all others.

Genus **Euchaeta**, Philippi.

1. **Euchaeta concinna**, Dana.

Occurrence: Localities B, J, O, P, Q.

This species seems to be extraordinarily local in its distribution, and, if present at all, is so in comparatively large numbers.

2. **Euchaeta marina** (Prestand).

This species appeared to be comparatively rare; a few specimens were found in Hinzé Basin (Q).

Genus **Scolecithrix**, Brady.

1. **Scolecithrix danae** (Lubbock).

A single male specimen was obtained from locality O.

Family *CENTROPAGIDAE.*

Genus **Centropages**, Kröyer.

1. **Centropages furcatus** (Dana).

Occurrence : Localities A, B, C, D, E, G, J, L, N, O, P.

This species was of almost universal distribution and in certain localities, especially C and N, was exceedingly common, large numbers of both sexes being obtained.

2. **Centropages notoceras**, Cleve.

C. notoceras, Cleve, Report on Plankton collected by Mr. Thorild Wulff during a voyage to and from Bombay. *Archiv för Zoologi*, vol. i, p. 373, pl. 17, figs. 2-10; pl. 18, fig. 1, 1903-4.

? *C. dorsispinatus*, Thompson and Scott, Report on the Copepoda. *Ceylon Pearl Oyster Fisheries and Marine Biology*, (Suppl. Rept. vii), vol. 1, p. 247, pl. i, figs. 19—25.

Occurrence: Localities B and Q.

Numerous examples of this species were obtained, both males and females, and they agree very closely with the description given by Cleve (*loc. cit.*) of his specimens from the Arabian Sea. As, however, they differ in a few details I append a full description below.

♀ Length from 1·2 to 1·4 mm.

The forehead, when viewed in profile, has a rounded outline, terminating anteriorly in a bifid, backwardly directed rostrum; behind the forehead is a well-marked dorsal hump. A little anterior to the posterior border of the head region, in the middle line, is a large backwardly-curved spine, which terminates in a pair of small antrorse hooks.

The head and 1st thoracic segments are separate. The last thoracic segment is armed on each side with a sharp backwardly-directed spine.

The abdomen is composed of three segments, of which the 1st is markedly swollen and bears on each side ventrally a row of sharp spines. The 2nd segment is longer than the anal and bears on its right side two short rows of spines, of which the proximal is the more ventrally situated. The furcal joints are three times as long as broad and the 5th seta is much shorter and stouter than the others, and arises at the junction of the middle and distal thirds.

The *1st antennae* are composed of 21 free joints, the first or basal joint being formed by the fusion of 1st to 4th segments, though in a few specimens traces of separation could be made out between the 3rd and 4th. The proportional lengths are as follows:—

1-4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
42.	7.	10.	10.	10.	14.	14.	14.	17.	23.	25.	28.	30.	30.	31.	29.	21.	19.	14.	14.	14.

The fused basal joint carries three spines, on its anterior border a small proximal and a large distal, and on its posterior border a small spine opposite the small proximal one on the anterior surface.

The *1st leg* closely resembles that of *C. typicus* (Krōyer), in having serrated spines on the 1st and 2nd segments of the exopodite, but differs in the possession of a small spine on the inner border of the 2nd basal segment near the joint for the endopodite.

The *5th pair of legs* corresponds exactly with Cleve's description and figures.

♂ Length 1·2 mm.

Abdomen 5-jointed, the last segment being very short.

The *anterior antennae* are, as usual, asymmetrical; that of the left side is identical with the female type; the right grasping antenna has the first four segments separate, not fused as in the female and left male antenna, and the 19th to 21st and 22nd

and 23rd segments are respectively fused together. The proportional lengths are as follows :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19-21.	22-23.	24.
11.	15.	7.	6.	7.	5.	8.	8.	7.	10.	10.	8.	15.	17.	25.	30.	27.	35.	50.	27.	15.

The knee-joint occurs between the 18th and 19th segments, and the 17th, 18th and proximal half of the 19—21st segments are all armed with rows of delicate teeth. The 2nd, 5th and 19—21st segments all bear spines, that on the 5th being large and well-marked.

The *5th leg* is exactly similar to that of *C. dorsispinatus*.

There can, I think, be no doubt that these examples, obtained by me in Hinzé Basin, are identical with those described by Cleve under the name of *C. notoceras* from the Arabian Sea. But there seems to be certain discrepancies between them and *C. dorsispinatus*.

Cleve himself, after seeing Thompson and Scott's paper, came to the conclusion that his examples were identical, but on comparing the two descriptions certain differences are apparent and I have tabulated these as far as possible :—

	C. notoceras, Cleve, and present specimens.	*C. dorsispinatus*, Thompson and Scott.
1	Abdomen ♀ 3-jointed.	Abdomen ♀ 4 (?) jointed (three only are shown in the fig., but in the text it is stated that four are present).
2	Spines on genital (1st) segment of abdomen ♀ on both sides.	Spines only on left side.
3	Rostrum, bifid.	Rostrum broad and triangular.
4	Antennal joints 1-4 fused (in female and left male).	Antennal joints all separate.
5	Well-marked spine on 5th joint right antenna ♂.	No spine present. (They make no mention of it in the text but figure it as absent).

Were it not that Cleve himself was convinced of the identity of his specimens with those from Ceylon, I should have had no hesitation in describing my examples as representatives of *C. notoceras* and distinct from, though closely allied to, *C. dorsispinatus*. Under these circumstances, however, I have left the matter open.

3. Centropages orsinii, Giesbrecht.

Occurrence: Localities B, C, D, F, G, H, K, M, N, O, P.

This species was quite common, especially in localities G and H.

4. Centropages tenuiremis, Thompson and Scott.

Pl. xxiv, figs. 6—7.

C. tenuiremis, Thompson and Scott, Report on the Copepoda. *Ceylon Pearl Oyster Fisheries and Marine Biology*, (Suppl. Rept. vii), vol. 1, p. 247, pl. i, figs. 14—18, 1903.

C. arabicus, Cleve, Report on Plankton collected by Mr. Thorild Wulff during a voyage to and from Bombay, *Arkiv for Zoologi*, vol. i, p. 371, pl. 16, figs. 1—9; pl. 17, fig. 1, 1903-4.

Occurrence: Localities C and E.

Numerous specimens were obtained in the above localities and agree very well with the descriptions of Cleve, and Thompson and Scott. The latter, however, state that in their examples the abdomen of the female possesses four segments (they only figure it with three). As Cleve (*loc cit.*) points out, the 1st and 2nd segments of the exopod of the right 5th leg of the female are fused together, a point apparently overlooked by Thompson and Scott. Both authors figure the spine as arising from the 1st segment. I have examined a large number of specimens, but can find no evidence whatever in favour of this view; on the contrary, where any trace of separation can be made out, it invariably runs on the proximal side of the spine, which therefore arises, as one would have expected, from the distal portion of the fused segment (vide pl. xxiv, fig. 6). A second point in which my examples appear to differ is in the length of the endopodite which reaches to the end of the spine, whereas both the previous authors show it as falling considerably short of this. Possibly this latter is a local variation, as Cleve figures it much shorter in his examples than in those from Ceylon.

Another point in which my specimens differ is in the 4th pair of legs of the male. Thompson and Scott state that in their specimens this appendage resembled that of *C. typicus*, that is to say the marginal spine of the 2nd joint of the exopodite of the 3rd and 4th legs of the right side is increased in length in comparison with its fellow of the opposite side. In all the specimens that I have examined, however, the 3rd pair of legs is symmetrical and the 4th leg of the right side bears enlarged spines on both exopod 1 and 2.

Genus Pseudodiaptomus, Herrick.

1. Pseudodiaptomus aurivillii, Cleve.

A few specimens were obtained in locality Q; they were, without exception, females and agreed with Cleve's description.

2. Pseudodiaptomus hickmani, sp. nov.

Pl. xxii, figs. 1—7.

Occurrence: Locality Q.

Several specimens were obtained, both males and females; they appear to differ from any previously described species, and I have much pleasure in naming it after Commander C. S. Hickman, R.I.M., Officer in charge, Marine Survey of India.

♀ Total length 1·37 mm.

The abdomen and furca are contained twice in the length of the cephalo-thorax. The head is separate from the 1st thoracic segment and terminates anteriorly in a bifid rostrum with long and delicate spines. The 5th thoracic segment is armed laterally with a sharp spine, directed backwards and slightly outwards. The abdomen is composed of four segments, the first three of which are armed posteriorly with a row of triangular teeth extending across the dorsal surface. The relative lengths of these segments and the furcal rami are 10 : 4 : 6 : 4 : 7. The latter are three times as long as wide.

The genital segment has a well-marked ventral swelling, and the genital operculum is produced posteriorly in a single spine on the right side. On the right side of the segment is a blunt spinous process and anterior to the genital orifice is a curved row of needle-shaped spines, which terminates laterally in the above mentioned process. Dorsally the segment is armed on each side with an elongated group of very fine spines.

The *1st antennae* are composed of 21 joints having the following relative proportions:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
15.	8.	4.	8.	7.	9·5.	6.	7.	12	13.	14.	15.	14.	14	15.	13.	10.	11.	11.	11.	13.

The *2nd antennae* have the usual characters as in the other members of the genus, but differ from the others in possessing a row of fine spine-like processes on the margin of the last segment of the endopodite.

In the *1st pair of legs* the endopodite and exopodite are of nearly the same length. The 1st joint of the exopodite bears a long slender serrated external margin spine and the 3rd joint has two short non-serrated external spines and a terminal spine, whose length is almost equal to the combined length of the last two segments; the 2nd joint is without a spine. The 1st joint of the basiopodite bears two rows of delicate spines on its antero-external surface, one at its distal margin and the second, in which the spines are somewhat longer, about the middle of its length.

The *2nd-4th pairs of legs* are of the usual type, but the 2nd pair differs in having three series of very delicate spines on the 1st joint of the basiopodite; two of these are similar to those of the 1st leg, the third is a delicate row of spines proximal to the origin of the seta on the inner border.

The *5th pair of legs* very closely resembles those of *P. serricaudatus* (Th. and Scott). The outer claw bears an inner toothed lamella and is slightly longer than the inner claw.

♂ Total length 1·3 mm.

Cephalo-thorax as in the female.

The abdomen consists of 5 segments, of which the 2nd, 3rd and 4th are armed posteriorly with a complete ring of triangular teeth; the relative lengths of the segments and furca are 2 : 5 : 5 : 5 : 3 : 5.

The *grasping antenna* consists of 21 free joints, of which the 13th-17th are swollen; the knee joint occurs between the 18th and 19th segments. The "endabschnitt" comprises three segments. Sickle-shaped spines are articulated with the anterior border of segments 10-13.

The *1st to 4th legs* are the same as in the female.

The *5th pair of legs*. On the right side, the 2nd basal segment carries on its inner aspect a Y-shaped spinous process, the endopodite. The exopodite is three-jointed; the 1st segment is produced externally in a Y-shaped spinous process, and the posterior border of the articulation with the 2nd segment is armed with a row of teeth. The 2nd segment bears on its outer surface distally a short thick spine with serrated margins, and the 3rd segment is sickle-shaped and its inner margin is finely denticulate. On the left side the endopodite is represented by a fringed unjointed process. The exopodite is two-jointed and the 2nd segment consists of a thin plate bearing a spine at each corner of the distal extremity, the margin between being finely denticulate; the outer border bears a blunt process which projects at a right angle.

It is not improbable that many of the records of the occurrence of *P. serricaudatus* in Indian waters really refer to this species.

Family *TEMORIDAE.*

Genus **Temora**, W. Baird.

1. **Temora discaudata**, Giesbrecht.

Pl. xxii, figs. 8 and 9.

Occurrence: Localities A, B, D, E, F, G, J, L, M, N, O, P.

This species was of almost universal distribution; its maximum frequency was obtained in A and B. A considerable degree of variation was found to exist in the structure of the 5th pair of legs of the female. In the majority of cases the condition was that usually described, the inner spine arising close to the end of the terminal segment, but in others it arose from the inner border some distance from the extremity, at about the junction of the middle and distal thirds; in all cases it appeared to retain the same relative position to the external margin spine, thus indicating that it was the terminal post-spinal portion of the segment that had increased in length.

2. Temora turbinata (Dana).

Occurrence: Localities A, B, C, D, E, F, G, H, J, K, L, M, N, O, P.

This species was usually present in large numbers and was much the commonest representative of the genus.

3. Temora stylifera (Dana).

Occurrence: Localities E, J, L.

This species appeared to be comparatively rare; only a few specimens being obtained.

Family *LUCICUTIIDAE.*

Genus **Lucicutia**, Giesbrecht, 1898.

1. Lucicutia flavicornis (Claus).

Occurrence: Localities F, J, N, O, P.

This species was comparatively rare, only a few specimens being obtained in each of the above localities.

Family *CANDACIIDAE.*

Genus **Candacia**, Dana.

1. Candacia aethiopica, Dana.

Only a single specimen, a female, was found in locality O. While agreeing with the description as regards structure, it differed in that it was only slightly pigmented, the spots most pigmented being not the back but the bases of the maxillae and the ends of the swimming feet.

2. Candacia bradyi, Scott.

Pl. xxiii, figs. 6 and 7.

C. bradyi, Scott, Some Red Sea and Indian Ocean Copepoda. *Trans. L. B. S.*, vol. xvi, p. 406, pl. 1, figs. 9—12.

C. tuberculata, Wolfenden, Notes on the collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 1015, pl. xcvi, figs. 40—44.

C. bradyi, Scott, The Copepoda of the Siboga Expedition, pt. 1, p. 156, pl. xlvii, figs. 1—9.

A large number of specimens were obtained in localities J, N, O. Associated with these were several females, which I take to be the hitherto undescribed female of this species.

♀ Length 1·8 mm.

The last thoracic segment terminates in a short spine.

The abdomen is contained 2½ times in the length of the cephalothorax. The 1st segment viewed from above is symmetrical and somewhat globular in shape, ventrally there is a well-marked genital swelling. The 2nd segment is produced ventrally in the middle line in a short spine, its length is about half that of the genital segment.

The furcal joints are about twice as long as broad; they are slightly asymmetrical, that on the right side being broader than the left.

The 1*st antennae* consist of 23 joints. The proportional lengths of the joints are as follows:—

1.	2.	3.	4.	5.	6.	7.	8	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
16.	21	7.	12.	16.	13.	7.	8.	8.	8.	14.	19.	19.	25.	26.	30.	29.	34.	23.	18.	12.	21.	24.

In the male the proportional lengths of the joints of the left antenna are:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
16.	21.	7.	15.	17.	10.	8.	8.	9.	9.	13.	20.	20.	27.	27.	33.	32.	37.	24.	16.	13.	19.	21.

The 2nd segment of the 2*nd maxilla* bears three spines and the proximal spine of the 3rd segment is longer and much stouter than the distal.

The 1*st leg* resembles that of the male in having a single jointed endopodite and in the absence of any hair on the basiopodite.

The terminal spine on the exopodite of the 3*rd leg* is, as in the male, two-thirds the length of the last segment.

In the 5*th legs* the terminal segments are almost symmetrical, are slightly curved inwards and bear on their inner margin two setae. The outer border carries three spines, the first about the middle of its length and the other two close together near the tip, which ends in a single stout spine. These external spines on the left side are blunt and pigmented, and on the right are sharp and devoid of pigment.

3. Candacia catula (Giesbrecht).

This species appears to be very rare in this region, only a single male specimen was obtained in locality O and one female in locality P.

4. Candacia discaudata, A. Scott.

Occurrence: Localities B, D, E, F, J, K, L, M, N, O, P.

A considerable number of specimens, both males and females, were obtained, especially in localities F, L, M. They were all quite typical, agreeing exactly with the description given by Scott (Siboga Expedition. Copepoda, pt. 1, p. 157, pl. xlvii, figs. 10—20, 1909).

5. **Candacia pachydactyla**, Dana.

Occurrence: Localities O and P.

A few specimens were obtained in the above localities, but on the whole this species was conspicuous by its absence. The examples obtained were quite typical.

6. **Candacia truncata**, Dana.

Occurrence: Localities O and P.

Several specimens, both males and females, were obtained.

Family *PONTELLIDAE*.

Genus **Calanopia**, Dana.

1. **Calanopia elliptica** (Dana).

Occurrence: Localities E, F, J, M, N, O, P.

This species was most abundant in localities F and J.

2. **Calanopia minor**, A. Scott.

Occurrence: Localities F, J, O, P.

As in the preceding species, this was most abundant in F and J; in other localities, however, it was rare or entirely absent.

3. **Calanopia thompsoni**, A. Scott.

C. thompsoni, A. Scott, The Copepoda of the Siboga Expedition, pt. i, p. 178, pl. xlix, figs. 1—8, 1909.

A single specimen, a female, was obtained in locality E. The specimen was somewhat immature, measuring only 1·6 mm., but from the barbed rostrum, the small 3rd segment of the antenna and the lateral spines on the head, I have no doubt that it belongs to this species.

Genus **Labidocera**, Lubbock.

1. **Labidocera acuta** (Dana).

Occurrence: Localities A, B, C, D, E, F, G, H, K, L, M, O, P, Q.

In localities A, B, C, D and E this species was extremely common, forming from 20% to 60% of the total catch, whereas in the remaining localities it was comparatively rare.

The males differ slightly from the Mediterranean form in that the "reibleistes" of the grasping antennae were somewhat longer on both joints of the knee-joint than as shown in Giesbrecht's figure (F. u. Fl. des Golfes von Neapel, vol. xix, plate 23, fig. 15), especially on the distal segment.

In several cases, in young specimens, it was found that the 3 central furcal setae were deeply pigmented at their bases with a purple-blue pigment; this appears to grow fainter and is finally lost during the later development.

2. **Labidocera euchaeta**, Giesbrecht.

Occurrence: Locality Q.

Several specimens of both sexes were obtained.

3. **Labidocera kroyeri** (G. Brady).

Occurrence: Localities B, E, O, P, Q.

On the whole this species was comparatively rare, occurring only in small numbers in the localities given above. The females were all typical in their structure, but all the corresponding males showed some form of variation.

4. **Labidocera kroyeri** (Brady) var. **stylifera**, Th. and Scott.

Several specimens were obtained showing this variation.

5. **Labidocera kroyeri** (Brady) var. **burmanica**, nov.

Pl. xxiii, figs. 4 and 5.

In this form the right side of the 5th thoracic segment terminates in a branched arrangement of 5 spines. Three of these spines are large and conspicuous and two smaller ones project respectively from the inner and outer surface of the lower border of the projection. In general structure the 5th natatory legs closely resemble those of the variety "*gallensis*" (Thompson and Scott)[1] from Ceylon; it differs, however, in possessing an extra process on the terminal segment of the left leg; this process arises from the inner border and is bluntly rounded.

This variety, like "*gallensis*," has the spine on the right basal corner of the first abdominal segment.

6. **Labidocera kroyeri** (Brady) var. **bidens**, nov.

Plate xxiv, fig. 8.

A single female, obtained in locality O, presented a variation from the normal in the structure of the 5th pair of legs.

As usually figured and described, the normal exopods of the 5th pair of legs have no spines on their outer margins, but in this case a single spine was present near the termination, and on the left side gave a bifid appearance to the exopodite. The endopodites were normal in structure. In all other respects the structure was perfectly normal.

1 "Ceylon Pearl Oyster Fisheries and Marine Biology," pt. 1, p. 251, pl. ii, figs. 6 and 7, 1903.

7. **Labidocera minuta**, Giesbrecht.

Occurrence : Localities A, B, C, D, E, G, L, N, O, P.

This species, like *L. acuta*, was common in localities A to E ; in the remaining ones, however, it was comparatively rare.

8. **Labidocera pectinata**, Thompson and Scott.

Pl. xxiii, figs. 8, 9.

L. pectinata, Thompson and Scott, *Ceylon Pearl Oyster Fisheries*. (Suppl. Report vii), vol. i, p. 252, pl. ii, figs. 10—14, 1903.

L. similis, Cleve, Report on Plankton collected by Mr. Th. Wulff. *Arkiv för Zoologi*, vol. i, p. 378, pl. 19, figs. 4—6, 1903-04.

♀ A single specimen was obtained in locality Q. This species was first described by Thompson and Scott from the Pamban Pass, Ceylon : almost simultaneously another account was published by P. T. Cleve, who had found it in the plankton off Karachi. These two descriptions, while agreeing in all main essentials, differ slightly in certain details. Cleve's specimens presented a symmetrical furca, and on the genital segment a large dorsal apophysis and a single lateral spine, whereas in the specimens from Ceylon the furca is slightly asymmetrical and the genital segment has two lateral spines and is without the apophysis. Another point of difference, judging from the figures given, is in the number of spines on the endopodites of the 5th pair of legs. These are more numerous in the specimens from Ceylon. In the single specimen that I obtained in Hinzé Basin this feature was still more marked, though in all other respects it exactly corresponded with the Ceylon specimens. It would appear that we have here an example of continuous variation, the further to the east the locality in which the species is obtained, the more numerous become the spines of the endopodites of the 5th pair of legs.

Genus **Pontella**, G. Brady.

1. **Pontella andersoni**, Sewell.

Vide *Ante*.

A single male and a single damaged female were obtained in locality D.

2. **Pontella danae**, Giesbrecht, var. **ceylonica**, Thompson and Scott.

P. danae var. *ceylonica*, Thompson and Scott, Report on the Copepoda. *Ceylon Pearl Oyster Fisheries and Marine Biology* (Suppl. Report vii), vol. i, p. 252, pl. ii, figs. 1—5.

P. danae, A. Scott, The Copepoda of the Siboga Expedition, pt. i, p. 159.

A few specimens were obtained in locality Q.

These all agreed exactly with the description given by Thompson and Scott of the variety found by them round Ceylon.

A. Scott also describes a form of *P danae* found by him in the "Siboga" collection, in which the 5th pair of legs are the same as in var. *ceylonica*, but the furca agrees with Giesbrecht's original specimens. This form is of interest in supplying the intermediate stage of variation.

3. **Pontella investigatoris**, sp. nov.

Pl. xxiii, figs. 1—3.

Three males were obtained in localities A and E.

These specimens appear to differ from any previously described species. No corresponding females were found.

♂ Total length 2·9 mm.

The cephalo-thorax is robust; the head is furnished with side hooks and terminates anteriorly in a well-developed rostrum, provided with well-marked rostral lenses; there is also a well-developed ventral lens. The 4th and 5th thoracic segments are separate and the latter terminates laterally in a triangular plate, which is slightly asymmetrical, being more sharply pointed on the right side.

The abdomen is contained $3\frac{1}{2}$ times in the length of the cephalo-thorax; it consists of 5 segments, of which the relative lengths are 7 : 4 : 6 : 2 : 4. The furcal rami are slightly asymmetrical, the right being a little stouter than the left; they are $2\frac{1}{2}$ times as long as broad and are equal in length to the preceding three segments. The 2nd furcal seta is about twice the length of the others.

The 1*st antennae* are as usual asymmetrical and the relative proportions of the joints of the left antenna are as follows:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
50.	33.	8.	8.	10.	12.	10.	9.	15.	12.	10.	20.	18.	19.	24.	32.	33.	37.	40.	30.	29.	29.	29.	25.

The 10th and 11th joints are partially fused together.

In the right *grasping antenna* the middle joints are much swollen. The proximal segment of the knee-joint bears on its upper margin a toothed-plate somewhat longer than the joint itself, and produced proximally over the preceding segment, and bears a series of sharply-pointed teeth that diminish in size distally. The distal segment bears two toothed-plates, each armed with a series of fine needle-shaped teeth, and has a sharp spine at its distal extremity. The proportional lengths of the three terminal joints are 21 : 18 : 23.

In the 5*th pair of legs* that of the right side somewhat resembles *P. atlantica* (M.E.); the proximal segment of the claw

has a well-marked proximal process and bears on its margin a single trilobed tooth, from the base of which a single seta arises. The distal segment is somewhat sharply curved about the middle of its length, and bears on its proximal half two setae but no tooth-like process. In the left leg the terminal segment is short and bears on its external border a short spine; terminally it is provided with a long curved spine and two shorter and more delicate processes, one of which is ribbed; the inner surface is clothed with hair. The penultimate segment carries a short spine at its distal external angle.

The remaining appendages resembled those of the other members of the genus.

4. **Pontella princeps**, Dana.

A single specimen, a male, was obtained in locality A.

5. **Pontella securifer**, G. Brady.

Pontella securifer, Brady, Rep. Voy. Challenger, Copepoda, vol. viii, p. 96, pl. 45, 1883.

Pontella securifer, Claus, Ueber die entwicklung und das system der Pontelliden. *Arb. Zool. Inst. Wien*, vol. x, p. 233, pl. v, fig. 6, 1892-93.

Pontella securifer, Giesbrecht, F. u. Fl. Neap., vol. xix.

Pontella spinipes ♂, Wolfenden, The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, p. 1020, 1903-4.

Occurrence: Localities A, B, E.

This species was comparatively rare in this region. Several typical examples of the female were obtained and associated with them were a few males.

From previous descriptions it would appear that the male of this species is somewhat variable as regards the grasping antenna. Brady's original description is of the briefest character and his figure of this antenna is very poor. Claus figures it as having on the proximal end of the 19th segment a rounded elevation bearing three pointed teeth. Giesbrecht, however, represents this portion as consisting of a plate bearing a number of lamellar teeth.

In the males obtained by me the right antenna agrees exactly with Claus's figure, and differs from that given by Giesbrecht.

The *5th legs* of my specimens agree with Giesbrecht. Wolfenden has described a male *Pontella*, which he takes to be the male of *P. spinipes*; in this, the right grasping antenna has on the 19th segment a "rounded projection with three arrow-shaped teeth." Other points of difference are that in his specimens the teeth on the 19th segment are smaller and the toothed plate on

the 18th segment is also smaller than in *P. securifer*. With regard to these last two points, it would appear not improbable that they may be merely a variety, and as I shall show in the next species, a considerable degree of variation is met with in specimens of undoubtedly the same species.

In the few specimens that I obtained the relative lengths of the two limbs of the knee-joint were 47 : 43, thus agreeing with Wolfenden's measurements of his supposed *P. spinipes* ♂.

The only difference that would appear to be constant between Wolfenden's *P. spinipes* ♂ and *P. securifer* ♂ is the absence of the large triangular tooth on the proximal limb of the claw of the 5th leg. I have, therefore, come to the conclusion that he was in reality dealing with a variation, either local or seasonal, of *Pontella securifer*.

6. Pontella spinipes, Giesbrecht.

Pl. xxiv, figs. 1—4.

Occurrence: Localities A, C, D, E, O.

A considerable number of typical females were obtained in the above localities and associated with them were several males that I believe to be the true male of this species.

♂ In these specimens the total length is 3·15—3·5 mm. The head is furnished with side hooks and the rostral lens is large and well-developed.

The last thoracic segment and abdomen are like *P. securifer*. The length of the abdomen and furca is contained nearly 3½ times in that of the cephalo-thorax.

1st antennae. The left antenna very closely resembles that of the female, the proportionate lengths of the segments in the two sexes are given below:—

♀

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
50.	35.	10	7.	10.	11.	11.	12.	16.	15.	14.	27.	25.	30.	31.	41.	37.	44.	46.	34.	30.	30.	23.	25.

♂

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23	24.
50.	37.	9.	7.	10.	11.	11.	11.	13.	14.	15.	17.	24.	22.	25.	33.	33.	40.	45.	31·5.	31.	33.	23.	25.

In both sexes the 11th and 12th segments are partially fused together.

In general appearance the grasping antenna very closely resembles that of *P. securifer*; there are slight differences in the toothed plate of the 18th segment, which is shorter apparently than in *P. securifer* and has fewer teeth; the teeth are long and sharp and set fairly widely apart, diminishing gradually in size towards the distal end. The number present varies from 25 to 30.

The toothed-plate is invariably shorter than the segment itself; an average of 8 measurements gave the relative proportions of segment and "reibleiste" as 27·5 : 24·5, whereas in *P. securifer*, Giesbrecht figures the reibleiste as much longer than the segment, and in my specimens the average was 20 : 24. The distal segment of the knee-joint bears two toothed-plates, the proximal being the smaller and having from 8 to 11 arrow-shaped teeth. These two segments appear to vary very considerably in their relative proportions; in some the proximal is the longer, while in others it is very distinctly shorter than the distal joint. Below I give the measurements in ten different individuals:—

(1) 22 : 21	(6) 21 : 19
(2) 23 : 21	(7) 20 : 21
(3) 21 : 21·5	(8) 20 : 21·5
(4) 22 : 21·5	(9) 24 : 22
(5) 22 : 22	(10) 22 : 22.

From the above it will be noted that it is in the smaller specimens, with a measurement of 20 or 21 for the proximal joint, that the distal exceeds the proximal in length, the condition becoming reversed in the larger specimens.

It appears possible that we are here dealing with a depauperized condition, the small size of the animal and the alteration in the proportions of the segments forming the knee-joint being correlated with one another. In any case, the relative proportions of these joints, in the absence of any other measurements, would seem to be of doubtful specific value.

It is in the *5th pair of legs* that these males present their greatest difference from *P. securifer*. The proximal segment of the claw has a well-marked simple process proximally and bears on its margin three teeth; the first is stout and triangular in shape, the other two are thin and more delicate and are respectively rounded and sharply pointed; between these two latter a single seta arises. The distal segment also bears on its margin three rounded teeth. The left leg has a short terminal joint, bearing a stout curved spine and two more delicate processes at its distal extremity and a short spine on its external border, and the inner surface is covered with hair. The penultimate joint has a short spine at its distal external border.

As I have shown (*vide P. securifer*, above), the male described by Wolfenden as the male of *P. spinipes* is in all probability merely a variation of the male of *P. securifer*, and not the hitherto-unknown male of *P. spinipes*. The above males are unlike anything previously described, though fairly closely resembling *P. securifer* in certain respects; they were associated in all the catches with undoubted females of *P. spinipes* and are, in my opinion, the hitherto-unknown male.

Genus **Pontellopsis**, G. Brady.

1. **Pontellopsis herdmani**, Thompson and Scott.

Pl. xxiv, fig. 5.

Pontellopsis herdmani, Thompson and Scott, Ceylon Pearl Oyster Fisheries (Suppl. Report vii), vol. i, p. 253, pl. ii, figs. 15—17 (1903).

Pontellopsis macronyx, A. Scott, The Copepoda of the Siboga Expedition, pt. i, p. 137, pl. liv, figs. 1—10 (1909).

Occurrence: Localities A, B, C, D, E, F, L, O, P.

A large number of specimens, both males and females, were obtained. The males correspond exactly with the description of *Pontellopsis macronyx*, A. Scott, from the "Siboga" collection. The females however present certain differences and are exactly intermediate between *Pontellopsis macronyx* and *Pontellopsis herdmani*, which was described by Thompson and Scott from Ceylon and to which no corresponding male was obtained.

Considering the differences between the two forms obtained from Ceylon and the waters to the east of Borneo, Scott was quite justified in making them different species, but the discovery of a third and intermediate form from the Burma coast indicates that in reality we are dealing with a single very variable species, and I propose to combine the three under the name of *P. herdmani*.

In the following table I have given the main characters of the three forms:—

	P. herdmani.	*P. macronyx.*	Intermediate form
Total length	1·9 mm.	1·97 mm.	1·64 mm.
Length of abdomen and furca.	Contained twice in cephalothorax.	Contained 2½ times.	As *P. macronyx*.
Abdomen ..	Composed of 2 joints, 1st segment twice as large as 2nd, two thorn-like projections on right side	2 joints. Genital segment long. two spines on each side	2 joints. Genital segment long. Spines variable from 2 to 4.
Furca	Rami twice as long as broad, fine hairs on inner surface, 5 short non-plumose setae.	Furcal joints short 5 short setae	As *P. heramani*.
Rostrum ..	Long, narrow and bifid.	Rami long and slender	Ditto ditto.
Antenna ..	16 jointed (judging from the fig segments 3 and 4 are each composed of 3 segments fused together), extend to end of thorax Relative lengths as follows: 1. 2. 3-4 5. 6. / 6. 7 5. 8. 3. 5.	2 jointed, extend to end of thorax.	As *P. herdmani*. Segment 3 and 4 each composed of 3 partially fused segments. Relative lengths as in *P. herdmani*.

	P. herdmani.	*P. macronyx.*	Intermediate form.
5th pair of legs	Symmetrical. Each 2 branched. Each branch bifid.	Asymmetrical. Inner margin of right exopodite produced into a strong spine. The spine on the inner margin of the left leg has become suppressed.	As *P. macronyx.*

In a few cases the abdomen, instead of being almost symmetrical, is produced on the left side into a long spine-like process, this being apparently an exaggerated phase of the condition normally found in which a rod-like spine is present at this point (plate xxiv, fig. 5).

From the above it would appear that we are here dealing with another example of continuous variation, apparently affecting only the females of the species, for as the habitat extends to the westward we meet with a tendency for a reduction of the number of spines on the genital segment of the abdomen, a fusion of certain joints at the base of the antennae, and the formation of a second spine on the left 5th leg.

2. **Pontellopsis krämeri**, Giesbrecht.

♀ A single specimen was obtained in each locality A and J and two in locality P.

The asymmetry of the furcal joints was well-marked and corresponded with Giesbrecht's original figures. The spines on the 5th pair of legs also resembled those in Giesbrecht's specimens. In both these points the specimens differed from Wolfenden's description of the specimens obtained by him in the Maldive and Laccadive Archipelagoes.

3. **Pontellopsis regalis** (Dana).

Occurrence: Localities A, C, D, E, K.

A few specimens were obtained in each of the above localities, but on the whole the species was comparatively rare.

Genus **Acartia**, Dana.

1. **Acartia danae**, Giesbrecht.

A single specimen, a female, was obtained in locality F.

2. **Acartia erythraea**, Giesbrecht.

Occurrence: Localities C, E, G, J, L.

Only a few specimens were obtained in the above localities, with the exception of locality E, where it was quite common.

3. **Acartia spinicauda**, Giesbrecht.

Occurrence: Localities A, C, K, N, O, P.

Genus **Tortanus**, Giesbrecht.

1. **Tortanus barbatus** (Brady).

Corynura barbata, Brady, Rep. Voy. Challenger, vol. 8, p. 71, plate 31, figs. 11-12, 1883.

Corynura barbata, Giesbrecht, F. u. Fl. Neapel, vol. 19, p. 525, 1892.

Tortanus barbatus, Giesbrecht and Schmeil, Das Tierreich, pt. 6. Copepoda, p. 158.

Tortanus barbatus, Scott, The Copepoda of the Siboga Expedition, pt. 1, p. 189, pl. lv, figs. 16—18.

Several specimens were obtained in localities E and Q.

A. Scott considers that *T. denticulatus* and *T. barbatus* are in reality the same species, but the present specimens differ in several particulars from the specimens that he describes as *T. barbatus* in the "Siboga" material. In my specimens the teeth on the left 5th leg all have whip-like ends, the outer hair of the furca is long and reaches to the end of the furcal joint, and in the mid-dorsal line there arises from the anal segment of the abdomen a spine-like projection. Brady in his original illustration figures a rounded projection.

The length of the specimens were 1·43 mm.

I consider that it is advisable to retain the distinction between these two species and the above would appear to be typical specimens of *Tortanus barbatus*, while Scott's specimens were in all probability *Tortanus denticulatus*.

2. **Tortanus gracilis** (Brady).

Tortanus gracilis, Cleve, Plankton from the Indian Ocean and Malay Archipelago. *Kongl. Svens. Vet. Akad. Handl.*, Bd. 35, No. 5, p. 51, pl. vii, figs. 11—15, 1901-02.

Occurrence: Localities B, E, F, G, J, N, O, P.

Considerable variation was met with in the degree of asymmetry of the 5th legs of the females. I am inclined to agree with Cleve that *T. forcipatus* and *T. gracilis* are in reality the same species, the difference in the 5th leg being due to age.

List of Localities showing species of Copepoda (Gymnoplea) taken.

Locality A { 14·8 to 14·10 N. / 97·42¾ to 97·46½ E. } 17 species.

Acartia spinicauda.
Acrocalanus longicornis.
Canthocalanus pauper.
Centropages furcatus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Paracalanus parvus.
Pontella investigatoris, sp. nov.
Pontella princeps.
Pontella securifer.
Pontella spinipes.
Pontellopsis krämeri.
Pontellopsis herdmani.
Pontellopsis regalis.
Temora discaudata.
Temora longicornis.

Locality B { 14·6 to 14·15½ N. / 97·49 to 97·58½ E. } 19 species.

Calanus minor.
Candacia discaudata.
Canthocalanus pauper.
Centropages notoceras.
Centropages furcatus.
Centropages orsinii.
Eucalanus subcrassus.
Euchaeta concinna.
Labidocera acuta.
Labidocera kroyeri.
Labidocera kroyeri var. *stylifera.*
Labidocera minuta.
Pontella securifer.
Pontellina plumata.
Pontellopsis herdmani.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.

Locality C { 14·5 to 14·6½ N. / 98·1¾ to 98·5 E. } 16 species.

Acartia erythraea.
Acartia spinicauda.
Acrocalanus gracilis.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Centropages tenuiremis.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Pontella danae.
Pontella spinipes.
Pontellopsis herdmani.
Pontellopsis regalis.
Temora turbinata.
Undinula caroli.

Locality D { 14·2½ to 14·5 N. / 98·2½ to 98·5 E. } 19 species.

Acrocalanus gibber.
Calocalanus pavo.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Eucalanus crassus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Paracalanus aculeatus.
Pontella andersoni.
Pontella spinipes.
Pontellina plumata.

Pontellopsis herdmani.
Pontellopsis regalis.
Temora discaudata.
Temora turbinata.
Undinula vulgaris.

LOCALITY E { 13°47¼ to 13°52½ N. / 98°3½ to 98°4¾ E. } 31 species and varieties.

Acartia erythraea.
Acrocalanus gibber.
Calanus minor.
Calanopia elliptica.
Calanopia thompsoni.
Calocalanus pavo.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Centropages tenuiremis.
Eucalanus crassus.
Eucalanus monachus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Labidocera kroyeri.
Labidocera kroyeri var. *stylifera.*
Paracalanus aculeatus.
Pontella investigatoris, sp. nov.
Pontella danae var. *ceylonica.*
Pontella securifer.
Pontella spinipes.
Pontellopsis herdmani.
Pontellopsis regalis.
Temora discaudata.
Temora stylifera.
Temora turbinata.
Tortanus barbatus.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.

LOCALITY F { 13°59½ to 14°4½ N. / 97°51½ to 98°0 E. } 20 species.

Acartia danae.
Acrocalanus longicornis.
Calanopia aurivillii.
Calanopia elliptica.
Calanopia minor.
Calanus minor.
Candacia discaudata.
Canthocalanus pauper.
Centropages orsinii.
Eucalanus subcrassus.
Labidocera acuta.
Lucicutia flavicornis.
Pontellina plumata.
Pontellopsis herdmani.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.
Undinula darwini.

LOCALITY G (13. 49¼ N. : 97.58½ E.) 16 species and varieties.

Acartia erythraea.
Acrocalanus gracilis.
Acrocalanus longicornis.
Acrocalanus longicornis var. *plumulosus.*
Acrocalanus monachus.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Labidocera acuta.
Labidocera minuta.
Paracalanus aculeatus.
Paracalanus aculeatus var. *plumulosus.*
Temora discaudata.
Temora turbinata.
Undinula caroli.
Undinula vulgaris.

Locality H { 13°51½ to 13°55½ N. / 97°57½ to 98°2 E. } 11 species.

Acrocalanus gibber.
Acrocalanus gracilis.
Acrocalanus longicornis.
Canthocalanus pauper.
Centropages orsinii.
Eucalanus monachus.
Eucalanus subcrassus.
Labidocera acuta.
Temora turbinata.
Undinula caroli.
Undinula vulgaris.

Locality J { 13°41 to 13°95 N. / 97°55 to 98°0 E. } 22 species.

Acartia erythraea.
Acrocalanus gibber.
Acrocalanus gracilis.
Acrocalanus longicornis.
Calanopia elliptica.
Calanopia minor.
Candacia bradyi.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Clausocalanus arcuicornis.
Eucalanus subcrassus.
Eucalanus pileatus.
Euchaeta concinna.
Lucicutia flavicornis.
Paracalanus aculeatus.
Paracalanus parvus.
Pontellopsis krämeri.
Temora discaudata.
Temora stylifera.
Temora turbinata.
Tortanus gracilis.

Locality K { 13°50 to 13°45 N. / 97°59½ to 97°55 E. } 14 species and varieties.

Acartia spinicauda.
Acrocalanus gibber.
Calanus minor.
Candacia discaudata.
Canthocalanus pauper.
Centropages orsinii.
Eucalanus subcrassus.
Labidocera acuta.
Paracalanus aculeatus.
Temora turbinata.
Undinula caroli.
Undinula caroli var. *plumulosus.*
Undinula vulgaris.
Undinula vulgaris var. *plumulosus.*

Locality L (13°50 N. : 97°56 E.) 20 species and varieties.

Acartia erythraea.
Acrocalanus gibber.
Acrocalanus longicornis.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Eucalanus crassus.
Eucalanus pileatus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Paracalanus aculeatus.
Pontellopsis herdmani.
Temora discaudata.
Temora stylifera.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.
Undinula vulgaris var. *plumulosus.*

LOCALITY M (13·44½ N. : 98·0½ E.) 14 species.

Acrocalanus gardineri.
Acrocalanus gracilis.
Acrocalanus longicornis.
Calanopia elliptica.
Candacia discaudata.
Centropages orsinii.
Eucalanus crassus.
Eucalanus pileatus.
Eucalanus subcrassus.
Labidocera acuta.
Temora discaudata.
Temora turbinata.
Undinula caroli.
Undinula vulgaris.

LOCALITY N { Byikhwaaw Bay. 13·33 N. : 98·8½ E. } 21 species.

Acartia spinicauda.
Acrocalanus gardineri.
Acrocalanus gibber.
Acrocalanus gracilis.
Acrocalanus longicornis.
Calanopia elliptica.
Calanus minor.
Candacia bradyi.
Candacia catula.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Eucalanus subcrassus.
Labidocera minuta.
Lucicutia flavicornis.
Paracalanus aculeatus.
Pontellopsis regalis.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.

LOCALITY O { 13·32 to 13·40 : N. 97·40 to 97·55 : E. } 35 species and varieties.

Acartia spinicauda.
Acrocalanus gibber.
Acrocalanus longicornis.
Calanopia elliptica.
Calanopia minor.
Calocalanus pavo.
Calocalanus plumulosus.
Candacia aethiopica.
Candacia bradyi.
Candacia discaudata.
Candacia truncata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Clausocalanus arcuicornis
Eucalanus attenuatus.
Eucalanus crassus.
Eucalanus monachus.
Eucalanus subcrassus.
Euchaeta concinna.
Labidocera acuta.
Labidocera minuta.
Labidocera kroyeri.
Labidocera kroyeri var. *stylifera.*
Labidocera kroyeri var. *bidens.*
Lucicutia flavicornis.
Paracalanus aculeatus.
Pontella spinipes.
Pontellopsis herdmani.
Rhincalanus cornutus.
Scolecithrix danae.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula vulgaris.

LOCALITY P { 13·40 to 14·5½ N. 97·40 to 97·50 E. } 32 species and varieties.

Acartia spinicauda.
Acrocalanus gibber.
Acrocalanus longicornis.
Calanopia elliptica.

Calanopia minor.
Calanus minor.
Candacia catula.
Candacia discaudata.
Candacia truncata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii
Clausocalanus arcuicornis.
Eucalanus attenuatus.
Eucalanus crassus.
Eucalanus monachus.
Eucalanus pileatus.
Eucalanus subcrassus.
Euchaeta concinna.
Labidocera acuta.
Labidocera kroyeri.
Labidocera minuta.
Lucicutia flavicornis.
Paracalanus aculeatus var. *plumulosus.*
Pontellopsis herdmani.
Rhincalanus cornutus.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.
Undinula vulgaris var. *plumulosus.*

LOCALITY Q { Hinzé Basin. 14·41½ N. : 97·53 E. } 21 species and varieties.

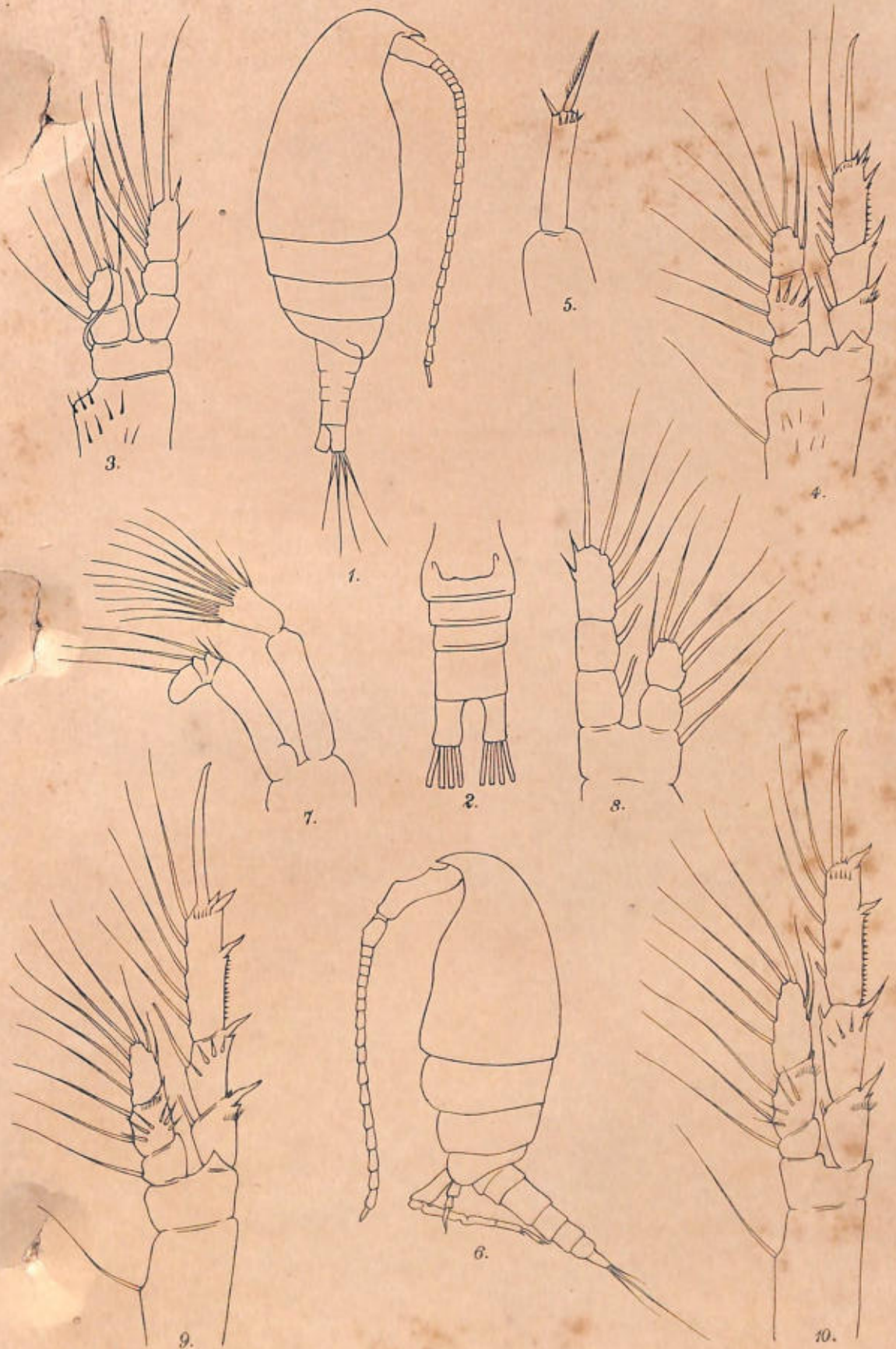
Acrocalanus gardineri.
Canthocalanus pauper.
Centropages notoceras.
Eucalanus crassus.
Eucalanus pileatus.
Eucalanus subcrassus.
Eucalanus subtenuis.
Euchaeta concinna.
Euchaeta marina.
Labidocera acuta.
Labidocera euchaeta.
Labidocera kroyeri.
Labidocera kroyeri var. *burmanica*, nov.
Labidocera pectinata.
Paracalanus parvus.
Pontella danae var. *ceylonica.*
Pseudodiaptomus aurivillii.
Pseudodiaptomus hickmani, sp. nov.
Tortanus barbatus.
Undinula darwini.
Undinula vulgaris var. *plumulosus.*

A. C. Chowdhary, del.

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1912.

EXPLANATION OF PLATE XV.

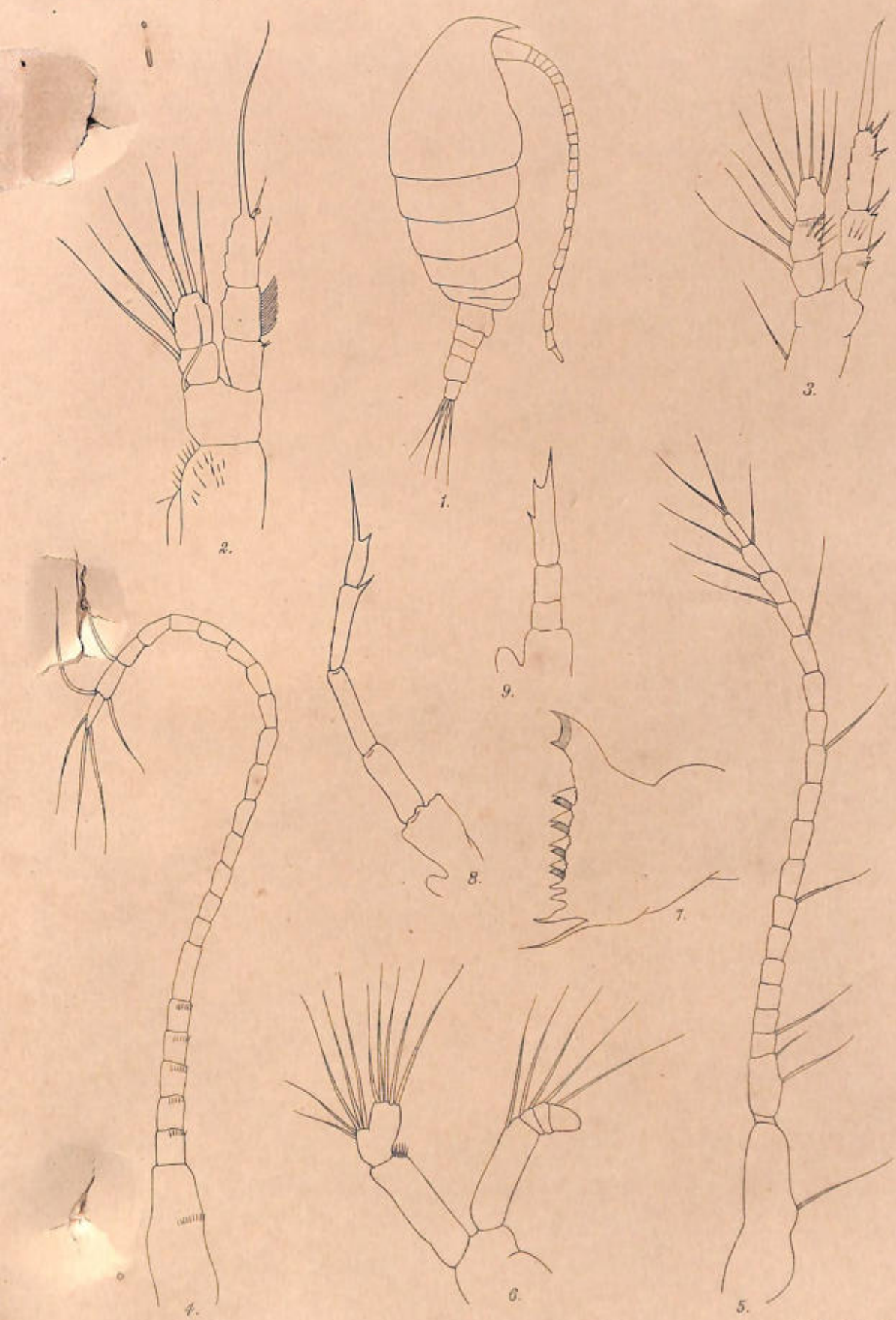
1.—*Paracalanus dubia*, sp. nov.	♀	Lateral view.
2.— ,, ,, ,, ,,	♀	Abdomen, ventral view
3.— ,, ,, ,, ,,	♀	1st Leg.
4.— ,, ,, ,, ,,	♀	2nd Leg.
5.— ,, ,, ,, ,,	♀	5th Leg.
6.—*Paracalanus serratipes*, sp. nov.	♂	Lateral view.
7.— ,, ,, ,, ,,	♂	2nd Antenna.
8.— ,, ,, ,, ,,	♂	1st Leg.
9.— ,, ,, ,, ,,	♀	2nd Leg.
10.— ,, ,, ,, ,,	♀	3rd Leg.



R.B.S. Sewell del. S.C. Mondul lith.

EXPLANATION OF PLATE XVI.

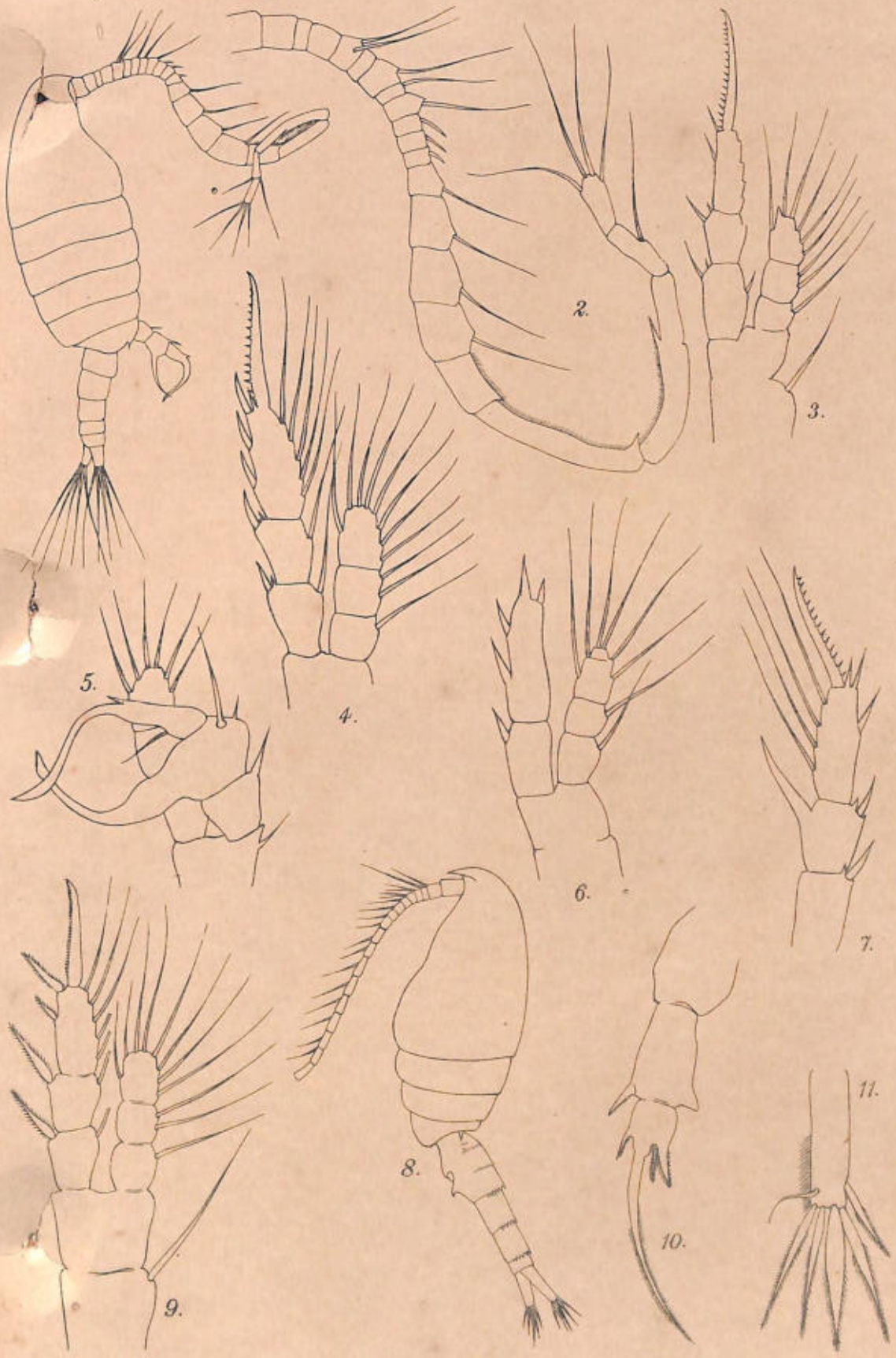
1.—*Acrocalanus inermis*, sp. nov.		♀	Lateral view.
2.—	,, ,, ,, ,,	♀	1st Leg.
3.—	,, ,, ,, ,,	♀	2nd Leg.
4.—	,, ,, ,, ,,	♀	1st Antenna.
5.—	,, ,, ,, ,,	♂	1st Antenna.
6.—	,, ,, ,, ,,	♂	2nd Antenna.
7.—	,, ,, ,, ,,	♂	Mandible.
8.—	,, ,, ,, ,,	♂	5th Leg, adult.
9.—	,, ,, ,, ,,	♂	5th Leg, immature.



R.B.S. Sewell del. S.C. Mondul lith.

EXPLANATION OF PLATE XVII.

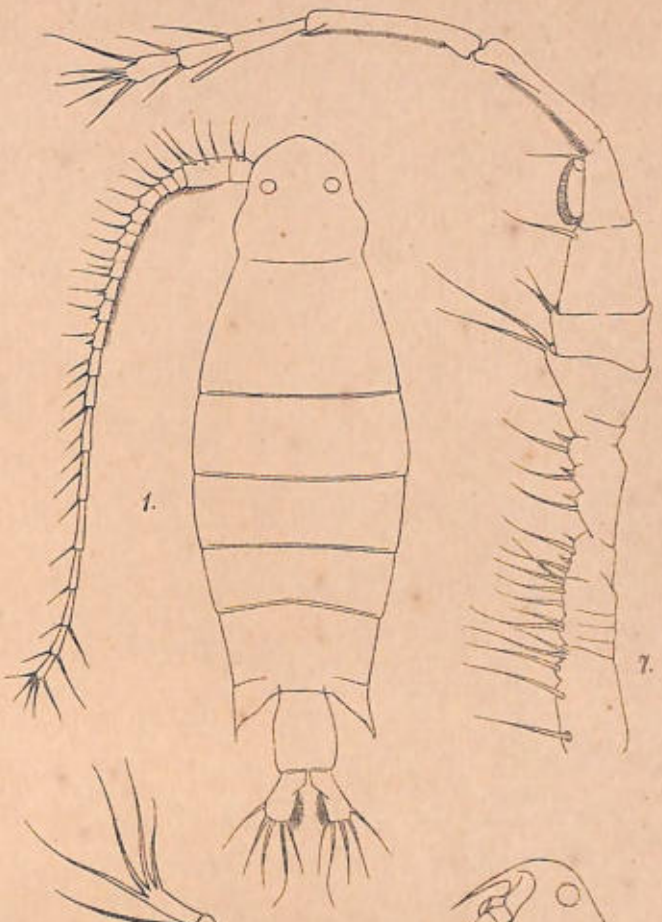
1.—*Centropages alcocki*, sp. nov.	♂	Lateral view.
2.— ,, ,, ,, ,,	♂	1st Antenna.
3.— ,, ,, ,, ,,	♂	1st Leg.
4.— ,, ,, ,, ,,	♂	2nd Leg.
5.— ,, ,, ,, ,,	♂	5th Leg, right side.
6.— ,, ,, ,, ,,	♂	5th Leg, left side.
7.— ,, ,, ,, ,,	♀	5th Leg.
8.—*Pseudodiaptomus binghami*, sp. nov.	♀	Lateral view.
9.— ,, ,, ,, ,,	♀	2nd Leg.
10.— ,, ,, ,, ,,	♀	5th Leg.
11.— ,, ,, ,, ,,	♀	Furcal ramus and setae.

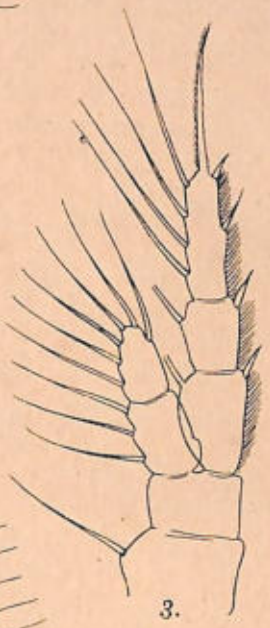


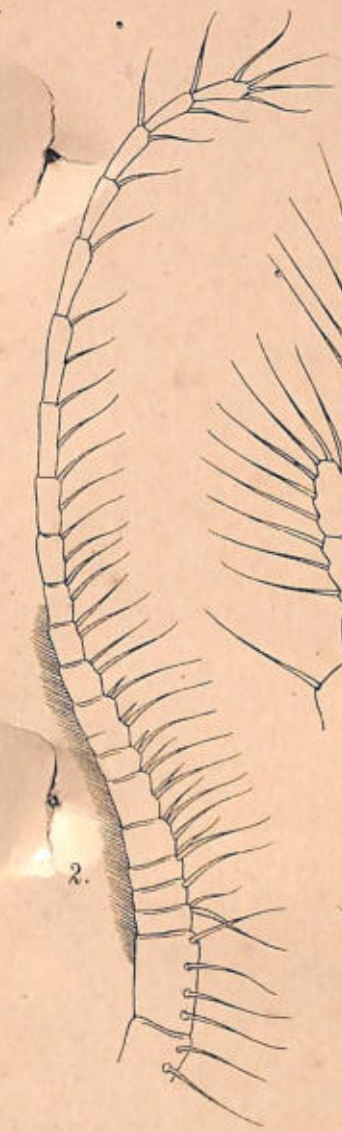
R.B.S. Sewell del. S. C. Mondul lith.

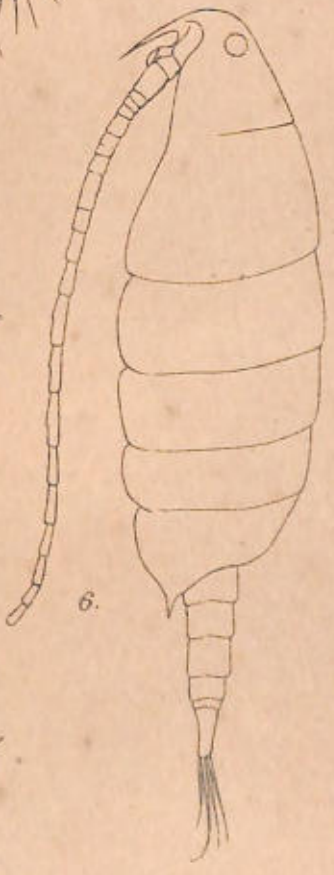
EXPLANATION OF PLATE XVIII.

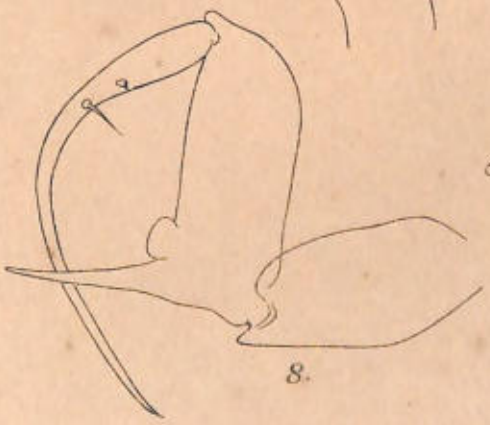
1.—	*Labidocera euchaeta*,	stage	1,	nov.		♀	Dorsal view.
2.—	,,	,,	,,	,,	,,	♀	1st Antenna.
3.—	,,	,,	,,	,,	,,	♀	1st Leg.
4.—	,,	,,	,,	,,	,,	♀	Maxilliped.
5.—	,,	,,	,,	,,	,,	♀	5th Leg.
6.—	,,	,,	,,	,,	,,	♂	Lateral view.
7.—	,,	,,	,,	,,	,,	♂	1st Antenna.
8.—	,,	,,	,,	,,	,,	♂	5th Leg, right side.
9.—	,,	,,	,,	,,	,,	♂	5th Leg, left side.







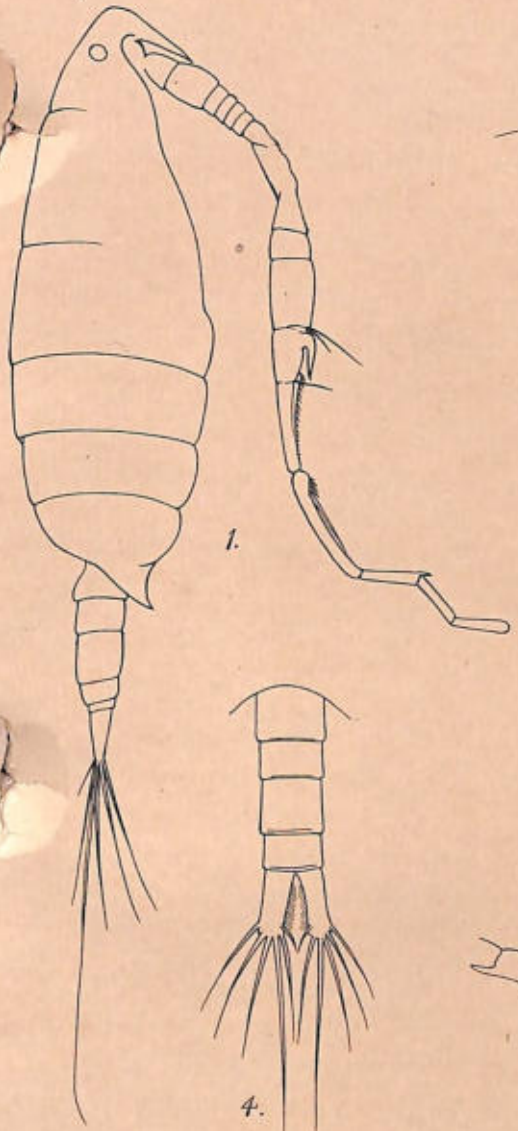




R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XIX.

1.—*Labidocera euchaeta*, Giesbrecht, stage II. ♂ Lateral view.
2.— ,, ,, ,, ,, ,, ♂ 1st Antenna.
3.— ,, ,, ,, ,, ,, ♂ 5th pair of legs.
4.— ,, ,, ,, stage III. ♂ Abdomen, dorsal view.
5.— ,, ,, ,, ,, ,, ♀ Abdomen, dorsal view.
6.— ,, ,, ,, ,, ,, ♀ 5th Leg.
7.— ,, ,, ,, ,, ,, ♂ 5th pair of legs.
8.— ,, ,, ,, stage IV. Abdomen.
9.— ,, ,, ,, ,, ,, 5th pair of legs



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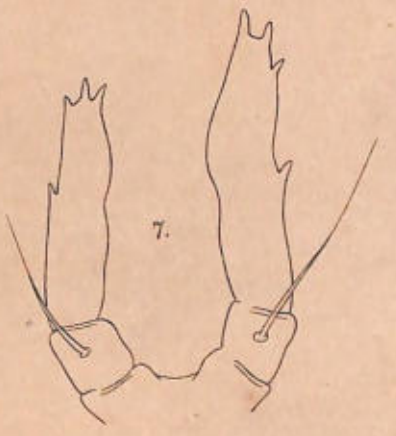

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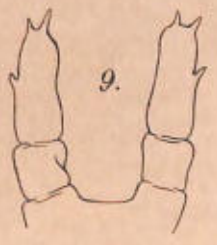

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R. B. S. Sewell del.

S. C. Mondul lith.

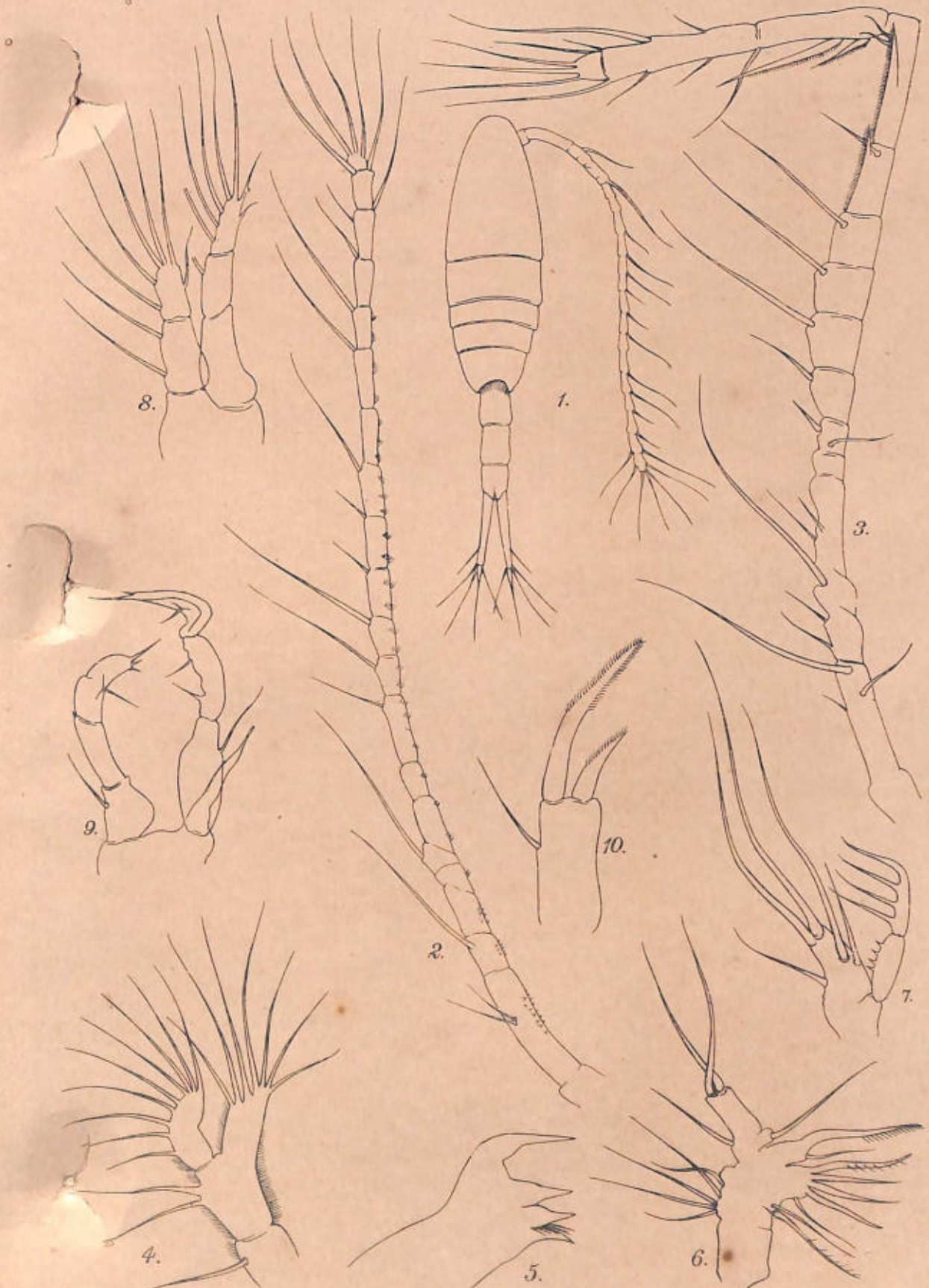
EXPLANATION OF PLATE XX.

1.—*Pontella andersoni*, sp. nov.		♀	Lateral view.
2.—	,, ,, ,, ,,	♀	1st Antenna.
3.—	,, ,, ,, ,,	♀	5th pair of legs.
4.—	,, ,, ,, ,,	♂	Abdomen.
5.—	,, ,, ,, ,,	♂	1st Antenna.
6.—	,, ,, ,, ,,	♂	5th pair of legs.
7.—	,, ,, ,, ,,	♂	1st Antenna, immature.
8.—	,, ,, ,, ,,	♂	5th Leg
9.—	,, ,, ,, ,,	♀	5th Leg ,,

R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXI.

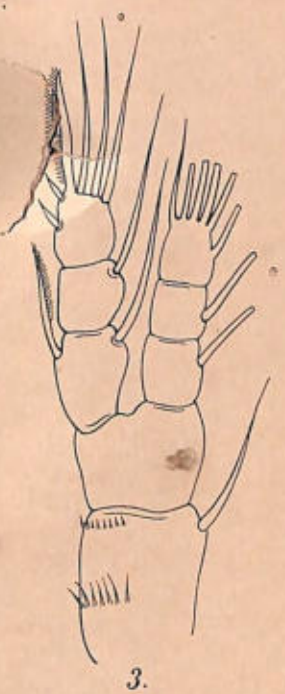
1.—	*Acartia tortaniformis*,	sp.	nov.		♀	Dorsal view.
2.—	,,	,,	,,	,,	♀	1st Antenna.
3.—	,,	,,	,,	,,	♂	1st Antenna.
4.—	,,	,,	,,	,,	♀	2nd Antenna.
5.—	,,	,,	,,	,,	♀	Mandible.
6.—	,,	,,	,,	,,	♀	1st Maxilla.
7.—	,,	,,	,,	,,	♀	Maxilliped.
8.—	,,	,,	,,	,,	♂	1st Leg.
9.—	,,	,,	,,	,,	♂	5th pair of legs.
10.—	,,	,,	,,	,,	♀	5th pair of legs.



R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXII.

1.—*Pseudodiaptomus hickmani*, sp. nov. ♀ Dorsal view.
2.— ,, ,, ,, ,, ♀ 2nd Antenna.
3.— ,, ,, ,, ,, ♀ 1st Leg.
4.— ,, ,, ,, ,, ♀ 2nd Leg.
5.— ,, ,, ,, ,, ♀ 5th Leg.
6.— ,, ,, ,, ,, ♂ 1st Antenna.
7.— ,, ,, ,, ,, ♂ 5th pair of legs.
8.—*Temora discaudata*, Giesbrecht. ♀ 5th Leg, normal.
9.— ,, ,, ,, ♀ 5th Leg, variety.



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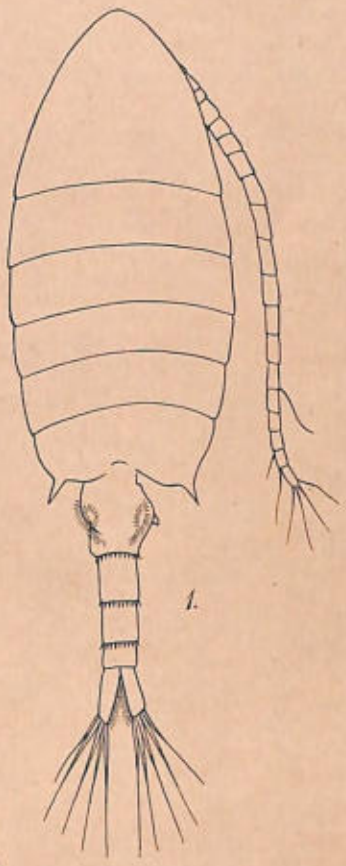

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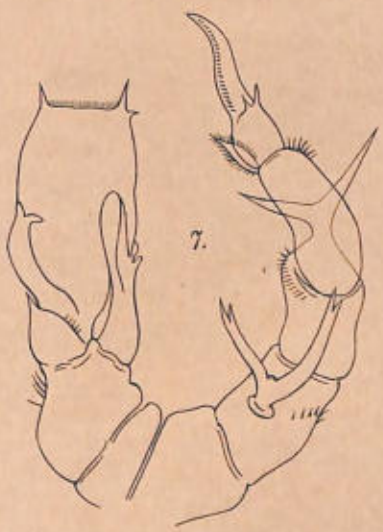

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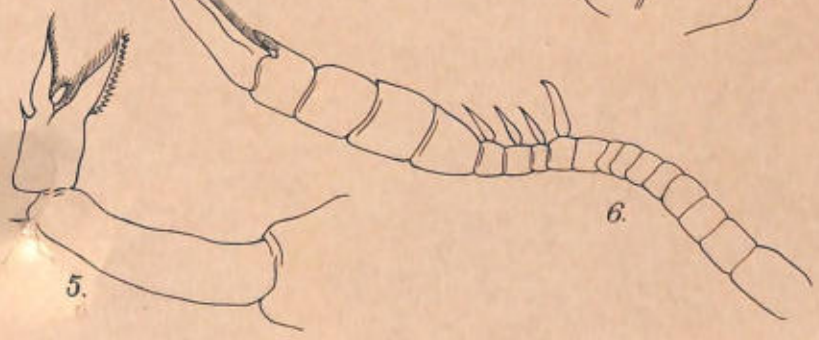

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R. B. S. Sewell del.

S. C. Mondul lith.

EXPLANATION OF PLATE XXIII.

1.—*Pontella investigatoris*, sp. nov. ♂ Lateral view.

2.— ,, ,, ,, ,, ♂ 1st Antenna, right side.

3.— ,, ,, ,, ,, ♂ 5th pair of legs.

4.—*Labidocera kröyeri* (Brady) var. *burmanica*, nov., lateral thoracic angle.

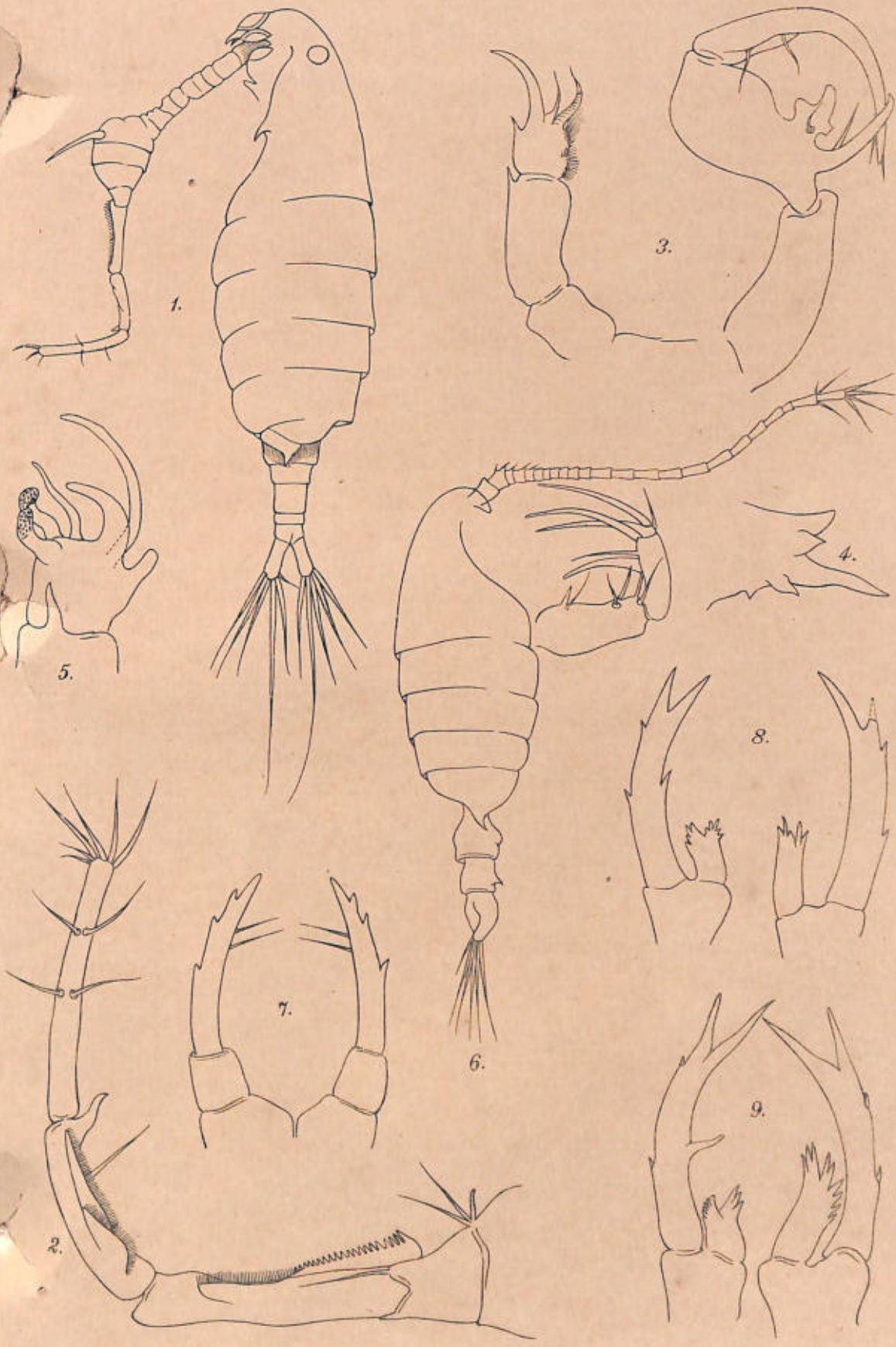
5.— ,, ,, ,, ,, ,, ,, ♂ 5th left leg, terminal segment.

6.—*Candacia bradyi*, A Scott. ♀ Lateral view.

7.— ,, ,, ,, ,, ♀ 5th pair of legs.

8.—*Labidocera pectinata*, Thomp. and Scott. ♀ 5th pair of legs (after Cleve).

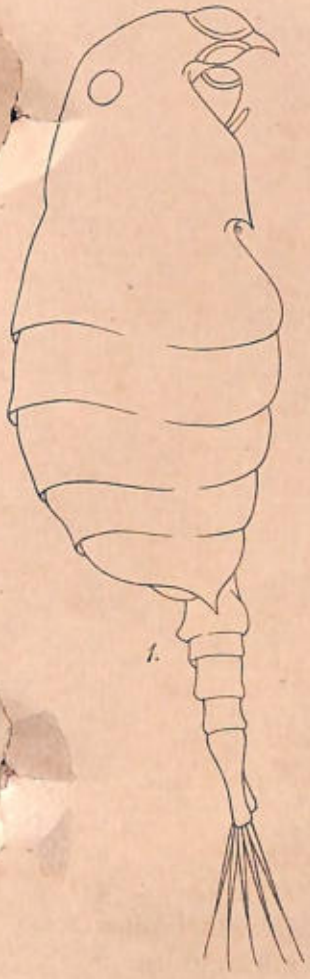
9.— ,, ,, ,, ,, ,, ♀ 5th pair of legs (from Burma).



R.B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXIV.

1.—*Pontella spinipes*, Giesbrecht. ♂ Lateral view.
2.— ,, ,, ,, ♂ 1st Antenna, right side.
3.— ,, ,, ,, ♂ 5th left leg.
4.— ,, ,, ,, ♂ 5th right leg.
5.—*Pontellopsis herdmani*, Thomp. and Scott. ♀ Abdomen with abnormal spine.
6.—*Centropages tenuiremis*, Thomp. and Scott. ♀ 5th right leg.
7.— ,, ,, ,, ,, ,, ♂ Exopodites, 4th pair of legs.
8.—*Labidocera kröyeri* (Brady) var. *bidens*, nov. ♀ 5th pair of legs.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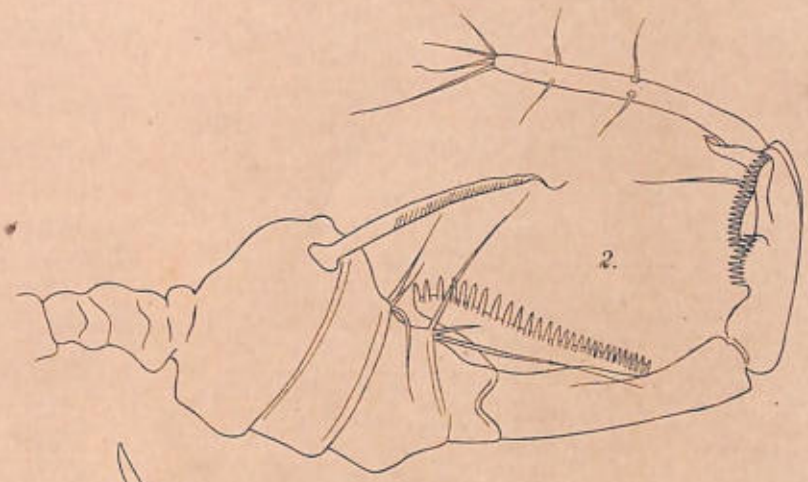
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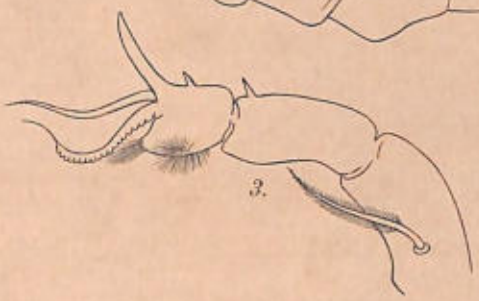
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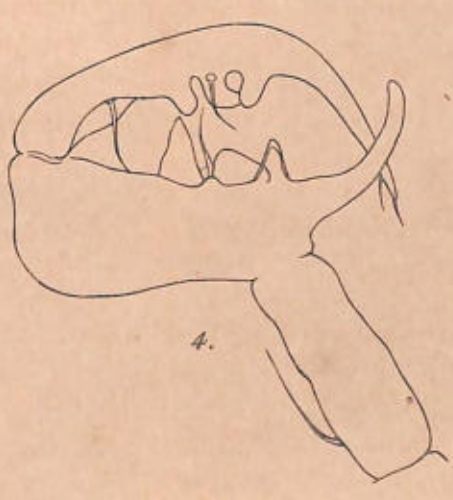
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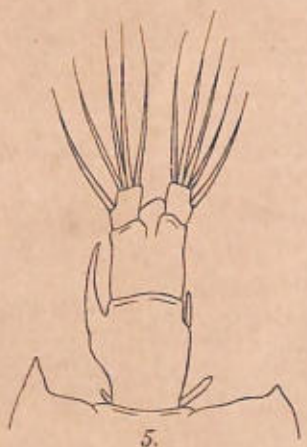
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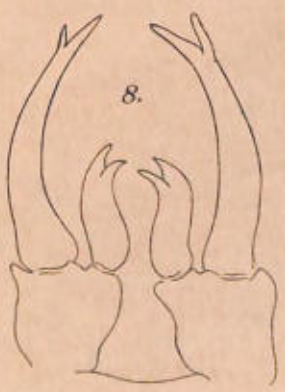
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XXX. THE FRESHWATER SPONGES OF THE MALABAR ZONE.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

The Malabar Zone is defined as consisting of the narrow strip of land on the west coast of Peninsular India between the Western Ghats and the Arabian Sea and of the Western Ghats themselves from the Tapti River in the northern part of Bombay proper to the extreme south of the Peninsula at Cape Comorin. The Western Ghats are a mountain-range (or rather a somewhat interrupted series of ranges) about 800 miles long and occupying in Peninsular India somewhat the same position as the Andes do in South America. They have not, however, anything like the same relative importance from a geographical point of view, for as a whole they cannot be reckoned among the higher ranges of the Indian Empire and they become insignificant in every way if compared with the Himalayas. It is true that in the so-called High Range in the north of Travancore an altitude of over 9,000 feet above sea-level is attained and that there are numerous peaks of over 3,000 feet at other points; but on the eastern side the mountains fall away gradually in the northern part of the Ghats into the plateau of the Deccan trap, while in the south they are inextricably confused with the ranges of the central part of the Madras Presidency, so that, although their height is often striking when they are viewed from the plains that lie below them to the west, it is difficult to distinguish them as a separate range at all from the east.

The freshwater sponges of the Malabar Zone were first studied by the late Dr. H. J. Carter over sixty years ago, but his investigations were confined to the Island of Bombay, the fauna of which is not nearly so characteristic as that of the Ghats. Recently large collections have been obtained by Mr. S. P. Agharkar of the Elphinstone College, Bombay, Mr. F. H. Gravely of the Indian Museum, Mr. R. Shunkara Narayana Pillay of the Trivandrum Museum, and myself in the Nasik, Poona, Satara and Ratnagiri districts of Bombay and in the Native State of Travancore. With this material in my hands I have thought it worth while to discuss the Spongillid fauna of the Malabar Zone as a whole.

List of the Freshwater Sponges of the Malabar Zone.

Genus Spongilla, Lamarck.

Subgenus Euspongilla, Vejdovsky.

1. *S. lacustris* subsp. *reticulata*, Annandale.
2. *S. proliferens*, Annandale.
3. *S. alba*, Carter.
4. *S. cinerea*, Carter.
5. *S. travancorica*,* Annandale.
6. *S. crateriformis* (Potts).

Subgenus Eunapius, Gray.

7. *S. carteri*, Carter.

7*a*. ,, ,, subsp. *lobosa*, Annandale.

Subgenus Stratospongilla, Annandale.

8. *S. gravelyi*,* nov.
9. *S. indica*,* Annandale.
10. *S. bombayensis*, Carter.

Genus Pectispongilla,* Annandale.

11. *P. aurea*,* Annandale.

11*a*. ,, ,, var. *subspinosa*,* Annandale.

Genus Ephydatia, Lamouroux.

12. *E. meyeni* (Carter).

Genus Dosilia, Gray.

13. *D. plumosa* (Carter).

Genus Trochospongilla, Vejdovsky.

14. *T. pennsylvanica* (Potts).

Genus Corvospongilla, Annandale.

15. *C. caunteri*, Annandale.
16. *C. ultima*, Annandale.

16*a*. ,, ,, var. *spinosa*,* nov.

17. *C. burmanica* subsp. *bombayensis*, Annandale.
18. *C. lapidosa*,* Annandale.

In the above list the names of those genera, species, etc. that are only known from the Malabar Zone are distinguished by an asterisk (*).

I.—SYSTEMATIC.

The great majority of the Malabar sponges have recently been discussed very fully in my volume on the Freshwater Sponges, etc. in the *Fauna of British India* and in subsequent papers, and it is not necessary to say anything more about them from a systematic point of view. So much new material has, however, been obtained in the genus *Corvospongilla* that I propose to revise this genus, so far as the Indian forms are concerned. It is also necessary to describe a new species of the subgenus *Stratospongilla* (genus *Spongilla*) discovered by Mr. Gravely.

Genus SPONGILLA.

Subgenus STRATOSPONGILLA.

The essential characters of this subgenus are, (1) that the gemmule-spicules lie parallel to the surface of the gemmule and (2) that the pneumatic coat, which is often poorly developed or altogether absent, lies entirely outside the gemmule-spicules. The skeleton is hard owing to the large number of megascleres present but friable owing to the poor development of spongin. Spicule-fibres are never very distinct, at any rate in the Indian species.

Key to the Indian species of Stratospongilla.

1. Skeleton-spicules sharply pointed.
   - A. Gemmules attached to base of sponge; gemmule-spicules cylindrical .. .. *S. bombayensis.*
   - B. Gemmules free in parenchyma; gemmule-spicules knobbed at the ends .. .. *S. gravelyi*, nov.
2. Skeleton spicules abruptly rounded at the ends.
   Gemmules attached to base of sponge; their spicules sausage-shaped .. .. .. *S. indica.*

SPONGILLA (STRATOSPONGILLA) GRAVELYI, sp. nov.

Sponge forming small, shallow cushions, very hard but easily broken; external surface smooth and rounded to the eye, with very long and shallow channels radiating beneath the dermal membrane from the oscula, which are minute and not raised above the surface. Colour bright green.

Skeleton forming a regular network of single spicules and slender, ill-defined spicule-fibres of which the radiating or vertical ones are a little more distinct than the transverse. At the external surface the spicules project vertically upwards without being grouped together in any very definite manner.

Spicules.—The megascleres are slender, sharply pointed and almost straight amphioxi. Their surface is neither smooth nor spiny but covered with minute, irregular projections; sometimes a ring of short spines encircles the spicule near one or both ends. The length is about 12 to 14 times the greatest breadth. There are very few flesh-spicules, which appear to be confined to the dermal membrane and the neighbourhood of the gemmules. The few that I have seen are short, slender, almost straight, sharply pointed amphioxi covered with relatively long and very irregular spines that project at right angles to their main axis. The gemmule-spicules are of peculiar form. Each is curved in a

wide arc and bears at either end a more or less distinct knob; the concave surface is slightly flattened and almost smooth, whereas the convex is rounded and densely covered with minute spines of somewhat unequal size; the length is usually from 3 to 4 times the thickness in the middle, but the proportions are variable.

Gemmules.—The gemmules are spherical and lie each in a little loculus in the skeleton near the base of the sponge. They do not, however, appear to be fixed to its support and the specimens

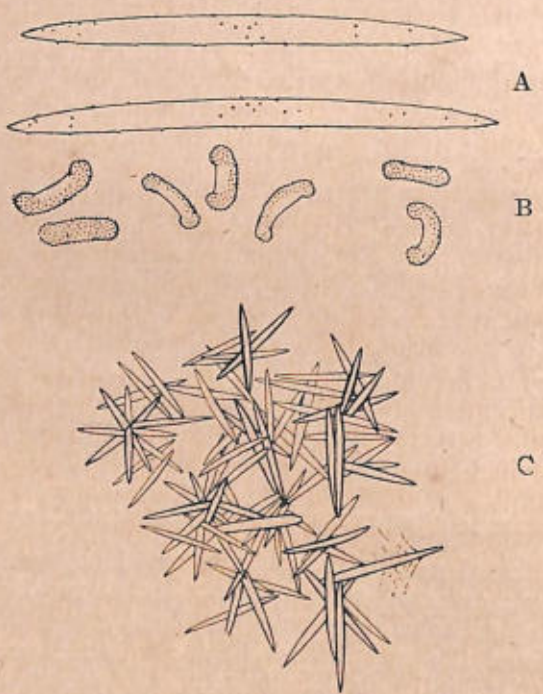

Fig. 1.—Spicules and skeleton of *Spongilla gravelyi*.
A. Megascleres, × 250.
B. Gemmule-spicules, × 250.
C. Vertical section through part of skeleton from external surface downwards, × 70.

do not possess a basal membrane. Each gemmule has a single aperture provided with a short cylindrical foraminal tubule.

Type.—No. Z.E.V. $\frac{2107}{7}$, Ind. Mus. (a dried specimen collected by Mr. Gravely in May, 1912).

Locality.—Pool in the Koyna River at Taloshi, Satara district, on the eastern slope of the Ghats.

This sponge is closely related to *Spongilla sumatrana*, Weber, which (*fide* Weltner) occurs in tropical Africa (in varietal forms) as well as in Sumatra. It is distinguished from that species by its peculiar gemmule-spicules, much more strongly spined flesh-spicules and smoother megascleres. From *S. indica*, its closest

Indian ally, it is distinguished by the sharp points of its megascleres as well as by the form of the gemmule-spicules and its free gemmules. In external appearance and in the form of its megascleres *S. gravelyi* closely resembles the mountain form of *Spongilla* (*Euspongilla*) *cinerea*, Carter, which Mr. Gravely took at Medha on the eastern side of the Ghats, but the structure both of the skeleton and of the gemmule are completely different.

Genus CORVOSPONGILLA.

Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., pp. 122, 243 (1911); *Rec. Ind. Mus.*, vii, p. 99 (1912).

When this genus was originally described only two Indian species (*C. burmanica* and *C. lapidosa*) were assigned to it, but it shortly became necessary, owing to the acquisition of fresh material, first to describe another Indian species and then to transfer to *Corvospongilla* a fourth species originally referred to *Stratospongilla*. A new race of one of the already-known species was also added, and I propose to describe here a new variety of another known species. The list of Indian forms now comprises, therefore, four species, a subspecies and a variety.

Owing to these additions to our knowledge of the genus its position and characters have become much less obscure, and, thanks to specimens recently obtained, a new fact has come to light, *viz.*, that certain forms of the genus produce two kinds of gemmules, which differ from one another not only in that one kind is fixed to the solid support of the sponge while the other lies free in the parenchyma, but also in form, in the structure of the external layers and in spiculation. The genus may be redescribed as follows:—

Sponge.—The sponge encrusts rocks or brick-structures in the form of a film or a more or less solid layer. It never possesses branches or bulky upward projections. There is always a stout chitinous membrane at the base

Skeleton.—The skeleton is always remarkably hard and sometimes has an almost stony consistency. Except in the basal membrane, however, and in the covering of the gemmules, chitinous substance is often present only in small quantities, although in some species it is unusually abundant In some species it is difficult to detect a definite skeletal network, while in others the skeleton-fibres, and especially the radiating or vertical fibres are very stoutly formed.

Spicules.—The megascleres are never very slender and are often stout and amphistrongylous. They are always very numerous. Flesh-spicules are always present in the form of birotulates in which each rotule consists of a ring of very long and slender recurved spines.

The free spicules of the parenchyma have a very characteristic form, closely resembling that of the longer gemmule-spicules of *Heteromeyenia* and *Asteromeyenia*. Each has a slender cylindrical

shaft, which is always more or less curved and invariably smooth. It bears at both ends a circle of relatively long and strongly recurved, slender spines, which are proportionately long enough, as well as sufficiently close together, to give the appearance of a regular rotule with back-turned margin.

The skeleton spicules are normally short, stout, cylindrical, blunt and spiny. They are, however, subject to great individual variation and in some species (*e.g.*, *C. ultima*) exhibit many abnormal forms.

Gemmules.—The gemmules are sometimes of two kinds, fixed and free. The latter are either spherical or subcylindrical. In either case they have a close layer of spicules arranged like a mosaic on the external surface and are further enclosed in a dense case formed of chitinous substance in which true gemmule-spicules, more or less deformed, or modified megascleres and sometimes even birotulate flesh-spicules are firmly bound together. Sometimes the wall of this outer case can be separated into definite layers. Its inner surface is separated from the gemmule by an empty space. Pneumatic substance is altogether absent or very poorly developed. The wall of the case is in continuity with the basal membrane of the sponge.

The free gemmules are situated in the parenchyma, lying in interstices of the skeleton. They are invariably spherical. Each has a horizontal layer of spicules on its external surface and is surrounded, outside these spicules, by a pneumatic coat. Outside the pneumatic coat there is, in some species, a cage of more or less deformed megascleres. The microscleres of the free gemmules are as a rule longer and more slender than those of the fixed ones. Thus the former differ from those of certain species of the subgenus *Eunapius* (*e.g.*, *Spongilla fragilis*) in which a "pavement-layer" of gemmules is sometimes formed, in that they have a different structure from the fixed gemmules.

Both fixed and free gemmules sometimes occur in the same sponge, but probably only free ones are produced in some species.

Remarks.—Even the more delicate forms of the genus can be distinguished, so far as my experience goes, from any other oriental Spongillidae (except certain *Spongillae* of the subgenera *Eunapius* and *Stratospongilla*) by their very hard consistency. In skeletal structure the species vary considerably; but the skeleton, owing to the large number of megascleres, is always extremely massive.

Although free microscleres of the type described are always present, their number is very variable even in sponges of the same species taken at different times and they are sometimes scattered so scantily in the parenchyma that it is difficult to find them.[1] The dermal membrane is apparently aspiculous.

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[1] Great care is also necessary to prevent them floating away if spicule-preparations are made by allowing the spicules to settle in a liquid.

The fixed and free gemmules are apparently analogous in function to the fixed and free statoblasts of *Plumatella*. The fixed reproductive bodies of both sponge and polyzoon serve to ensure renewed growth of the organism in a situation that has already, in certain conditions, proved favourable for its proper development. Their production is either correlated with a change in conditions or perhaps in some few cases precedes any such change and is due rather to a form of senescence. Conditions suitable for renewed activity on the part of the organism are similarly either correlated with or antecedent to renewed vegetative growth on the part of the resting bodies. The free gemmules, on the other hand, are carried away by floods and thus aid in the dispersal of the species. So far as the facts as yet ascertained justify a statement as to conditions that bring about or precede the production of the two kinds of gemmules in *Corvospongilla*, it would seem that the fixed gemmules are formed as soon as the sponge is in full vigour or just past its prime, and that the free gemmules are formed at a later season. Sponges of the genus frequently occur on the beds of rocky streams that rise with great violence in the "rains" but sink to a series of more or less disconnective pools in the cool season. They are often left high and dry at the latter time of year. Their compact skeletons remain firmly adherent to the rock until the floods come again. Then, in all probability, the free gemmules are washed away to places down stream, while the fixed gemmules cling fast and in due course produce a new sponge on the old basis.

Key to the Indian Forms of Corvospongilla.

I. Majority of the megascleres sharply pointed.
  1. Delicate species with only free gemmules .. .. *C. caunteri.*
  2. Much stouter species with fixed (and sometimes also free) megascleres.
    (*a*) External surface rough but not spiny .. .. *C. ultima* (typical).
    (*b*) External surface distinctly spiny .. .. *C. ultima* var. *spinosa.*

II. Majority of the megascleres distinctly amphistrongylous.
  1. Sponge hard but brittle, radial spicule-fibres produced vertically upwards to form spines on external surface.
    (*a*) Oscula elevated on cylindrical, turret-like eminences.. *C. burmanica.*

(*b*) Oscula either not elevated or on eminences of irregular form . . . . *C. burmanica bombayensis.*

2. Sponge of almost stony consistency, external surface without spines; radiating fibres indistinct . . . . . *C. lapidosa.*

Corvospongilla caunteri, Annandale.

Faun. Brit. Ind., Freshwater Sponges, etc., p. 243, fig. 48 (1911).

The first specimens of this species were taken in April, 1911, on the pier of a brick-work bridge near Lucknow. Mr. Gravely obtained others in April, 1912, on rocks in the pool of a stream at Medha on the eastern side of the Western Ghats. Both sets of specimens were taken in running water. Both contained only free gemmules with well-developed pneumatic coats and formed only very thin films on their supports. It is improbable that fixed gemmules are ever formed in this species, unless it sometimes attains a very much greater thickness than the specimens examined have attained, for the outer cases of such gemmules would be almost as deep as the sponge itself. Although the sponge only forms a thin film of two or three millimetres' thickness, its hardness can be readily felt if it is squeezed between the finger and thumb. Mr. Gravely's specimens are a trifle thicker than the types and darker in colour.

Corvospongilla ultima (Annandale).

Spongilla (*Stratospongilla*) *ultima*, Annandale, *tom. cit.*, p. 104, fig. 19.

Corvospongilla ultima, *id.*, *Rec. Ind. Mus.*, vii, p. 99 (1912).

Specimens obtained by Mr. Gravely on rocks in a pool of a stream at Taloshi on the eastern watershed of the Western Ghats in April are sufficiently different from those taken at Cape Comorin and at Tanjore to be made the types of a new variety, for which I propose the name,

var. spinosa, nov.

The chief taxonomic peculiarity of this variety lies in the fact that its external surface is distinctly spiny. This is due to the protrusion of the radiating fibres, which, instead of becoming dissipated as they approach the surface, are prolonged upwards beyond it, often for a distance of several millimetres. The oscula also are larger than in the typical form and have no radiating furrows.

A more striking peculiarity is the occurrence of free as well as fixed gemmules; but of course this may be due to the season at which the sponge was taken or to its physiological condition rather than to any inherent character. The free gemmules are smaller

than the fixed ones; their diameter is about 0·42 mm., whereas that of the fixed gemmules is about 0·9 mm. without the external case. The free gemmules are spherical and have as a rule two apertures, each of which is provided with a short conical or cylindrical tubule. The pneumatic coat is poorly developed and there is no outer cage of megascleres. The spicules of the free gemmules are long and narrow and as a rule somewhat inflated at the ends; their measurements on an average are:—length from 0·054 to 0·063 mm., breadth about 0·0048 mm. The spicules of the fixed gemmules are, like those of the fixed gemmules of the typical form of the species, exceedingly variable and liable to all sorts of abnormalities, but those of the inner layer are, unless deformed, from 0·029 to 0·05 mm. in length and from 0·007 to 0·012 mm. in greatest breadth.

Type.—No. Z.E.V. $\frac{5106}{7}$, Ind. Mus.

Locality.—Taloshi, Koyna valley, Satara district, Bombay Presidency (2,000 ft).

CORVOSPONGILLA BURMANICA (Kirkpatrick).

Spongilla loricata var. *burmanica*, Kirkpatrick, *Rec. Ind. Mus.*, ii, p. 97, pl. ix (1908).

Corvospongilla burmanica, Annandale, *Faun. Brit. Ind.*, *tom. cit.*, p. 123.

The typical form of the species has only been found as yet in the Pegu-Sittang Canal in Lower Burma, but the Bombay race has now been taken at three different localities in that Presidency.

Subsp. BOMBAYENSIS, Annandale.

Annandale, *Rec. Ind. Mus.*, vi, p. 225 (1911).

The first specimens of this race were taken by Mr. Agharkar at Khed in the Poona district and others were found by Mr. Gravely and him at Pimpli in the Ratnagiri district. The former place is on the eastern, the latter on the western face of the Ghats. Remarkably fine examples were also obtained by Mr. C. S. Middlemiss of the Geological Survey of India in the native state of Idar, which lies between 23°6′ and 24°29′ N. and 72°45′ and 73°39′ E., considerably north of the Tapti River. About these specimens, which he mistook at first sight for a calcareous tufa, Mr. Middlemiss writes: "The locality of the specimens is Hàthmati River opposite Thuravas, Idar State (Máhi Kántha); occurring as incrustations on pebbles of recent conglomerate left dry by subsidence of the water." They were taken in December, 1911, and covered considerable areas; some of them are 2·5 cm. thick.

Both the specimens from Idar and those from the Ratnagiri district contain free as well as fixed gemmules, although there are only fixed gemmules in those from the Poona district. In the Idar specimens the free gemmules are only in a few instances fully developed and many stages can be found, but in the Ratnagiri ones they are complete.

Although the free gemmules do not differ so much from the fixed ones as is the case in *C. ultima* var. *spinosa*, the differences are of the same nature. In both kinds of gemmules the shape (apart from the external case) is almost spherical and there is a single aperture with a straight foraminal tubule, but the free gemmule is slightly more flask-shaped than the other and has a longer and more tapering tubule. The diameter of both varies somewhat, but in the case of the free gemmule it is on an average about 0·5 mm. and in that of the fixed gemmule about 0·6 mm. The free gemmule has a well-developed pneumatic coat outside its proper spicules and, outside this coat, is enclosed in a hollow sphere of unusually small and often ill-formed megascleres mixed with spicules like its own and held together by a chitinous membrane. The microscleres are very little longer or more slender than is the case in the fixed gemmules.

II.—GEOGRAPHICAL.

In the introduction to my volume on the Freshwater Sponges, etc., in the *Fauna of British India* I laid great stress on the African affinities of the lower invertebrates that inhabit the streams, lakes and pools of the Western Ghats. So far as the sponges are concerned the chief foundation for this view lies in the strong representation of the genus *Corvospongilla* and the subgenus *Stratospongilla* of the genus *Spongilla*. Recent investigations have on the whole given support to my belief but have shown that the African element is more widely distributed than was at first realized. The discovery of a freshwater medusa of the genus *Limnocnida* in the Western Ghats is evidence in favour of African affinities, and so also is the fact that three additional forms of *Corvospongilla* have now been added to the known fauna of the range, as well as a new species of *Stratospongilla*; but on the other hand two species of *Corvospongilla* have been found in India east of the Ghats and the range of *Spongilla* (*Stratospongilla*) *bombayensis*, formerly believed to be peculiar to Bombay and Natal, is now known to extend into the W. Himalayas in the north and to the Mysore plateau in the south, while there is strong evidence that *Limnocnida indica* only occurs in those streams which run eastwards from the Ghats.

Of the genus *Corvospongilla* three species, *C. loricata* (Weltner), *C. böhmi* (Hilgendorf) and *C. zambesiana* (Kirkpatrick), and possibly a fourth only recognized from isolated spicules are known to occur in Africa. The first, which is the type of the genus, is from an unknown locality in that continent, while the other three occur in Central Africa. Of the four Indian and Burmese species, one (*C. burmanica*) is very closely allied to *C. loricata*, while another (*C. lapidosa*) is perhaps no more than a local race of the African *C. zambesiana*, the gemmules of which are not known. The two sponges apparently differ only in the structure of their skeleton. All the Indian forms, with the exception of the typical

race of *C. burmanica* (the only species as yet found east of the Bay of Bengal), occur in the Western Ghats. One of them ranges eastwards and northwards in practically identical form to Lucknow, another has been found north of the Tapti River and the third occurs in one form at Cape Comorin, in Travancore and at Tanjore near the east coast of Madras, and in another on the western side of the Ghats in Bombay.

It is difficult to say what are the exact limits of distribution of *Stratospongilla*. Although I believe that this subgenus is founded on characters of sufficient weight, it is difficult to say whether it is really distinct from *Potamolepis*,[1] Marshall, the gemmules of which are unknown. Certain African species, however, namely *Spongilla sumatrana*, Weber, *S. rousseletii*, Kirkpatrick, and possibly *S. cunningtoni*, Kirkpatrick, are closely related to the three Indian species, *S. indica*, *S. gravelyi* and *S. bombayensis*, the type of the subgenus. *S. sumatrensis* was originally described from the Malay Archipelago, as its name would suggest, and it is possible that the two African forms which Weltner has ascribed to the species as varieties are specifically distinct from it, if not one from the other. In any case the three forms at present associated under the name are closely related to *S. indica*, *S. gravelyi* and less closely to *S. bombayensis*, which occurs in Natal as well as India. These sponges differ considerably from the Congo species originally ascribed to *Potamolepis* by Marshall (15) and even from *P. barroisi*, Topsent (17) from the Lake of Tiberias. They are, however, less different from the latter than they are from the former, while the species from Western China and the Philippines (*S. coggini* and *S. clementis*) that I have assigned provisionally to *Stratospongilla* (4,5) come very near to *P. barroisi*, from which it is difficult to believe that they are subgenerically distinct. It is noteworthy, moreover, that the gemmules of *S. coggini* are of a very simple nature, totally lacking microscleres, as is also the case with two of the Tanganyika species, while the gemmule-spicules of *S. clementis* are small and poorly developed. The fact that the gemmules of all known species of *Potamolepis* are wanting is, however, one of little importance. I recently examined a large collection of Spongillidae from France and Switzerland comprising all the common European species of *Spongilla* and *Ephydatia*. Only a very small proportion of the specimens, most of which had been collected in summer, contained gemmules. On the other hand I have recently found these bodies in *Veluspa bacillifera* from Lake Baikal and they are known to occur in many sponges not even remotely related to the Spongillidae.

On the whole, therefore, we can only say as regards *Stratospongilla* that the species which occur in the Malabar Zone are closely allied to African species but have, with one exception, not

[1] I cannot accept the view that *Potamolepis* is identical with the S. American genus *Uraguaya*, the gemmule-spicules of which resemble those of *Trochospongilla*. *Veluspa*, Micl. Macl. (*Lubomirskia*, auct.) is not, in my opinion, a Spongillid at all.

been found outside that zone. The exception (*S. bombayensis*), which occurs in Natal, has been found both in the W. Himalayas and on the Mysore plateau in the very centre of southern Peninsular India.

The only genus of Spongillidae that appears to be endemic in India is *Pectispongilla*, which has not been found except on the western side of the Western Ghats. It has no very close allies, so far as we know, in any other district.

The majority of the remaining sponges of the Western Ghats and the plains between them and the Arabian Sea are widely distributed forms. *Spongilla cinerea*, however, has only been found at Bombay, in the Ghats and in the W. Himalayas, its range somewhat resembling the Indian range of *Spongilla bombayensis*, but being more restricted in that it does not, apparently, extend into the main area of the Peninsula. The race *lobosa* of *Spongilla carteri* appears to be endemic in Travancore on the western side of the Ghats, while *Trochospongilla pennsylvanica* has probably, according to Miss Stephens (16), only been found in N. America and in Travancore.

It is thus clear that the sponge fauna of the Malabar Zone is abundantly distinct from that of any other part of India, although it includes many widely distributed species that occur in other districts. It appears to have distinct affinities with that of tropical Africa, and especially with that of Lake Tanganyika, but exhibits no more trace of a recent marine origin than is shown by the Spongillidae of any other country. In considering its peculiarities, however, allowance must be made for the bionomical factor. Some of the most characteristic sponges of the zone are only found in the beds of rocky streams which for part of year are raging torrents and for part a series of almost isolated pools. Few sponges have been found in similar conditions in other parts of India, the mountainous districts of which are for the most part almost unexplored so far as the aquatic fauna is concerned. It may be that many of the peculiarities or apparent peculiarities of the Spongillidae of the Western Ghats are merely characteristic of sponges that flourish in the peculiar circumstances that prevail there, and that these peculiarities will be found to be much less distinctive when other mountain ranges are as well known as the Western Ghats.

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Geographical List of Freshwater Sponges of the Malabar Zone.

Name.	Malabar Zone.		W. Himalayan Territory.	North-East Frontier Territory.	Burma Territory.	Main Peninsular Area.	Indo-Gangetic Plain.	Distribution outside India.	Remarks.
	East.	West.							
Genus SPONGILLA ..	×	×	×	×	×	×	×	Cosmopolitan.	
Subgenus EUSPONGILLA.	×	×	×	×	×	×	×	Ditto.	
S. lacustris subsp. *reticulata.*	×	×	×	×	×	×	×	....	The typical form of the species is cosmopolitan.
S. proliferens.. ..	×	—	—	×	×	×	×	Yunnan; Java; Celebes, etc.	A purely Oriental species.
S. alba	—	×	—	—	—	×	×	Egypt (var. *cerebellata*) ..	The "varieties" *cerebellata* and *bengalensis* are perhaps no more than phases.
S. cinerea	×	×	×	—	×	×	—	....	Not known outside India.
*S. travancorica** ..	—	×	—	—	—	—	—	....	Only known from Travancore.
S. crateriformis ..	—	×	—	—	—	—	×	Common in N. America; probably occurs in Ireland.	Distribution apparently discontinuous.
Subgenus EUNAPIUS ..	×	×	×	×	×	×	×	Cosmopolitan.	
S. carteri	×	×	×	—	×	×	×	S.-E. Europe; Mauritius; Malay Archipelago.	Possibly occurs in Central Africa (*fide* Kirkpatrick). The form *lobosa* seems to be confined to Travancore, while the "varieties" *cava* and *mollis* may be mere phases.
S. carteri lobosa ..	—	×	—	—	—	—	—		
Subgenus STRATOSPONGILLA.	×	×	×	—	—	—	—	Central and South Africa; Sumatra; S.-W. China; the Philippines.	The Chinese and Philippine species are by no means typical.

XXXI. NOTES ON THE HABITS AND DISTRIBUTION OF *LIMNOCNIDA INDICA*, ANNANDALE.

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(Plate xxxvi).

The medusa which forms the subject of the present paper was discovered in May, 1911, by Mr. Agharkar who sent the few specimens he was then in a position to collect to Dr. Annandale for examination. Dr. Annandale communicated the discovery to the Asiatic Society (see A.S.B. Proceedings for August, 1911) and to "Nature" (vol. lxxxvii, 1911, p. 144). As the specimens had reached him in a fragmentary condition Dr. Annandale was unable to describe them fully and further collecting was undertaken by the authors of this note in April, 1912, since when he has described the species under the name *Limnocnida indica* (Rec. Ind. Mus. vii, pp. 253–256).

Our knowledge of the distribution of the genus *Limnocnida* in India is probably still very incomplete. So far it has only been collected in Western India from the Yenna and Koyna, two tributaries of the Krishna, and we have been unable to add to these records by personal observation; but the Mamlatdar of Medha, after seeing the specimens we had collected near his village, told us that he had seen similar organisms at Dhôm in the Krishna itself in March, 1912, and we think his evidence may be accepted as trustworthy. These three rivers, together with two others which flow down on the western side of the Ghats, rise in a small temple near Mahabaleshwar at an altitude of 4385 ft. above sea level. All of them sooner or later fall precipitously over a band of hard rock from the plateau into wide valleys which at their commencement are probably not more than 3000 ft. above sea level. No medusae have been seen or heard of above these falls, although we searched the only place in which they were likely to occur—an artificial lake in the upper course of the Yenna Valley close to Mahabaleshwar. Nor did we hear of any place where they were known west of the Ghats, or find them ourselves in the Vashishti, the only river we were able to examine on that side.

In the Yenna *Limnocnida* was found in May, 1911, and again in April, 1912, in a pool at Medha, about 2200 ft. above sea level and about 15 miles below the falls; and local information points to its occurrence in a pool at Kelghar at the head of the deep valley and in some pools considerably below Medha. In the Koyna

the medusae were equally abundant in the same months in a pool at Tambi, about 2100 ft. above sea level, and a single specimen was obtained by Mr. Agharkar in 1911 at approximately the same altitude at Vela, about 10 miles further down the valley; again local information points to the occurrence of the organism in places we were unable to visit, particularly at Bamnoli, 5 miles above Tambi, and at Patan, 27 miles lower down.

We have no evidence of the occurrence of *Limnocnida* in the Krishna below its junction with the Yenna and Koyna, where it flows throughout the year without becoming broken into a series of pools in the dry season; and at present we are unable to confirm Col. Alcock's record from the lake at Purulia ("Nature," vol. lxxxvii, p. 214). With regard to this record, however, it is noteworthy that the rivers near Purulia are of a very similar character to those in which *Limnocnida* lives in the Western Ghats; and there is no reason to suppose that at the right time of year a more careful enquiry than we have yet been able to institute in Chota Nagpur will not result in its discovery there in large numbers in widely separated pools just as in Western India.

The Yenna, so far as our observations went, resembles the rivers near Purulia and Chakardharpur—the only ones in Chota Nagpur known to either of us personally--more closely than does the Koyna. Near Medha it consists of a number of rather shallow mud-lined pools varying greatly in length and connected to one another by channels among rocks where the fall of the river is usually more rapid than elsewhere. In the midst of one of these rocky portions of its bed, just below the foot-bridge, there is a pool of exceptional depth with rocks rising vertically out of it on both sides, and it was in this pool only that we found *Limnocnida*, a pool in which it had been found in the previous year also. There seemed to be nothing unusual about this pool except its depth and vertical rocks; but there was no means at hand of making any attempt at a survey either of this or any other part of the river. The total depth cannot have been more than fifteen or twenty feet; and the bottom as far as we could discover consisted entirely of mud. Though of small size its character makes it a favourite bathing pool for the village, and every morning, while the water is free from the sediment brought down by the first rains, it is filled with bathers.

The medusa is most easily obtained at this time, as it frequents the deepest part of the pool, a few rising to the surface at frequent intervals, particularly after any great disturbance of the water. Though colourless and more or less translucent it is a conspicuous and beautiful object when at the surface and the natives of all places where it occurs seem to know it well. They have applied to it two most appropriate names—*chakra* meaning a wheel, and *phul*, a flower. The few who speak English talk simply of "flowers." When actively swimming to the surface the tentacles naturally trail out behind; but when at rest either on

the bottom of an aquarium or when sinking through the water they are carried somewhat as in Günther's figure of *L. tanganicae* (P.Z.S. Lond., II, 1907, pl. xxxvii, fig. 1) except that the small tentacles, which are less adhefent to the exumbrella than are the large ones, hang downwards when not carried upwards by the motion of sinking. Both the position of these tentacles in Gunther's figure and the unnatural thinness and flatness of the bell there indicated are no doubt due to the imperfect preservation of the specimen from which it was drawn. For the preservation of our specimens we used a mixture of corrosive-sublimate solution and 5% formalin; when the specimens were carefully fixed and the corrosive solution used was saturated excellent results were obtained, the medusae shrinking but little when transferred gradually to strong spirit; but when, on one occasion, the preservation of the specimens was hurried and the corrosive weak, by the time the specimens were in spirit they were found to have shrunk enormously and some of the best of them are very like the one shown in Günther's figure.

The mouth varies greatly in size from time to time in the same individual. It generally falls open when specimens are fixed, but it is usually we think, if not always, a sign of decrepitude for the wall of the stomach to be vertical and the mouth as widely open as in Günther's figure. In all our best preserved specimens it is more or less oblique, and in many it is very markedly so, the thin lip within the gonad ring being much deeper and the aperture much smaller than when the mouth is more widely open. In life, we saw the aperture abruptly contracted on many occasions; but we never remember to have seen it reduced to the "minute star-shaped aperture" found in the specimen figured by Dr. Annandale in his recent paper (*loc. cit.* fig. 1). This specimen is a very minute one and was not examined microscopically when alive. Small specimens in general seemed to close their mouths more than big ones; but we never saw the mouth other than circular in thoroughly healthy specimens. We failed to observe any of the specimens feeding; but the stomachs of some small specimens mounted in Canada balsam have been found to contain the skins of entomostraca from which all trace of the soft parts has disappeared, having presumably been absorbed by the medusa.

The medusae in the pool at Medha, when we were there, included specimens of all sizes and both sexes; but no asexual generation was observed. In both sexes the gonad ring is white, but in the female it is marked by numerous equidistant vertical grooves, whereas in the male it is quite smooth. The number of very small medusae in the pool made it evident that reproduction of some kind was actively going on; but whether this was direct from the sexual generation or from an asexual hydroid stock we were unable to determine. We attempted to obtain large numbers of all the earliest stages with the help of a townet; but the swimmer to whom the net was entrusted dropped it, and it was not recovered till too late to use it again that day. Next day all the medusae

had disappeared before the thick brown sediment brought down by the first heavy rain of the season. That they had completely disappeared we established as far as was possible both by stirring the pool with our nets and by attaching a townet to a large fishing net on the end of a very long bamboo, which the village fishermen were passing backwards and forwards over the muddy bottom of the deep rocky channel with which the pool commences. The townet must have been fishing quite close to the bottom, for it several times came up filled with thick black mud. The fact of the complete disappearance of the medusae has since been further established by the Forest Ranger at Medha, who reported a month later that nothing more had been seen of them although the river became clear about a fortnight after the sediment first appeared.

From Medha we crossed over the hills into the valley of the Koyna. The pools of which this river is composed in April are much broader and often much longer than are those of the Yenna. As many of them are connected only by the percolation of water through gravel barriers, rain near the source of the river does not carry sediment very far down; and all the pools near Tambi, where we first halted, were still quite clear. Only one of them contained medusae, again a pool in which they had been found in the previous year, but we were told that they were sometimes found in others. The pool in which we found them was long and wide without rocky banks, differing completely from that in which they had been found at Medha so far as could be judged from the surface. One evening, when a strong wind had swept the pool from end to end for a few hours, the medusae were found in enormous numbers in the shallow water at the leeward end, many of them in very poor condition. This shoal had entirely disappeared next morning. Medusae were often found in quite shallow water at the other end (the one we could most easily get to), having come there without the assistance of any wind so far as we could see, but these too were often in bad condition. The best specimens were obtained by watching for them to come up out of deeper water,[1] but even these seemed to us scarcely as healthy as those we saw at Medha. Moreover not a single specimen of unusually small size could be found even with the help of townets dragged both along the bottom and nearer the surface. From this we think it follows either that all the medusae were being produced in some unknown rocky cavity out in the middle of the pool and that only the feebler adults ever wandered far enough to drift ashore, or else that the season of the medusae was drawing to a close and would not require any catastrophe to end it completely. In either case the existence of a hydroid generation seems to us to be clearly indicated, since even the dying medusae showed no signs

[1] While at Tambi we tried to ascertain whether they were more abundant at certain times of day than at others. Local testimony on this point was conflicting. We found medusae plentiful between daybreak and sunrise, as well as throughout the heat of the day. We seemed to see them best during brief times of sunshine, but this may have been due to the illumination of the water to a greater depth than when the sun was obscured by clouds.

of the production of special resting eggs. The completeness of the disappearance of all medusae from the pool at Medha when this became muddy, and the absence of medusae from all pools between May of one year and February of the next[1] also seem to point to the same conclusion. Moreover the occurrence of the medusa year after year in certain pools and its absence from others seems probable from what we saw, though by no means certain; and the organism must by now have had ample time to establish itself in every pool suited to its requirements. As far as one can see from above there is no difference between the various pools of the Koyna which can account for the occurrence of the medusa in one and not in all of them, so we are driven to suppose this difference to exist in the bottom—a point, unfortunately, which could only be settled by a survey such as our equipment did not permit us to carry out. The character of the pool at Medha seems to indicate that the hydroid must live on solid rock; and as the medusae always came up from deep water and no hydroid could be found near the edge it is probable that the hydroid lives only at a distance from the surface.

We therefore conclude that in the life-cycle of *Limnocnida indica* there is probably an asexual hydroid stage which lives attached to rocks[2] at the bottom of deep pools, and that this hydroid produces medusae by budding from February till April or May, when it ceases to do so whether the pool in which it lives is flooded or not, and very possibly dies. It is perhaps noteworthy that the long duration of this supposed fixed asexual generation corresponds to that of the free asexual medusae found in Tanganyika, while the duration of the free medusoid generation of which only sexual individuals are yet known corresponds to that of the sexual generation of Tanganyika and occurs only a little earlier in the year, this difference of season being necessitated by the summer rains of India. It is still possible, however, that asexual medusae may be found in India earlier in the medusa season; and our knowledge of the times at which the Tanganyika form reproduces in different ways rests on very few observations[3] and may prove to be misleading.

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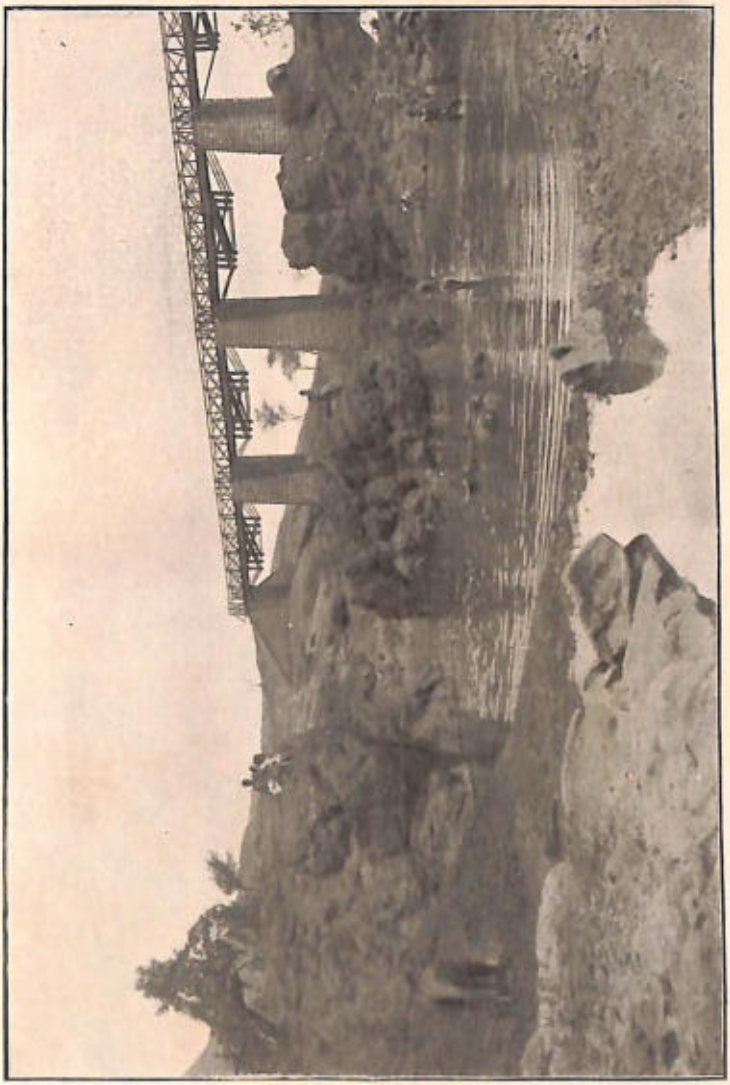
[1] All the inhabitants of the district seem to be agreed on this point.

[2] These pools contain no water-weeds.

[3] For a summary of these see Günther, *P.Z.S.* II, 1907, p. 644.

EXPLANATION OF PLATE XXXVI.

The pool inhabited by *Limnocnida indica* near Medha. The medusa is only found in the deep water between the rocks at the back of the picture.



Habitat of *Limnocnida indica*.

XXXII. THE ANATOMY OF *MELO INDICUS*, Gmelin.

By H. J. FLEURE, *Professor of Zoology, University College of Wales, Aberystwyth.*

(Plates xxviii–xxxii).

I.—INTRODUCTORY.

Through the kindness of the authorities of the Indian Museum of Natural History, and of Dr. J. Travis Jenkins, two specimens of *Melo indicus*, Gmelin, were forwarded to me for examination.

The identification was made by Mr. Preston and confirmed by Mr. E. A. Smith. *Melo* is a genus, or subgenus, in the family *Volutidae*, belonging to the Stenoglossa Rhachiglossa in Bouvier's classification of the Monotocard Gastropods.

Bouvier makes the following the chief characteristics of the RHACHIGLOSSA:—

1. The central tooth of the radula is nearly always well developed and the radular formula is not above 1. 1. 1.
2. The special unpaired gland of the oesophagus is well developed, but its duct only rarely traverses the nerve collar (pl. xxx, fig. 6, Unp. Gl.).
3. The supra-intestinal ganglion approaches the right pleural ganglion (pl. xxxii, fig. 21, R. Pl. G. and Sp. Int. G.).
4. The visceral ganglion is subdivided (pl. xxxii, fig. 21, V and V^1).

These characters seem to mark them out among the STENOGLOSSA, which are characterized by Bouvier as follows:—

1. Radular formula 1. 1. 1., often reduced in various ways.
2. A retractile proboscis (pls. xxviii and xxix, figs. 1—4, Pr.), a well-developed pallial siphon (S), a siphonostomatous shell, a large and bipectinate osphradium (Osph.), a penis. Accessory tubular buccal glands (pl. xxx, fig. 6, T. B. G.) may occur, there is one pair in *Halia*, one pair with ducts uniting in Volutidae, etc., none are found in Buccinidae.
3. A pair of racemose buccal glands with ducts which do not traverse the nerve collar (pl. xxx, fig. 6, R. B. G.).
4. A special unpaired gland of the oesophagus in many forms (pl. xxx, fig. 6, Unp. Gl.).
5. A highly concentrated nervous system without labial commissure or pedal cords. The ganglia of the reduced buccal mass near the cerebrals. Zygoneury

very highly developed on the right side (pl. xxxii, fig. 22, Zy.). Position of supra-intestinal ganglion variable. One otolith in each otocyst.

The Volutidae are a family of the Stenoglossa Rhachiglossa with the following characters, according to Bouvier:—

Externals (pls. xxviii–xxx, figs. 1—5). A fore-roof (Fore-R.) above and in front of the mouth, covering a part of the front end of the foot. On this are the reduced tentacles (t.), and, behind them, at the sides, the oculiferous projections (e.). Innervation shows that this fore-roof is due to concrescence and enlargement of the tentacle-bases. A strong, rather short siphon (S.) with a large thin projection on each side of the siphonal gutter (R.S.T. and L.S.T.). A fairly short proboscis and sheath.

Alimentary canal (pl. xxx, figs. 5—7). A pair of normal, racemose, buccal glands (R.B.G.) forming a mass from which the ducts go far forwards, becoming engaged in the gut-wall on the way. Accessory glands of tubular form (T.B.G.), typically uniting before they reach the gut, the common duct lying in the ventral wall of the radular sac and opening very far forwards, almost into the mouth.

Nervous system (pl. xxxii, figs. 21—22). Cerebral ganglia fused to form a trapezium. Pleurals barely separated from cerebrals. Supra-intestinal ganglion relatively very far from the right pleural (but in thus generalising Bouvier is probably wrong). Subintestinal ganglion almost continuous with left-pleural, zygoneurous (Zy.) connection with the right pleural short and broad.

Pilsbry-Tryon describes the Volutidae as characterized by the radula:—

Tooth formula 0-1-0, the tooth being tricuspid with large lateral points in *Cymbium*, *Melo*, *Voluta*, *Hyria*, etc. In *Voluta musica* the tooth is multicuspid and very transverse. In *Amoria* the tooth is unicuspid with a concave base.

The genus *Melo* is defined by shell characters and Pilsbry thinks the absence of an operculum is not proven for many of them. Adams states that the animal is ovoviviparous, the young ones being arranged in the oviduct of the female in a long string without egg-shells. In *Voluta*, the mantle is not so greatly expanded as in *Cymbium* and *Melo* and the foot is proportionately not so large. Volutid shells are rarely collected with the animal except when accidentally thrown ashore after a storm. The reason is that, like the Naticae, they bury themselves under the surface as soon as the water falls and the sand is left dry by the tide (Gray).

Haller's papers on the Rhachiglossa relate to Buccinids and Purpurids for the most part. Bouvier examined *Voluta neptuni* which is said to belong to the genus *Melo*. Woodward worked at *Voluta* (*Cymbiola*) *ancilla*, Sol., *Neptuneopsis gilchristi*, Sby., and *Volutilithes abyssicola*, Ad. and Reeve. My results are in very general agreement with his.

Pace has worked at *Voluta musica*, about the relationships of which there is some doubt. It is a West Indian form, whereas 80% of the species of Volutes live within a triangle having its extreme points at Ceylon, Japan and New Zealand. It has a fusoid, narrowly elongated operculum mounted on a distinct pad. This is also found in *Neptuneopsis*, *Volutolyria* and *Lyria*, but no trace of it appears to subsist in *Melo*.

II.—External Characters and Branchial Cavity.

(Pls. xxviii–xxx, figs. 1–5).

The lack of adequate illustrations of the Rhachiglossa has led me to sketch this type from several points of view, both the specimens used being females.

The foot is large and massive with a long definite anterior edge, grooved (pl. xxviii, fig. 2, Gr.) and glandular as usual. This type of foot can be compared with that of *Natica*, *Bulla*, *Scaphander*, etc., being apparently in every case an adaptation to the burrowing habit. In this connection, too, the compact rolling of the spire above the foot is noteworthy. The disposition of the spire and the columellar muscle makes possible the wide opening of the branchial cavity on the animal's right side (pls. xxviii and xxix, figs. 1 and 4) with the result that the rectum opens well back on that side (pl. xxix, fig. 4, A.), and the other openings are also a good way off from the ctenidium and osphradium. The roof of the cavity between the ctenidium and rectum has the usual mucus gland with oblique ridges in its surface. In one specimen, as also in a part of another sent, but not in the other complete one, there was a well-marked swelling (pl. xxviii, fig. 1) not far in from the edge of the cavity's roof.

The siphon (S.) is short and strong and possesses two tentacles at its base, one above and to the right (R.S.T.) and the other below and to the left (L.S.T.) of the gutter.

The osphradium (Osph.) is situated in the branchial roof and is bipectinate, with its leaflets approximately parallel to those of the ctenidium and somewhat oblique to the incoming stream of water along the siphon. The leaflets are rather thinner and finer than those of the ctenidium.

The monopectinate ctenidium (ct.) and the osphradium both curve round to the left as they go back. The leaflets of the ctenidium are long-based low triangles.

The proboscis (Pr.) is fairly short and pleurembolic. Pl. xxviii, fig. 1 shows it expanded to some extent while pl. xxx, fig. 5 gives it in the completely retracted condition. The great mass formed by the retracted proboscis and the sheathing body wall displaces the oesophagus (pl. xxx, fig. 5). When the proboscis is extended its wall continues back practically without a kink into that of the proboscis sheath.

The lamina or fore-roof (Fore-R.) above the proboscis, mentioned as a characteristic of the Volutes, is very well developed

and the small tentacles (t.) occur at the sides of its front edge with an eye (e.) on the outer side of the base of each of the two anterior ones; the additional tentacle is situated at the base of the fore-roof on the right side. The fore-roof may be compared with the analogous developments in *Bulla*, *Scaphander*, etc., and pl. xxviii, fig. 2 shows how it lies over the proboscis If the siphon is contracted and the anterior edge of the mantle pressed against the fore-roof, the proboscis, etc. being contracted underneath and pressed up by the expansion of the foot in burrowing, the branchial cavity must be fairly effectually closed in front.

III.—ALIMENTARY CANAL. (Pl. xxx, figs. 5—7).

The actual entrance to the food canal found on dissection will vary a little according to the state of protraction or retraction but there is always a short conjoint section of the canal which then divides giving fore-gut above and radular sac below. The cavity of the latter is practically nil except just in front.

There is a cushion for the radula, a membrane with thickening on either side, *i.e.*, one may speak of a pair of cartilages which are long and narrow, lath-like in fact. They are bound together by the membrane in which they develop and by muscle-fibres joining them. There are also muscle-fibres around them and at the sides, joining them to the proboscis wall. Some of the fibres run forwards and protract the cushion and others run backwards and serve for retraction. The fact that the radula is in an organ (the proboscis) which moves back and fore, however, makes the separate movement of the radula less important and the odontophore and its musculature are therefore less complex than in Gastropods without a long retractile proboscis.

The radula has been described elsewhere. It is reduced to one tooth, the median or Rhachis tooth, in each row; the tooth is powerful and tridenticulate. The whole radula rests on a strong membrane, the front end of which, bent down over the cushion, is held by a strong pair of ventral-stretching muscles going back in the middle line.

Muscle-fibres arise also from the sides of the subradular membrane and go to join the sheath; they keep the main part of the radula tense, pulling it backwards and outwards on either side.

The glands of importance to the mouth region of the gut have their ducts much elongated as they are necessarily massed behind the proboscis region. They are:—

(*a*) One pair of ordinary acinous buccal glands (R.B.G.). The ducts run alongside the fore-gut and get involved in its wall, ultimately opening near the junction of gut and radular sac.

(*b*) One pair of glands (T.B G.) formed of long, much bent, folded tubes. These tubes ultimately unite and the united duct curls along in the ventral wall of the radular sac to open near the junction of the sac with the fore-

gut. The distal ends of the tubes are much longer than the ends which unite.

Behind the proboscis, the gut lies in the general anterior cavity suspended by many fibrous strands. Just behind the proboscis is a short section of somewhat increased diameter (Ph. L., pl. xxx, fig. 6) corresponding with the "Pharynx de Leiblein" noted by French observers in some other Rhachiglossa Behind this, the nerve-collar gathers round the gut, and, some distance behind this, the great median or unpaired gland of the fore-gut stands out above it. The duct of the latter goes forward in the gut wall and opens near the level of the nerve-collar. Bouvier thought the gland was usually small in Volutids but large in *Melo neptuni* which he studied. Woodward thought the gland longer in Volutids than in the Rhachiglossa in general. Pace found a very large gland in *V. musica*. It is certainly large in *M. indicus* and the other observations make it probable that Woodward is right.

The oesophagus is continued back as a cylindrical tube which widens suddenly at a certain level. The lining of the wider section is strongly ribbed by longitudinal folds (pl. xxx, fig. 7*a*) and this section goes back into the visceral mass where it opens into a stomach which is of a U, or, rather, a V-shape with a caecal outgrowth on one side. The digestive gland occupies the upper part of the spiral and communicates, so far as I have been able to trace it, with the caecal outgrowth of the stomach by two openings (see pl. xxx, figs. 6—7). Following upon the stomach is the short intestine overlying the oviduct and wrapped around to a considerable extent by the right (or posterior) portion of the excretory organ. The anus (pl. xxix, fig. 4, A.) is deeper in the branchial cavity than the oviducal opening. Both lie, as already stated, well back on the right side and thus out of the way of the ctenidium and osphradium and the arrangements which, it has been suggested, secure the closing of the front margin of the branchial cavity.

IV.—NERVOUS SYSTEM. (Pl. xxxii, figs. 21 and 22).

The nervous system has been described more thoroughly than any other, and Bouvier's observations are established and confirmed, as usual, by subsequent workers. A detailed account of the system is therefore superfluous though reference may be made to the interesting question of the supra-intestinal ganglion.

Cerebral, pleural and pedal ganglia are intimately united in pairs and the cerebrals are closely fused with the pleurals to form a trapezoidal mass. From this mass are given off, as Bouvier found,—

(*a*) Two large nerves to the proboscis on each side.
(*b*) Nerves to the fore-roof above the head.
(*c*) Nerves to the anterior part of the body wall

The above are from the cerebral ganglia.

(*d*) Parietal nerves from the pleural ganglia.

(*e*) The short connective, so short as to be almost non-existent, to the supra-intestinal ganglion (pl. xxxii, fig. 21, Sp. Int. Gl.).

This ganglion is similarly near the cerebropleural mass in the Volutids examined by Woodward, in *Voluta* (*Cymbiola*) *ancilla* (Sol.), *Neptuneopsis gilchristi* (Sby.), and *Volutolithes abyssicola* (Ad and Rve). Pace examined *Voluta musica* and found that this form has the supra-intestinal ganglion separated from the cerebropleural mass by a considerable length of visceral connective. Bouvier's type was *Voluta neptuni*, Gmelin, which is referred by Pace and Woodward to the section "*Melo*," but is grouped by Pilsbry-Tryon with *Cymbium*; he found the connective between the pleural and the supra-intestinal ganglion long. This seems to indicate that the type now under discussion, *Melo indicus*, Gmelin, can hardly be in the same section of "*Voluta*" as Bouvier's species.

The supra-intestinal ganglion gives rise to three chief trunks, not so many as in Bouvier's type which had eight to ten nerves arising here. The two anterior trunks branch and supply the body-wall and the ctenidium and osphradium. There seems to be an anastomosis between one branch nerve to the body-wall and siphon from this ganglion and a nerve from the left pleural ganglion.

The third of the trunks is the visceral loop (V.L. sp.).

The sub-intestinal ganglion is, as usual, close to the pleural, but is more closely bound up with the right pleural than in Bouvier's type, the zygoneurous connection (Zy.) being very short and thick. The zygoneurous connection, it will be remembered, is formed by a great parietal nerve of the right-side passing through the subintestinal ganglion. The subintestinal ganglion therefore appears to give off this parietal nerve (R. par.) and also the visceral loop.

The visceral loop is quite normal, with two ganglia (v and v^1) at the back, the supplementary ganglion being to the left of the principal one. From the supra-intestinal part (V.L. sp.) of the commissure, near the point when it passes over the oesophagus, a nerve seems to branch off to the branchial region. The supplementary ganglion is situated on the loop just after it has crossed the intestine, and from it a nerve runs up towards the heart and visceral mass. The principal ganglion is a short distance to the right and it gives off various nerves including one to the heart, etc. and one to the rectum and neighbouring parts.

The buccal ganglia are close below the cerebrals and are connected by a commissure. The pedal ganglia are connected closely with the cerebropleural mass and with one another and give off numerous nerves which I have not further studied.

V.—Circulatory System.

The heart is slung in the pericardial cavity (pls. xxix & xxxi, figs. 3 and 8) by the connection of the efferent ctenidial vein with

the auricle above (technically forwards and to the left) and by the base of the aortæ below. The pericardial cavity is fairly spacious and its connection with the renal organ is on the posterior or right side of its floor. The pericardial lining does not seem to possess glandular specialisation though my specimens were not in a condition for histological examination. The ventricle is strongly muscular, with the muscle internally in longitudinal bands, the bands being radially arranged. The auricle was strongly contracted in the specimens examined, but a valve seems to exist between it and the ventricle.

The base of the aortae is guarded by a pocket valve on the side towards the anterior aorta and the wall projects inwards from the side towards the posterior aorta; these arrangements must be effective against back-flow.

There are as usual two aortae.

The anterior aorta is strongly walled and follows the oesophagus for some time (pl. xxxi, fig. 9), giving off several branches to bodywall, columellar muscle and foot across it. A large branch goes to the siphonal region, and the anterior region generally.

The visceral aorta is also strong and it divides as shown in fig. 9.

The spaces throughout the body are blood spaces. They may be grouped, more or less, into sets:—

(*a*) The spaces in the foot, often running along with the nerves.

(*b*) The general anterior cavity continued into the cavity of the proboscis. This cavity communicates with the spaces in the foot more especially, though not exclusively, in the neighbourhood of the pedal ganglia.

(*c*) The spaces between and amongst the parts of the renal organ, reproductive organs, and intestine, *i.e.*, the lower part of the visceral mass. The connection of these spaces with those of the anterior cavity appears to be regularized into what is practically a vessel (pl. xxxii, fig. 16, Ant. V.) and certainly these spaces are, otherwise, practically completely cut off from those under (*a*) and (*b*).

(*d*) The spaces amongst the parts of stomach and liver, *i.e.*, in the upper part of the visceral mass, somewhat distinctly marked off from those under (*c*) with what may be called an anterior visceral sinus.

(*e*) The spaces in mantle roof, cteniduim, and siphon. The afferent channel to the ctenidium continues the anterior visceral sinus. These spaces, especially towards the siphon, are also in connection with those of the general anterior cavity (*b* above). The afferent ctenidial channel is well marked.

The blood channels in connection with the renal organ are regularized to some extent and are discussed in connection with that system.

If one may infer from the arrangement of blood channels, the general course of the circulation would be from the heart *via* the aortae to either the head, foot, siphon, etc., or to the visceral mass. From the former to the general anterior cavity, thence *via* the renal organs to the anterior visceral sinus which presumably also gets the blood from the channels amongst the viscera (*d* above). Thence to the mantle and ctenidium roof and so back to the heart.

The separation of the sets of spaces is perhaps somewhat marked and one gets the idea of a fairly regular system allowing of course for movements of blood due to such other causes as the expansion and contraction of the foot, the protrusion and retraction of proboscis and siphon, and so on.

VI.—Excretory System.

The renal organ is treated by Perrier who studied *Voluta neptuni*. It is situated on the right side of (that is, actually, behind) the pericardium (pl. xxix, fig. 3), and is a large massive organ occupying the lower part of the visceral mass and covered by the ovarian tubules. It consists of (1) the massive posterior or right lobe (see R. L., pls. xxix & xxxi, figs. 3, 10—13), which has a spongy structure (pl. xxxi, fig. 15) and opens into the general renal cavity by fissures between some of its projecting lobes (pl. xxxi, figs. 12 and 13). This lobe is wrapped around the rectum on the dorsal side of the latter.

(2) The smaller anterior or left lobe (L.L., pls. xxix & xxxi, figs. 3, 10—13), a band of tissue of a lighter colour than the other lobe. It runs vertically, parallel to the posterior (morphologically right) wall of the pericardium. This band is, as it were, suspended from the roof of the cavity (pl. xxxi, figs. 11 and 12) and is attached to the floor just within the lips of the external openings (see fig. 12). Through this attachment it receives a branch channel (pl. xxxii, fig. 16, L.L.V.) from the great blood channel leaving the general anterior cavity (A.V.). The surfaces of the left lobe are somewhat swollen out, making numerous flat lobes with furrows between them (pl. xxxi, fig. 14).

(3) The so-called nephridial gland (N. G., pls. xxix & xxxi, figs. 3 and 10—13) against the pericardial wall, but not extending over its (morphologically) anterior end. The internal surface is somewhat ridged and grooved and there are pits at intervals (pl. xxxi, fig. 13).

The general renal cavity is partly subdivided by the vertically hanging left lobe as described. Just below the nephridial gland, and towards the right side (morphologically, forwards) the reno-pericardial canal (Rn. P.P., pl. xxxi, fig. 12) enters. The pericardial canal is short and direct. The circulatory arrangements of the renal

organ were worked out as far as possible. A very definitely walled channel (Ant. V., pl. xxxii, fig. 16) coming from the anterior cavity of the animal (see above) runs just beneath the side of the external opening of the renal organ and, once arrived under the floor of the organ, it gives off branches as follows:—

(*a*) A branch to the nephridial gland (N. G. V., pl. xxxii, fig. 16).

(*b*) A branch to the left lobe (L.L.V., pl. xxxii, fig. 16).

(*c*) A branch to the large part of the posterior or right lobe which lies morphologically in front of and topographically to the right of the external aperture (R.L.V., pl. xxxii, fig. 16).

(*d*) A branch which goes along beneath the floor of the renal cavity and gives off branches to the several projecting lobes of the right lobe (R.L.V., pl. xxxii, fig. 16).

The last-named blood channel appears to connect with the anterior visceral or abdominal sinus (A. Abd. S). The latter apparently also gathers blood from sinuses in the body wall and elsewhere around the renal organ, liver, etc.; it is situated between the pericardium and the stomach and communicates with the afferent blood channel of the ctenidium.

VII.—Reproductive System. (Pl. xxxii, figs. 17—20).

Both my specimens were females so I can only describe this sex and, in connection with it, I have mainly to confirm Haller's results from *Concholepas peruviana* with some additional observations. In other words, the genitalia are very similar in this sex for the two types.

The ovary is composed of a number of long tubules spreading over the surface of that portion of the visceral mass which is occupied by the large posterior or right lobe of the kidney. The tubules form a branched system and lie side by side. As they unite they approach the posterior edge of the upper surface of this portion of the visceral mass and then bend round to its under (posterior) side in the lower part of which they open (after further uniting in pairs) into the common collecting duct which goes forward to open into the large oviduct.

This collecting duct receives a duct from a large bladder-like structure which I shall call, tentatively at least, the albumen sac (Alb., pl. xxx, fig. 7). It is in the position of the receptaculum seminis, so called at any rate, of *Concholepas*, but in the latter the collecting duct from the ovary seems to go into this organ and the channel to the uterus out from it again. The relations are therefore not exactly the same, even if, as seems probable, the name receptaculum seminis is an error.

The oviduct is a large sac-like duct abutting on the posterior side of the branchial cavity narrowing down to a terminal duct-

like portion which projects freely into the branchial cavity (pl. xxix, fig. 4).

Internally the duct portion of what has been tentatively named albumen sac is marked by numerous fine longitudinal ridges, all of which become much weaker as soon as they enter the sac. Most of the sac seems to have a simple membranous wall. The collecting duct of the ovarian tubules is also ridged longitudinally.

The wall of the oviduct internally is evidently glandular almost throughout. Slight ridges and hollows run in transverse lines on the side towards the branchial cavity, being weakest (see pl. xxxii, figs. 18—20) along the line where they are nearest to that cavity (through the wall).

Along the back-line, almost dorsally, a swollen ridge with grooves in its surface projects as an almost horizontal shelf into the cavity along practically its whole length. Sheltering beneath its under side is the main channel which is bounded on its forward and lower side by a thick ridge. This ridge rises up towards the end and finally goes into the roof of the terminal narrow part of the duct. On the anterior side of this ridge the transverse ridges and hollows mentioned above are much higher than elsewhere (pl. xxxii, figs. 18 and 19).

The whole effect is to partially mark off a canal portion of the oviduct, ventral and posterior, from a large chamber, more or less dorsal and anterior. The shelf and the thick ridge already mentioned have not grown sufficiently to meet and fuse so the canal portion and the chamber are connected all along (see pl. xxxii, figs. 18 and 20).

The following are some of the papers referring to Volutidæ :—

Bouvier, E. L.—Le système nerveux des Gasteropodes Prosobranches.—*Ann. Sci. Nat. Zool.*, ser. vii, tome 3, 1887.

Bouvier, E. L.—L'organisation des Volutes.—*Bull. Soc. Philomathique*, ser. vii, tome xii, p. 102, 1886-7.

Gray, J. E.—Observations on Volutids.—*Ann. Mag. Nat. Hist.*, ser. 4, vol. i, p. 310, 1868.

Pace, S.—Voluta musica.—*Proc. Malacol. Soc.*, vol. v.

Perrier, R.—Le rein des Gasteropodes Prosobranches.—*Ann. Sci. Nat Zool.*, 1890.

Pilsbry-Tryon.—Manual of Conchology.

Woodward, M. F.—Anatomy of Voluta, etc.—*Proc. Malacol. Soc.*, iv, 1900.

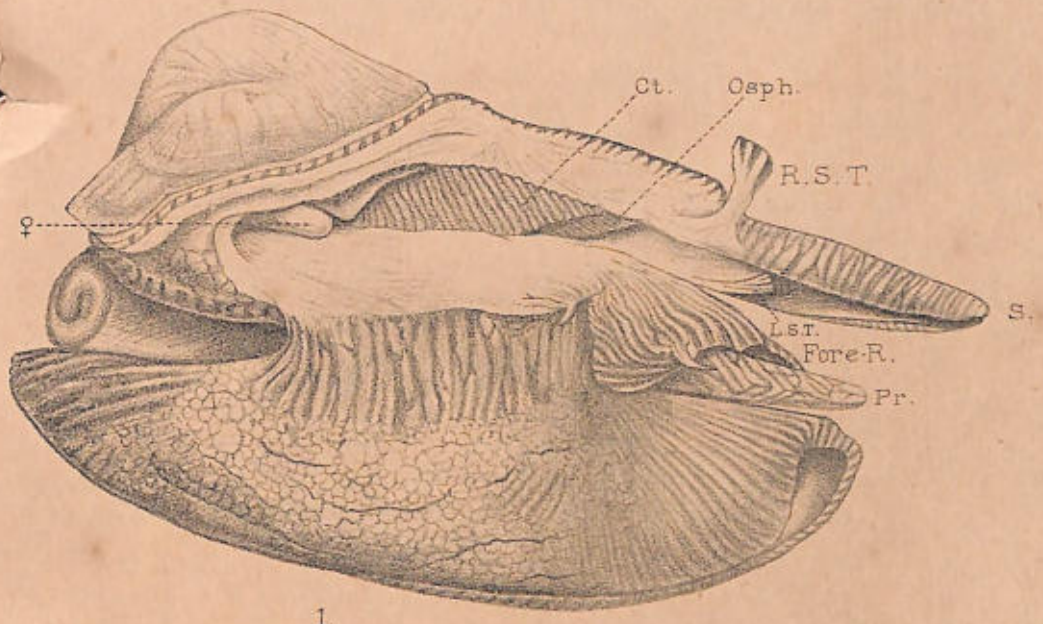
EXPLANATION OF PLATE XXVIII.

MELO INDICUS.

FIG. 1.—The animal after removal of shell, from the right side.

,, 2.—The same, from the front.

Ct., Ctenidium; Osph., Osphradium; R. S. T., Right siphonal tentacle; L. S. T., Left siphonal tentacle; S., Siphon; Fore-R., Fore-roof; Pr., Proboscis; Gr., Groove in anterior edge of foot; t., Cephalic tentacle (on fore-roof); e., Eye.



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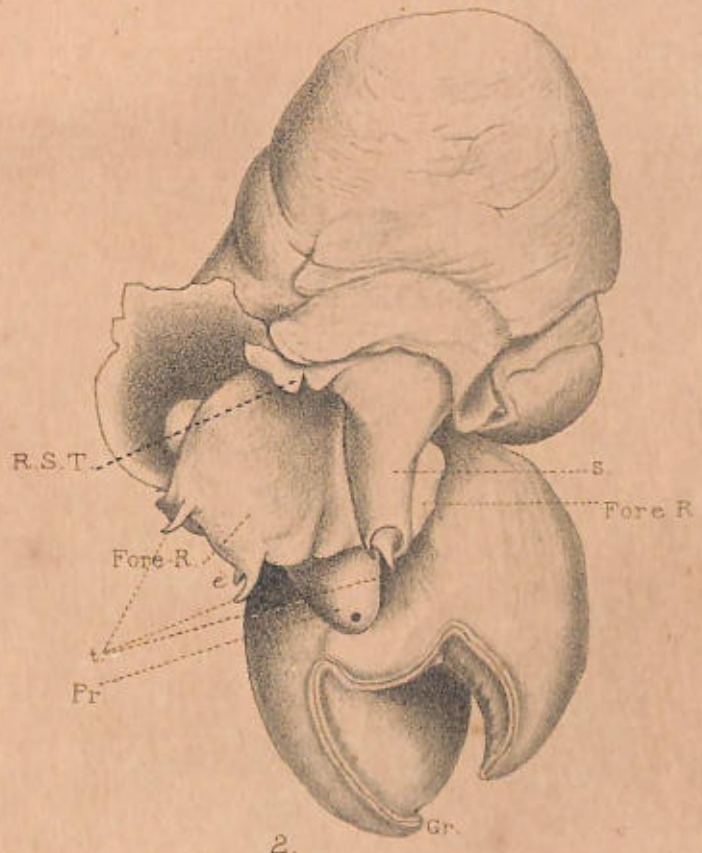

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H. J. Fleure, del. A. C. Chowdhary, Lith.

ANATOMY OF MELO INDICUS.

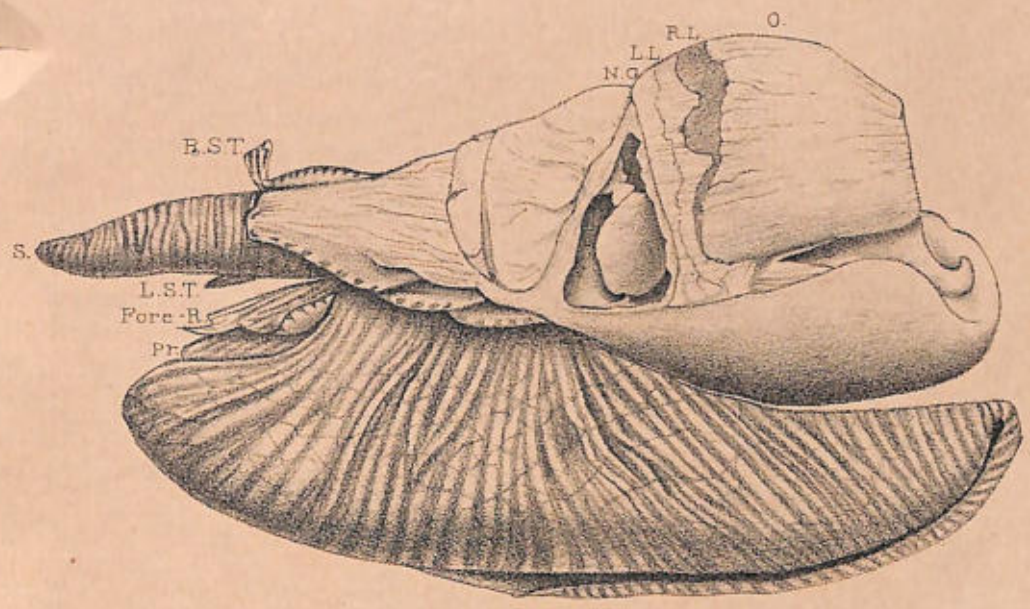
EXPLANATION OF PLATE XXIX.

MELO INDICUS.

FIG. 3.—The animal after removal of shell, from the left side. The pericardial roof has been removed.

,, 4.—The same, from the right side. The branchial roof has been cut and turned back.

Ct., Ctenidium; Osph., Osphradium; R. S. T., Right siphonal tentacle; L. S. T., Left siphonal tentacle; S., Siphon; Fore-R., Fore-roof; Pr., Proboscis; t., Cephalic tentacle (on fore-roof); e., Eye; O., Ovarian tubules; R. L., Right lobe (or posterior lobe) of renal organ; L. L., Left lobe (or anterior lobe) of renal organ; M. Gl., Mucus gland in branchial roof; U., Excretory aperture; A., Anus; ♀., Oviduct, in branchial cavity.



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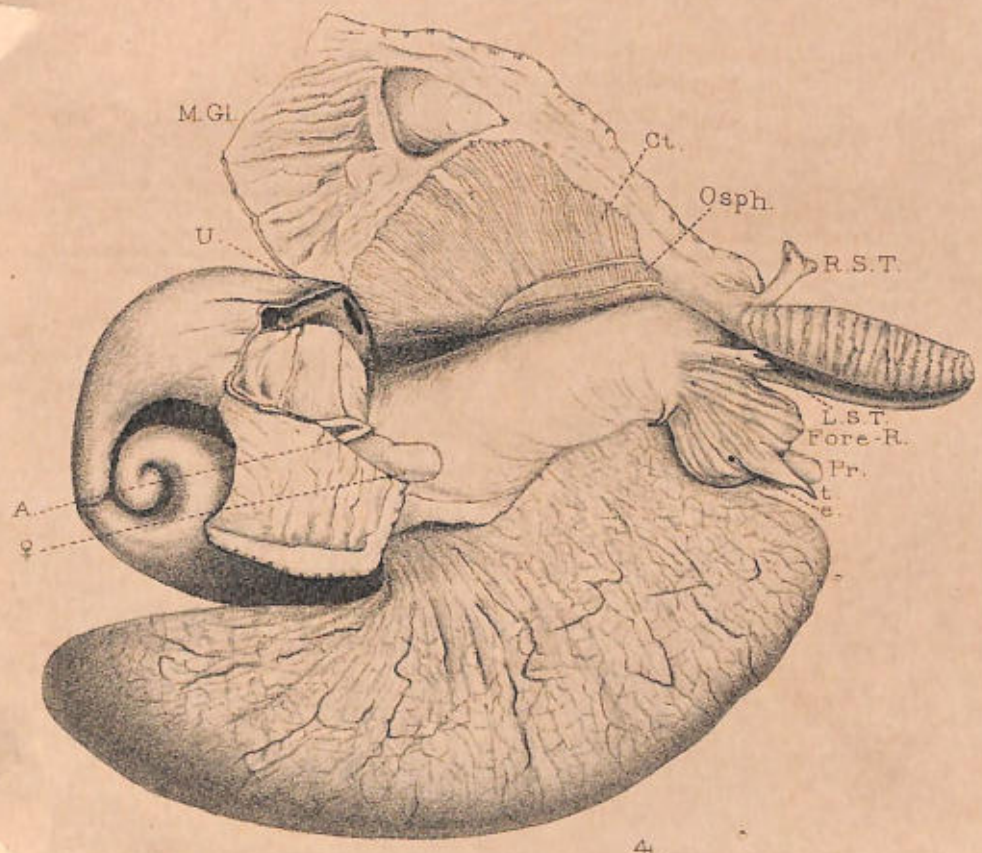

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H.J. Fleure, del. A.C. Chowdhary, Lith.

ANATOMY OF MELO INDICUS

EXPLANATION OF PLATE XXX.

MELO INDICUS.

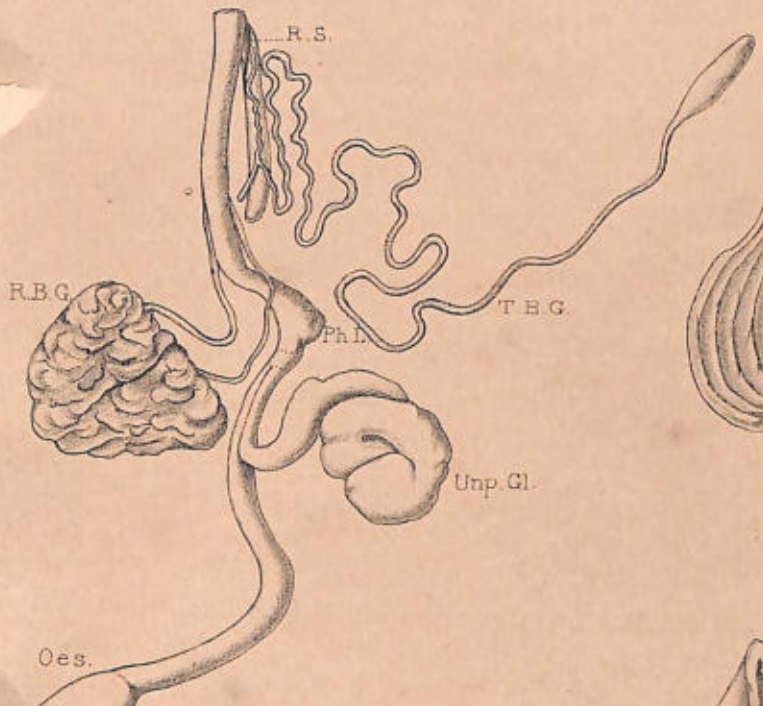
FIG. 5.—A longitudinal section through the proboscis, etc. in a state of complete retraction.

,, 6.—The alimentary canal.

,, 7.—The stomach region showing the openings from the digestive gland.

,, 7*a*.—The oesophagus and stomach opened, to show the longitudinal ribbing of the wall.

Ph. L., Expansion of oesophagus called by French authors "Pharynx de Leiblein"; R. S., Radular sac (turned to show ventral surface); R. B. G., Ordinary or racemose buccal glands; T. B. G., Tubular buccal glands; Unp. Gl., Unpaired gland of oesophagus; Oes., Oesophagus; St., Stomach; Int., Intestine.



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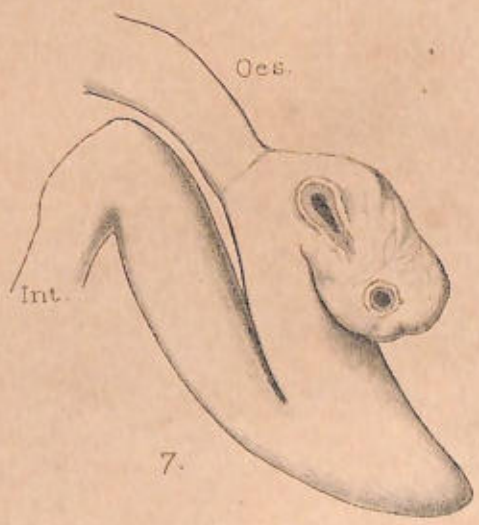

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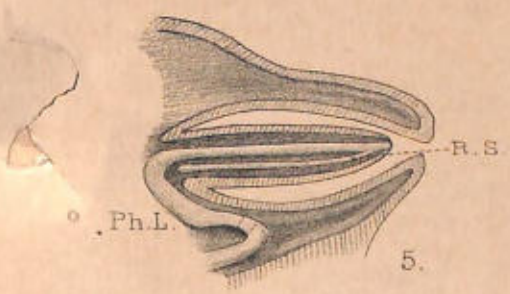

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H. J. Fleure, del. A. C. Chowdhary, lith.

ANATOMY OF MELO INDICUS.

EXPLANATION OF PLATE XXXI.

MELO INDICUS.

FIG. 8.—The pericardium.

,, 9.—The aortae and their chief branches.

,, 10.—The renal organ as seen at the side of the pericardium before opening.

,, 11.—An imaginary section through the renal cavity about the level of R. L. (Fig. 12).

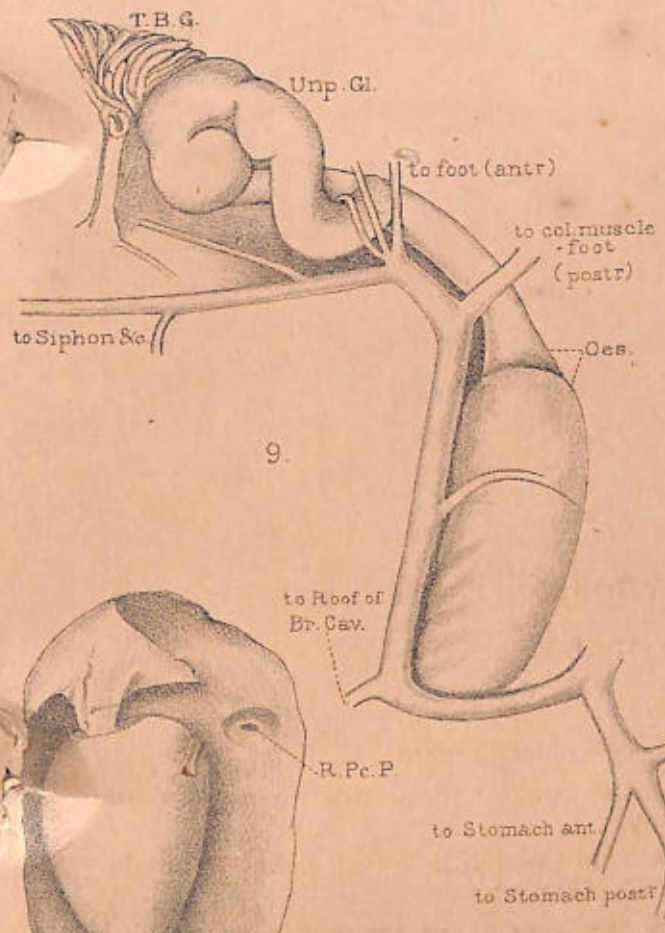
,, 12.—The renal cavity after removal of the roof.

,, 13.—The renal cavity looking up towards the roof

,, 14.—The left lobe of the renal organ seen from the side.

,, 15.—The spongy structure of the greater part of the right lobe of the renal organ

R. Pc. P., Pericardial opening of renopericardial canal; T. B. G., Tubular buccal glands; Unp. Gl., Unpaired gland of oesophagus; Oes., Oesophagus; R. L., Right lobe (or posterior lobe) of renal organ; L. L., Left lobe (or anterior lobe) of renal organ; N. G., Nephridial gland; U. L., Lip of excretory aperture; Rn. P. P., Renal opening of renopericardial canal.



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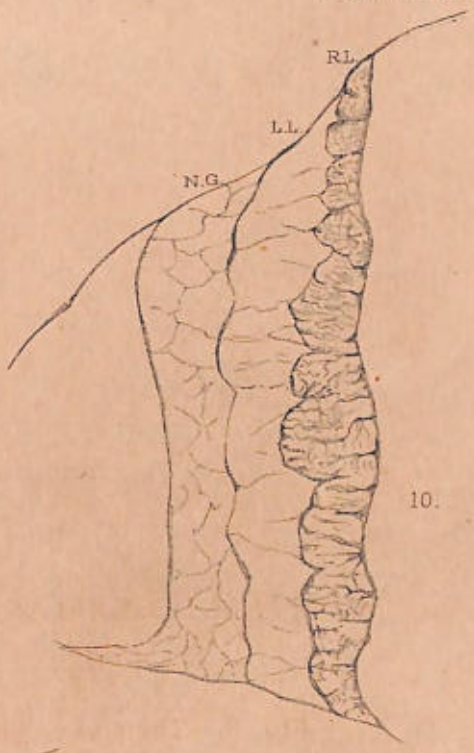

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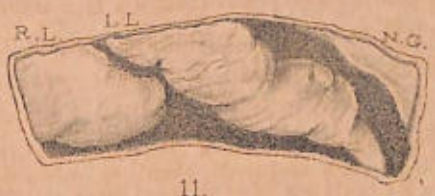

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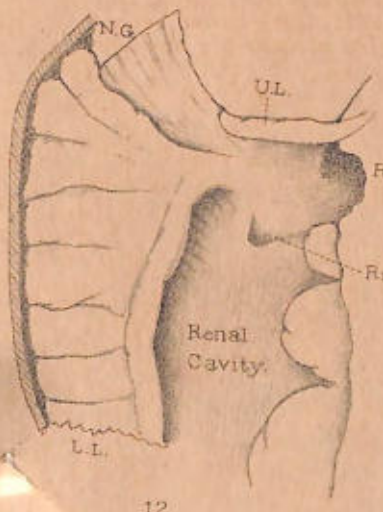

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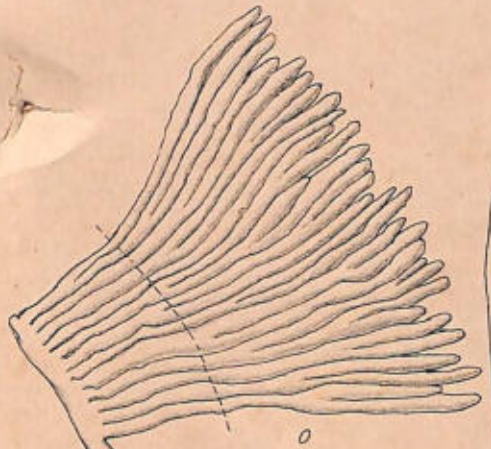
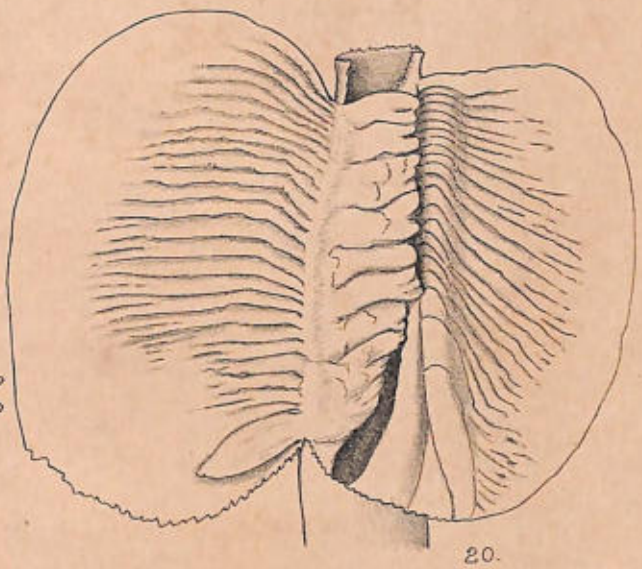
H. J. Fleure, del.

A. C. Chowdhary, lith.

ANATOMY OF MELO INDICUS.





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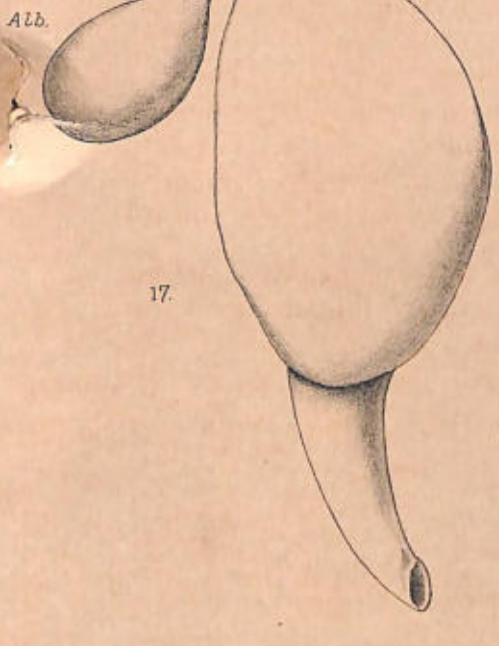

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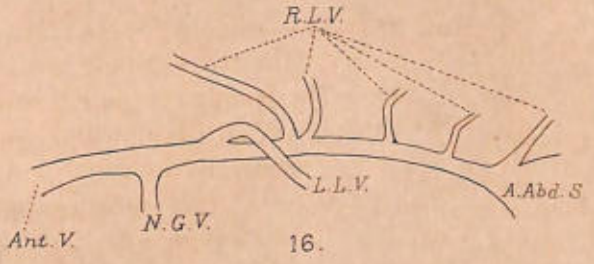

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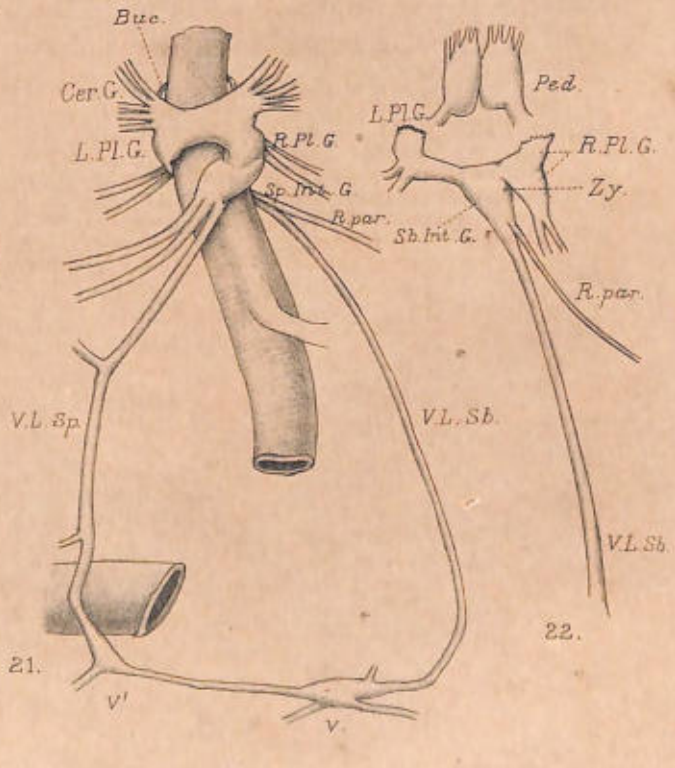

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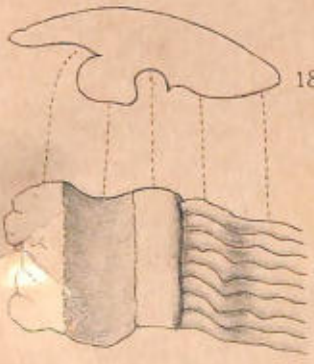

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H. J. Fleure, del.

A. C. Chowdhary, lith.

ANATOMY OF MELO INDICUS.

XXXIII. TWO NEW SPECIES OF SCOLOPENDRIDAE.

By F. H. GRAVELY, *M.Sc., Assistant Superintendent, Indian Museum.*

The Indian Museum collection of Scolopendridae has increased very rapidly since it was catalogued after being examined by Dr. Kraepelin two years ago (Rec. Ind. Mus., v, 1910, pp. 161-166). In spite of this, very few additional species have been added to it, and the new locality records for the most part only seem to show that our knowledge of the distribution of such species as are easily obtained is already complete. Such records as extend the known range of any species all happen to refer to species obtained by Mr. Kemp during the Abor Expedition, and have been incorporated in the special report on the zoological results of that expedition (Rec. Ind. Mus., vol. viii). Two out of the four undescribed species added to our collection since it was returned to us by Dr. Kraepelin were also obtained in the Abor Country, and have been described in the same report. In the present paper the two remaining species and one subspecies are dealt with.

Subfamily *OTOSTIGMINAE.*

Genus **Rhysida.**

R. ceylonicus, n. sp.

A single specimen was found under a stone in damp mud in the jungle on the hill above the experiment station at Peradeniya, Ceylon, at an altitude of about 2000 feet. Before it was finally caught it escaped into a small stream down which it swam with lateral undulating movements of the body, diving under the water to hide beneath stones that were partially immersed. This is the only centipede I have seen under such conditions, but whether or not it is normally amphibious I am unable to say.

Description.—Length (excluding appendages) 57 mm. Antennae 20-jointed, all the joints longer than broad, the distal ones from two to four times longer, the first two smooth and hairless throughout, the third with a ventral pilose patch distally, the rest pilose throughout. Dorsal surface somewhat slate-coloured, segments 4-19 with a pair of very short longitudinal grooves close to the posterior margin; no segments grooved more extensively than this except marginally; more or less complete marginal grooves present from about the sixth or eighth segment, those on

the posterior segments being better developed than those further forwards; strong marginal ridges present on the twenty-first segment only. Ventral surface paler than dorsal. Sternocoxal plate armed on each side with five teeth of which the three innermost are very close together, the fourth distinctly separated from the third, and the fifth somewhat more distant from the fourth, behind these teeth the defining lines meet in an angle of about 120°; sterna of body segments not grooved except the last of them which is vaguely grooved behind in the middle line; this last sternum is nearly as broad in front as it is long, narrower behind, with its posterior margin very broadly V-shaped, forming a distinct right angle with the oblique lateral margins on each side. Pseudopleural processes bluntly conical, with a pair of terminal teeth, without dorsal teeth, and with a minute side tooth on one side only in my one specimen. First pair of legs armed with 1 (ventral) claw spur and 1 (anterior) tarsal spur; second, third and fourth pair with 1 (anterior) tibial spur, 2 tarsal and 2 claw spurs, fifth to eighteen pairs with 2 tarsal and 2 claw spurs, nineteenth with 1 tarsal and 2 claw spurs, twentieth with 2 claw spurs only; anal legs also with 2 claw spurs only, femora armed only with a single minute tooth on the (outer ?) side.

This species is very near *R. brasiliensis*, Kraepelin, but differs in that the grooves behind the teeth of the sternocoxal plate meet not in a straight line but in an angle of about 120°.

Subfamily *SCOLOPENDRINAE.*

Genus **Pseudocryptops,** Poc.

Members of this genus, which has hitherto been recorded only from Perim Island, can be recognized at sight by their short stumpy antennae and enormously thick anal legs.

P. agharkari, n. sp.

This sluggish little centipede is not uncommon under stones in jungle at Taloshi and Helvak in the Koyna Valley of the W. Ghats, Satara Dist., Bombay Presidency, at an altitude about 2000 feet.

Description.—Length up to 29 mm. Antennae 17-18-jointed. Colour dark reddish purple in life, various paler shades of greyish or brownish tints in spirit. Head rounded in front, more or less broadly grooved in the middle line in front, not produced. First segment vaguely grooved in the middle line, segments 2-4 usually with more or less incomplete, 5-20 with complete and very strongly marked pair of longitudinal grooves, but without marginal grooves or ridges; anal segment very short, grooved in the middle line, marginal ridges present, posterior margin convex. Sternocoxal plate armed with three teeth on each side of the middle line which is strongly grooved. Sterna of segments 2-20 marked

throughout with a pair of longitudinal grooves; sternum of anal segment almost semi-circular in outline, vaguely grooved in the middle. Femur of poison-jaws armed with a distinct tooth. All legs armed with a pair of claw-spurs except the anal legs which are entirely unarmed. This species differs from *P. walkeri*, the only species previously described, in the shape of the head. The antennae too are usually as long as the head and first segment together, but this depends purely on the extent to which they are expanded or contracted at the time of death. Specimens with contracted antennae usually have the back of the head drawn under the margin of the tergum of the first segment, whereas the others do not.

P. agharkari subsp. **singhbhumensis**, nov.

This subspecies occurs under stones in jungle on the hills near Chakardharpur in the Singhbhum district of Chota Nagpur, but is far from common there. It differs from the Koyna Valley form in colour only, being grey with a dark line down the middle of the back between the longitudinal grooves in life, and blue (ultimately brown ?) still with a dark middle line, in spirit.

XXXIV. INDIAN PSYLLIDAE.

By D. L. CRAWFORD, *Stanford University, California.*

(Plates xxxiii—xxxv).

The following paper presents the descriptions of several new genera and species of *Psyllidae*, a family of Homoptera near to the *Aphididae*, which were sent to me for determination by the Indian Museum in Calcutta and the Museum of the Agricultural Research Institute in Pusa, Bengal. For the sake of convenience the two collections are treated separately, since only a few of the species are found in both. Several species of Indian *Psyllidae* have been described by Dr. Kieffer and Mr. Buckton, and at a later date the writer hopes to publish a key to all the Indian genera and species so far described. The types of new species from the Indian Museum are deposited in that place; the other types, however, are retained in the author's collection.

The illustrations, designed to show the most important characters, are drawn more or less to scale. Especially is this true of the figures of the forewings, in order to show the relative sizes of the insects; *Trioza gigantea*, *Kuwayama hirsuta* and *Phacopteron lentiginosum* are enlarged to only one-half the relative size of the others.

I.—COLLECTION OF THE INDIAN MUSEUM.

Genus **Phacopteron**, Buckton.

Insect large, robust; thorax strongly arched; head small, more or less retracted, narrower than thorax, with facial cones rather short, divergent, separate at base, subacute; eyes large, hemispherical; antennae slender. Prothorax long, almost vertical; propleurites at least moderately large, suture between them and pronotum not distinct; mesopleurum large; legs long; femora large; hind coxae very large, elongate, contiguous along inner margin, with spur short. Forewings large, more or less hyaline, somewhat rhomboidal in outline; radius and fourth furcal connected by a short cross-vein, making a third marginal cell. Usually gall-making.

Type of genus: *Phacopteron lentiginosum* (Buckt.).

This genus is unmistakably related closely to *Pachypsylla* in nearly all its characters except the venation, in which it is similar to *Ceriacremum*. Because of this similarity it has hitherto been grouped with the latter genus, but this relation is only in the wing venation, whereas all the rest of the anatomical characters, even the shape of the wing, point to its affinity with *Pachypsylla*. By some unaccountable error Enderlein, in his paper on the *Psyllidae*

of Kilimandjaro, separated this genus from Kieffer's *Phacosema* by the absence of the cubital petiole. Buckton's original description and accompanying figure clearly show that this is not true. As a matter of fact, these two species, *Phacopteron lentiginosum*, Buckt., and *Phacosema gallicolla*, Kieffer, are undoubtedly not only congeneric but also very closely related specifically. Until I have further evidence, however, than Kieffer's description, I will not merge the two genera.

Phacopteron lentiginosum, Buckt.

(Pl. xxxiii, figs. A, B, F; Pl. xxxv, fig. A.)

Length of body 4·7 mm.; length of forewing 4·5 mm.; greatest width of wing 2 mm.; width of vertex between eyes ·45 mm.; with eyes ·9 mm. General colour brown, most of surface blotched with lighter brown, especially on vertex, pronotum and abdomen; venter lighter brown; legs concolorous; antennae brown, with tips of segments and entire terminal segment black; forewings maculated apically dark brown to black; veins spotted closely with black. Body very large, robust, sparsely and briefly pubescent.

Head small, retracted under pronotum, with eyes much narrower than thorax, about as broad as prothorax; vertex transversely rather flat but rounded down forward; post-ocelli strongly elevated; facial cones short, widely separate at base, divergent, porrect, subacute at tip; pubescence short; labrum small; eyes large, hemispherical; ocelli large; anterior ocellus between and a little above facial cones; antennae slender, long, almost as long as head and thorax, tip slightly clavate.

Thorax very large, broad, strongly arched; pronotum long, almost overhanging vertex; propleurites moderately large, with suture between them and pronotum scarcely visible. Dorsulum ascending, long; mesopleurites very large, conspicuous; scutum long; legs long, large; all femora somewhat enlarged, stout, with tibial groove deep, conspicuous; tibiae armed; tarsi large; hind coxae very large, elongate, with coxal spur small, blunt. Forewings large, hyaline, maculate, somewhat rhomboidal in shape, a little more than twice as long as broad, broadest just beyond first marginal cell; cubital petiole more than half as long as discoidal subcosta; radius straight, not parallel to margin, connected with arch of fourth furcal by short cross-vein, thence flexed sharply toward margin, terminating slightly before apex of wing; first marginal cell small, furcals subequal; second marginal cell quadrangular, broadest at margin; third marginal cell includes apex of wing.

Abdomen large, robust. *Male*—Genital segment rounded; claspers rather short, roundly acute at tip, curved forward; anal valve large, broadest near base. *Female*—Genital segment relatively small, acute at apex; dorsal and ventral plates subequal in length.

Redescribed from one male and three females from Dehra Dun, base of West Himalayas, and from Poona, W. India, on *Garuga pinnata*. These specimens are paratypes of the specimens used by Mr. Buckton in his original description. This species produces galls on *Garuga pinnata*, Roxb.

Apsylla, gen. nov.

Body robust; thorax broad, strongly arched, shagreened; head small, short, more or less retracted; vertex rounded forward, shagreened; facial cones entirely wanting; eyes moderately large, hemispherical; anterior ocellus in front, or inferior; antennae ten-segmented, short, thick, with two very long setae at tip. Pronotum almost, or quite, vertical; pro-epimeron short; pro-episternum longer Legs short, all similar and of equal size and length, apparently not saltatory; hind coxae unusually small, not larger than mesocoxae and very similar in shape, with coxal spurs lateral, small and almost obsolete. Wings hyaline, both pairs more nearly similar than usual; forewings weakly veined, especially on margin apically.

Type of genus: *Apsylla cistellata* (Buckt.).

This genus is very distinct from all others in several respects. The principal difference lies in the metacoxae and antennae. It is possible that *Pauropsylla udei*, Rubsaamen, a species which I have not seen, is related to this species.

Apsylla cistellata (Buckt.).

(Pl. xxxiii, figs. C, D, E, K; Pl. xxxv, fig. B.)

Length of body 3·1 mm.; length of forewing 3·4 mm.; greatest width 1·4 mm.; width of vertex between eyes ·5 mm.; with eyes ·78 mm. General colour black, male sometimes brown; antennae lighter; wings whitish-hyaline. Body short, relatively robust, surface shagreened.

Head small, short, deflexed, with eyes much narrower than thorax; vertex transversely rather flat, rounded down strongly forward, with post-ocellar area strongly elevated. Eyes large; anterior ocellus in front, barely visible from above; antennae, with terminal setae, about as long as width of head with eyes, basal segments scarcely thicker than succeeding, decreasing in length to tip; terminal setae about as long as four distal segments, black; labrum small.

Thorax strongly arched, broad; pronotum somewhat overhanging vertex, long; propleurites indistinct; mesopleurum large; femora all short, not enlarged; meso- and metacoxae similar in shape and size, metacoxal spur small, lateral; hind tibiae unarmed. Forewings hyaline, transparent, weakly veined, a little more than two and a half times as long as broad, broadest across first marginal cell; marginal veins very weak apically; first furcal very short,

almost obsolete; second arched; second marginal cell triangular, larger; radial cell short; cubital petiole almost twice as long as discoidal subcosta; clavus long, large. Hind wings veined less distinctly than forewings but very similarly, except radial cell wanting.

Abdomen short, thick. *Male*—Claspers curved forward, subacute, moderately long; anal valve erect, large, with short rounded lobe projecting caudad, truncate above, with anal opening distinct. *Female*—Genital segment short, large and subglobose at base, produced into two short, needle-like processes with a bivalve ovipositor between, exserted.

Redescribed from two pairs ("type material") from Dehra Dun, West Himalayas, and seven males and nine females from Bettiah, Champaran, Bengal, from galls on mango shoots; one male from Dehra Dun in mango gall. Buckton described this species as a *Psylla*, but, of course, it is widely different from the members of that genus.

Eurhinocola, gen. nov.

Body robust; head broad, more or less recessive over pronotum and pleurites, closely adpressed to prothorax; vertex somewhat roundly emarginate over base of antennae; facial cones short, truncate, transversely rectangular or nearly so, almost contiguous on inner margin, not continuing in plane of vertex as in *Euphyllura*, but distinctly separated therefrom; anterior ocellus on front margin of vertex; eyes small; antennae short. Thorax broad; propleurites more or less concealed by eyes; legs short. Wings more or less coriaceous, not hyaline, slightly rhomboidal in outline or elongate-ovate; venation somewhat similar to *Euphyllura*.

Type of genus: *Eurhinocola gravelyi*, Crawf.

This genus is closely related to *Euphyllura*, differing markedly in the cephalic characters chiefly. Many of the species heretofore included in the genus *Rhinocola* will fall into this genus, since *Rhinocola* must be removed to the subfamily Liviinae. *Rhinocola aceris*, L., the type of that genus, is closely related to *Livia* in the fundamental characters and, therefore, can not include most of the species heretofore placed therein. This matter is treated more in detail in another paper on Psyllidae which is at present in manuscript form.

Eurhinocola gravelyi, n. sp.

(Pl xxxiii, figs. G. H.; Pl. xxxiv, fig. E; Pl. xxxv, fig. I.)

Length of body 1·5 mm.; length of forewing 1·4 mm.; greatest width ·65 mm.; width of vertex between eyes ·30 mm.; with eyes ·46 mm. General colour brown to black, with abdomen and legs apically light brown to dirty white; wings yellow. Body very small, robust; surface shagreened.

Head almost as broad as thorax, closely adpressed to prothorax, scarcely deflexed; vertex a little broader than long, rather plane, with a shallow fovea discally on each side of median line, almost straight behind, anterior margin roundly emarginate above antennae; facial cones short, broad, transversely rectangular, somewhat deflexed from plane of vertex and distinctly separated therefrom by a deep suture (not as in *Euphyllura*), scarcely pubescent; anterior ocellus visible from above; eyes small, white, slightly recessive over pronotum; labrum visible from front. Antennae short, not longer than width of head, rather thick.

Thorax broad, robust, short; prothorax moderately long, rather flat transversely, concealed somewhat laterally by recessive eyes; propleurites mostly concealed by eyes; coxae small; legs short, relatively stout. Wings small, somewhat coriaceous and wrinkled, not transparent, a little more than twice as long as broad, very slightly rhomboidal in outline; first marginal cell elongate; cubital petiole twice as long as discoidal subcosta; pterostigmal vein almost obsolete. Hind wings smaller, hyaline.

Male—Abdomen constricted at base of genitalia; latter large; anal valve large, bilobed; claspers large, acute at tip, simple. *Female*—Genital segment as long as rest of abdomen, deflexed, acuminate; ventral valve shorter than dorsal, more acute.

Described from a considerable number of specimens of both sexes collected by F. H. Gravely from the "jungle between foot of Dawna Hills and Burmo-Siamese Frontier." I take pleasure in naming this species after the collector.

Type No. 3618/19.

Euphalerus vittatus, n. sp.

(Pl. xxxiii, figs. I, J, L, M; Pl. xxxv, fig. C.)

Length of body 2·2 mm.; length of forewing 2·2 mm.; greatest width ·9 mm.; width of vertex between eyes ·39 mm.; with eyes ·63 mm.; length from crown to tip of cones ·41 mm. General colour whitish and dark brown or black; dorsum and vertex whitish; a dark brown vitta extending from each eye over upper portion of pleurum and thence along upper half, or slightly less, of forewing to apex of latter; lower portion of pleura whitish; venter brown; abdomen more or less variegated. Body of medium size, not robust.

Head with eyes not as broad as thorax, quite long, descending; vertex broader than long, conspicuously vermiculous-punctate, flat, with a fovea on each side of median line posteriorly; anterior margin marked by an impressed line between vertex and facial cones; latter large, broad, rounded at tip, contiguous, about two-thirds as long as vertex, emarginate laterad in front of antennae, with short stiff white pubescence. Eyes large, hemispherical; ocelli large. Antennae slender, about as long as head to metanotum, whitish with segments black apically and two terminal

segments black; insertion large, between vertex and facial cones. Labrum narrowly visible from side.

Thorax slightly arched; pronotum vermiculous-punctate, rather long, sides parallel; propleurites narrow, typical for genus; coxa large. Dorsulum ascending, finely punctate, about as long as scutum. Forewings rather thick, not coriaceous, whitish except on black or brown vitta, about two and one-third times as long as broad, broadest across first marginal cell, very slightly rhomboidal in shape; first marginal cell large, long, larger than second; first cubital short; radius quite long; discoidal subcosta shorter than cubital petiole; pterostigma prominent; veins spotted with black.

Male—Genital segment small, rounded; anal valve simple, rather long, sides parallel; claspers short, small, with stiff spiny pubescence, acute at tip; penis long, slender, clavate at tip. *Female*—Genital segement short, small; dorsal plate slightly longer than ventral, both very acute.

Described from seven males and seven females from Calcutta, on *Cassia ? fistula* (N. Annandale). This is somewhat similar to an American species, *E. vermiculosus*, Crawf. (MS.).

Type No. 9738/18.

Euphalerus citri (Kuwayama)

(Pl. xxxiii, figs. N, O, P; Pl. xxxv, fig. D.)

Length of body 2·4 mm.; length of forewing 2·4 mm.; greatest width 1·0 mm.; width of vertex between eyes ·35 mm.; with eyes ·55 mm.; length of vertex to tip of cones ·32 mm. General colour brown, vertex slightly lighter; antennae black at tip; eyes darker, with black stripe from eye to tip of cone on side; forewings with a spotted macula of brown on the upper margin from a little below tip of clavus to tip of radius, and another on lower margin not quite merged into first; maculae not continuous but composed of smaller scattered spots.

Head narrower than thorax, descending; vertex flat, very finely pubescent, finely punctate, broader than long, with a fovea on each side in rear centre; anterior margin almost straight; facial cones broad at base, in same plane with vertex, convergent toward and rounded at apex, almost contiguous, finely pubescent. Antennal bases scarcely visible, as in other species; antennae short, not longer than head and pronotum combined, slender. Eyes large.

Thorax very finely pubescent; pronotum rather long, sides parallel; pleurites typical for genus. Forewings subhyaline, rather thickened as in other species, maculate, attenuate at base, broadest subapically, rounded at apex, about two and a third times as long as broad; first cubital long; second marginal cell larger than first; radius long; pterostigma very narrow, quite long.

Male—Genital segment rather conspicuous; anal valve elongate-pyriform or flask-shaped, attenuate above; claspers long,

slender, subacute at tip, simple. *Female*—Genital segment short, small, acute at tip; dorsal plate very slightly longer than ventral.

Described from one female from Adra, Manbhum District (J.T. Jenkins), November 12th, 1909. Seventeen specimens, both sexes, of this species were collected by Mr. Geo. Compere on citrus trees in the Philippine Islands. He states that he found the same insect in India on citrus trees in considerable numbers. The description of the male is based on these specimens.

Diceraopsylla, gen. nov.

Body robust; thorax strongly arched; body surface conspicuously shagreened; head with eyes not as broad as thorax; vertex more or less plane, concave transversely, slightly cleft in front; facial cones entirely wanting, with two rounded ridges on face extending from antennal bases to labrum; eyes not large; antennae slender, at least moderately long. Pronotum ascending; proepisternum large, protruding above, hindmost tergite of metanotum (post-scutellum) bifid; appearing as two blunt horns extending back; legs normal; wings membranous, hyaline, rounded at apex, with a pterostigma.

Type of genus: *Diceraopsylla brunettii*, Crawf.

This genus is somewhat similar to *Heteropsylla*, Crawf. (MS.) in the absence of facial cones, but differs not only from this but from all other genera in the bifid post-scutellum, for which the genus is named.

Diceraopsylla brunettii, n. sp.

(Pl. xxxiii, figs. Q, R, U; Pl. xxxv, fig. G.)

Length of body 2·5 mm.; length of forewing 3·8 mm.; greatest width 1·7 mm.; width of vertex between eyes ·35 mm.; with eyes ·68 mm. General colour black; face, legs, tip of abdomen brown; antennae brown, with segment tips and terminal segment black; wings somewhat maculate. Body rather small, very robust, surface conspicuously shagreened, including antennae and femora.

Head small, short, with eyes distinctly narrower than thorax; vertex with post-ocellar regions and ocular margins elevated, with a small fovea on each side of median line posteriorly; front margin rounded down, with anterior ocellus in front visible from above, somewhat cleft in front, as in *Rhinopsylla*. Antennae ten-segmented, slender, longer than head and thorax; I moderately large; III longest; IX and X short, thickened; labrum small.

Pronotum ascending, arched; episternum large, prominent; epimeron small, mostly concealed; dorsulum large; scutum long; post-scutellar processes fully as long as thick, rounded at tip. Legs normal; hind tibiae unarmed. Forewings rather large, with a macula over first furcal and several small black spots on the veins especially at the furcations, broadly rounded at the apex, about two and a half times as long as broad; first marginal cell usually

large; second marginal cell smaller than first; radius short, terminating far from apex of wing: pterostigma short, broad; cubital petiole almost as long as discoidal subcosta. Hind wings hyaline, scarcely veined.

Male—Abdomen slender; genital segment relatively large; scarcely rounded; claspers slender, arched, quite acute at tips; anal valve slender, rather long.

Described from two males from Darjeeling, East Himalayas, altitude 7000 ft. (E. Brunetti), May 29th, 1910.

Type No. 9733/18.

Psylla simlae, n. sp.

(Pl. xxxiii, figs. S, T; Pl. xxxv, fig. S.)

Length of body 2 mm.; length of forewing 2·5 mm.; greatest width 1 mm.; width of vertex between eyes ·41 mm.; with eyes ·67 mm. General colour brown, head, legs and antennae lighter brown. Body small.

Head rather large, with eyes about as broad as thorax, deflexed; vertex descending, almost flat, with a small fovea on each side of median line, lobes rather triangular in shape; facial cones large, almost as long as vertex, slightly declinate from plane of vertex, separated therefrom by a deeply impressed line, divergent, subacute at apex, briefly pubescent. Antennae slender, about as long as head and thorax, black at tip. Eyes recessive toward thorax.

Thorax somewhat arched; notum finely shagreened, except pronotum; latter rather short; propleurites long; epimeron small. Legs normal; hind tibiae with small spur at base. Forewings hyaline, a little more than twice as long as broad, with a black spot at tip of clavus; marginal cells subequal; radius long; pterostigma long, rather broad; cubital petiole about half as long as discoidal subcosta.

Female—Genital segment moderately short, plates subequal, rather acute.

Described from one female from Simla, West Himalayas, altitude 7000 ft. (N. Annandale).

Type No. 9701/18.

Rhinopsylla stylata, n. sp.

(Pl. xxxiii, fig. W; Pl. xxxiv, fig. F; Pl. xxxv, fig. H.)

Length of body 2·5 mm.; length of forewing 3 mm.; greatest width 1·2 mm.; width of vertex between eyes ·34 mm.; with eyes ·56 mm. General colour deep black; body moderately large, surface conspicuously reticulated or shagreened.

Head a little narrower than thorax, slightly deflexed; vertex excavated in centre between median line and elevated post-ocellar area, deeply emarginate on front margin, with anterior ocellus at

apex of emargination and visible from above; facial cones wanting, slightly swollen at base of antennae; labrum visible from front. Antennae slender, about three times as long as width of head; I and II large; III long, yellowish. Eyes large; rostrum long.

Prothorax moderately long; pleurites large, prominent; dorsulum deeply reticulated; hind coxae very large, with long spur; hind tibiae with small tooth at base. Wings hyaline, a little more than twice as long as broad, rather rounded at apex; marginal cells subequal; fourth furcal at apex of wing.

Female—Abdomen broad, suddenly narrowed before genital segment; latter slender, rather long, acuminate, valves subequal in length, acute at tip.

Described from one female from valley of River Sutlej, below Simla (W. Himalayas), May, 1910 (N. Annandale).

Type No. 9708/18.

Kuwayama hirsuta, n. sp.

(Pl. xxxiii, figs. V, Y; Pl. xxxv, fig. I.)

Length of body 2·7 mm.; length of forewing 5·6 mm.; greatest width 2·2 mm.; width of vertex between eyes ·52 mm.; with eyes ·96 mm. General colour light brown, with brown markings on dorsulum; venter of abdomen lighter; antennal segments black at tips. Body large, long, entire surface covered with long, light brownish pubescence.

Head large, with eyes about as broad as thorax, not deflexed; vertex sulcately impressed on each side of median line, each lobe rounded forward in front, post-ocellar areas elevated strongly; facial cones wanting, with a slight rounded swelling at base of antennae; anterior ocellus in front; eyes large, very prominent. Antennae slender, almost as long as entire body, not pubescent. Labrum small.

Thorax long, rather narrow, scarcely arched; pronotum moderately long, narrow transversely; propleurites large; episternum prominently bulging outward above. Dorsulum long, not arched; legs long; femora stout, with tibial groove long; hind coxae very large; hind tibiae with large spur at base. Forewings large, hyaline, transparent, acutely angled at apex, about two and a half times as long as broad, broadest across middle, with a brown spot near tip of clavus; first marginal cell unusually large, about three times as large as second; first cubital very short; fourth furcal terminating at tip of wing; radius short.

Male—Abdomen short, thick; genital segment short, somewhat retracted; claspers slender, arched, toothed at apex, anal valve broad at base, slender at tip.

Described from one male from Igatpuri, Western Ghats, Bombay Presidency, November 20th, 1909.

Type No. 9730/18.

Until further material is available, at least, this species is included in the genus *Kuwayama* which was erected for a Mexican

species and one from Southern California. In the tribe Triozini to which this belongs, the hind tibial spur in this species is rather remarkable.

Trioza gigantea, n. sp.

(Pl. xxxiii, figs. X, Z; Pl. xxxv, fig. J.)

Length of body 4 mm.; length of forewing 6·6 mm.; greatest width 2·6 mm.; width of vertex between eyes ·53 mm.; with eyes ·93 mm. General colour black on dorsum, light brown on venter; vertex, eyes and antennae black; facial cones brown; pronotum brown; dorsulum shining black; metanotum dark brown; fore tibiae dark brown. Body surface covered sparsely with long brown pubescence, which is not very prominent; body very large.

Head broad, about as broad as thorax, much broader than prothorax and dorsulum which appear somewhat as a neck; vertex roundly concave between eyes, descending, smooth, glossy; facial cones long, almost as long as vertex, vertical, divergent, acute at apex, pubescent. Eyes large, prominent; anterior ocellus in front; antennae very long, as long as body, moderately thick, densely hirsute, all segments long, except I, II and X.

Thorax arched; pronotum short, depressed below head and dorsulum; propleurites large; dorsulum strongly arched, narrow, overhanging pronotum. Legs long; femora rather thick; hind coxae very large; hind tibiae without tooth at base. Forewings large, hyaline, transparent, narrowly rounded at apex, two and a half times as long as broad; first marginal cell more than twice as large as second; first cubital shorter than first furcal; radius long, parallel with costa; veins setose, conspicuously so on basal portion of wing. Hind wings long, slender, hyaline.

Female—Abdomen long, large; genital segment short, subacute at tip; dorsal plate blunt at tip.

Described from one female from Darjeeling, East Himalayas, altitude 7000 ft. (E. Brunetti), May 26th, 1910.

Type No. 9734/18.

This is somewhat related to Kuwayama's *Stenopsylla nigricornis*, and probably does not belong in the genus *Trioza*. Until further evidence, however, is available, it will be included in the large genus.

Trioza hyalina, n. sp.

(Pl. xxxiv, figs. A, B; Pl. xxxv, fig. K.)

Length of body 1·9 mm.; length of forewing 2·9 mm.; greatest width 1·2 mm.; width of vertex between eyes ·33 mm.; with eyes ·47 mm. General colour lemon yellow, dorsulum brown cephalad, antennae black at tip, eyes black. Body small.

Head narrower than thorax, small, deflexed; vertex impressed discally, bulging on each side of median line in front; facial cones almost as long as vertex, subvertical, divergent, acute at tip,

pubescent. Antennae about three times the width of head, slender. Eyes prominent; anterior ocellus slightly visible from above.

Thorax not broad; pronotum short, depressed below dorsulum; latter long, narrow. Wings proportionately rather large, hyaline, about two and a third times as long as broad, radial margin arched, rather rounded at apex; radius flexed; fourth furcal terminating at apex of wing.

Male—Genital segment rather large, anal valve long, sides concave cephalad, subparallel, truncate at tip; claspers long, stout at base, acute at tip. *Female*—Genital segment about half as long as rest of abdomen; dorsal valve slightly longer than ventral, both acute.

Described from three males and two females from Simla, West Himalayas, 7000 ft. (N. Annandale).

Type No. 9707/18.

Trioza analis, n. sp.

(Pl. xxxiv, figs. C, D; Pl. xxxv, fig. L.)

Length of body 2·4 mm.; length of forewing 3·4 mm.; greatest width 1·3 mm.; width of vertex between eyes ·30 mm.; with eyes ·57 mm. General colour black, with vertex, part of pronotum, abdomen ventrad, legs, basal half of antennae reddish brown.

Head not as broad as thorax, somewhat deflexed; vertex with a deep sulcus down median line and one on each side extending obliquely toward front margin of eye, pubescent; facial cones almost as long as vertex, slightly divergent, deflexed from plane of vertex, subacute at tip, pubescent. Antennae slender, about twice as long as width of head; eyes large.

Prothorax moderately long; propleurites large, prominent; dorsulum long. Legs rather short and stout. Wings hyaline, about two and a half times as long as broad, roundly acute at tip; first marginal cell smaller than second; radius rather short; clavus black at tip.

Female—Abdomen long, convergent to tip; genital segment very short, slightly longer than preceding segment; ventral valve very small, triangular in profile.

Described from two females from Simla, West Himalayas, 7000 ft. (N. Annandale).

Type No. 9702/18.

II.—PUSA COLLECTION.

Apsylla cistellata (Buckton).

Six specimens, both sexes, from Pusa, Bengal, on mango trees.

Pauropsylla depressa, n. sp.

(Pl. xxxiv, figs. G, H; Pl. xxxv, fig. N.)

Length of body 2·3 mm.; length of forewing 3·3 mm.; greatest width 1·7 mm.; width of vertex between eyes ·43 mm.; with eyes

·76 mm. General colour orange red; legs and antennae lighter to yellowish, latter black at tip; tarsi often more or less black. Body robust, moderately large.

Head short, deflexed, with eyes narrower than thorax; vertex somewhat pubescent, rather broad, posterior margin arcuate downward between eyes, median line not visible; anteriorly roundly bulging, surface smooth, with anterior ocellus in front visible from above; antennal insertions beneath and slightly swollen; facial cones entirely wanting. Eyes rather small; post-ocelli elevated. Labrum large, globose, visible from front. Antennae about one and a third times as long as width of head, slightly compressed at tip, terminal setae moderately long.

Thorax strongly arched, broad, glabrous; pronotum short, scarcely visible from above between head and dorsulum; latter rather large, ascending; mesopleurae very large and prominent. Legs long, slender, typical. Forewings large, hyaline, transparent, broadest subapically, rather square at apex, slightly more than twice as long as broad; marginal cells small, subequal; radial cell broad at base; cubital petiole very short.

Abdomen in both sexes usually broad and depressed, subcircular in outline from above. *Male*—Genital segment rather small; anal valve broadest at base; claspers as long as anal valve, truncate at tip. *Female*—Genital segment about half as long as rest of abdomen, acute at tip; usually bent down, and often (in dried specimens at least) lying along ventral surface of abdomen.

Described from one male and five females from Pusa, Bengal, in galls on leaves of *Ficus glomerata* ("gular").

Pauropsylla tuberculata, n. sp.

(Pl. xxxiv, figs. I, J, L; Pl. xxxv, fig. E.)

Length of body 1·8 mm.; length of forewing 2·1 mm.; greatest width 1·0 mm.; width of vertex between eyes ·38 mm.; with eyes ·68 mm. General colour red to dark reddish brown; dark form:—dorsulum posteriorly orange yellow, vertex above and between ocelli orange, remainder dark reddish brown, except connexivum of abdomen white; light form:—same as above but shades lighter; antennae black at tip. Body robust, rather small.

Head short, deflexed, with eyes fully as broad as thorax; vertex angularly emarginate behind, rounded down and forward, surface rather plane; anterior ocellus visible from above, near to labrum; post ocelli rather remote from eyes, not prominently elevated; labrum large, almost visible from above, easily from front; facial cones entirely wanting; antennae attached a little above anterior ocellus, a little longer than width of head; terminal setae half as long as antennae.

Thorax strongly arched, robust; pronotum short, ascending; pleurites mostly concealed by recessive eyes and occiput; dorsulum arched; mesopleurae large, anterior; post-scutellum pentangular.

Legs typical; hind coxae thick, long; hind femora constricted midway. Forewings relatively rather small, broadest and rather square at apex, attenuate at base, hyaline and transparent, a little less than twice as long as broad, basal margin black; first marginal cell very small, triangular; second large, rectangular; radius angulate midway and touching arch of fourth furcal; cubital petiole shorter than discoidal subcosta.

Abdomen robust, third and fourth tergites produced upward into two prominent humps. *Female*—Genital segment short, stout, acute at tip; dorsal valve a little longer than ventral.

Described from six females from Pusa, Bengal; two (darker forms) on "pumpkin," and four (lighter and slightly smaller forms) on *Alstonia scholaris*. While this is somewhat atypical of the genus, yet it seems to be closely allied thereto.

Euphalerus vittatus, Crawford.

Six specimens from Narainganj, Eastern Bengal and Assam, "on a bush."

Euphalerus citri (Kuwayama).

Seven specimens from Pusa, Bengal, on orange (*Citrus aurantium*), and on Lucerne.

Psyllopa punctipennis, n. sp.

(Pl. xxxiv, figs. K, O; Pl. xxxv, fig. U.)

Length of body 1·7 mm.; length of forewing 2·3 mm.; greatest width 1·0 mm.; width of vertex between eyes ·33 mm.; with eyes ·53 mm. General colour light brown; dorsulum and scutum with several dark brown longitudinal stripes; antennae black at tips of segments III to X; forewings with numerous brown or black dots and spots both on veins and membrane.

Head a little narrower than thorax, not much deflexed; vertex longer than half its width, with a slight foveal impression discally; facial cones about two-thirds as long as vertex, rather strongly divergent, narrowly rounded at tip; eyes large; antennae less than twice as long as width of head, slender.

Thorax not strongly arched; pronotum rather long; pleurites broad. Legs typical. Forewings hyaline, rounded at apex, relatively rather small, about two and a third times as long as broad; cubital petiole a little shorter than discoidal subcosta.

Male—Genital segment rather large; anal valve broad at base, truncate at apex; claspers rather blunt at tip. *Female*—Genital segment thick, about half as long as rest of abdomen, valves subequal, rather thickly pubescent.

Described from four males and four females from Pusa, Bengal, on indigo. This is probably the adult of Buckton's *Psylla isitis*, which he described from the nymph only. In order to avoid con-

fusion, however, in case they should not be identical, I have given it another name. The forewing of this species bears a close resemblance to *Aphalara multipunctata*, Kuwayama (Japanese).

Psyllopa obscura, n. sp.

(Pl. xxxiv, fig. S; Pl. xxxv, fig. M.)

Length of body 2·1 mm.; length of forewing 3·6 mm.; greatest width 1·5 mm.; width of vertex between eyes ·44 mm.; with eyes ·68 mm. General color orange yellow throughout; antennae black on apical half. Body rather large, robust.

Head about as broad as thorax, deflexed; vertex moderately large, typical; facial cones a little more than half as long as vertex, thick at base, roundly acute at apex, much deflexed from plane of vertex; eyes large; antennae fully twice as long as width of head, slender.

Thorax broad, arched; pronotum rather long; legs moderately long. Forewings hyaline, two and a third times as long as broad, rounded at apex; pterostigma moderately large; cubital petiole shorter than discoidal subcosta.

Female—Genital segment thick at base, as long as abdomen, subacute at apex; dorsal valve a little longer than ventral.

Described from one female from Pusa, Bengal, taken on mango leaves.

Tenaphalara elongata, n. sp.

(Pl. xxxiv, figs. M, N, P, Q; Pl. xxxv, fig. O.)

Length of body 3·1 mm.; length of forewing 3·4 mm.; greatest width 1·0 mm.; width of vertex between eyes ·28 mm.; with eyes ·56 mm. General colour greenish yellow throughout; antennal joints V to X black at tip. Body slender, very long.

Head moderately long, not deflexed, as wide as thorax; vertex rather broad, rounded down and forward uniformly, rather plane, long behind eyes; facial cones entirely wanting; eyes small; postocelli not elevated; anterior ocellus visible from above; antennae half as long as body, slender, terminal setae short; labrum small, subacute apically.

Thorax long, slender, cylindrical, not arched; pronotum rather long; pleurites large, sutures often indistinct; dorsulum small. Legs rather short; hind tibiae short, not longer than femora, with a small tooth at base. Forewings long, slender, hyaline, transparent, acute at tip, three and a half times as long as broad; venation suggests *Carsidara*; second marginal cell larger than first; fourth furcal near apex of wing; pterostigma open; with a callus (appears as a pseudo-vein) extending from tip of pterostigma to radius and from radius to base of second marginal cell; cubital petiole longer than discoidal subcosta; veins and apical portion of membrane yellowish.

Abdomen elongate, slender. *Male*—Anal valve long, constricted at base, sides subparallel; claspers long, slender, subacute at tip, not toothed. *Female*—Dorsal genital valve irregular in outline, constricted near tip, acute; ventral valve usually as long as dorsal, broad basally (viewed from beneath), divided and very acute at tip.

Described from seventeen males and females from Pusa, Bengal, on "Silk Cotton." This is very similar to the Japanese species *Tenaphalara acutipennis*, Kuwayama, differing only in a few minor characters.

Homotoma distincta, n. sp.

(Pl. xxxiv, figs. T, U; Pl. xxxv, fig. P.)

Length of body 1·7 mm.; length of forewing 2·8 mm.; greatest width 1·1 mm.; width of vertex between eyes ·37 mm.; with eyes ·59 mm. General colour light yellow, glossy; antennae brown to black. Body rather small.

Head short, somewhat deflexed, with eyes not quite as broad as thorax, deeply cleft in front between antennae; vertex glossy, sparsely pubescent, descending from each side to median line; anterior ocellus not visible from above; facial cones inferior, not visible from above, short, widely divergent, slightly pubescent. Antennae thick, more than twice as long as width of head, thickly pubescent; I stout, III as long as IV—VI; terminal setae short. Eyes large; labrum small.

Thorax somewhat arched; pronotum short, depressed below dorsulum. Legs rather stout, short; hind tibiae without tooth at base. Forewings hyaline, transparent, acute at apex, about two and a half times as long as broad; first marginal cell wanting; second very large, including apex of wing; cubital petiole and base of second cubital very close to discoidal subcosta and base of radius but not joined thereto; radius short, black.

Female—Genital segment about as long as rest of abdomen, stout; dorsal valve a little longer than ventral, both rather acute.

Described from one female from Pusa, Bengal, taken "on the wing." This is very close to *Homotoma radiatum*, Kuwayama (Japan), but seems to be quite distinct in several respects.

Allotrioza minuta, n. sp.

(Pl. xxxiv, fig. R; Pl. xxxv, fig. F.)

Length of body 1·2 mm.; length of forewing 1·8 mm.; greatest width ·75 mm.; width of vertex between eyes ·20 mm.; with eyes ·34 mm. General colour of male brown to dark brown, legs, facial cones and antennae light greenish yellow; female brown on vertex and dorsum of thorax and abdomen; ventral portion, legs, facial cones and antennae light greenish yellow; antennae black at tip in both sexes.

Head scarcely or only slightly deflexed, relatively rather large; vertex with a foveal impression on each side of median line somewhat posteriorly, emarginate on anterior margin over front ocellus and full on each side of emargination; facial cones very small, whitish, acute at tip, not strongly divergent, subhorizontal, scarcely pubescent. Antennae short, only a little longer than width of head.

Thorax scarcely arched, pronotum relatively rather long, on same level as vertex and dorsulum; latter moderately long; legs typical. Forewings small, hyaline, narrowly rounded at apex, about two and two-thirds times as long as broad; radius short.

Male—Genital segment rather large; anal valve moderately broad, truncate above, slightly constricted near apex; claspers stout, not toothed at tip. *Female*—Genital segment about half as long as abdomen, valves of equal length, pubescent near apex.

Described from three males and two females from Hazaribagh, Bengal, "on leaves."

Trioza urticae, Linn.

Two females from Keonthal, Punjab, on nettle (*Urtica* sp.). This is quite typical of the European form of the same species.

Trioza fletcheri, n. sp.

(Pl. xxxiv, fig. V; Pl. xxxv, fig. Q.)

Length of body 1·7 mm.; length of forewing 2·8 mm.; greatest width 1·2 mm.; width of vertex between eyes ·26 mm.; with eyes ·46 mm. General colour flavous yellow; antennae black at tip Body rather small.

Head narrower than thorax, deflexed; vertex moderately long, with a prominent longitudinal sulcate impression on each side of median line; facial cones small, about half as long as vertex, only slightly divergent, subvertical, acute at tip. Antennae a little longer than width of head. Thorax somewhat arched, typical. Legs moderately long, slender. Forewings hyaline, more than two and a half times as long as broad, subacute at apex; radius short; marginal cells subequal.

Female—Genital segment about as long as abdomen, stout, valves subequal, rather acute.

Described from three females from Pusa, Bengal, on *Gmellina arborea*. This species is named for Mr. T. B. Fletcher, Imperial Entomologist in Pusa.

Trioza fletcheri minor, n. var.

(Pl. xxxv, fig. R).

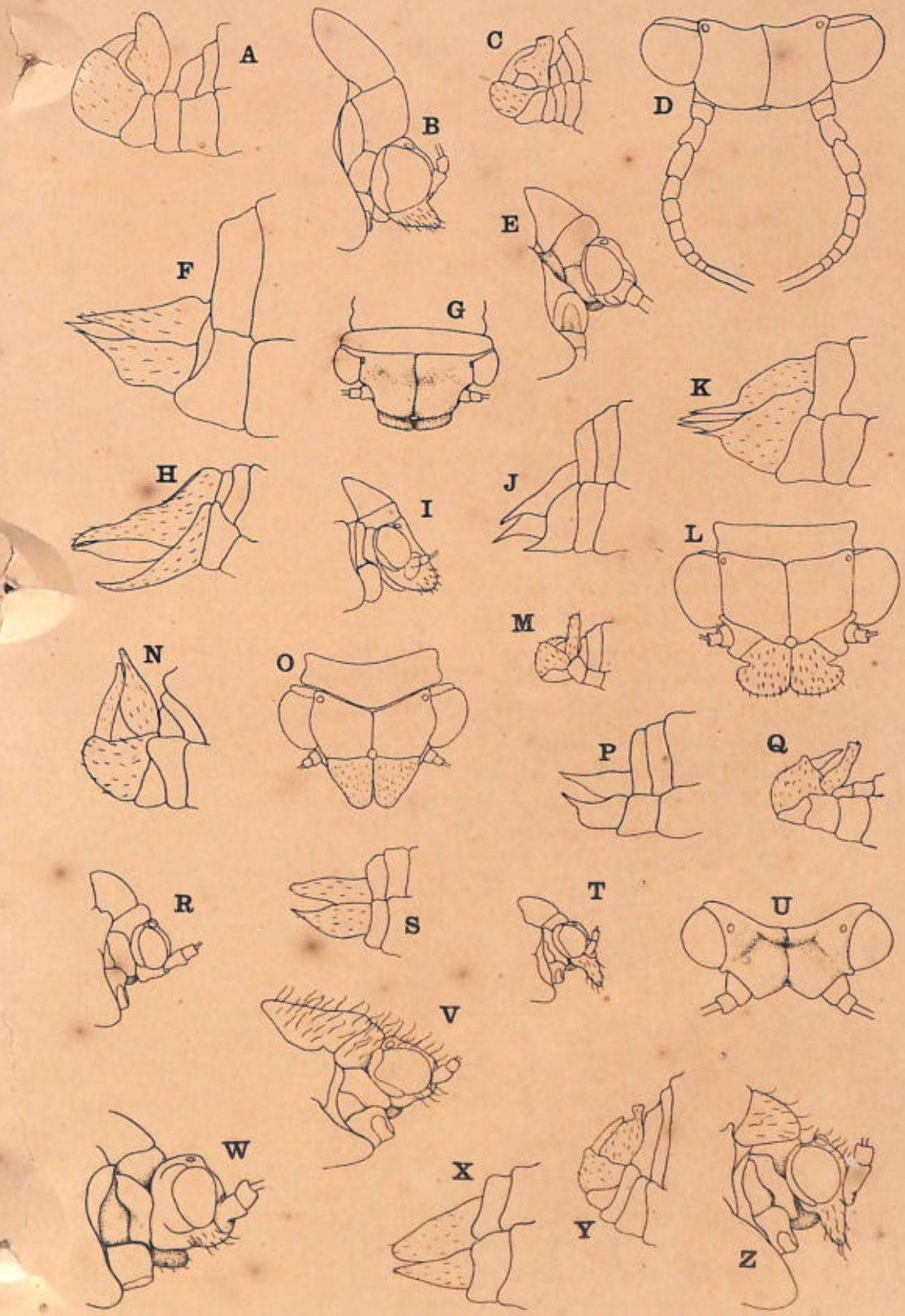
Similar to the species in most respects but uniformly smaller throughout; facial cones scarcely one-third as long as vertex and

less divergent. *Male*—Genital segment typical; anal valve subtriangular in profile; claspers long, blunt and black at tip.

Described from two males and two females from Pusa, Bengal, on *Terminalia arjuna*.

EXPLANATION OF PLATE XXXIII.

A. *Phacopteron lentiginosum.*
B. Same, profile of head.
C, D, E. *Apsylla cistellata.*
F. *Phacopteron lentiginosum.*
G, H. *Eurhinocola gravelyi.*
I, J. *Euphalerus vittatus.*
K. *Apsylla cistellata.*
L, M. *Euphalerus vittatus.*
N, O, P. *Euphalerus citri.*
Q, R. *Diceraopsylla brunettii.*
S, T. *Psylla simlae.*
U. *Diceraopsylla brunettii.*
V. *Kuwayama hirsuta.*
W. *Rhynopsylla stylata.*
X. *Trioza gigantea.*
Y. *Kuwayama hirsuta.*
Z. *Trioza gigantea.*



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EXPLANATION OF PLATE XXXIV.

A, B. *Trioza hyalina.*
C, D. *Trioza analis.*
E. *Eurhinocola gravelyi.*
F. *Rhynopsylla stylata.*
G, H. *Pauropsylla depressa.*
I, J. *Pauropsylla tuberculata.*
K. *Psyllopa punctipennis.*
L. *Pauropsylla tuberculata.*
M, N. *Tenaphalara elongata.*
O. *Psyllopa punctipennis.*
P, Q. *Tenaphalara elongata.*
R. *Allotrioza minuta.*
S. *Psyllopa obscura.*
T, U. *Homotoma distincta.*
V. *Trioza fletcheri.*

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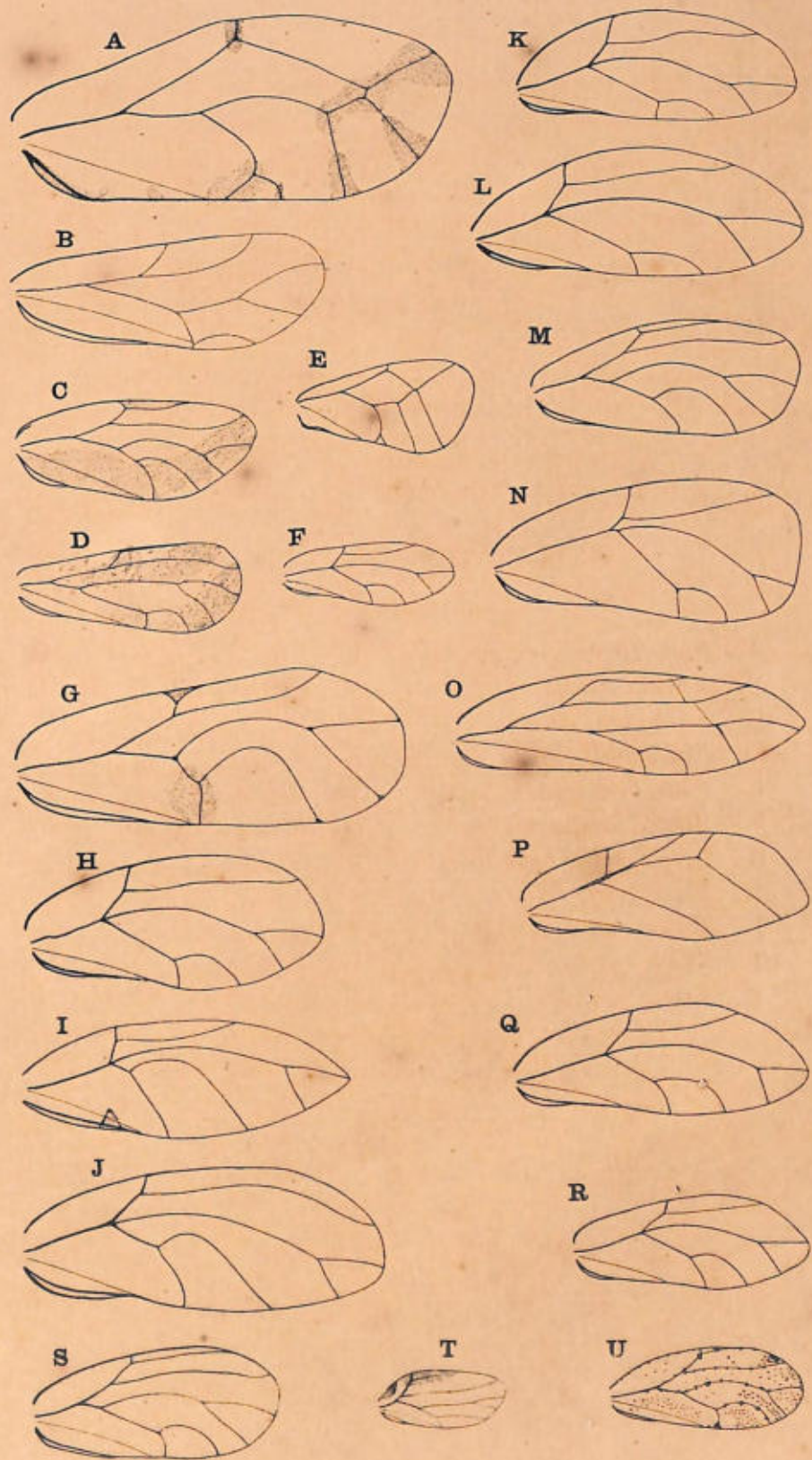
INDIAN PSYLLIDAE.

Reg No. 1780 E 12-H.-425.

EXPLANATION OF PLATE XXXV.

(Forewings.)

A. *Phacopteron lentiginosum.*
B. *Apsylla cistellata.*
C. *Euphalerus vittatus.*
D. *Euphalerus citri.*
E. *Pauropsylla tuberculata.*
F. *Allotrioza minuta.*
G. *Diceraopsylla brunettii.*
H. *Rhynopsylla stylata.*
I. *Kuwayama hirsuta.*
J. *Trioza gigantea.*
K. *Trioza hyalina.*
L. *Trioza analis.*
M. *Psyllopa obscura.*
N. *Pauropsylla depressa.*
O. *Tenaphalara elongata.*
P. *Homotoma distincta.*
Q. *Trioza fletcheri.*
R. *Trioza fletcheri minor.*
S. *Psylla simlae.*
T. *Eurhinocola gravelyi.*
U. *Psyllopa punctipennis.*



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INDIAN PSYLLIDAE.

Sub-Order **OSTARIOPHYSI.**

Fam. CYPRINIDAE.

Sub-fam. *CYPRININAE.*

Labeo almorae, sp. nov.

(Pl. xxxviii, figs. 2, 2*a*, 2*b*.)

Body compressed, its depth $3\frac{1}{3}$ times and length of head $4\frac{2}{5}$ times in the length. Snout broadly rounded, on the top studded with numerous pores and tubercles and with a deep depression in the middle. Length of snout greater than the post-orbital length, the latter contained $1\frac{1}{2}$ times in the length of the former. Eye $5\frac{1}{7}$ and length of snout $2\frac{1}{4}$ in the length of head. The inter-orbital width is nearly half the length of the head. Eyes perfectly lateral. Dorsal II 10; equally distant from anterior-orbital border and the base of caudal fin; upper edge deeply concave; the longest ray nearly as long as head. Anal II 5; not reaching root of caudal. Pectoral $\frac{3}{4}$ of the length of head, not reaching the ventral. Caudal deeply immarginate. Scales—lateral line 45, lateral transverse $\frac{12}{14}$, 6 between lateral line and ventral fin, and 24 round caudal peduncle.

Colour.—Dark brown except in abdominal region which is dull white and silvery.

One specimen measuring about 180 mm. from Almora, Western Himalayas.

Labeo kunki, sp. nov.

(Pl. xxxviii, fig. 3.)

Depth of body $3\frac{3}{5}$ times, length of head $4\frac{1}{4}$ times in the length. Snout slightly convex, $1\frac{3}{5}$ times the diameter of eye and longer than the post-orbital length. There is a deep groove on each side of the snout. The diameter of eye $3\frac{1}{2}$ times in the length of head and twice in inter-orbital distance. There are two maxillary barbels concealed under the fold of skin at the corner of the mouth and are nearly as long as diameter of eye. Both upper and lower lips are lobulated. Dorsal II 10; the longest ray being slightly longer than the length of head; free edge concave. Pectoral as long as head. Scales 41 in the lateral line, in lateral transverse $\frac{7}{6}$ and 6 between the lateral line and the ventral fin; 9 round caudal peduncle.

Colour in spirit greyish brown with lower half lighter, back deep brown, a black blotch on each side of caudal peduncle, beginning from the 38th scale in the lateral line and roundly spreading over about 7 scales.

One specimen, length 100 mm., from the river Gandak, Saran, Bihar, collected by Mr. Mackenzie of Siripur. Local name Kunki.

Labeo rilli, sp. nov.

(Pl. xxxviii, fig. 4.)

Depth of body 4 times, length of head $4\frac{1}{3}$ times in the length. Snout shorter than the post-orbital length, the latter $1\frac{1}{3}$ to $1\frac{1}{2}$ times the length of the former. There is a narrow groove on either side of snout and a slight depression above. Diameter of eye slightly shorter than length of snout and contained $3\frac{1}{2}$ times in the length of head. The inter-orbital length is $1\frac{1}{4}$ to $1\frac{1}{2}$ in the diameter of eye. Two minute maxillary barbels. Lips fleshy, lower lip finely lobulated. Chin slightly corrugated with concentric curves. Dorsal II 10; its origin being equidistant between the post-orbital line and the anterior root of the base of anal; length of the longest ray slightly longer than length of head; free edge concave. Anal II 5. Length of pectoral somewhat less than length of head. Scales 44-46 in lateral line, $\frac{9}{4\frac{1}{2}}$ in the lateral transverse and 6 between lateral line and ventral fin; there are no scales on the chest. Caudal deeply divided, both lobes being equal.

Colour in spirit.—A dark brown dorsal band on the middle of the back from nape of the neck to the caudal peduncle; the upper two-thirds of the sides is brown, lower third with abdomen silvery white. There is a large black blotch on each side of the caudal peduncle, commencing on the forty-first scale on the lateral line and spreading roundly over about sixteen scales.

Four specimens from the river Gandak, Saran, collected by Mr. M. Mackenzie. Total length from 85 to 100 mm. Local name Rilli.

Labeo tezpurensis, sp. nov.

(Pl. xxxix, figs. 1, 1*a*, 1*b*.)

Depth of body 4 times, length of head $3\frac{1}{3}$ to $3\frac{4}{5}$ times in the length. Snout broadly rounded with a deep groove on each side. Four barbels; two rostrals are minute and are placed at the posterior ends of the grooves of the snout; maxillary nearly double the length of rostral and half the diameter of eye. Eye nearer end of snout than posterior border of head, perfectly lateral, $3\frac{1}{3}$ to $3\frac{4}{5}$ times in length of head. Dorsal II 10—11; equally distant from nostril and from root of caudal; upper edge distinctly concave. Anal II 5, not reaching root of caudal. Pectoral $1\frac{1}{5}$ in the length of head, not reaching ventral. Scales—41-42 in the lateral line and $\frac{8}{5}$ in the lateral transverse, 6 between lateral line and ventral fin.

Colour in spirit dark brown above, silvery or dull white beneath; fins yellowish white, a faint grey blotch in middle of caudal peduncle.

Three specimens from the Belsiri River, Tezpur, Assam, measuring 75 to 85 mm.

Nuria danrica (H. B.) var. **grahami**, var. nov.

(Pl. xxxix, fig. 3.)

Depth of body 4 times, length of head $4\frac{2}{3}$ times in the length. Snout short, being $\frac{2}{3}$ of the diameter of the eye which is contained $3\frac{1}{3}$ times in the length of head, and $1\frac{1}{3}$ times in the inter-orbital length. Barbels four, both the pairs very short; the upper two, which are flattened and blunt, are as long as the diameter of eye or a little longer. The lower ones, which are generally found to be very long (reaching the anal and ventral) in all other known species and varieties, are exceptionally short, being only twice as long as the diameter of the eye. This is a very distinctive character of the new variety. Mouth narrow. Dorsal II 6; situated above the space between the ventral and anal fins; there are 15 scales in front. Pectoral 10; rather broad and blunt, reaching the base of the ventral. Ventral I 7; the outermost ray, which is articulated and is very much prolonged beyond the membrane, reaches the base of the anal and is twice as long as the membranous portion. Anal III 5. Scales—lateral line incomplete, 30.

Colour in spirit.—Upper half brownish grey, a broad black longitudinal stripe from below the eye to the base of the caudal just beneath the middle line.

One specimen from Kalinadi, Meerut (U. P.), measuring 50 mm. in length, collected by Captain J. D. Graham, I.M.S.

Amblypharyngodon saranensis, sp. nov.

(Pl. xxxix, fig. 2.)

Depth of body 3 times, length of head 4 to $4\frac{1}{3}$ times in the length. Diameter of eye $3\frac{1}{3}$ times in the length of the head, equal to the length of snout and also to the inter-orbital length. The opening of the mouth is somewhat superior, the cleft being directed outward and upward. The lower jaw slightly longer with a knob at the symphysis, which fits in the groove of the upper jaw. Dorsal II 7; third ray the longest. Pectoral 14—15; two thirds the length of head. Ventral 8; reaching cloacal opening and overlapping the same. Scales in lateral line 81 to 92, incomplete, with 16 to 18 perforted scales, in lateral transverse series $\frac{11}{1\frac{1}{2}}$ and between the lateral line and ventral fin 12.

Colour.—Golden yellow with a broad dark band from above the gill cleft to the caudal peduncle.

Two specimens from the Jharai river, Saran, measuring about 78 mm., collected by Mr. M. Mackenzie.

Barilius bonarensis, sp. nov.

(Pl. xxxix, figs. 4, 4*a*, 4*b*.)

Depth of body $4\frac{1}{2}$ to $4\frac{3}{4}$ times, length of head $4\frac{1}{3}$ times in the length. Snout rather pointed, slightly projecting beyond mouth,

not longer than eye, which is contained $3\frac{3}{4}$ to $3\frac{4}{5}$ times in length of head. Inter-orbital width equal to diameter of eye or a little greater. Mouth extending to below anterior one-third of eye; a pair of rostral barbels, rather long—nearly half the length of head. Dorsal II 7; above space between ventral and anals, with last two rays of dorsal over the first two of anal; originating midway between posterior border of eye and root of caudal; the longest ray $\frac{3}{4}$ or $\frac{4}{5}$ of the length of the head. Pectoral acutely pointed, a little shorter than head, not reaching ventral; the latter much shorter not reaching vent. Caudal widely forked. Scales—lateral line 47, lateral transverse $\frac{8\frac{1}{2}}{4\frac{1}{2}}$ and between lateral line and ventral $2\frac{1}{2}$.

Colour.—Upper one-third dark brown, below silvery; pectoral, ventral and anal fins reddish yellow, dorsal and caudal sprinkled with grey.

Three specimens, measuring 100, 110 and 115 mm., from Bonar, Ghərwal, (U.P.), Western Himalayas.

Danio naganensis, sp. nov.

(Pl. xl, figs. 1, 1*a*, 1*b*.)

Depth of body 4 times, length of head 4 to $4\frac{1}{3}$ times in the length. Diameter of eye 3 in the length of head, $\frac{2}{3}$ to 1 in the length of snout, 1 to $1\frac{1}{3}$ in the inter-orbital length. Barbels four, both pairs close together near the angles of the jaws; maxillary pair the smaller, being half the length of the pair in front, the latter half the diameter of the eye. Dorsal 10; 20 scales in front. Anal II 12; pectoral 13; ventral 8. Scales—40-42 in the lateral line which runs close to the ventral border after descending from the gill cleft; in the transverse series $8\frac{1}{2}$ above the lateral line and $3\frac{1}{2}$ below, $2\frac{1}{2}$ between the lateral line and the ventral fin.

Colour in spirit.—A black mark on the back of head and on the back, upper half of the side greenish brown, lower half of the side and fins dull white. There is a black spot behind the upper corner of the gill cleft, a steel grey longitudinal band in the middle of the side which runs quite close to the root of the caudal growing broader as it passes backwards, and a thin dull silvery band just above the steel grey band with traces of a faint one below: these two silver lines are almost in juxtaposition with the steel grey band.

Six specimens, measuring 42—62 mm., from Lungting River, Naga Hills, Manipur.

Sub-fam. *COBITIDINAE.*

Botia lohachata, sp. nov.

(Pl. xl, figs. 2, 2*a*, 2*b*.)

Depth of body 4 times, length of head $3\frac{3}{4}$ times in the length. Snout $2\frac{1}{3}$ times in the length of head and twice as long as eye;

diameter of latter contained 4 times in the length of head and 1½ times in the inter-orbital width. Lip in fleshy band, interrupted in the lower median line. Barbels eight; of the two rostral pairs, the upper pair is slightly the longer, 1½ times the diameter of the eye; maxillary pair the longest and mandibular pair the shortest. One pair of bifid and curved spines just in front of the eye (not below). Dorsal I 9; its anterior origin being equidistant from end of snout and root of caudal, free edge of the fin convex. Anal I 5; its tip touching the caudal. Pectoral 14, ventral 8 and caudal 20, the latter deeply bilobed. Scales minute and deciduous, the lateral line is straight, it runs through the middle line and is complete.

Colour in spirit.—A triangular black marking over the snout and a round black blotch in the inter-orbital space behind which on the back there are four black loops, on each side there are four broad black transverse bands descending from the dorsal loops already mentioned. In the centre of each area bounded by these transverse bands there is a round black blotch. The pectoral, ventral, and anal fins are white. The dorsal has one black spot on the upper third and the caudal has two dark bands.

One specimen measuring 40 mm., from the Gandak river, in Saran, Bihar, collected by Mr. M. Mackenzie. Local name Lohachat.

Lepidocephalichthys annandalei, sp. nov.

(Pl. xl, figs. 3, 3*a*, 3*b*.)

Depth of body 5½ to 6 times, length of head 4 to 4½ times in the length. Snout 3 to 3½ times in the length of head and 1½—1½ times as long as the diameter of eye, the latter contained 4½ to 5 times in the length of head and equal to the inter-orbital width. Mouth inferior. Barbels eight, all small. Dorsal I 7; the anterior origin equidistant from the anterior margin of the eye and the root of the caudal. Anal II 5. Pectoral 7—8, with a slight padding or cushion-like thickness over two of the outer rays. Caudal 16—18; notched in the middle, in some cases the margin of the fin is lunate by considerable shortening of the middle rays. Body variegated with collections of brown and grey spots arranged in patches; the dorsal is faintly banded and the caudal is obliquely banded with three faint grey bars on each side of the middle line. There are two intensely black spots encircled in white rings in the caudal fin, one of these is placed slightly above the middle line near the middle notch at the outer margin of the caudal fin, and the other at the base of the caudal fin slightly above the middle line. The intensely black spot in the middle of the outer margin of the caudal fin and its notched or concavely lunate outside border are very distinctive and constant characters.

Seven specimens measuring from 33 to 42 mm., three from the river Mahananda at Siliguri collected by Dr. N. Annandale,

and four specimens from the river Tista near Jalpaiguri collected by Dr. Annandale and Mr. S. W. Kemp.

Nemachilus manipurensis, sp. nov.

(Pl. xl, figs. 4, 4*a*, 4*b*; and Pl. xli, figs. 1, 1*a*, 1*b*.)

Depth of body $5\frac{1}{2}$ times, length of head $4\frac{1}{2}$ times in the length. Snout shorter than the post-orbital part of head, nearly $2\frac{1}{2}$ times as long as eye; diameter of latter contained 6 times in the length of head and $2\frac{1}{2}$ times in the inter-orbital width. Breadth of head $1\frac{1}{3}$ times its length, and depth of head $1\frac{1}{3}$ times its breadth. Lip—a fleshy band interrupted in lower median line. Barbels six, outer rostral $3\frac{1}{2}$ times and maxillary 3 times the diameter of eye. Dorsal I 7; its anterior origin being nearly equidistant from base of nostril and root of caudal, free edge of fin convex. Anal I 5. Pectoral extending $\frac{3}{4}$ distance from its base to the base of ventral. Ventral 8, extending nearly $\frac{3}{4}$ distance from its base to the root of anal. Caudal slightly notched in the middle making the outer margin look bilobed. Caudal peduncle rather broad, nearly $1\frac{1}{2}$ times as long as deep and contained $1\frac{1}{2}$ times in the length of head. Scales minute all over the body, lateral line incomplete; the openings of a series of muciferous glands beginning from the end of the snout, continue below the eye and become continuous with those of the lateral line.

Colour.—Uniform steel grey on the upper two-thirds, below yellowish white; ventral and anal fins and lower part of pectoral yellow. Dorsal and caudal fins banded with 4 or 5 transverse wavy bands made up of minute black spots. Upper side of pectoral greyish yellow.

In the males there is a secondary sexual character in the form of a round flat cartiligenous flap in front of the eye, somewhat similar to the structure found in *Nemachilus mackenziei*, Chaudhuri (Rec. Ind. Mus., V, 183), pl. xli, fig. 2.

Three specimens, two males and one female, from Manipur, Assam, measuring from 50 to 82 mm.

Fam. SILURIDAE

Olyra kempi, sp. nov.

(Pl. xli, figs. 4, 4*a*, 4*b*.)

Depth of body 9 to 10 times, length of head 5 to 6 times in the length. Head very much depressed and snout spathulate; eyes subcutaneous, diameter of eye $4\frac{1}{2}$ to 5 times in the length of head, $1\frac{1}{2}$ to 2 in the length of snout and 2 in the inter-orbital space. Barbels eight, the maxillary reaching almost to the end of pectoral, outer mandibular half of maxillary; nasal and inner mandibular about half the length of head. Upper jaw slightly longer. Dorsal 7; first ray short, rest slender but high. Adipose dorsal long and

low, terminates in a raised knob-like end just above the termination of the anal fin. Pectoral I 4–6; serrated spine with about 15 serrations on each side, slightly shorter than the rays, the anterior fourth of the spine free from any serration and is pointed. Ventral 6; slightly in advance of the rayed dorsal. Anal 17—18, the rays subequal. Caudal 15—16, deeply lobed, some of the superior rays of the upper lobe considerably longer than those of the lower lobe. Numerous gland openings in the head and chest, also conspicuous glandular opening along the lateral line.

Colour in spirit.—There are two longitudinal pale brown bands on each side of the lateral line, the position of which is noticeable by a dark brown band. The rest of the body is coloured brown; abdomen, anal, pectoral, ventral and dorsal fins dull white, adipose deep brown.

Five specimens from Mangaldai (Assam-Bhutan Frontier), collected by Mr. S. W. Kemp. The largest measures 54 mm. without caudal.

Owing to the discovery of this species the generic description has to be modified a little as the caudal fin in this species, unlike others of the genus, is deeply lobed. It also extends the range of the genus from the Khasi Hills and certain parts of Burma further northwards to the base of the Eastern Himalayas.

Pseudeutropius atherinoides (Bloch) var. **walkeri**, var. nov.

(Pl. xli, fig. 3.)

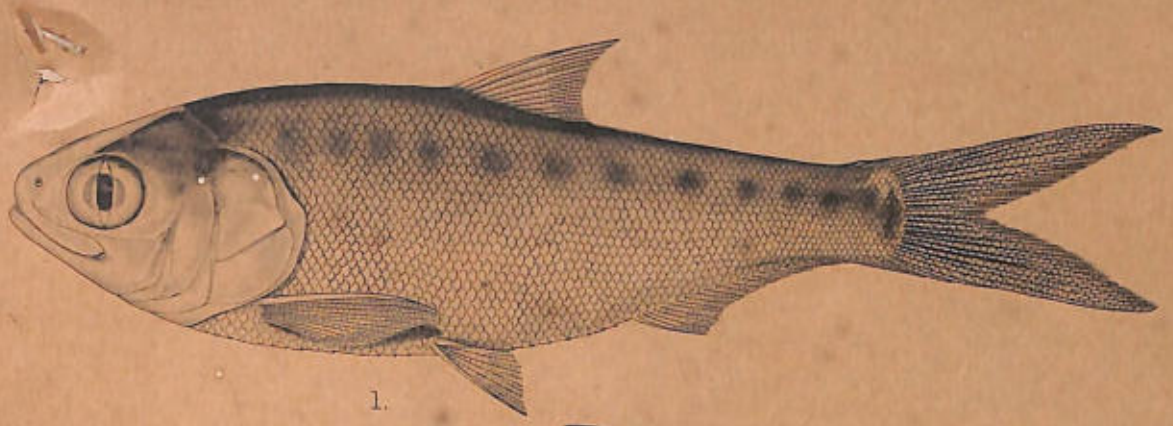
Depth of body $4\frac{1}{2}$ in the length, length of head $4\frac{5}{6}$. Snout equal to the diameter of eye and shorter than the postorbital length, eyes subcutaneous, the diameter of which is $3\frac{1}{4}$ in the length of head and about $1\frac{1}{4}$ in the inter-orbital length. Barbels eight, nasals slightly longer than length of head, maxillary pair reach the root of ventral, outer mandibular reach half of pectoral and inner mandibular root of pectoral. Dorsal I 6; dorsal spine strong, finely serrated anteriorly and coarsely serrated posteriorly, longest ray as long as head, length of spine two-thirds of the same. Pectoral II 6; the spine is a jointed double structure, outer terminates in a point, inner in a bent (denticulate), outer surface of jointed spine is serrated, inner side of same denticulated with 12 denticulations and equal to dorsal spine in length. Ventral 7 and anal 37. Caudal lobed. A narrow spiral corrugation on chest.

Colour in spirit.—A black blotch on the nape of neck and a black ring enclosing basal process of dorsal spine, a narrow white stripe joins these two black markings; three longitudinal brown stripes on each side; fins dull white; a large black blotch behind gill cleft concealing a thin membrane which bulges out opposite osseous air bladder, thus suggesting the presence of a sounding apparatus.

Two specimens from Siripur Saran, Bihar. Total length with caudal 70 mm.

EXPLANATION OF PLATE XXXVIII.

Fig. 1.—*Clupia suhia*, sp. nov., × $\frac{1}{6}$.
„ 2.—*Labeo almorae*, sp. nov., × $\frac{1}{6}$.
„ 2*a*.— „ „ ventral view of mouth parts, × $\frac{1}{6}$.
„ 2*b*.— „ „ dorsal view of head, × $\frac{1}{6}$.
„ 3.— „ *kunki*, × $\frac{1}{6}$.
„ 4.— „ *rilli*, × $\frac{1}{6}$.



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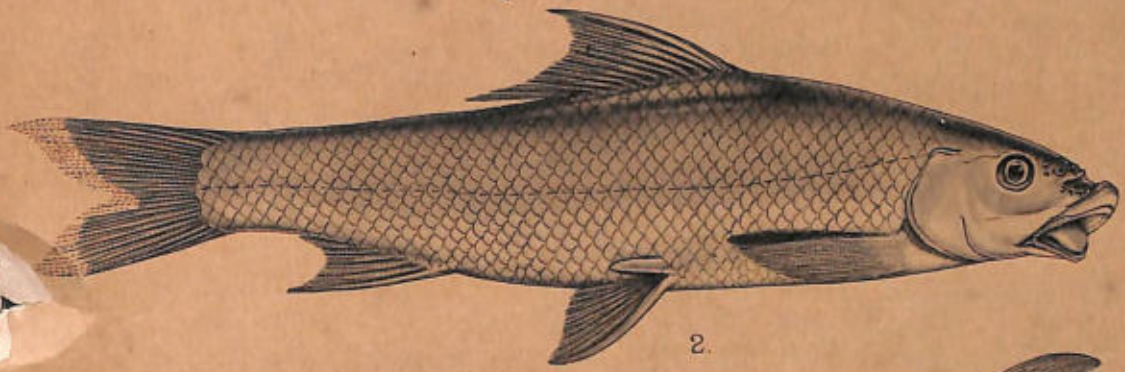

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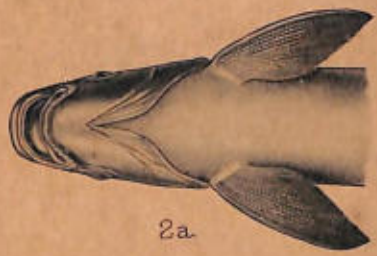

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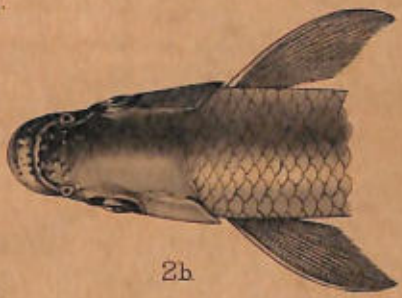

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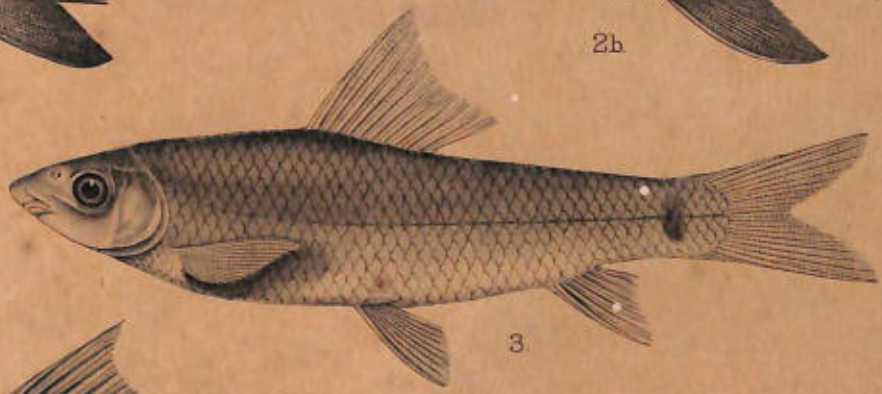

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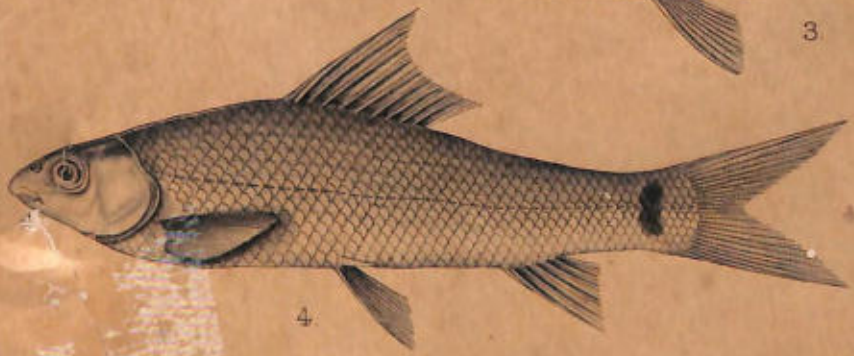


4.

A.C.Chowdhary. del

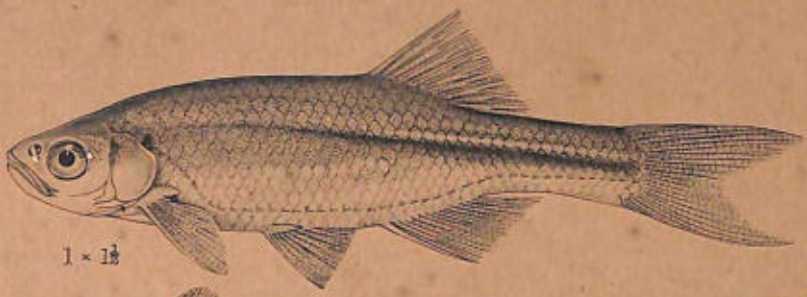
Bemrose, Collo, Derby.

EXPLANATION OF PLATE XXXIX.

Fig. 1.—*Labeo tezpurensis*, sp. nov.,
,, 1*a*.— ,, ,, dorsal view of head, × 2.
,, 1*b*.— ,, ,, ventral view of mouth parts, × 2.
,, 2.—*Amblypharyngodon saranensis*, sp. nov.
,, 3.—*Nuria danrica* (H.B.) var. *grahami*, var. nov., × 1½.
,, 4.—*Barilius bonarensis*, sp. nov.
,, 4*a*.— ,, ,, dorsal view of head.
,, 4*b*.— ,, ,, ventral view of mouth parts.

EXPLANATION OF PLATE XL.

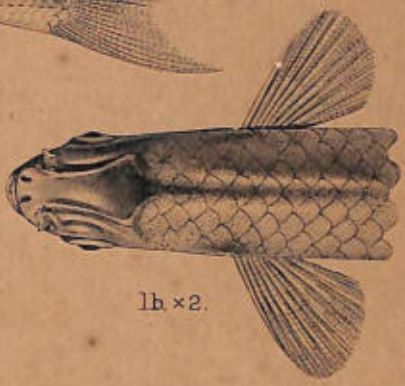
Fig. 1.—*Danio naganensis*, sp. nov.
,, 1*a*.— ,, ,, ventral view of head and neck, × 2.
,, 1*b*.— ,, ,, dorsal view of head, × 2.
,, 2.—*Botia lohachata*, sp. nov., × 2.
,, 2*a*.— ,, ,, ventral view of head and mouth, × 3.
,, 2*b*.— ,, ,, dorsal view of head, × 3.
,, 3.—*Lepidocephalichthys annandalei*, sp. nov., × 2.
,, 3*a*.— ,, ,, dorsal view of head, × 3½.
,, 3*b*.— ,, ,, ventral view of head, × 3½.
,, 4.—*Nemachilus manipurensis*, sp. nov. ♂, × 1½.
,, 4*a*.— ,, ,, dorsal view of head, × 1½.
,, 4*b*.— ,, ,, ventral view of head, × 1½.



1 × 1½

1a. × 2.

2b × 3.



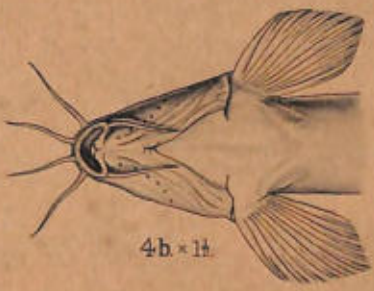
1b. × 2.

2.

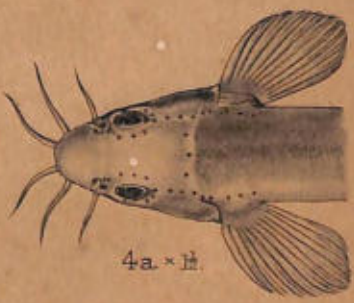
2a. × 3.

3a. × 3½

3. × 2.



4b × 1½



4a. × 1½

3b. × 3½

4. × 1½

EXPLANATION OF PLATE XLI.

Fig. 1.—*Nemachilus manipurensis*, sp. nov., ♀, × 1½.

,, 1*a*.— ,, ,, dorsal view of head, × 2.

,, 1*b*.— ,, ,, ventral view of head and chest, × 2.

,, 2.— ,, *mackenziei*, Chaudhuri, ♂.

,, 3.—*Pseudeutropius atherinoides* (Bloch) var. *walkeri*, var. nov.

,, 4.—*Olyra kempi*, sp. nov., × 2.

,, 4*a*.— ,, ,, dorsal view of head, × 2.

,, 4*b*.— ,, ,, ventral view of head, × 2.

XXXVI. NEW ORIENTAL DIPTERA, I.

By E. BRUNETTI.

(Plate xxxvii).

Descriptions of sixty-eight new species of oriental diptera are given in the present paper, and those of four new genera. Four previously known species are redescribed and four European species introduced to the Oriental fauna. The Indian Museum possesses all the types of the new species except one or two in my own collection. A number of the types of new species obtained by Dr. A. D. Imms have been very kindly presented by him to the Museum collection.

New material in the Indian Museum in *Syrphidae* and *Acalyptrata* will form the subject of two subsequent papers.

CHIRONOMIDAE.

Ceratopogon lignicola, mihi, sp. nov.

♂. Western Himalayas. Long. $1\frac{2}{3}$ mm.

Head.—Black. Eyes distinctly separated above, reniform. Antennae blackish with very long dense black hair (which in certain lights appears paler), except on the ultimate two joints, these latter bearing only a little short greyish pubescence.

Thorax.—Black, with very long black stiff hairs laterally and on the posterior part and scutellum. Anterior half of dorsum with closely placed semi-recumbent very short bright yellow hairs. Hind border of scutellum with a row of long stiff bristles.

Abdomen.—Blackish, with long blackish hairs (which give greyish reflections, viewed from certain angles). Genital organs moderately large, concolorous, pubescent; each clasper with a very long strong dorsal bristly hair, posteriorly directed.

Legs.—Blackish, with long brownish hair on femora and tibiae; knees brownish yellow; tips of tibiae and of tarsal joints more or less brownish yellow. Fore metatarsi a little longer than 2nd joint.

Wings.—The 3rd longitudinal vein ends a little before middle of wing; "intercalary" (*Kieffer*)* vein, simple, ending opposite tip of upper branch of 5th vein; anterior cross vein oblique; 4th longitudinal vein forked a short distance beyond anterior cross vein, the branches gently divergent throughout their length; 5th vein forked widely at or just beyond middle of vein, upper branch in a line with basal part except for the very gentle curve the whole vein takes; 6th vein close to and parallel to the

* I temporarily follow Kieffer in the use of this term, not having studied Chironomidae sufficiently to speak with decision, but there is no vein of this name accepted amongst dipterologists.

5th, its lower branch, nearly attaining wing margin, though becoming very faint towards its tip; 7th vein half as long as 6th, close to and parallel to the hind border of the wing.

Whole surface of wing with short dark hairs. A patch of black hairs at tips of 1st and 3rd longitudinal veins, the intermediate space on the costa covered with whitish hairs. Halteres pale lemon yellow.

Described from 3 ♂ ♁. The specimens were bred from larvae found under dead bark of a Sal tree (*Shorea robusta*), at Thano, Dehra Dun, 9-ii-12, Siwalik Forest Division, United Provinces, at about 1500 feet (*Imms*).

Type in Indian Museum, cotypes in the Forest Zoology collection.

BIBIONIDAE.

Plecia impostor, mihi, sp. nov.

♂ ♀. Western Himalayas. Long. 4—5 mm.

This species is conspicuous by the extraordinary resemblance it has to *Pleciomyia melanaspis*, Wied. The whole insect is black with the exception of the hinder part of the thoracic dorsum, which is of the same ferruginous red colour which appears in the same part in *melanaspis* and, as in that well-known species, without being sharply demarcated. The antennae differ from all other oriental species by having only nine joints; the two scapal joints normal, 1st flagellar joint narrowed at base, a little longer than the remaining five annular subequal joints, in addition to which there is a small apical conical joint. The 3rd longitudinal vein forks at or just beyond one third of the distance between the anterior cross vein and the tip of the 3rd vein. The 4th vein forks distinctly proximad of the fork of the 3rd vein rather broadly, but the degree of divergence of the prongs is variable. Wings blackish.

Described from 3 ♂ ♂ and 3 ♀ ♀, from Airadeo (6880 ft.), 31-v-12 (*type* ♂ and ♀); and Bhowali, 25-vi-12, both places in the Kumaon District. [*Imms*].

Type ♂ and ♀ in the Indian Museum, presented by Dr. A. D. Imms; cotype ♂ ♀ in the Forest Zoology collection.

N.B.—In my paper on New Oriental Nemocera (Rec. Ind. Mus., iv. 259) there were some inaccuracies respecting the antennae in this genus. These inaccuracies are corrected in my volume on Nemocera for the "Fauna of British India" series, now in the press. *Plecia fulvicollis*, *atra* and *indica* have 12 joints to the antenna, *P. tergorata* and *obscura* only 10. *Pleciomyia melanaspis* has twelve.

PARAPLECIOMYIA, mihi, gen. nov.

Differs from *Pleciomyia*, Brun., by the 4th longitudinal vein forking some distance beyond the anterior cross vein, approximately opposite the fork of the 3rd vein

N.B.—It seems permissible to establish a new genus on the character given, which makes it intermediate between *Pleciomyia* and *Plecia*, although quite distinct from both.

Parapleciomyia carbonaria, mihi, sp. nov.

♂ ♀. Western Himalayas. Long. 6 mm.

Body wholly black, including legs, genitalia and halteres. Wings blackish as in *Pleciomyia melanaspis*, a little darker on the fore border; stigma black, distinct. Venation in accordance with generic diagnosis.

Described from a single pair, the ♂ taken near Bhowali, 11-v-12, the ♀ at Sat-Tal, near Kumaon, 9-v-12, both in the Indian Museum, presented by Dr. A. D. Imms.

Bibio aequalis, mihi, sp. nov.

♂. Shanghai. Long. 5 mm.

Black, hardly shining. *Thorax and abdomen* (dorsum, sides and belly) with rather thick and long yellowish grey hair, almost as copious as in *B. laniger*, Mg. Eyes with rather long yellowish pubescence, and yellow hairs below the head. Coxae blackish, a little shining; femora, tibiae and tarsi dark mahogany brown. Terminal spines on fore tibiae exactly equal in length, bright reddish brown.

Wings nearly clear; stigma very distinct, rather large, clear cut, black; 4th longitudinal vein forking at the posterior cross vein, and just before tip of 2nd longitudinal vein.

Described from two males in my collection captured by me 16-iv-06 at Shanghai.

TIPULIDAE.

Dicranomyia bicinctipes, mihi, sp. nov.

♂. Lower Burma. Long. 5 mm.

Head.—Brownish yellow, antennae and palpi dark brown.

Thorax.—Rather more arched than usual, brownish yellow, with a pale median line from about the middle of the dorsum, carried continuously posteriorly across the scutellum to the rear of the metanotum. Sides and under side of thorax pale whitish yellow; a brown stripe between and across the anterior coxae.

Abdomen.—Dark brown, the posterior part of many of the segments paler. Belly wholly whitish yellow, genitalia brown, normally structured, apparently.

Legs.—Pale brownish yellow; tips of femora and two narrow rings on the tibiae black, these latter situated just before the first third and second third respectively; tarsi snow white; tibiae becoming white towards and at their tips.

Wings.—Cuneiform, pale grey, iridescent, stigma large, oval, black, well defined; discal cell absent. Upper branch of 4th

longitudinal vein forked at one-third of its length, the veinlets parallel; posterior cross vein in a line with the base of the 3rd posterior cell. Halteres dirty yellow, tips darker.

Described from 3 ♂ ♂ in the Indian Museum from Thingannyinaung to Sukli, Dawna Hills (900—2100 ft.), 23—27-xi-11 *Gravely*].

Mongomioides albogeniculata, mihi, sp. nov.

♂. Lower Burma. Long. 5 mm.

Head.—Brownish yellow, as are also the antennae and palpi.

The *thorax* and *abdomen* brown, the latter the darker, being in one specimen nearly blackish; the posterior margins of the segments faintly pale in one specimen.

Sides of thorax yellowish white; under side of abdomen yellowish, sometimes whiter towards the base.

Scutellum and metanotum brownish yellow.

Legs mainly dark brown; coxae and base of femora whitish yellow, femora tips and base of tibiae rather broadly snow white. Apical part of tibiae (about one-third to one-half), and all the tarsi, snow white.

Wings pale grey, unmarked, halteres blackish.

Described from two ♂ ♂ in the Indian Museum, labelled 3rd camp to Misty Hollow, Dawna Hills (400—2400 ft.), 22—30-xi-11 [*Gravely*].

STRATIOMYIDAE.

MONACANTHOMYIA, mihi, gen. nov.

Allied to *Pachygaster*, Mg., from which it differs by the extraordinary formation of the scutellum, which is produced upwards so as to form a very large conical base, from which it is continued upwards in the form of a long strong spine with blunted tip.

Monacanthomyia annandalei, mihi, sp. nov.

♀. Darjiling District. Long. 2 mm.

Head.—Vertex triangular, elevated, the three ocelli distinct, reddish. Frons between one-fourth and one-fifth width of head, nearly linear, shining black, with (seen from above) two small nearly contiguous, oval, silvery grey dusted spots a little above the antennae. Eyes with very small uniform facets. Face shining black, lower eye orbits silver dusted. Proboscis short, narrowed at base, pointed at tip, yellow, microscopically pubescent. Antennae yellow, third joint very large, round, with a rather long apical thickened bristle. Back of head blackish, lower posterior eye orbits with silvery reflections and a few very short snow-white hairs.

Thorax.—Shining black, with microscopic grey hair, with which on the dorsum is intermixed (or possibly wholly replaced by ?) yellow hairs, all microscopic. Scutellum shining black, with microscopic whitish and a few yellow hairs.

Abdomen.—Shining black, with microscopic snow-white hairs. Belly similar, genitalia very minute.

Legs.—Basal half of coxae and a broad band occupying nearly all the femora except base and tips, black or blackish brown, remainder of coxae and femora yellowish; tibiae and tarsi white.

Wings.—Very pale grey, highly iridescent; stigma yellow; basal half of costa and 1st longitudinal vein much blacker than the remainder of the veins. Halteres, stem yellowish, clubs milk white, rather large.

Described from a perfect ♂ in the Indian Museum, captured by Dr. Annandale at Kurseong (4700 ft.), 15-iv-11, on a window in a bedroom.

Pachygaster nigrofemorata, mihi, sp. nov.

♀. Madras. Long. 3 mm.

Head.—Frons shining black, with very sparse short white hairs on the upper part; ocellar triangle roughened; two small round white hair spots contiguous to the eyes (one on each side), placed just above the level of the antennae. From these spots, along the inner margins of the eyes, a very thin line of snow-white hairs. Underside of head shining black; proboscis dark brownish yellow. Antennae brownish yellow, 3rd joint divided by five annulations into six apparent parts, of which the two basal ones are the broadest; style black, as long as the 3rd joint itself, composed of at least two segments, of which the 1st is very minute, the tip of the 2nd being curved. Back of head shining black, bare.

Thorax.—Shining black, with a moderate amount of very short golden yellow hairs; pleurae similar, but the hairs whitish. Scutellum shining black with golden yellow hairs.

Abdomen.—Shining black, with short sparse whitish hairs; belly shining black, bare.

Legs.—Yellow, except the femora, which are wholly black but for the very narrowly yellow tips. Extreme tips of tarsi a little brown. Femora with soft hairs, tibiae and tarsi minutely pubescent.

Wings.—Clear, stigma and veins on anterior part of wing yellowish; halteres milk white.

Described from a unique ♀ taken by Dr. Annandale at the south end of Lake Chilka, N. E. Madras, 4-iii-10. *Type* in Indian Museum.

Acanthina auricollis, mihi, sp. nov.

♂ ♀. Assam. Long. 9 mm.

Head.—Eyes in ♂ not absolutely contiguous, the intervening space extremely narrow, black; vertex dull brownish yellow with

pale yellow hairs. Eyes black, with short thick pubescence, posterior orbit with grey hairs. Occiput black. Facial protuberance conspicuous, brownish yellow, bearing the concolorous antennae, of which the 3rd joint bears several faintly marked annulations, the style black. In the ♀ the frons is narrow, almost linear, of a deep orange yellow colour, the hind borders of the eyes are very thick and of the same colour, the pubescence of the eyes is pale yellow.

Thorax.—Shining blue black, with concolorous hairs. Three wide stripes, composed of short yellowish grey hairs, lie crossing one another on the dorsum, one being median and transverse, carried over the sides in front of the wings, the other two form the letter X, the anterior ends lying just inside the shoulders, the posterior ends attain the posterior angles of the dorsum. Pleurae blue black with grey hairs below the shoulders, the continuation of the median transverse grey stripe reaching to the middle coxae. *Shoulders and anterior margin of dorsum with conspicuous thick bright golden yellow hair.* Scutellum blue black, shining, with similar hair, posterior margin with short grey hair, the four spines dark brownish yellow or black.

Abdomen.—Shining blue black, with microscopic black spines, each set in a raised black socket, giving the abdomen a roughened appearance. A little pale grey pubescence towards the sides and at the tip. Belly similar to dorsum, but the pale hairs cover the whole surface. Genitalia small, two short telescopic cylindrical joints in ♂, two short filaments in ♀.

Legs —Femora black, tibiae dark brown, tarsi reddish or brownish yellow in the ♂, black in ♀. Femora with whitish grey hair below, remainder of legs microscopically pubescent.

Wings.—Broadly speaking, the anterior and distal halves moderately dark brown, the costal cell always quite clear; the proximal half of the posterior part of the wing more or less pale grey or clear. Stigma and veins dark brown The discal cell may be all clear or the upper part (even to the half or more) may be darkened. Halteres chrome yellow.

Described from 3 ♂♂ and a ♀ in the Indian Museum. The ♂♂ were labelled *Acanthina auricollis*, Big., which is a *nomen nudum* and are from Sadiya (*type*) and Kohima, Assam; the ♀ is a more recent specimen from Karkur Ghat, Nilgiri Hills, South India (1500 ft.), taken in May 1911 by Mr. H. L. Andrewes.

N.B.—As a synonym to *azurea*, Gerst., Van der Wulp gives Walker's *Clitellaria obesa* (Proc. Linn. Soc. Lond., v, 232, 1861), but Walker himself described the year previously a *Clitellaria obesa* from Mexico, Trans. Ent. Soc. Lond. (2) v, 270). That this latter is a good species is evident by its inclusion in Aldrich's Cat. N. Amer. Dipt. and in Kertesz's Cat. of Dipt.

Although in my paper on Oriental Stratiomyidae I distinguished *azurea* and *auricollis*, Big., by the presence or absence of a cross (former by silver grey hair stripes) on the thoracic dorsum, this is unsatisfactory, as *auricollis* also possesses a similar cross.

As Gerstaecker does not mention any gold hair on the anterior margin of the thorax in *azurea*, it is presumably absent, but with this exception the present species might, allowing for a moderate amount of variation, be identical with *azurea*.

The genus *Acanthina*, Wied., although the name is preoccupied, has been recognized for too many years to be supplanted, as some authors desire, by *Artemita*, Walk.

Evasa ? flavipes, Big.

A ♀ in my collection, taken by me at Darjiling, 22—30-vi-12, is almost certainly this species, the only discrepancy from the description being that Bigot's species has the anterior part of the wings broadly darkened, whereas in the present specimen they are only a little darkened on the distal part of the wing beyond the very black distinct stigma, the proximal half and the costal cell being quite clear. The only other described species with all yellow legs is *bipars*, Walk., which has the disc of the abdomen, hind border of the scutellum and a line on each side of the thorax yellow. In the present specimen a narrow rather pale ridge runs from the wing base nearly to the shoulders.

Negritomyia maculipennis, Macq.

(*Redescription.*)

♀. Ceylon. Long. 11 mm.

Head.—Black, with a little short whitish pubescence. Eyes black, shortly pubescent. Antennae blackish, inner side of 3rd joint pale, style closely pubescent. Frons at vertex about one-fifth the width of the head, widening at level of antennae to nearly one-third. An indistinct whitish mark above each antenna. Palpi black, with short yellow pubescence. Back of head black; posterior orbit of eyes with narrow silvery white pubescence.

Thorax.—Black, moderately shining, with very short black hairs; covered with microscopic grey hairs except along a broad median line, and on two large spaces towards each side of the dorsum, i.e., one behind the shoulder and one above each wing. Sides of thorax shining black, with microscopic grey pubescence below shoulders and some short snow-white hairs above the fore coxae. There is also a rather wide, perpendicular side stripe of similar pubescence above the middle coxae, joining the dorsal pubescence in front of the wing. Side spines short, strong, black. Scutellum black, with short black hairs and concolorous grey pubescence and two broadly separated strong, short, black spines on hind margin.

Abdomen.—Black, with grey pubescence forming a broad dorsal line on hinder half and a sub-triangular spot towards each side of each segment. Belly shining black, practically bare.

Legs.—Black, with very minute whitish pubescence. Basal fifth of anterior femora and basal fourth of hind pair, also major portion (from the base) of all the tarsi pale yellowish white.

Wings.—Sub-hyaline; stigma dark brown, roughly oval, very distinct. Tip of wing, from outer side of discal cell, thence in a straight line to the costa, and extending hindwards, until filling the 2nd posterior cell, distinctly brown, the colour filtering more or less into the 3rd posterior cell. Halteres, stem yellow, clubs dark brown.

Redescribed from a single perfect ♀ in my collection from Kandy, Ceylon, viii-08 [*Green*].

N.B.—Macquart's description is quite correct, but a fuller one is not out of place as the species of this genus appear closely allied. Very near *N.* (*Clitellaria*) *responsalis*, Walk., from Papua; the agreement in the pale inner side of the 3rd antennal joint and the pattern of the thorax being exact. Walker describes the thorax as "covered with cinereous tomentum, except a dorsal stripe and two spots on each side." The discrepancy is in the legs and wings. In Walker's species the "femora are livid, except towards the tips, posterior tibiae and tarsi whitish, with black tips." He also distinctly notes that the wings are "without any blackish tinge."

Clitellaria bistriata, mihi, sp. nov.

♂. Western Himalayas. Long. 8—9 mm.

Head.—Vertex wholly occupied by the ocellar tubercle, black, shortly black pubescent; occiput blackish, the orbit bare, but a little whitish grey hair on lower part. Eyes closely contiguous, with dense dark brown hair. Frontal triangle black, a little whitish grey hair on its uppermost part. Antennae black, normal, under side of head with whitish hair.

Thorax.—Black, with minute black pubescence. The anterior margin covered with, also two moderately wide dorsal stripes extending from the anterior margin to the scutellum, composed of very short golden-brown hairs; these hairs also appearing on, behind and below the shoulders. At the extreme lower anterior corner of the dorsum is a reddish brown, bare, prominent but very small callus. Scutellum rather broad, black, with microscopic black pubescence, some longer black hairs above and ragged dirty grey hair on under side. The scutellum furnished with two slightly curved, moderately long, obtusely pointed spines, placed one at each extreme posterior corner. Some greyish hair on posterior corners of lower part of thorax.

Abdomen.—Black, microscopically pubescent, with some very short greyish pubescence towards the sides, rather more extensive on first two segments, on posterior margin of penultimate segment and covering most of the last segment. Belly black, with very short greyish pubescence.

Legs.—Black, with microscopic pubescence, and some very short greyish white hair on under side of anterior femora; the pubescence on the lower side of the tarsi dark brown.

Wings.—Anterior part deep brown, becoming a little lighter on posterior two-thirds, but still dark brown. Stigma small, blackish brown, veins deep black; halteres black, stem yellowish.

Described from a unique ♂ from Bhowali, Kumaon District (5700 ft.), captured by Dr. A. D. Imms and now in the Indian Museum.

Ptecticus cyaneus, mihi, sp. nov.

♀. Assam. Long. 14 mm.

Head.—Frons almost linear, brilliantly shining violet and blue, with short soft black hairs; ocelli placed much below the vertex, small pale yellowish brown, ocellar triangle very slightly elevated; the slight protuberance above the antennae pale whitish yellow. Face blackish, with black hairs, lower part of head reddish brown, prominent. Back of head black, with a fringe of white hairs. Antennae with 1st and 2nd joints black, shining, 3rd joint and the overlapping inner side of the 2nd joint coffee brown, arista black, apical.

Thorax.—Dorsum and scutellum brilliantly shining violet, with rather copious brownish grey hairs. Thorax below dorsum brilliantly shining peacock green, with short whitish hairs. A small brownish yellow spot on the shoulders is connected with the wings by a very narrow brownish yellow ridge delimiting the dorsal and ventral surfaces.

Abdomen.—Brilliantly shining violet, with pale grey hairs; belly similar.

Legs.—Femora black, with short white hairs; a little brownish yellow at base; the knees of similar colour, and the coxae with a mark or two of the same shade. Tibiae black, more or less yellowish on apical part, the whole surface with short pale yellow hairs, tarsi dark, with pale hairs. Under side of hind tarsi with short very dark golden brown pubescence.

Wings.—Grey; stigma ill defined; this region of the wing brownish; veins dark brown; halteres yellowish.

Described from one ♀ in the Indian Museum from Ukhral Manipur, Assam (6400 ft.), taken by the Rev. W. Pettigrew.

Microchrysa calopa, mihi, sp. nov.

M. calopus, Big. nom. nud.

♀. Assam and Chota Nagpur. Long. 3 mm.

Head.—Frons broad, bright metallic green on vertex, changing insensibly to brilliant violet blue just above antennae; very short pale yellow pubescence. Face metallic green; oral opening brown. Eyes dark brown, the upper corners rounded off, thus widening the vertex considerably. Antennae pale yellow, tip of 3rd joint which has a slight reddish tinge, shortly pubescent; 1st and 2nd joints with one or two microscopic hairs. Back of head dark.

Thorax.—Dorsum brilliant metallic green, with very short pale yellow pubescence. Belly similarly coloured and pubescent.

sharply delimited from the dorsum by a narrow yellow side ridge at the level of the wings. Posterior calli yellowish. Scutellum and metanotum brilliant green, the former with pale yellow hairs and yellow underside.

Abdomen.—Dorsum violet, not intense, shining, and with a bluish tinge in certain lights; pale yellow pubescence. The colour covers all the surface except a narrow, irregular yellow border round the edges. Belly yellow, shortly pubescent.

Legs.—Wholly yellow, except a broad brown ring on distal half of hind femora, and a blackish hind metatarsus.

Wings.—Clear, stigmatic area pale yellow. Halteres deep yellow.

Described from two ♀ ♀ in good condition in the Indian Museum, from Margherita, Assam, and Paresnath (Chota Nagpur, 4400 ft.), May 1909 [*Dr. Jenkins*].

Eudmeta flavida, mihi, sp. nov.

Id. id., Big. nom. nud.

♂. Assam. Long. 8 mm.

Head.—Eyes contiguous for two-thirds the distance from the very small vertex to the frons; upper facets rich red brown, much larger than the lower ones, which are nearly black. Ocellar triangle small, black, slightly elevated, with a few hairs, lower margin of eyes white. Frons and face smooth, bare, livid yellow. Mouth and proboscis brown; palpi small, black, oval at tip. Antennae yellow, almost bare, except a few hairs at tips of the two first joints, which are very short; 3rd joint elongate, a little greyish shimmer towards the rather narrowed tip, ending in a distinct, moderately long, black, cylindrical style, which is 3-jointed and very closely black pubescent, the first two joints very short. Occiput not projecting beyond hinder margin of eyes, much invaginated in the middle; yellowish, with very short hairs.

Thorax.—Rather dull brownish yellow, sides, scutellum and metanotum concolorous, except that the scutellum is a little reddish, Whole dorsum, sides and scutellum covered with soft, dense, pale yellow hair.

Abdomen.—Rather shorter and more globose than Meijere's *brunnea*. Ferruginous brown, a little blackish on the edges and towards tip. Whole surface with close, short, yellow pubescence. Belly similar, pubescence very short.

Legs.—Brownish yellow, a dark brown ring on apical half of hind tibiae; tarsi tips black. The legs are minutely yellow pubescent, the colour brightest on the tarsi.

Wings.—Pale yellow, veins brownish; a stigma-like oval black spot towards tip of upper basal cell. The end of the wing mainly occupied by a brown suffusion which dies away towards posterior margin. Halteres yellow.

Described from a single ♂ in good condition in the Indian Museum collection from Margherita, Assam.

N.B.—Wiedemann (Auss. Zweifl., ii, 43) describes the antennae as 5-jointed and Macquart (Suite à Buff., i, 259) follows suit, both illustrating these organs. I describe them as 3-jointed, with a 3-jointed style; what the older authors regarded as a short 4th joint is really double. Moreover, in the present species the 3rd joint is the most robust and longest, the 3rd joint of the style being half as long as the true 3rd joint. Meijere's figure (Bijd. Dierk., xvii. 14, pl. viii. 10) more nearly represents that of my species, the ultimate joint in the latter being, however, shorter. The abdomen, as stated above, is much shorter and more rounded, which makes me doubtful as to whether it is well placed in *Eudmeta*.

Beris annulipes, mihi, sp. nov.

♀. Darjiling. Long. 6½ mm.

Head.—Frons nearly one-fourth the width of the head; brilliantly shining, dark blue, uniformly wide. Back of head shining black, with a little grey hair on posterior ocular orbits. Eyes very shortly but distinctly pubescent, antennae with first two joints black, with bristly hairs, 3rd joint yellowish on basal, black on apical half; a little grey hair about the base of the antennae. Proboscis reddish yellow.

Thorax.—Brilliantly shining violet blue, with yellow pubescence on dorsum. Scutellum brilliantly shining peacock (greenish) blue, with six strong equidistant shining darker green spines on hind margin.

Abdomen.—Violet, moderately shining, sides with brownish yellow pubescence. Belly darker with short yellow hairs.

Legs.—Yellow; tips of anterior femora with an indistinct brown band; hind femora and tibiae with a distinct broad brown apical band on each; tarsi marked extensively with brown.

Wings.—Grey. Upper part (except costal cell) as far hindwards as to include the anterior basal and first posterior cells, brown. Halteres yellow.

Described from one example taken by me at Darjiling (7000 ft.), 27-v-10. In the Indian Museum.

(?) Allognosta inermis, mihi, sp. nov.

♂. Darjiling. Long. 4½ mm.

Head.—Vertex very small, occupied by the three ocelli? Eyes with uniform, very small facets, bare, contiguous. Frons an equilateral triangle, moderately large, blackish seen from above, but with grey reflections viewed from other directions. Antennae black, normal, as in *Beris*, the 3rd joint, by seven annular impressions appearing as if composed of 8 closely compressed joints. Palpi and proboscis black; the underside of the large labella yellowish. Back of head blackish.

Thorax and scutellum blackish with a slight aenous tinge, microscopically roughened, and with microscopic yellow hairs. The anterior margin and shoulders with a very little short

yellowish hair, which extends also over the pleurae to some extent. Scutellum unspined, with microscopic yellow hairs.

Abdomen.—Dull black, barely shining, the sides with very short yellow hairs. Belly similar with very minute yellow hairs. Genitalia consisting of a pair of blackish, fairly thick claspers, each with a small narrow appendage; there being also an upper pair of yellow, hairy, finger-like appendages.

Legs.—Black, the knees distinctly but not broadly yellowish brown; pulvilli pale yellowish.

Wings.—Blackish brown; stigma large, well defined, brown. Halteres black.

Described from a unique ♂ in the Indian Museum taken by me at Darjiling (7,000 feet), 29-v-10, on the hillside.

N.B.—When first describing this species I considered it as representing a new genus differing from *Beris* only in having an unspined scutellum. A closer investigation of existing genera revealed its close affinity to *Allognosta*, Os. Sac., a genus which, curiously enough, does not appear to have ever been properly characterized. Its history is as follows: Macquart in 1847 set up *Metoponia* for an Australian species and Loew in 1863 described a North American species *similis* and in 1873 a species *vagans* from Siberia, both of which he placed in *Metoponia*. Osten Sacken in 1883 (Berl. Ent. Zeits., xxvii, 297) notes that Loew's idea of *Metoponia*, Macq., was incorrect, forming this opinion on an examination of Macquart's types in Bigot's collection and states that Loew's two species were not congeneric with *Metoponia*. He had at the moment no specimens of *Metoponia*, Lw., for comparison but suggested *Allognosta* as a *nom. nov.* for Loew's genus. No proper diagnosis or differentiation from any other genus seems to have appeared. I possess in my collection both "*Metoponia vagans*, Lw.," as actually identified by that author, and several of the rather common *Allognosta fuscitarsis*, Say, from North America, but unfortunately they are not available for comparison in this country.

The present species is therefore retained in *Allognosta*, and the name *Anacanthoberis* is suggested if it should prove generically distinct.

Chorisops tibialis, Mg.

One ♀ of this commonly distributed European species occurs amongst some diptera sent me for examination by Dr. A. D. Imms. There can be no possible doubt of the identity. It is from Binsar, Kumaon District, Western Himalayas, 28-v-12, and is in perfect condition.

TABANIDAE.

Diachlorus fulvescens, mihi, sp. nov.

♀. Western Himalayas. Long. 11 mm.

Head.—Eyes sparsely and shortly, but distinctly hairy; frons between one-seventh and one-eighth the width of the head, with

parallel sides, and covered with close greyish yellow tomentum; a small, low vertical tubercle, devoid of ocelli.

An indistinct median dark narrow slightly irregular line and, at the lowest point of the frons, immediately abutting on the antennal tubercle, a bare dull black spot or callus.

Frons rather sparsely covered with yellow and black hairs, intermixed. The antennal protuberance is placed immediately below, and contiguous to, the lower angles of the eyes, and is covered with cinereous grey tomentum, and is rather low but distinctly obvious.

Face greyish yellow with very short black hairs just below the eyes, and longer yellow hairs on the lower side. The cheeks, which extend only a little below the level of the eyes, are concolorous, with yellow hair; the back of the head similar in colour, with very sparse and short yellow hairs. Antennae with 1st and 2nd joints approximately cup-shaped, of moderate size, the 1st a little the larger and longer; both thickly beset with both yellow and black bristles. The 3rd joint a little longer than the first two together, elongate conical, quite bare, with (apparently) four indistinct annulations dividing the joint into five parts, of which the first is the broadest and stoutest, equalling in length two-thirds of the third joint; the remainder of the divisions subequal to one another. The antennae are reddish brown except the apical half of the 3rd joint, which is blackish. Palpi normally tabaniform, robust, acutely conical, proboscis normal, both a little pubescent.

Thorax.—Blackish grey, dorsum and scutellum covered with short light yellow hair; sides of same colour, with longer yellow hair.

Abdomen.—Blackish, covered with pale yellow hairs which are more numerous on the apical half, and are nearly absent on the basal corners. Hind margins of segment, after the 1st, narrowly brownish yellow. Belly similar to dorsum.

Legs.—Reddish yellow; all coxae dark grey, major part of fore femora at least on under side, and about the basal third of posterior femora dark grey or blackish; tarsal joints black tipped, the colour deeper on the fore pair. Legs normally pubescent, with a little yellowish hair on the femora, shorter bright yellow hairs on tibiae mixed with short rows of microscopic bristly hairs.

Wings.—Pale grey, a little brownish yellow at base and along the costa; all the veins very faintly but just perceptibly infuscated, a perceptible infuscation across the middle of the wing from the costa, in a line with the cross veins, and a slight infuscation at the fork of the 3rd vein, where there is no appendix. Venation typically tabaniform; halteres black; squamae dirty white.

Described from a single perfect ♀ in the Indian Museum from Dha Kuri, Kumaon District (8,900 ft.), 29-v-09, taken by Dr. A. D. Imms.

N.B.—The example, on which the present species is founded, was returned by Miss Ricardo to the Indian Museum marked

Abdomen.—Dark brownish grey, with soft blackish hairs; extreme margins of segments pale; sides with whitish hairs; belly similar to dorsum.

Legs.—Dark brownish grey. A pale yellowish white ring just beyond base on fore tibiae; two rings, rather more whitish in colour, on middle tibiae, one placed beyond the base, the other beyond the middle; hind tibiae similarly banded. Major part of posterior metatarsi whitish.[1]

Wings.—Dark grey, stigma distinct but ill-defined. A whitish subapical streak across the wing from the tip of the 2nd longitudinal vein to that of the upper branch of the 4th vein; and the extreme tips of all the posterior cells (except, of course, the closed 6th cell) whitish.

The surface of the wing is covered with numerous small pale dots forming irregular and incomplete circles or rings. The most nearly complete of these rings is formed by two small spots just beyond and below the stigma, two each in both submarginal cells (beyond the furcation of the 3rd vein); these latter four being nearly in a line; two at about the middle of the 1st posterior cell, near its anterior margin, and two placed perpendicularly, before the middle of the 1st submarginal cell. In the centre of this ring is a triad of spots placed respectively before, beyond and above the basal section of the upper branch of the 3rd vein. A row of spots from just before the stigma stretching across the discal cell to the anal cell but not encroaching on it; a second row begins a little lower and more distad in the wings and runs nearly parallel to the first row. Another ring of spots lies over the first four posterior cells and the discal cell, enclosing in its centre a triad of spots placed respectively at the tip of the discal cell and at the base of both the 2nd and 3rd posterior cells. It must be noted that of this ring or rosette, the two spots forming its most proximal side also form part of the more distad row of spots crossing the discal cell.

A row of spots approximately parallel to the hind margin of the wing lies posterior to this second rosette of spots, constructed of about two spots in each posterior cell. Two continuous zigzag transverse lines across both anal and axillary cells; they being more or less continued anteriorly, in the form of subcontiguous spots, across the basal cells. Halteres blackish, squamae dirty grey.

Described from two ♂ ♂ in the Indian Museum from near Bhowali, Kumaon District (5700 ft.), July 1909, taken by Dr. A. D. Imms.

N.B.—According to Miss Ricardo's table of groups, this species falls in group V, but it is certainly distinct from any mentioned by her in that group. The wing-pattern has a great general

[1] Miss Ricardo erroneously uses the term "posterior tibiae" for "hind tibiae." The term "posterior" applies to the four hind legs taken together, as "anterior" legs refer only to the four front legs taken together and not to the first pair of legs alone. If not used in their correct sense these terms foster false conclusions.

"? new genus." The species is at least provisionally referred to *Diachlorus*, as it complies more nearly with the more important characters of that than with those of any other genus. Between *Diachlorus* and *Udenocera*, Ricardo, the differences consist (1) of the lengthened 1st antennal joint (nearly as long as the 3rd), in the latter genus, and (2) in the absence (*Diachlorus*) or presence (*Udenocera*) of the antennal protuberance. In *Diachlorus* the fore tibiae should be curved and slightly broadened, in *Udenocera* they are not so. This latter character is of doubtful generic value unless quite pronounced. Such characters as the presence or absence of small callosities on the face, the exact point in the vertical height of the head at which the antennae are inserted; and the comparative shape and relative size of the proboscis and palpi must be employed with much reserve when applied to the validity of genera. In profile, the head of my species considerably resembles the figure of Macquart's *Diabasis* (= *Diachlorus*) *scutellata* (Dipt. Exot. 1.), except that the head is much shorter below the eyes in my species than in his, and the annulations of the 3rd antennal joint much less distinct.

Haematopota albofasciatipennis, mihi, sp. nov.

(Pl. xxxvii, fig. 1.)

♂. Western Himalayas. Long. 7 mm.

Head.—Eyes with the upper, large facet light coffee-brown, the lower, smaller ones black. Frons pale grey tomentose, with a conspicuous velvet black spot immediately above the antennae, and a short narrow black line above it. Under side of head, comprising the face and cheeks, bluish ash grey with whitish hairs and numerous small black dots on the face.

Antennal 1st joint about as long as first annulation of 3rd joint, oblong, slightly thickened in middle, moderately pale blackish brown with a slight dusting of grey, and appearing wholly brownish when viewed from certain directions. The 2nd joint paler, very short; 3rd joint a little longer than 1st and 2nd together, bare, the first annulation reddish brown, the remainder blackish; the 1st and 2nd antennal joints with a little greyish hair.

Palpi pale dirty yellowish brown, almost whitish at the tips, with pale pubescence. Proboscis blackish; back of head dark grey.

Thorax.—Dorsum dark brownish grey, the colour sometimes (in one example) not reaching the margin on hinder half, and with a trace of paleness towards the sides at the transverse suture, and (in one example) around the humeral space. In the type specimen the dorsum is entirely blackish grey, except slightly paler on the transverse suture towards the sides, but a little grey dust appears on the posterior margin only when viewed from behind. There are three indistinct but obvious very narrow whitish grey longitudinal stripes. Scutellum blackish grey, concolorous with dorsum, with a few black hairs.

Abdomen.—Dark brownish grey, with soft blackish hairs; extreme margins of segments pale; sides with whitish hairs; belly similar to dorsum.

Legs.—Dark brownish grey. A pale yellowish white ring just beyond base on fore tibiae; two rings, rather more whitish in colour, on middle tibiae, one placed beyond the base, the other beyond the middle; hind tibiae similarly banded. Major part of posterior metatarsi whitish.[1]

Wings.—Dark grey, stigma distinct but ill-defined. A whitish subapical streak across the wing from the tip of the 2nd longitudinal vein to that of the upper branch of the 4th vein; and the extreme tips of all the posterior cells (except, of course, the closed 6th cell) whitish.

The surface of the wing is covered with numerous small pale dots forming irregular and incomplete circles or rings. The most nearly complete of these rings is formed by two small spots just beyond and below the stigma, two each in both submarginal cells (beyond the furcation of the 3rd vein); these latter four being nearly in a line; two at about the middle of the 1st posterior cell, near its anterior margin, and two placed perpendicularly, before the middle of the 1st submarginal cell. In the centre of this ring is a triad of spots placed respectively before, beyond and above the basal section of the upper branch of the 3rd vein. A row of spots from just before the stigma stretching across the discal cell to the anal cell but not encroaching on it; a second row begins a little lower and more distad in the wings and runs nearly parallel to the first row. Another ring of spots lies over the first four posterior cells and the discal cell, enclosing in its centre a triad of spots placed respectively at the tip of the discal cell and at the base of both the 2nd and 3rd posterior cells. It must be noted that of this ring or rosette, the two spots forming its most proximal side also form part of the more distad row of spots crossing the discal cell.

A row of spots approximately parallel to the hind margin of the wing lies posterior to this second rosette of spots, constructed of about two spots in each posterior cell. Two continuous zigzag transverse lines across both anal and axillary cells; they being more or less continued anteriorly, in the form of subcontiguous spots, across the basal cells. Halteres blackish, squamae dirty grey.

Described from two ♂ ♂ in the Indian Museum from near Bhowali, Kumaon District (5700 ft.), July 1909, taken by Dr. A. D. Imms.

N.B.—According to Miss Ricardo's table of groups, this species falls in group V, but it is certainly distinct from any mentioned by her in that group. The wing-pattern has a great general

[1] Miss Ricardo erroneously uses the term "posterior tibiae" for "hind tibiae." The term "posterior" applies to the four hind legs taken together, as "anterior" legs refer only to the four front legs taken together and not to the first pair of legs alone. If not used in their correct sense these terms foster false conclusions.

resemblance to her figure of *latifascia*, Ric. The position of the two rosettes or rings, each with an inner triad of spots similarly situated; the two transverse rows across the discal cell, etc., the outer row parallel to the hind margin of the wing; the subapical whitish band and whitish extremities to the posterior cells, also the two zigzag lines across the anal and axillary cells, are all more or less distinctly traceable in *latifascia*.

It seems quite possible therefore that the present species may prove to be the ♂ of *latifascia*, in spite of the apparent discrepancies in the relative lengths of the antennal joints. However, as the species was returned by Miss Ricordo herself to the Indian Museum as being probably new, I venture to characterize it as such.

Haematopotas triatipennis, mihi, sp. nov.

(Pl. xxxvii, fig. 2.)

♂. Western Himalayas. Long. 8 mm.

Head.—Eyes with upper facets bright chocolate brown, lower ones greenish black, with a narrow violet horizontal stripe. Frons ash grey, with a pair of contiguous pale livid yellowish calli immediately above the antennae, and occupying nearly all the frons. Face ash grey, with black hairs; proboscis reddish brown; palpi pale dirty brownish yellow with black pubescence. Antennae bright yellowish; 1st joint half as long as 3rd, only moderately thickened; 3rd joint slender, elongate, constricted immediately beyond base (1st annulation); apical part (the last three annulations) narrow, tip black. The 3rd joint at its greatest width is less wide than the 1st joint.

Thorax (stained).—In life, evidently dark ash grey; no trace of any dorsal stripes, though these may have been present. Sides of scutellum a little yellowish.

Abdomen.—Basal half dull brownish with a little yellowish tinge towards sides, apical half blackish, the whole surface with blackish brown hair. Belly similar, but much less pubescent.

Legs.—Coxae dark grey, fore pair a little lighter. Femora dark brown; tibiae brownish yellow, fore pair with apical half black; fore tarsi black, posterior tarsi brownish yellow, a little darker on the emarginations.

Wings.—Grey, except at extreme base; the costal cell very pale yellowish. No trace of rosettes of the usual pattern in this genus, but the wing is crossed transversely by six narrow whitish streaks situated as follows :—

The two first streaks begin at the upper margin of the 1st basal cell, thence crossing the two basal cells at equidistant points, the 1st streak ending at the 7th longitudinal vein, and the 2nd very nearly reaching the wing border, crossing the anal and axillary cells at the centres. The 3rd streak begins at the upper margin of 2nd submarginal cell, passing through the discal cell where this section of the streak is "interrupted," being placed

a little but quite distinctly more proximad. The streak continues through the 4th posterior cell before the middle of the latter, and ends broadly in a widened state at the 5th longitudinal vein a little before the margin of the wing. The 4th streak begins on the costa, immediately beyond the stigma, crosses the 1st submarginal and 1st posterior cells about their centres, crosses the 2nd posterior cell before the middle, and the 3rd at its middle, where it becomes bifid; a small single elongate spot in the 4th posterior cell marking its termination. The 5th streak, which is rather narrower than the others, runs from the lower branch of the 2nd longitudinal vein, near the tip of the wing, to the upper branch of the 4th longitudinal, also near its tip, crossing the 2nd submarginal cell just before its middle. The 6th streak very short and subapical, from immediately before the tip of the 1st submarginal cell to about half way down the 2nd submarginal. Between the 4th and 5th and the 5th and 6th streaks is a small whitish elongate spot near the wing margin. Halteres black (apparently discoloured).

Described from a single ♂ in the Indian Museum from Dehra Dun (foot of Mussoorie Hills) taken 17-1-10, and presented by Dr. A. D. Imms.

N.B.—Easily known from all other oriental species in the genus by the six whitish narrow streaks on the wings in place of the usual rosettes.

It falls in Miss Ricardo's Division II.

LEPTIDAE.

Rhachicerus bicolor, mihi, sp. nov.

♀. Ceylon. Long. 8½ mm.

Head.—Frons nearly ⅓ width of head, shining black, bare; 3 small yellow ocelli at vertex; eyes blackish, bare. Proboscis bright yellow, palpi of similar colour, very small. A whitish triangular spot on each side between the eyes and the base of the antennae. Antennal 1st and 2nd joints black, 2nd with a circlet of black and yellow bristles around its tip; flagellar 1st joint much wider than the rest, which are blackish brown, the comb-like prolongations on the under side, bright yellow. (The antennae being incomplete, the exact number of joints cannot be given).

Thorax and scutellum, wholly shining black, practically bare, humeri conspicuous, bright yellow.

Abdomen black. Dorsum of first three segments mainly yellow, the borders being black, the 4th segment more or less yellow in the centre. Belly principally yellow on the first three segments; remainder blackish.

Legs.—Bright yellow, hind coxae black.

Wings.—Venation as in *Xylomyia*. Grey, a hardly perceptible darkening from the costa partly across the wing, and again towards the tip. Halteres bright yellow.

Described from one ♀ in good condition in my collection from Kandy, v-09, sent by Mr. E. E. Green.

DESMOMYIA, mihi, gen. nov.

Sub-fam. *Arthroceratinae.*

Apparently near, but quite distinct in several characters from *Arthroceras.*[1] Five posterior cells, 4th without any trace of contraction towards wing border; anal cell closed just before wing border. Remainder of venation in accordance with Williston's fig. of *Arthroceras* wing.[2] Antennae elongate, 1st joint as long as 2nd and 3rd together, cylindrical, 2nd broadly annular, 3rd elongate with an apical style-like prolongation. Eyes contiguous for a considerable distance, bare; 3 ocelli. Proboscis rather short, stout, cylindrical; palpi elongate, narrow. Face with two dividing furrows below antennae and rather bulbous cheeks, as in *Arthroceras.* General appearance of whole insect, that of a *Thereva*, soft pubescence on thorax and abdomen, the latter with seven distinct segments. Fore tibiae unarmed, posterior tibiae with two distinct pale spurs each. Legs slender, thereviform.

Desmomyia thereviformis, mihi, sp. nov.

♂. Western Himalayas. Long. 5—6 mm.

Head.—Vertex small, dark; three ocelli; occiput of a lighter grey than the dark blackish grey face. Proboscis and palpi blackish grey. The whole head with stiff black hairs Eyes bare. Antennae dark grey, 1st joint elongate, cylindrical, 2nd broadly annular, half the length of the 1st, the 3rd joint is best described as diamond shaped, with rounded angles, the greatest breadth beyond the middle; the tip produced into an elongate narrow style with blunted tip, the style as long as the whole antennae.

Thorax.—Dorsum dark grey, with three separated, moderately broad blackish stripes, the outer ones with a tendency to an interruption in front of the middle. Sides and scutellum moderately dark grey, with pale yellowish white soft pubescence.

Abdomen.—Seven segmented, the second the broadest, dark blackish grey with pale yellowish white soft pubescence. Genitalia small, inconspicuous.

Legs.—Black; knees and femora more or less at base brownish yellow, the colour on the fore pair extending beyond the middle. Hind tibiae widened towards tips, hind metatarsus distinctly incrassate. The whole of the legs shortly pubescent, anterior tibiae unarmed, posterior tibiae with two distinct yellowish spines.

Wings as in *Leptis*, except that the anal cell is closed just before the border, pale grey, stigma blackish, very elongate. Two

[1] The description of this genus is not accessible in this country.
[2] North American Diptera (3rd Ed.), p. 161, fig. 18.

indistinct pale blackish suffusions, the first, from the origin of the 2nd vien, embracing the anterior cross-vein, the base of the discal cell, and the posterior cross-vein. The second runs from the fork of the 3rd vein to the hinder side of the discal cell, along its outer side. Costal cell rather broad, the costa curving outwards slightly. Halteres brownish yellow.

Described from two ♂ ♂ in the Indian Museum, taken by Dr. A. D. Imms at Badrinath, Gahrwal District (10,200 ft.), 27-v-10.

Atherix caerulescens, mihi, sp. nov.

(Pl. xxxvii, fig. 3.)

♀. Darjiling District. Long. 6 mm.

Head.—Blackish, mainly bluish grey dusted. Frons, from the ocelli downwards for three fourths of the distance to the antennae, shining black, bare, in which colour is inset a deep dull velvet black triangle, its base on the lower margin of the shining part. Antennae black, bluish grey dusted, 3rd joint dull reddish yellow. Mouth parts bluish grey dusted.

Thorax.—Blackish, a little shining bluish grey reflection. Two not very obvious whitish dorsal stripes, and there are greyish reflections on the shoulders, posterior corners and elsewhere, viewed in certain lights. A few soft black hairs on dorsum. Sides, pleurae and scutellum concolorous, a little yellowish behind the thoracic stigma.

Abdomen.—Blackish, barely shining, with short sparse greyish pubescence; 1st segment bluish grey dusted; 5th and 6th with light bluish grey hind margins. Belly mainly blackish.

Legs.—Black, minutely pubescent, coxae bluish grey dusted.

Wings.—Very pale grey. Across the centre a reversed triangular brown spot reaching from the costa to the hind margin, where its apex meets the tip of the closed anal cell. The colour fills most of the discal cell and crosses the tip of the upper basal cell. Following the discal margin of this brown triangle (at a distance leaving a moderately wide intermediate clear band) is the proximal margin of a second, large brown band which fills thence the whole of the discal part of the wing. A brown streak in the middle of each basal cell. Stigma dark brown, filling distal half of cell. Halteres yellow, clubs black.

Described from a perfect ♀ in the Indian Museum collection from Kurseong (5000 ft.), 6-ix-09 [*Annandale*].

Leptis discoidalis, mihi, sp. nov.

♀. Darjiling. Long. 3 mm.

Head.—Blackish, vertex black, frons blue-grey dusted; antennae and proboscis moderately dark brown, palpi black. Back of head bluish grey.

Thorax and scutellum clear shining brown, humeri, sides and metanotum a little lighter.

Abdomen darker brown, with short, pale pubescence, posterior margin of segments with a not very distinct blackish band. Genitalia small, short, cylindrical, with two small terminal lamellae.

Legs pale brownish yellow, microscopically pubescent.

Wings pale brown; discal cell, 2nd basal cell, 5th posterior cell and all the wing posterior to these cells, nearly clear. No distinct stigma but the region along both sides of the 1st longitudinal vein, blackish. Halteres dark brown.

Described from two ♀ ♀ in the Indian Museum, Kurseong (5000 ft.), 7-vii-08 (*type*), and Darjiling (7000 ft.), 7-viii-09, the latter taken by Mr. C. Paiva.

Leptis unicolor mihi, sp. nov.

♂. Darjiling. Long. 5 mm.

Head.—Eyes contiguous for half the distance from vertex to antennae. Frons dark blackish grey, ocellar triangle small, ocelli distinct, the vertex grooved each side of the middle, near the eye. Back of head grey, posterior ocular orbit with a fringe of delicate pale yellow hairs. Antennae yellow, tip of 3rd joint, with its arista, black; 1st and 2nd joints short, 3rd subconical. Proboscis relatively small, and much more slender than in most species; yellow, as are the rather distinct elongate palpi, bearing black bristly hair.

Thorax.—Uniformly light brownish yellow. In certain lights small quadrate grey reflections on the shoulders, and a distinct whitish grey broad horizontal stripe across the pleurae.

Abdomen.—Concolorous; both thorax and abdomen with very sparse short pale hairs; belly similar.

Legs.—Coxae and femora concolorous; knees narrowly brown; tibiae a little darker brownish yellow, becoming nearly or quite brown at the tips; tarsi dark brown. Legs minutely pubescent.

Wings.—Uniformly pale yellowish grey. The 2nd posterior cell narrow, the sides almost parallel; anterior cross-vein before one-fourth of the discal cell; branches of 4th longitudinal vein issuing from discal cell well separated; and cell widely open. Halteres light brownish yellow.

Described from a single perfect ♂ in the Indian Museum labelled simply "Darjiling." A very clean-looking, graceful yellow species.

Chrysopilus helvolus, Meig.

A specimen in the Indian Museum from Kurseong taken 8-vii-08 is very close to if not identical with this European species, so much so that I hesitate to give it a name even as a variety. The femora are nearly bare and more yellowish, with the slight greyish minute pubescence of *helvolus*, and their tips are narrowly blackish. The colour of the abdominal pubescence is a richer

deeper golden yellow and the wings are practically clear. In all other respects it agrees absolutely when placed side by side with a European specimen of Meigen's species.

Chrysopilus maculipennis, Walk.

(*Redescription.*)

♀. Borneo. Long. 6 mm.

Head.—Blackish grey; frons $\frac{1}{4}$ to $\frac{1}{5}$ the width of the head, with a distinct median groove; ocellar triangle concolorous, distinct. Proboscis blackish grey, labella arge, conspicuous, brownish yellow, a little pubescent; palpi black, pubescent. Antennae blackish grey; 1st joint nearly bare, 2nd with a few stiff black hairs, 3rd with soft grey hairs, arista long, black, microscopically pubescent.

Thorax.—Ground colour blackish; originally undoubtedly covered with bright golden yellow pubescence (greatly denuded in the present specimen). The surface is also clothed with small bright emerald green scale-like hairs, which also extend over the scutellum. Sides grey, pleurae with a rather bluish grey tinge. Scutellum black, brownish yellow on hind margin.

Abdomen blackish; posterior margins of segments with a moderately broad, yellowish brown, well-defined band, apical segments yellow, genital organ blackish, elongate.

Legs.—Fore coxae yellowish, posterior coxae blackish grey; femora brownish yellow, tibiae blackish yellow, tarsi black.

Wings.—Very pale grey, with blackish grey markings, in a general way resembling my *C. marmoratus*. Stigma black but not distinctly defined from the transverse median band that runs from the costa to the hind margin of the wing, gradually diminishing in width, embracing the base of the upper branch of the 3rd longitudinal vein, the distal third of the discal cell, crossing, in narrowed width, the 4th posterior cell, widening abruptly behind the last branch of the 4th longitudinal vein. A narrower band of similar colour and irregular width begins at the base of the 2nd longitudinal vein, crossing the anterior cross vein, the basal third of the discal cell, the posterior cross-vein, following the 5th longitudinal vein to the wing margin, and filling nearly the apical half of the anal cell. A third band begins on the costa near the wing tip, moderately broad, passing over the sub-marginal cell, which it fills, with the exception of the extreme base and tip, joining the median band proximally. Beyond the lower branch of the 3rd vein it abruptly becomes very narrow, and passes over the middle of the 2nd and 3rd posterior cells in widened form. The wing immediately in front of the stigma is distinctly yellowish. Halteres yellowish.

Redescribed from a single ♀ in the Indian Museum, perfect except for the denudation of the thorax. It was taken at Mujang, Sarawak, by Mr. C. W. Beebe, 12-vii-10.

N.B.—This specimen can hardly fail to be the *maculipennis* of Walker, the description agreeing exactly throughout except that he speaks of the proboscis as yellowish, for which I anticipate he has mistaken the conspicuous yellowish labella.

Chrysopilas humeralis, mihi, sp. nov.

♂. Darjiling. Long. 6 mm.

Head.—Eyes practically contiguous for the greater part of their length above the antennae, leaving a narrowly elongate frons of the shape of an isosceles triangle, which is bluish grey; ocellar protuberance blackish, occiput dark grey; face narrowly triangular, bluish grey. Antennae brownish yellow, proboscis and palpi similar, the latter rather darker, both with yellow hairs.

Thorax.—Shining blackish with pale yellow hairs; shoulders livid yellow; pleurae dark bluish grey varying to blackish; scutellum and metanotum blackish.

Abdomen.—Blackish, with pale pubescence; the major part of the basal half yellowish, leaving generally a narrow anterior and posterior blackish margin of varying width to each segment; about the apical half of the abdomen all black. Belly similar to upper side.

Legs.—Coxae and femora yellowish, apical half, more or less, of fore and hind femora blackish or quite black; remainder of legs dark brown.

Wings.—Grey, no stigma; a very slight brownish darkening about the fork of the 2nd longitudinal vein, continued in diminished intensity along a further or lesser part of the marginal cell. Halteres yellowish with blackish brown knobs.

Described from 3 ♂ ♂ in the Indian Museum from Chumbi, Darjiling District (4000 ft.), July 1911 [*Gravely*].

BOMBYLIDAE.

Hyperalonia semifuscata, mihi, sp. nov.

(Pl. xxxvii, fig. 4.)

♀. Bombay Presidency. Long. 10 mm.

Head much developed behind eyes. Frons one-third of head at level of antennae, narrowing at vertex to half this width; blackish, with yellowish scales and long black hairs. Face with brighter and thicker yellow hair, mouth border broadly orange yellow, with yellow hairs. Proboscis dark brown. Antennae reddish brown, 3rd joint very elongo-conical, with distinct style. Back of head blackish, with some pale yellow scales on orbital margin and with black and yellow hairs over the central part.

Thorax.—Black. Front part of dorsum and around and below shoulders with thick long bright yellow scale-like hairs; centre of dorsum with only sparse short yellow and black hairs. Below the wing the hair is nearly white and bristly, behind the

wing bright yellow and bristly. Some strong and very long black bristles on posterior corners of dorsum, and two or three (or thereabouts) before the wing. Scutellum dull reddish brown with sparse depressed short yellow hairs, erect short black hairs, and a row of black bristles along hind border.

Abdomen black, with uniformly distributed short black hairs, 3rd, 6th and 7th segments each with a band of dirty white small scales occupying the greater part of their dorsal surfaces, the bands on the 6th and 7th segments less conspicuous. Sides of 1st and 2nd segments with long scale like yellow hairs. Belly blackish with yellowish pubescence, the basal part a little paler with whitish hairs.

Legs.—Coxae black, femora brownish yellow, hind pair blackish towards tips; tibiae a little darker brown, hind tibiae and all tarsi black. The whole of the legs with minute sparse black bristles and microscopic pubescence.

Wings dark grey, the anterior half (about), except at tips, moderately dark blackish brown, the colour insensibly dying away along the veins behind the middle of the wing. Halteres yellowish.

Described from two ♀ ♀ from Mahabaleshwar, Satara District, Bombay Presidency, 4200 ft., 13—16-iv-12 [*Gravely*]. In the Indian Museum.

Notes on the **Exoprosopa vitrea**, Big., group.

At the time of publishing my revision of the Oriental species of this family (Jan. 1909), *E. vitrea*, Big., was the only species of the genus in the East with absolutely hyaline wings. However, a careful study of a number of specimens has led me to believe that either there are two or three closely allied species, or else *vitrea* is very variable. One form is therefore set up as a good species, with a certain amount of reservation. The points of difference between my interpretation of *vitrea*, my new species, and a third form, as they appear to me at present, are as follows:—

1. **E. vitrea**, Big. (1) Antennae black, reddish at base: (2) wings brownish yellow on anterior part, costal cell generally concolorous, but exceptions with practically clear wings occur: (3) yellowish hair on anterior part of thorax[1]: (4) scutellum practically, always wholly red: (5) sides of abdomen distinctly reddish or reddish brown, the colour varying in intensity and extent, spreading over more or less of the first four segments,[2] but exceptions occur in which no reddish colour can be perceived.
2. **E. vitripennis**, sp. nov. (1) Antennae wholly reddish brown: (2) wings wholly clear: (3) whitish grey

[1] This applies really to the whole thorax, but, although specimens are frequently more or less denuded of pubescence there is in most cases sufficient left along the anterior margin to decide its colour.

[2] Bigot said "first two" segments, but this is a character likely to be found a variable one.

hair on anterior margin of thorax: (4) scutellum wholly black: (5) sides of abdomen wholly black.

3. **E.** *form*, ♀ sp. nov. (1) Antennae wholly black: (2) wings quite clear, except for a little yellowish in the subcostal cell: (3) black hair on anterior margin of thorax: (4) scutellum very dark, reddish brown, nearly black: (5) sides of abdomen so closely covered with dense white scales that its ground colour is not properly visible, but I am under the impression that the sides are red, as in vitrea.

Unfortunately only one specimen each of my new species and the uncertain form is available but what I take to be *vitrea*, Big., is represented by several, including a pair taken *in cop*. The third form has the appearance of having been wetted (at least its head and thorax) so that I view it with some suspicion, but the abdomen appears in good condition.

On the assumption of my correct identification of *vitrea*, Big., I have ventured to redescribe it.

Exoprosopa vitrea, Big.

(Pl. xxxvii, fig. 5.)

Redescription.

♂ ♀. Bombay Presidency. Long. 7—12 mm.

Head.—Frons at level of antennae barely one-third of the head, narrowing to nearly one-third of that width at vertex in ♂ and to half that width in ♀; black with black hairs; the lower half with bright yellow short scales. Face with similar scales and a few short bright yellow hairs; facial bump fairly large; mouth border pale whitish yellow. Proboscis black, antennae black, no trace of lighter colour. Back of head moderately protruding, black, an irregular narrow fringe immediately behind the eyes of very small greyish white scales lying close to the surface; hind margin of head with a fringe of short yellow or yellowish white hairs.

Thorax.—Ground colour dark blackish brown. Anterior margin and shoulders with thick scale-like bright yellow hairs. This hair is continued around the whole of the prothorax, but in the ♂ it is *quite black* for a considerable space on the lower part (immediately below the mouth), whereas in the ♀ it is sometimes uniformly yellow and sometimes similar to the ♂. Surface of dorsum covered with short depressed brownish yellow hairs, pleurae with yellowish grey or grey hair, there is also some around the base of the wing.

Abdomen.—Black, with very short depressed bright yellow hairs and black pubescence in the ♂; the sides of the 2nd, 3rd and 4th segments are broadly and completely covered with small snow white depressed scales, which also form an entire band across the

basal half of the two latter segments. These scales are practically absent in the ♀ but a few are usually present. Belly blackish, the middle part a little paler, generally with a considerable space covered with soft short white hairs; tip inclined to be reddish. A considerable amount of white hairs in both sexes at anterior corners of abdomen.

Legs.—Wholly black, with the usual fine pubescence and very short black bristles.

Wings clear, costal and subcostal cells very pale yellowish grey; halteres pale yellow.

Redescribed from a ♂ and ♀ *in cop* from Helwak, Koyna Valley, Satara District, 2000 ft., 28—30-iv-12, and several others of both sexes from other localities in the same neighbourhood, up to 3500 ft. and from the 23rd to the 30th. The ♂ and ♀ taken *in cop* are only 7 mm. long, but the species varies up to 12 mm. The degree of yellow hair on the abdomen and the extent of the white scales are both variable.

Exoprosopa vitripennis, mihi, sp. nov.

♂. Bombay Presidency. Long. 10 mm.

Head.—Frons above antennae nearly one-third of the head lessening to one-third of that width at the vertex; shining black with short black pubescence and pale whitish yellow scales above the antennae and over the shining black face also. These scales show prismatic colours in certain lights. Antennae dark brownish yellow, 3rd joint ending in a fine point. Oral opening whitish yellow, bare, or with a few very short pale yellow hairs. Proboscis rather long, blackish, palpi black, curved, very slender, with short hairs. Occiput and under side of head black, a few scales closely pressed to the surface, behind the eyes.

Thorax.—Shining black, with milk-white bristly hairs on the sides, anterior border of dorsum and around the wings. Scutellum dull coffee brown, some small white scales below its hind margin, closely applied.

Abdomen black, moderately shining, almost bare; small milk-white scales at the bases of the segments towards the sides. Belly black, with the basal part of most of the segments covered with small snow-white scales.

Legs.—Wholly black, except for a little dull-brown reflection of the tibiae in certain lights.

Wings.—Absolutely clear, vitreous, highly iridescent, costal, auxiliary and 1st longitudinal veins and those at base of wing yellowish, the remainder black; halteres yellow.

Described from a single ♂ from Mahabaleshwar, Satara District, Bombay Presidency, 4200 ft., 13—16-iv-12 [*Gravely*].

N.B.—Very near *vitrea*, Big., differing by the wholly reddish brown antennae; the whitish hair on anterior margin of thorax; the wholly black scutellum; the wholly clear wings; and the absence of any reddish colour towards the sides of the dorsum.

Argyramoeba argentiapicalis, mihi, sp. nov.

(Pl. xxxvii, fig. 6).

♀. Bombay Presidency. Long. 5—7 mm.

Head.—Frons at level of antennae rather less than one-third width of head, black with black hairs, with which are intermixed on the lower part some dirty greyish scales. Antennae black; normal. Face black with thick black bristly pubescence and some greyish scales. Proboscis dark, mouth opening very narrowly pale. Back of head wholly black.

Thorax.—Blackish or blackish grey with very short black pubescence and with mainly black bristly hairs on anterior margin, around the wings, and about the shoulders and pleurae. A little grey hair intermixed adjacent to the head.

Abdomen.—Black, shortly black pubescent. A spot formed of silvery white scales towards the sides, on the hind borders of 1st and 2nd segments. A few intermediate scales suggest the possibility that in some specimens the whole hind border of at least the 2nd segment may be similarly scaled. The tip of the abdomen (two segments) is covered with very conspicuous, elongate, shining silvery white scales, which are sparser or nearly absent on the median line. Belly black, black pubescent; genitalia comparatively prominent, dull brown, consisting of a pair of large lamellae and other parts. Anterior corners of abdomen with copious greyish white hair; sides with black hair.

Legs.—Femora black, bearing a little sheen through the presence of very small greyish, closely impressed scales; tibiae and tarsi reddish brown. The usual pubescence.

Wings.—Clear, more than the basal half dark brown; the line of demarcation, which is emarginate at each of the veins it crosses, running from the tip of the 1st longitudinal vein to the middle (on wing margin) of the last posterior cell; thus passing distad of the base of the 3rd vein and the discal cell. Anal cell closed just before or actually on the wing margin. The endings of the 4th longitudinal vein are liable to variation, as in the type there is an extra cell formed below the discal cell (in one wing only), caused by the upper prong of the lower branch of the 4th vein curving towards and joining the lower prong, thus closing the 4th posterior cell. In the dark part of the wing are small lighter yellowish spaces irregularly disposed. Halteres black.

Described from three ♀ ♀ from Mahabaleshwar, Satara District, 4200 ft., 13—16-iv-12 [*Gravely*]. In the Indian Museum.

Argyramoeba gestroi, mihi, sp. nov.

(Pl. xxxvii, fig. 7).

♂. Bombay Presidency. Long. 6—8 mm.

Head.—Frons immediately above antennae one-third the width of the head, diminishing to half that width at vertex; covered

not very closely with elongate bright yellow hair-like scales, these being absent towards the vertex; also with stiff black hairs from vertex down to and below antennae. Antennae blackish grey, 3rd joint shortly conical, with rather long style, and the usual pencil of short hairs at tip. Underside of head black, some stiff black hairs and a small quantity of deeper yellow hair-like scales on each side below, but not contiguous to, base of antennae. Mouth opening small, black. Occiput rather widely produced behind eyes, black, with a patch of small yellow scales behind the middle of each eye, and a fringe of very thick short dark brown hair at hinder margin of occiput.

Thorax (somewhat denuded), black, with moderately thick bright yellow and whitish grey bristly scale-like hairs intermixed, around the shoulders, the sides and anterior margin of dorsum, the whitish grey scaly hairs in this latter part being more prominent. Surface of dorsum with very short recumbent bright yellow hair. The usual strong bristles towards the sides; a certain quantity of stiff black hairs on anterior and posterior parts of thorax, whilst the dorsum is lightly covered with softer sparser black pubescence. Scutellum blackish, sometimes dull reddish brown, with very short recumbent bright yellow hairs and soft black pubescence, and a row of about twelve long curved brownish yellow bristles on posterior margin.

Abdomen.—Blackish, with short bright yellow recumbent hairs and longer yellow bristly hairs more or less in a row towards the hind border of each segment. At each side at the base of the abdomen, a large bunch of milk-white long scale-like bristly hairs, the edges of the segments bearing rather thick yellow bristly hairs, with some long black similar hairs about the middle of the actual edges of each segment. The last three or four segments bear some large milk-white elongate scales and isolated similar scales are attached here and there towards the sides of the posterior margins of some of the other segments. Belly blackish, with rather thick yellow and white hairs on the posterior borders of all the segments. Genitalia rather large, concealed, brownish yellow, apparently consisting of a pair of plates.

Legs.—Coxae and femora dark brown; fore coxae, at least, with a little yellow hair and black bristles; tibiae and tarsi brownish yellow, both, with the femora also, with very short bristles.

Wings hyaline. Basal half of wing blackish brown, the limits of the colour forming an irregular diagonal line from the fork of the 2nd longitudinal vein (which is immediately above the anterior cross-vein) towards the anal margin of the wing (though the colour dies away at the border), and just enclosing the base of the discal cell and the posterior cross-vein. Costal and subcostal cells blackish brown to their tips; a semi-hyaline elongate spot in marginal cell immediately proximad of fork of 2nd longitudinal vein, another similar spot just below it, in first basal cell, in which same cell there is a third similar spot towards its base.

An irregularly-shaped semi-hyaline spot of some little size at upper outer angle of 2nd basal cell. Halteres yellowish, with whitish clubs.

Described from several specimens in the Indian Museum from Medha, Yenna Valley, Satara District, 2200 ft., 17–23-iv-12 [*Gravely*].

N.B.—This species is very near *A.* ("*Anthrax*") *carbo*, Rond., but Prof. Gestro has very kindly compared a specimen with the type of Rondani's *carbo* in the Genoa Museum and pronounced it quite distinct, in spite of the similarity of characters contained in the description of that species. It is with pleasure therefore that I name the present species after Prof. Gestro.

Systoechus nivalis, mihi, sp. nov.

♂. Western Himalayas. Long. 10 mm.

Head.—Frons and face blackish grey, darker above, both thickly covered with long black bristly hairs. Antennae rather long, black, 1st and 3rd joints subequal, each about three times as long as the 2nd; 1st two joints cylindrical, 3rd much slenderer on apical half. Proboscis very long, labium reaching to the middle of the abdomen (actually bent backwards to this distance below the body in the type), the tip bifid; labrum shorter; palpi extremely short and slender but distinct. Underside of head dark grey, with whitish hair.

Thorax and *abdomen* closely covered with pale yellowish grey hairs, which is more yellowish on anterior part of former, and whitish on the pleurae and apical part of abdomen. Underside of thorax and abdomen with whitish hair.

Legs black; tibiae from the base, for the major part of their length, brownish yellow.

Wings pale grey, costal cell a little darker grey; base of wing a little yellowish.

Described from one ♂ from Airadeo, Kumaon District, 31-v-12 [*Imms*].

Type in Indian Museum, presented by Dr. Imms.

CYRTIDAE.

Pialea auripila, mihi, sp. nov.

♂. Darjiling District. Long. 12 mm.

Head.—About half the full height of the thorax. Eyes closely touching from the extremely small vertex to the base of the antennae, rather densely covered with long brownish yellow hair. Vertical triangle with three ocelli, slightly elevated. Occiput much flattened, with brownish yellow hairs. Proboscis very short, subconical, blackish, with some yellow hairs at tip; palpi not obvious. Frontal triangle black, very small, projecting over

basal joints of antennae; which are short, a little broader at tip, blackish, with black bristles; the 3rd joint of the shape of an elongated leaf, flattened, with obtuse tips, three times as long as the two basal joints together, yellowish, with dark brown lower margins.

Thorax.—High, robust, nearly quadrate; ground colour dark shining brown, closely covered with rather long thick bright golden yellow hair. Scutellum and metanotum concolorous in ground colour and hair with the dorsum. Sides of thorax dull yellowish, with long thick golden yellow hair. A little brownish hair is intermixed here and there with the yellow hair of the thorax.

Abdomen.—Robust, thickened, longer than thorax, oblongo-conical, tip jointed Brownish yellow, 1st segment very short; the dorsum of each segment mainly occupied by a large semi-circular dark brown spot at the base, and extending in the middle of the segment to the hind margin, leaving the sides of the segments mainly yellow; 5th and 6th segments all black, the latter very small. Belly blackish brown, practically bare, emargination of segments narrowly yellow. The whole upper side of the abdomen with bright golden yellow hair, which is brownish towards the tip.

Legs.—Coxae half as long as femora, yellowish with pale yellow hairs. Tibiae (which are a little longer than the femora) and tarsi black, with blackish brown hair; under side of tibiae brownish yellow, and emarginations of the tarsal joints below, narrowly yellowish. Tibiae a little broadened at tips, where they end in a small blunt tooth-like projection on the outer side. Tarsi a little longer than tibiae, base of metatarsus (which is equal in length to the rest of the tarsus) pale yellow.

Wings.—Barely as long as abdomen, rather broad, tip rounded, pale grey, costal vein very distinct, ending at tip of lower branch of 3rd vein, immediately before the extreme tip of the wing. Auxiliary (subcostal) and 1st longitudinal veins thick, the former ending at about two-thirds of the wing, the latter a little beyond it, both nearly straight, distinctly separate (though approximate) from just beyond the humeral cross-vein. The 2nd and 3rd longitudinals with the anterior cross-vein have the appearance of springing from a common stem (or else the 3rd longitudinal and the anterior cross-vein spring simultaneously from the 2nd vein at a little beyond its base). The 2nd vein is nearly straight, but curved upward at its tip, to the costa. The 3rd vein is nearly straight, and in a straight line with the basal section (the "common stem") of the 2nd, and, at about two thirds of its length, it forks widely; the upper branch (which becomes suddenly much thinner) being again forked before half its length, the two prongs ending in the costa distinctly before the wing tip. The lower branch is short and ends in the upper branch of the 4th vein. The anterior cross-vein is a little shorter than the basal section of the 2nd longitudinal vein (or the "common stem"). The 4th longitudinal vein forks just before the anterior cross vein, the upper branch nearly straight, turning up slightly on quitting the

discal cell, meeting the lower branch of the 3rd vein and just failing to reach the wing margin.

The lower branch of the 4th vein is also nearly straight, diverging slightly from the upper branch, so that the discal cell is broader distally than at its base (which is pointed); and it is forked at the middle of the discal cell, the upper prong turning upwards at an obtuse angle, forming the distal side of the discal cell; unless this section be regarded as a discal cross-vein whilst the lower prong is recurved upward at a sharp acute angle (where there is a very short appendix), meeting the angle of the upper prong which forms the distal lower corner of the discal cell.

The posterior cross-vein is very oblique, and placed at the forking of the lower branch of the 4th vein; and is about as long as the anterior cross-vein. The 5th longitudinal is thickened, rather suddenly bent at its junction with the posterior cross-vein; meeting the 6th a little before the wing border, with a trace of a very small appendix at their union; the 6th vein is slightly curved, the 7th is indistinct but present, short, not reaching the wing margin.

The first basal cell is rather large and broad, bounded distally by the anterior cross-vien, the 2nd basal cell is much longer and narrower, bounded distally by the posterior cross-vein; the discal cell elongate, about 3½ times longer than its greatest breadth. The 1st submarginal cell nearly as long as the marginal, and narrowed at the wing margin, the 2nd submarg nal cell small, sub-conical, the 3rd submarginal cell of irregular shape, fairly large, bounded proximally by the two branches of the 3rd vein.

The 1st posterior cell is closed by the lower branch of the 3rd vein; the 2nd posterior cell is large, of irregular shape, nearly as large as the 3rd submarginal; the 3rd posterior cell is small, closed some distance before the border; the 4th posterior cell is large, much broader at the wing margin; the anal cell closed distinctly before the wing border; the axillary cell large, the 2nd axillary or spurious cell narrow

Alulae very small, squamae pale yellowish, the upper ones small, the lower ones very large and pubescent. Halteres yellowish.

Described from a single perfect ♂ in the Indian Museum from Kurseong (6000 ft.), 26-viii-09 [*D'Abreu*].

N.B.—There is little doubt that this species belongs to *Pialea*, although the venation offers a slight difference to Westwood's figure. That author also illustrates what appears to be three short basal joints to the antennae, and I can only suppose the first of these supposed joints is really the frontal triangle, which, projecting forwards, would from a side view appear much as an antennal joint. Westwood was however so careful and precise an observer that I may be mistaken in supposing him in error. The abdomen of *lomata*[1] is quite differently shaped to that of my species,

[1] Trans. Ent. Soc. Lond. (1876), pl. vi. *P. lomata*, Erichs (as *P. lutescens*, Westw. sp. nov.), the only other known species (from Brazil).

being much broader in the middle. The very peculiarly-shaped antennae however, the very short proboscis and head generally, in combination with a practically identical venation makes me refrain from setting up a new genus, and characters of structure are therefore included in the present description.

As regards the identity of the veins, it may be considered that my short lower branch of the 3rd vein is really an upper (erect if not slightly recurved) branch of the anterior branch of the 4th vein, but its thickness (corresponding with the major part of the 3rd vein) and its direction give every appearance of it belonging to the 3rd vein. The outer side of the discal cell may be regarded as the discal cross vein, and the small closed elongate cell below the discal cell, as being formed by the upper prong of the lower branch of the 4th vein turning down into the lower prong, thus closing what must be considered the 3rd posterior cell. As several of the veins fail to reach the wing margin it is clear that the 3rd submarginal, 2nd and 4th posterior and anal cells are all narrowly united at the wing margin.

Pterodontia dorsolineata, mihi, sp. nov.

(Pl. xxxvii, figs. 8, 9, 10).

♀. Upper Burma. Long. 7 mm.

Head.—Eyes very large, black, closely contiguous, rather thickly pubescent; occiput moderately puffed out, dark grey; vertex small, three dull red ocelli. Antennae yellowish, the three joints nearly equal in length, but the 3rd rather the longest, with three very long straight bristly hairs at tip. Proboscis distinct, but short, cylindrical, pale yellow.

Thorax.—Brownish yellow, the dorsum mainly occupied by a large black shining spot, which is continued forward as a stripe as far as the anterior margin. Sides of thorax below dorsum black, except the mesopleura, which is brownish yellow, with a square black spot in the middle. The whole thorax covered with brown or yellowish hair, concolorous with the colour of the surface. Scutellum brownish yellow, pubescent, a large basal nearly circular black spot.

Abdomen.—Brownish yellow, 1st segment all black; 2nd all black except towards the sides; 3rd, 4th and 5th with a black spot on each segment, widest in front, extending from fore to hind margin, except on the 5th segment, where the spot fails to reach the latter. These spots form, with the black colour of the 2nd segment, a conspicuous, clear-cut, dorsal band of irregular width. The 6th segment wholly black. On each of the 2nd, 3rd, 4th and 5th segments is a subquadrate black spot placed contiguous to the anterior and lateral margins. Belly yellowish, the segments faintly emarginate with brown, unmarked. The whole abdomen is brown or yellow pubescent, concolorous with the colour of the surface.

Legs.—Wholly yellowish, except the blackish coxae. The middle femora and tibiae are distinctly longer than the fore pair and the hind pair are proportionately longer than the middle pair. Tarsi long; the anterior ones about equal in length but the hind pair are distinctly longer, proportionately. The tibiae end in a well-developed (almost *Bibio*-like) blunt spine on the front side with a smaller one (easily seen on the hind legs only) on the inner side. The pulvilli, three in number, elongate, very greatly developed; the claws very long and strong, curved.

Wings.—Colourless, veins yellow, venation normal. Upper squamae quite small, nearly circular, lower pair very large, with a short yellow fringe, both practically colourless. Halteres black.

Described from a single perfect specimen in the Indian Museum from Maymyo (3800 ft.), near Mandalay, Upper Burma, taken in May 1910 by Mr. H. Andrewes.

Oncodes octomaculatus, mihi, sp. nov.

♂. Bombay Presidency. Long. 4 mm.

Head.—As usual, practically all eye, which is very dark reddish brown, bare, vertex and back of head blackish; two ocelli present. Antennae normal (apparently, as they are not properly visible), terminated by a long arista, which is slightly thickened at the base, and is thinnest in the middle, the tip provided with two minute stiff hairs.

Thorax.—Brownish yellow, with three dorsal, clear-cut black stripes of moderate and equal width, the median one attaining the anterior margin, the outer ones considerably foreshortened. Hinder part of dorsum all blackish, the colour extending to the scutellum; the metanotum brownish yellow. A short black streak (which in one specimen forms nearly a complete circle) on each side in front, below each shoulder, sometimes joined to the tips of the outer dorsal stripe. A small blackish mark at base of wing and the under side of the thorax mainly blackish. Thorax with a little light yellow pubescence generally distributed both on dorsum and sides.

Abdomen.—Mainly blackish; hind margins of segments narrowly pale yellowish white, the colour widest on 5th segment; 2nd segment with two large oval greyish white spots nearly filling the dorsum, but quite clear of the borders in all directions. The 3rd and 4th segments each with a pair of moderate-sized brownish yellow spots, one on each side of the middle; 5th segment with an elongated similarly coloured spot, clear of the borders in all directions, and nearly filling the segment; 6th segment much smaller, practically a replica of the 5th. Lateral margins of each segment occupied by a shining black elongate spot which does not overlap the pale hind margin. Belly pale yellowish; sometimes (in one example) a black spot towards the lateral margins as on dorsal surface. Abdomen with light yellowish pubescence.

Legs.—Brownish yellow; hind pair with coxae more or less at base, femora at base and with a broad subapical band, and tibiae and tarsi almost wholly brown or blackish.

Wings.—Yellowish grey; venation normal; squamae dirty grey, shortly and closely pubescent; and of the normal enormous size.

Described from two ♂♂ in the Indian Museum, from Igatpuri, Western Ghats, Bombay Presidency, 20-xi-09 [*Annandale.*]

Oncodes fuscus, mihi, sp. nov.

? ♀. North India. Long. 3 mm.

Head.—Wholly blackish; eyes closely contiguous; vertex a little prominent; two ocelli; some black hair on the rather puffed-out occiput. Arista pale yellowish, nearly transparent, shaped as in *O. octomaculatus*, mihi.

Thorax.—Wholly dark shining brown, with greyish brown pubescence.

Abdomen.—Dark nut brown, with greyish-brown pubescence; the sides and belly a little darker; hind margins of segments with a trace of being narrowly black.

Legs.—Uniformly brownish yellow; coxae darker brown.

Wings.—Colourless, the stronger veins brownish yellow.

Described from a single perfect specimen in the Indian Museum from Sahelwa, Bahraich District, United Provinces, India. 2-iii-09.

N.B.—From the relatively smaller size of the head and the more puffed-out occiput I infer the present specimen is a ♀.

SCENOPINIDAE.

Scenopinus fenestralis, L.

Several examples are in the Indian Museum of this common European species, taken at Kasauli, Naini Tal, and Simla.

They agree perfectly with European specimens except that the legs are brownish yellow rather than quite yellow.

NEMESTRINIDAE.

Atriadops nivea, mihi, sp. nov.

(Pl. xxxvii, fig. 11).

♂. Ceylon. Long. 12 mm.

Head.—Blackish grey; palpi thin, small, of same colour. Eyes brown, very large, contiguous for half the distance from the very small vertex, bearing the three small ocelli, to base of antennae, the first two joints of which are brown (third joint missing). Underside of head with some grey hair.

Thorax.—Thickly clothed with pale yellowish grey hair, which becomes white on the sides.

Abdomen.—Thickly clothed with pale yellowish white hair, which, seen from in front, appears silvery white. Belly dark grey, with grey hair.

Legs.—Dark reddish brown (tarsi missing).

Wings.—Clear, narrowly dark brown at base; also a narrow, irregular but clearly cut stripe across the middle from the costa nearly to the hind border; a second, wider, similar band towards tip, this band reaches the hind margin, spreading over both sides of the "diagonal" vein, and is connected along the costa with a small apical spot, and, less distinctly, proximally, with the median band; leaving a well-marked clear oblong spot between the 1st and 2nd longitudinal veins. A small brown spot on wing margin at tip of 5th longitudinal vein and a larger one at tip of 6th.

Described from one ♂, perfect as regards structure, except for the missing third antennal joint and all the tarsi, but otherwise not in very good condition, in my collection from Haldumulla, Ceylon, sent by Mr. E. E. Green. Evidently in life a most brilliant and conspicuous object.

MYDASIDAE.[1]

Leptomidas indianus, mihi, sp. nov.

id. id. Big. nom. nud.

(Pl. xxxvii, fig. 12).

♂. Assam. Long. 16. mm.

Head.—Much wider than thorax. Frons black, shining, with two narrow diagonal grooves on upper part; vertex consisting of two dark brown shining oval calli placed end to end, with a small recessed space between them. Face rather dark grey, smooth. Antennae missing, except the short, cylindrical, dark brown, slightly pubescent first joint, placed on a slight transverse ridge running from eye to eye. Eyes prominent, black, bare, shining. Proboscis and oral opening dark brown, shining, former very short. Back of head grey. The whole frons, face, back and underside of head with moderately thick (but not dense) grey hair.

Thorax.—Dorsum dull black, with a little dirty grey tomentum towards the sides and posterior part, and on the humeral calli, which bear a small bunch of concolorous hairs Similar hairs on posterior part of dorsum, in front of and below the wings. Sides of thorax more or less shining black, mostly bare. Prothorax and neck with silvery grey tomentum. Scutellum and metanotum blackish, with silvery grey tomentum.

Abdomen.—Cylindrical, slightly narrowed in middle, very dark blackish brown, shining; posterior borders of segments pale yellow, most distinct on 2nd to 5th segments, the bands on the 2nd, 3rd and 4th segments passing unbroken over the sides and across the belly; 4th segment light reddish brown, whole abdo-

[1] See end of this paper for *Cephalocera annulata*, sp. nov.

men minutely pubescent; 1st and 2nd segments with grey hair at sides. Genitalia small, partly withdrawn, dark shining brown; ultimate portion with a row of light brown scale-like spines on each side.

Legs.—Simple, no traces of bristles or longer hairs, except two apical bristles at the tips of the anterior tibiae (the hind tibiae and tarsi are missing); dark brown with minute grey pubescence, which is longer on the coxae, and short and thick on the tibiae; tarsal joints with black tips.

Wings.—Uniformly pale yellow, veins darker yellow, costa black, border of wing without a single hair; 3rd longitudinal vein with a minute appendix at base of upper fork. Abulae concolorous, bare; tegulae very small, bright yellow with a very narrow fringe. Halteres blackish, stem brown.

Described from a single ♂ in the Indian Museum from Sadiya, Assam.

N.B.—Bigot marked this specimen as a ♀ but, though the genital apparatus is much concealed, it looks to me more like that of a ♂.

THEREVIDAE.

Phycus brunneus, W. (*Xylophagus*, id.)

(*X. canescens*, Walk.)

After a careful examination of a considerable number of specimens in the Indian Museum collection I can have no hesitation in pronouncing these two species as identical. Examples are present answering exactly to the descriptions of both authors, but certain characters are sufficiently variable to easily embrace both forms.

The whitish dorsal stripe on the thorax is marked by a very narrow still whiter median line (which is not always very distinct), and when this is distinct it fulfils Walker's description of "two hoary stripes side by side." The scutellum is nearly always reddish on the posterior margin to an obvious extent, but is sometimes practically all black. The colour of the abdominal bands varies from quite white to distinct yellow. The coxae and femora are always wholly yellow, sometimes lighter in colour, varying to deep chrome; and the *middle* tibiae are invariably much lighter than the others, sometimes as pale as the femora, and the fore and hind tibiae vary from brownish yellow to nearly black. The pubescence of the body is whiter and more conspicuous in the form Walker describes. The wing is often absolutely clear, but generally with either a pale brownish tinge towards the tips or with (more often in the ♂) the veins towards the tip distinctly brown suffused. All these characters vary irrespective of one another, which is convincing that the specimens all represent but a single species.

Localities.—Calcutta, 27-ii-07—12-iii-07 [*Annandale*]; Bhogaon, 19-iii-09, 18-x-07; Katihar, 26-iii-09 (both Purnea District, N. Bengal, both *Paiva*); Dhikala, Naini Tal District, 22-iv-08.

Two pairs taken *in cop.*; Tenmalai (Travancore, S. India), 22-xi-08, by Dr. Annandale, and also a pair taken by him in Calcutta, 27-ii-07, in the Indian Museum offices.

Phycus brunneus var. **brunnipes**, mihi, var. nov.

♀. Burma. Long. 5½—7½ mm.

Three ♀ ♀ in the Indian Museum from Mandalay (12-iii-08) and Moulmein (28-ii-08) taken by Dr. Annandale appear to represent a variety, as they possess a broad brown ring on the posterior femora which leaves only a very narrow part yellow at both base and tip, the front femora being brownish yellow. The scutellum is wholly black, with a little greyish tomentum; the abdominal bands milk white, whilst the wings in one example are practically clear, in the second faintly brown tinged at tip, and in the third the veins are distinctly brown suffused towards the tips. The sex appears to be female.

Phycus nigripes, mihi, sp. nov.

? ♂. Darjiling District. Long. 10 mm.

Very near *brunneus* and *brunnipes* but differing as follows. Lower half of frons wholly shimmering silvery white, without the large shining jet black spot immediately above the antennae which is so conspicuous in both those forms; 3rd antennal joint cylindrical, much narrower than in the other species. Median dorsal stripe faint; abdominal bands very narrow, milk white, only the one on the 2nd segment really distinct. *Legs wholly black*, including coxae, which have a little bluish-white shimmer. Wings clear, with a distinct blackish suffusion towards tip, extending from the costa covering about the distal half of the 2nd longitudinal vein, reaching irregularly to the hind margin, just encroaching on the discal cell, and with a small irregular clear space in each of the two submarginal cells. Halteres knobs wholly black. From the narrow frons and the appearance of the abdomen I conclude the single specimen is a ♂. Kurseong, 27-iii-10 [Annandale]. Quite a distinct species.

Thereva flavolineata, mihi, sp. nov.

♂. Assam. Long. 10 mm.

Head.—Frons small, black, with black hairs, ocelli red. Eye facets larger in front. Face grey, with long stiff black hairs above the antennae and with long greyish hairs below them. Antennae 1st joint black (rest missing), oral orifice reddish yellow. Back of head grey, with greyish hairs; vertex and upper border of eyes with black hairs.

Thorax.—Dorsum dark brown, with two well-separated, moderately wide, chrome yellow stripes; dorsum covered with mixed brown and yellow hairs, the former mainly on the darker parts.

Sides of thorax blackish grey in front of wings, ashy grey on lower part, with shaggy dirty white hair in front of and below shoulders, and in front of wing base. Some yellow hair above insertion of wings. A row of three bristles between the humerus and transverse suture, two supra alar bristles (others possibly broken off). Scutellum yellowish, with a brownish basal triangle, dorsum with brown and grey hairs, two preapical well-separated bristles.

Abdomen.—Ground colour blackish grey, posterior margins of segments very narrowly yellow, but more widely so on 3rd and 4th. The 1st segment wholly, 2nd, 3rd, and 4th wholly except posteriorly at the sides, 5th at base, black. Dorsum of abdomen with black hairs, which are thickest and longest on the black parts. Sides of abdomen with whitish yellow moderately long hair; posterior margins of segments with very short similarly coloured hairs. Belly bluish grey, posterior margins of segments more broadly yellow, especially on 3rd and 4th segments; the whole surface with soft white hairs. Genitalia distinct, shining brown, with brownish hair on upper, and with whitish hair on lower parts.

Legs (hind pair wanting).—Coxae and femora blackish grey, former with long greyish white hair in front; latter with grey hair below on proximal half, blacker hairs on distal half. Tibiae reddish yellow, blackish at tip, microscopically pubescent, with numerous rather short spines, tarsi darker.

Wings nearly clear, veins brownish yellow; tegulae dirty white; halteres brown and yellow.

Described from a unique in the Indian Museum from Shillong, in good condition except for the missing antennal joints and the hind legs.

LONCHOPTERIDAE.

Lonchoptera lutea, Panz.

Two specimens in the Indian Museum from Darjiling (7000 ft.) taken by me, 29-v-10, belong to this common European species. As *Cadrana*, Walk., referred originally to this family, was afterwards noted by its author as most probably belonging elsewhere; this is the first assured species from the East, of the Lonchopteridae.

PLATYPEZIDAE.

Platypeza orientalis, mihi, sp. nov.

id. id. Big. nom. nud.

♀. Assam. Long. barely 3 mm.

Very near *argyrogyna*, Meij. Frons and face mouse grey, a little whitish shimmer on face. Antennae, mouth and proboscis reddish yellow. Upper facets of eyes reddish brown, lower ones coffee brown.

Thorax light blue grey dusted, except on anterior part, which is moderately shining blackish, with a slight leaden reflection in

certain lights. The rows of minute dorso-central bristly hairs diverge until they meet two strong bristles, one placed towards each posterior corner of the dorsum. Three bristles on each side below the dorsum. Scutellum with the inner pair of bristles much longer than the outer pair.

Abdomen wholly rich dark reddish brown, unmarked, almost bare; stiff hairs along the sides, and no apical bristles. The 3rd and 4th joints of the hind tarsi are light brown, instead of wholly yellow as in *argyrogyna*, and the 2nd joint is more cut away at the base on the underside than in Meijere's species.

Stigmatic cell very pale yellow, but that is also the case to some extent in *argyrogyna*.

Described from a single ♀ in the Indian Museum from Sadiya.

Platypeza obscura, mihi, sp. nov.

♂. Darjiling District. Long. 2¼—3 mm.

Also considerably resembling *argyrogyna*. The eyes have the upper facets large and bright cherry red, the lower ones very much smaller, chocolate brown. Posterior margins of eyes with a distinct fringe of black hairs. Antennae bright yellow, arista distinctly thickened for some distance from base, bright yellow, the bristle black, mouth and palpi bright yellow.

Thorax.—Dorsum blackish grey in both sexes; without sign of any white shimmer. In addition to two or three bristles of different lengths close together, towards each side near hinder margin of dorsum there are three similar ones on the sides of the thorax, below the posterior calli. There are two on each humeral callus, and three stronger ones a little below them. Scutellar spines equal in size.

Abdomen blackish grey, without bands, and with seven or eight bristles at the tip. Legs rather paler than in *argyrogyna*; hind tarsi dull yellow, without the bright golden yellow pubescence of that species, posterior margins of segments with the black bristles more distinct, and continued further over the lateral edges. The first four hind tarsal segments more nearly equal in length than in the other species.

Described from a ♂ from Kurseong, 4—6-vii-08 [*Annandale*].

Notes on **Platypeza.**

Walker's *glaucescens*, ♂ ♀ was the first oriental species described (Proc. Linn. Soc. Lond., iv, 117), and this although very briefly diagnosed should be a good one. According to that author it is piceous black, with the disk of the thorax of a bluish cinereous tinge, the remainder of the thorax being presumably black as are also (presumably) the antennae.

The only other two species recorded are *P. wulpii*, Kert. (Termes. Fuzet., xxii, 179) and *P. argyrogyna*, Meij. (Tijd. Ent., l, 237, ♂ ♀, pl. vi, 23, wing).

It seems evident that all the species are more or less closely allied, and the meagre material upon which they have been set up makes great caution necessary in establishing new ones.

From a wing figure of *wulpii*, this species seems to differ from the other three before me (*glaucescens* I have not seen) by the 3rd longitudinal vein emerging abruptly from the 2nd at almost a right angle, forming almost another right angle on meeting the inner cross-vein. The antennae are blackish brown, whereas they are yellow in the other three species; in which moreover, the 3rd vein emerges gradually from the 2nd at a very acute angle, after which it continues without a further angle.

P. argyrogyna is the only species with pale borders to the abdominal segments; the hind tarsi also characterize this species by their brilliant golden-yellow pubescence.

P. orientalis is distinguished from all others by the rich dark reddish brown abdomen.

P. obscura is noteworthy from the blackish grey colour of the disc of the thorax, which is whitish grey shimmered in *argyrogyna*, *orientalis* and *glaucescens*. The ♂ has seven or eight stiff yellow bristles at the tip of the abdomen.

Platypeza argyrogyna, Meij.

As regards the mouth parts, these organs are very distinct in a ♀ specimen of *argyrogyna* in the Indian Museum. They consist of a pair of dark red, large, fleshy, hairy organs apparently forming the lower half of the proboscis, above which are a pair of dark reddish brown, flat, oval, similar organs, rather smaller, and placed close to the surface of the head, possibly capable of forming the upper part of the proboscis which might then be used for sucking. The palpi are small, slender, slightly enlarged at the end, bright reddish yellow, bare.

The Indian Museum has this species from Sukna (500 ft.), E. Himalayas, 1-vii-08; Calcutta, 18-vii-08; Bangalore, S. India (3000 ft.), 16-x-10 [all *Annandale*] and a ♂ and ♀ from Semarang, Java, 1-06; Peradeniya, Ceylon, 14-vii-10 [*Green*].

N.B.—A headless specimen (presumably typical) in that collection from Sadiya, Assam, is labelled *P. cothurnata*, Big., sp. nov. The name is probably a *nomen nudum* and the specimen cannot be differentiated from *argyrogyna*.

PIPUNCULIDAE.

In introducing several new species of this family, it seems advisable to reproduce Prof. Kertesz's useful table of oriental species of *Pipunculus*, and incorporate my new ones in their respective positions. The table must, however, be used with caution, as only one, or at most two, of the species are known to me other than my own. The expression "stigma, present" or "absent," is adopted in preference to costal border, "coloured" or "uncoloured."

Table of oriental species of **Pipunculus.**

A	Stigma present: i.e., 3rd costal segment more or less distinctly darkened.	
B	Anterior cross-vein distinctly before middle of discal cell.	
C	The 4th longitudinal vein with a distinct appendix	*appendiculatus*, sp. nov.
CC	The 4th longitudinal vein without appendix.	
D	Claws and pulvilli exceptionally developed	*hepaticolor*, Beck.
DD	Claws, normal.	
E	Wings distinctly brownish.	
F	3rd antennal joint exceptionally small.	*fumipennis*, Kert.
FF	3rd antennal joint with a blunt tip.	*sauteri*, Kert.
EE	Wings clear or nearly so.	
G	Femora in greater part black, always darker than remainder of legs.	
H	Abdomen all black, or at most, a little greyish, never marked with yellow.	
I	Femora black to the extreme tips.	*beckeri*, Kert.
II	Femora with tips always distinctly broadly or narrowly pale.	
J	Tibiae all yellow	*biroi*, Kert.
JJ	Tibiae with apical half black ..	*campestris*, Latr. var. nov. *himalayensis*.
HH	Abdomen with basal half yellow, the colour continued over the sides and belly	*flavocinctus*, sp. nov.
GG	Femora not darker than remainder of legs, uniformly yellow.	
K	Abdomen with 3rd, 4th and 5th segments yellow; 3rd antennal joint with long black apical bristle ..	*filicornis*, sp. nov.
KK	Abdomen without yellow marks, and antennae without apical bristle.	
L	Antennae yellow, and cell comparatively short	*cinereo-aeneus*, sp. nov.
LL	Antennae black, anal cell reaching nearly to the wing margin. ..	*nigro-nitens*, sp. nov.
BB	Anterior cross-vein distinctly beyond middle of discal cell. ..	*brevis*, sp. nov.
AA	Stigma absent; i.e., 3rd costal segment clear, or practically so; wing entirely clear.	

M Anterior cross-vein practically at, or distinctly beyond, middle of discal cell.
N Abdomen distinctly pubescent .. *aeneiventris*, Kert.
NN Abdomen bare
O 4th longitudinal vein forming towards its tip a distinct angle, which bears a long appendix .. *amboinalis*, Walk.
OO 4th longitudinal vein without angle or appendix.
P Abdomen with a greenish tint.
Q Ambient vein absent; femora blackish brown to extreme tips. .. *singalensis*, Kert.
QQ Ambient vein distinctly present, microscopically spinose; femora tips very broadly pale .. *limpidipennis*, sp. nov.
PP Abdomen shining bluish black .. *nitens*, sp. nov.
MM Anterior cross-vein very distinctly before middle of discal cell.
R Anterior cross-vein though distinctly before middle of discal cell, yet not remarkably so, i.e., situated in the second fourth of its length.
S Abdomen light grey, covered with very distinct pubescence; pulvilli and claws remarkably developed .. .. *mirabilis*, sp. nov.
SS Abdomen black or blackish, bare, pulvilli and claws normal.
T Hind femora without long hair on under side .. .. *javanensis*, Meij.
TT Hind femora with long yellow hair below, along their entire length *ciliatus*, Meij.
RR Anterior cross-vein remarkably near base of discal cell.
U Anterior cross-vein situated at one-sixth of the discal cell; femora blackish brown to extreme tips. *angustipennis*, Kert.
UU Anterior cross-vein placed almost exactly at one-fourth of the discal cell; femora tips distinctly and moderately broadly pale .. *quartarius*, sp. nov.

N.B.—Possibly *limpidipennis* and *nitens* are the same species.

Pipunculus appendiculatus, mihi, sp. nov.

♀. Assam. Long. 3 mm. (without head or ovipositor).

Head.—(Wanting.)

Thorax.—Bluish grey with light brown reflections, but with no distinct marks; humeri distinct, rather large, brownish. Sides of thorax dark bluish grey, with whitish reflections seen from behind. Scutellum bluish grey, tinged with pale brown; metanotum bluish grey with whitish reflections.

Abdomen.—Bluish ash-grey; rather more than the basal half of each segment rich velvet black, extended hindwards in the centre until it nearly meets the next segment; these black bands extending over the sides and right across the ventral surface so that the belly is practically a replica of the dorsum. Last segment (6th) all bluish grey, bent under the belly and carrying a moderately long reddish brown shining process bearing a bunch of hairs near the tip.

Legs.—Dark blackish brown, extreme base and tips of femora pale yellowish brown; tibiae blackish brown, with bases rather broadly, and tips rather narrowly yellowish brown; tarsi dark brown above, light brown below; femora with silvery white shimmer, when seen in certain lights. Legs microscopically pubescent, hairy but without distinct bristles.

Wings.—Distinctly pale brown. Second costal segment quite clear and transparent; third twice as long as the fourth, the stigma distinct, but ill-defined on inner side. The 4th longitudinal vein curved outwards in a bow after quitting the posterior cross-vein and possessing an appendix, commencing as far from the junction of the 4th longitudinal with the posterior cross-vein as the length of that cross-vein, this appendix extends more than half way to the wing border. Anterior cross-vein exactly over centre of discal cell. Basal part of wing rather clear but extreme base pale yellowish. Halteres brownish yellow.

Described from a single ♀ in the Indian Museum collection from Margherita, in perfect condition, except that the head is missing. I would not have described as new a decapitated specimen, but for the strikingly distinctive characters of this species, in which the furcation of the 4th longitudinal vein makes it impossible for it to be confounded with any other oriental species except *amboinalis*, Walk.

N.B.—This species must be near *furcatus*, Egg., occurring in Europe but that species has all yellowish tibiae and tarsi.

Walker's species *amboinalis* would be almost unrecognizable from the brief description, except for the appendiculation of the "praebrachial" vein (4th longitudinal), a character I do not know of as occurring in any other eastern species but these two.

Herr Kertesz does not mention this character in his notes on *amboinalis* (Ann. Mus. Hung., I, 470), founded on an examination of Walker's type by Miss Ricardo, but I presume he would have called attention to the fact had Walker's description been in error on the point.

My *appendiculatus* is therefore distinguished by the mainly black legs and the slightly different (but, I should think, consistent) colouration of the abdomen. The latter might equally well

be described as black, with grey posterior borders (interrupted in the middle) to the segments, this colour being continued over the sides and across the belly, and which colour is, moreover, of uniform width at all times except being rather wider on the 1st segment.

Pipunculus biroi, Kert.

Specimens of this species are in the Indian Museum from Rangoon, taken by me 23-xii-04 to 3-i-05; Calcutta, where it appears to be not uncommon from at least the middle of August to the end of November; Puri (Orissa Coast), 18—19-i-08; and Port Canning, near Calcutta, 6-xii-07; Bhagalpur (Bengal), on sandy banks of R. Ganges, 16-ii-10 [*Chaudhuri*]; Paresnath, Chota Nagpur (4,500 ft.), 11-iv-09 [*Annandale*]. I also took a few at Darjiling, 23-ix-08 to 2-x-08, on the hillsides in grass and weeds.

Pipunculus campestris, Latr. himalayensis, mihi, var. nov.

♂. Darjiling. Long. 2¾ mm.

Head.—Frons blackish grey, with a little grey shimmer above the antennae. Vertex shining black. Antennae black, somewhat short, 3rd joint with a grey shimmer; arista only twice as long as the antennae. Eyes contiguous for a considerable distance, facets almost uniform in size. Back of head dark grey.

Thorax.—Blackish, sides lighter. Scutellum shining blackish, metanotum with silvery grey tinge.

Abdomen.—Blackish; the segments greyish towards the sides, the colour with a tendency to extend a little along the margins of the segments. Hypopygium black, short, wide, with distinct depression in centre.

Legs.—Black, dull; femora brownish yellow at base and tip, with some traces of a greyish shimmer. Basal half of tibiae and under side of part of the tarsi brownish yellow.

Wings.—Clear; stigma pale brown; 3rd costal segment a little longer than the 4th; anterior cross vein at about one-third of the discal cell; 4th longitudinal vein slightly curved after quitting the posterior cross vein. Halteres black.

Described from two males in the Indian Museum, taken by me at Darjiling, 29-v-10 (type) and 29-ix-08.

N.B.—These two specimens vary so little from typical *campestris*, which is one of the commonest European species, possessing a wide distribution and therefore likely to occur in the Himalayas, that it seems impossible to regard them as other than a variety. The length of the arista being only twice instead of thrice the length of the antenna, the absence of any shining black segment in the abdomen, and the almost bare thorax are the only differences.

The frons is about one-tenth the width of the head (measured immediately above the antennae), as is shown in Verrall's figure,[1]

[1] British Flies, viii, 99.

and as is the case in European specimens before me. Mr. Verrall, however, says in the text that the frons is only one-twentieth the width of the head.

This species in typically marked specimens is easily distinguished from *biroi* by the apical black half of the tibiae, and from my *cinereo-aenous* by its black antennae and halteres, and the mainly black legs. However, three specimens in the Indian Museum appear to show an intermediate form, which may possibly be a third species. The antennae are white tipped, the body colour dark grey, the abdomen quite similar to that of *biroi* but the tibiae show the black apical half in two specimens and distinct traces of them in the third, which would associate the form with my new variety *himalayensis*. The greyish thorax and abdomen and distinctly whitish-tipped antennae seem to prevent them being any form of *campestris*. Moreover in one of the two males (the third, the Sahelwa specimen, is a ♀), the tip of the antennae is produced into a long black bristle as in my new species *filicornis*. This specimen (the one from Theog) will be the type should the form be specific, as the bristle is absent in the second ♂ although the specimen is in good condition. They show the following data: Simla, 9-v-09; Theog, Simla Hills, 13-v-09 [both *Annandale*]; Sahelwa, Bahraich District, United Provinces, India, 11-iii-09.

Pipunculus flevocinctus, mihi, sp. nov.

♂. Darjiling District. Long. 2½ mm.

Head.—Eyes contiguous for a considerable distance. Back of head, frons and face wholly black. Antennae with 1st and 2nd joints black, 3rd brownish yellow, whitish towards tip when seen from above. Proboscis a little brownish yellow.

Thorax.—Black, mainly dull, bare, but dorsum a little shining. Sides inclined towards blackish grey. Scutellum and metanotum apparently concolorous.

Abdomen.—Black, barely shining; posterior margin of 1st segment, the whole of the 2nd, 3rd and 4th, and towards the sides of the 5th segment brownish yellow, the colour extending over the sides across the belly. Genitalia black.

Legs.—Yellow. Coxae (except tips); femora (except broadly at base and narrowly at tips) black.

Wings.—Clear, 3rd costal segment brown, the colour filling the apical three-fourths; 3rd segment about equal to the 4th in length, and much shorter than the 2nd. Anterior cross vein just before middle of discal cell; 4th longitudinal vein gently angled after quitting discal cell. Anal cell ending at a moderate distance before the margin. Halteres pale yellow.

Described from a type specimen in the Indian Museum taken by Dr. Annandale at Kurseong, 28-vi-10.

N.B.—A second specimen in the same collection appears to be a variety of this species, the differences consisting in the antennae

being all black; a greater contrast between the scutellum and metanotum, the former being shining black, bare, the latter distinctly grey; and the presence of a wide dorsal black band, connecting the basal and apical black parts, although the yellow colour extends over the sides and across the belly, as in the type. The legs and wings are identical, except that the third costal segment is relatively a little longer. Size identical. One specimen, a male, taken by Mr. C. W. Beebe at Tonglu, Darjiling District (10,000 ft.), 22-iv-10.

Pipunculus filicornis, mihi, sp. nov.

♀. Darjiling District. Long. 4 mm.

Head.—Frons and face very narrow, still narrower at the level of the antennae, almost wholly with a greyish white reflection. Antennae bright yellow, 3rd joint very elongate, pointed, and the tip bearing a *long straight black bristle.* Arista thickened considerably on the yellow base, thence black and long, thus giving the appearance of the antennae bearing two aristas, one pointing upwards and one downwards. Facets of eyes immediately in front very greatly enlarged. Back of head very slightly puffed out, grey with a narrow fringe of pale hair.

Thorax.—Dark aenous black, moderately shining with microscopic pale pubescence; humeral calli yellowish grey dusted, rather more prominent than usual in this genus. Sides dirty yellowish, scutellum livid yellow, microscopically grey dusted; metanotum dark grey.

Abdomen.—Pale yellow, microscopically pale haired with a black rather wide dorsal stripe on the 2nd, 3rd and 4th segments, which has a tendency to form a narrow transverse line at the bases of these segments; 5th and 6th segments wholly black, posterior corners of former slightly yellowish. Belly dirty yellow, blackish towards tip. Genitalia large, blackish globular, shining, with a long, shining, brown ovipositor bent under the belly.

Legs.—Practically entirely yellow, coxae brownish on basal half; tibiae and tarsi microscopically beset with black bristles, on the former longitudinally, on the latter transversely. Claws long, pale yellow, black tipped; pulvilli apparently large, strong and reddish yellow. (The apical parts of most of the legs are damaged).

Wings.—Clear. Stigma pale yellow, stigmatic segment barely longer than 4th costal segment. Anterior cross-vein at two-fifth of the discal cell. The 4th longitudinal well curved.

Described from one specimen in the Indian Museum taken by Dr. Annandale, 5-vii-08, at Kurseong (5000 feet).

N.B.—A striking and abnormal species, the yellow abdomen and filiform 3rd antennal joint characterizing it sufficiently to ensure immediate recognition. The feet seem to be peculiarly constructed, but are too damaged to define accurately, the specimen being otherwise in good condition.

Pipunculus cinereo-aeneus, mihi, sp. nov.

♀. Lower Burma. Long. 4 mm. (without ovipositor).

Head.—Front narrowed towards vertex until the eyes nearly touch. Frons and face silver grey seen from above; antennae bright yellow; eye facets distinctly larger in the vicinity of the facial groove. Back of head too damaged to describe.

Thorax (somewhat damaged).—Blackish grey, sides light ash-grey with concolorous pleurae and metanotum. Scutellum aenous brown with some pale hairs on posterior border.

Abdomen.—Blackish grey; the posterior borders of the segments rather narrowly ash-grey, the colour widened at the sides and carried over to the underside; 6th segment bearing a large conical ash-grey process, ferruginous brown at tip, and from which projects a brown, pointed, shining, horny ovipositor. This appendage is curled under the belly and its tip reaches the middle of the 3rd segment.

Legs.—Coxae brown, legs entirely brownish yellow; upper side of tarsi tips blackish.

Wings.—Almost clear, stigma pale brown; internal transverse vein placed at one-third distance from the base of the discal cell; 4th longitudinal vein running almost straight to the wing tip after leaving the posterior cross-vein. Halteres pale yellow.

Described from one ♀ in the Indian Museum collection from Mergui, in fairly good condition. The species is quite distinct.

Pipunculus nigronitens, mihi, sp. nov.

♂. Darjiling. Long. 3 mm.

Head.—Vertex shining black, slightly elongated. Frons and face blackish, but if viewed from above the former appears greyish with a slight bluish tinge, and the latter nearly snow white. Antennae wholly black, but seen from above the tip of the 2nd joint and the apical part of the 3rd is more or less grey dusted. Arista black, thickened at base. Proboscis light brown.

Thorax and scutellum, shining black, bare. Sides grey dusted, the colour carried across the metanotum. Humeri brownish yellow.

Abdomen.—Shining black, 1st segment conspicuously grey dusted. Genitalia black, shining, belly black but less shining than the dorsum.

Legs.—Nearly wholly yellow. Coxae black, tarsi tips blackish brown.

Wings.—Clear. Third costal segment wholly brownish yellow; longer than 4th segment. Anterior cross-vein placed just before one-third of the discal cell. The 4th longitudinal vein forming a wide curve before the posterior cross-vein, and distinctly bisinuate beyond. The first posterior cell rather narrowly open.

Halteres dirty yellow, the clubs blackish.

Described from a single ♂ taken by me at Darjiling, 29-v-10. In the Indian Museum.

Pipunculus brevis, mihi, sp. nov.

♀. Lower Burma. Long. 3½ mm. (without ovipositor).

Head.—Frons moderately wide, of uniform width up to the vertex, blackish seen from in front, silver grey seen from above; face similar; antennae brown, arista black. Back of head blackish grey, only moderately produced hindwards.

Thorax.—Almost uniformly blackish grey, ash-grey at sides, humeri small, brown. Scutellum dark brown, bare, except for a few hairs on posterior border; metanotum ash-grey.

Abdomen.—Blackish grey, shortened; sides of segments, and almost the whole of segments 1 and 2 grey tinged, which colour goes over the sides to the belly. The abdomen appears discoloured, and probably in its natural state it is wholly dark grey. The last segment bears a long shining brown horny process which reaches under the belly almost to the base of the abdomen. This process is turned slightly to the left.

Legs.—Blackish brown; knees and base of tibiae light yellowish brown.

Wings.—Very pale grey, nearly clear; stigma brown; anterior cross-vein placed rather after two-thirds of the distance from base of discal cell, but distinctly before its middle; 4th costal segment very shortened, not half as long as 3rd; 3rd and 4th together about equal to the 5th. The 4th longitudinal vein, after quitting the posterior cross-vein, takes an outward curve before proceeding to the wing border. Halteres brown.

Described from 1 ♀ in the Indian Museum collection from Mergui, in good condition, except that, being gummed on cork, the underside cannot be properly examined.

Pipunculus limpidipennis, mihi, sp. nov.

♂ ♀. India. Long. 2 mm., very nearly.

Head.—Frons of uniform width, greyish, with a silvery white shimmer seen from above; face below antennae similar; antennae blackish, 3rd joint white with silver shimmer; arista black; eyes (in ♀) with the facets much larger on each side of the frontal space than those behind. Back of head prominent, grey with a whitish shimmer.

Thorax.—Dark aenous-grey, moderately shining, bare, sides and humeri a little lighter; scutellum aenous black, bare, shining.

Abdomen.—Concolorous, with a slight olive green tint, submetallic, bare, unmarked. Belly unicolorous. The last abdominal segment bears in the ♂ a knob-like process, and in the ♀ a long horny process bent under the belly.

Legs.—Femora blackish, base and tips yellowish brown, tibiae with a broad blackish ring, occupying the middle third or more, tarsi yellowish brown.

Wings quite clear; 4th longitudinal vein, after quitting the posterior cross-vein, runs almost straight to the wing border, with-

out being bent outwards in a bow. Anterior cross-vein almost exactly over centre of discal cell, no distinct stigma, but the costal vein is a little thickened along the 3rd and 4th segments; 3rd and 4th costal segments of about equal length, and taken together are only half the length of the 5th segment; wings barely pale yellowish at base. Halteres pale livid yellow.

Described from 5 ♂ ♂ and 1 ♀ in good condition in the Indian Museum collection.

Localities.—Calcutta, 4-ix to 20-xi-07 and 22-v-09; Puri (Orissa Coast, 20-1-08; Benikhola (Ind. frontier of Nepal), 7-ii-08; Igatpuri, Western Ghats, Bombay, 20-xi-09 [*Annandale*].

Pipunculus nitens, mihi, sp. nov.

♂. South India. Long. 2 mm.

Head.—Frons and face shining silvery white; eyes contiguous for some distance. Antennae black, 3rd joint, except at the base, reddish yellow. Back of head blackish grey, with silver shimmer at least round the edge.

Thorax.—Blackish, with a slight bluish tint, moderately shining. Sides dark bluish grey with a little whitish shimmer in certain lights. Thorax practically bare. Scutellum concolorous, with a few hairs; metanotum with a greyish white shimmer.

Abdomen.—Shining bluish black, with some short whitish hairs; 1st segment pale bluish grey. Genitalia rather small, clubbed, concolorous.

Legs.—Femora black except at tips, with a little grey shimmer. Rest of legs yellow; the tibiae with a broad band (apparently not always complete) occupying nearly their entire length; tarsi tips blackish on upper side.

Wings.—Clear, 3rd costal segment very short, 4th very slightly yellowish, practically clear. Anterior cross-vein exactly at middle of discal cell (in one specimen) or immediately before it (in the 2nd specimen).

Described from two specimens in the Indian Museum in good condition from Maddathoray, at the western base of the Western Ghats, Travancore State, South India, 19-xi-08, taken by Dr. Annandale.

N.B.—I suspect this and *limpidipennis* may represent but a single species, as some specimens show neither distinct greenish or bluish tinges, being moderately shining blackish.

Pipunculus mirabilis, mihi, sp. nov.

♀. Assam. Long. 4 mm. (without ovipositor).

Head.—Front rather narrower at vertex, which is black. Frons greyish white, face below antennae similar, and with a silvery white sheen seen from above; mouth light brown; eyes light brown; the facets in the vicinity of the antennae much larger. Antennae (missing).

Thorax.—Dorsum blackish aenous, humeri yellowish brown; edge of dorsum and sides of thorax greyish; a broad stripe of grey with silver reflections extends across the metanotum and embraces the metapleura on each side. Scutellum light yellowish brown; the posterior part and margin with pale long pubescence.

Abdomen.—Ash-grey; on the 2nd segment is a large brown round spot in the middle; on the 3rd, 4th and 5th are back basal bands, very narrow in the centre, and much widened at the sides of the segments. On the 6th the black band is of uniform width and very narrow. This segment bears a long ferruginous brown process bent under the belly, with hairs towards its tip. The whole abdomen is covered with rather long (but not dense) pale hairs, mixed with a number of black ones, these latter having no relationship to the black parts in the ground colour.

Legs.—Coxae brown, with a little silvery reflection in certain lights. Remainder of legs bright lemon yellow, practically bare, but the tibiae have several rows of almost microscopic spines towards the apices; tips of tarsi dark brown; claws and pulvilli much enlarged as is mentioned by Herr Becker in his species *hepaticolor*.

Wings.—Quite clear, extreme bare, very pale yellow. Anterior cross-vein placed at two-fifths from the base of the discal cell; 4th longitudinal vein taking an outward curve on quitting the posterior cross-vein; 3rd costal segment twice as long as 4th and about equal in length to the 5th. Halteres pale yellow.

Described from a perfect ♀ from Margherita, Assam, in the Indian Museum collection. A very striking and beautiful species and apparently closely allied to Becker's *hepaticolor*, from which I differentiate it as follows: there is no darkening of the stigma; the thoracic dorsum is blackish not greyish, the abdominal marks are somewhat different, the femora have no black streaks above; and the anterior cross-vein is placed distinctly before the centre of the discal cell.

Pipunculus quartarius, mihi, sp. nov.

♀. Calcutta. Long. 1¾ mm.

Head.—Frons shining black, wide, lower part with white shimmer seen from below. Face with white shimmer. Proboscis brownish yellow. Eyes with the facets contiguous to the region of the antennae, very much enlarged. Antennae blackish, 3rd joint yellowish white with long white style, arista very long, black. Back of head cinereous grey, with a tendency to whitish on post-ocular orbits, bearing a slight fringe of pale hairs.

Thorax.—Dark cinereous grey, slightly shining. Sides of thorax a little lighter. Scutellum concolorous with dorsum; metanotum light grey.

Abdomen.—Blackish grey, practically bare, but microscopically pubescent, slightly shining, 1st segment grey, 5th segment widest. Ovipositor of moderate length, shining brown, a little hair at its base. Belly cinereous grey, unmarked.

Legs.—Mainly black; tips of fore coxae, tips of all femora rather broadly, basal third and tips of tibiae, and apical part of all tarsi, black. Femora not shining and absolutely bare.

Wings.—Clear. Stigma absent but the 3rd costal space much reduced, and the veins limiting it somewhat thickened. Anterior cross-vein placed slightly before one-fourth of the discal cell. The 4th longitudinal runs nearly straight from its junction with the posterior cross-vein up to the 3rd vein which it almost meets rather sooner than usual, thence running parallel with it to the border for a longer distance than in most species. Halteres pale brownish yellow.

Described from a unique ♀ in perfect preservation in the Indian Museum collection, taken in Calcutta, 13-xii-07.

N.B.—A second specimen in the same collection is probably this species, varying only in being larger, the back of the head shining black instead of greyish, and the abdomen more blackish and more shining. Taken at Simla, 7-v-10 [*Annandale*].

Verrallia argentisegmentata, mihi, sp. nov.

♂. Lower Burma. Long. 3½ mm.

Head.—Frons black, face grey with silvery white shimmer seen from above. Antennae yellow, 3rd joint rounded at tip, arista black; 2nd joint bristly above and below. Eyes contiguous on vertex, small facets, uniform in size. Mouth reddish.

Thorax.—Blackish, moderately shining. Scutellum aenous black, metanotum grey. Sides of thorax dark grey.

Abdomen.—Velvet black; posterior borders of segments with a band (of varying width) of shining bright silvery leaden colour. Genitalia large and thick, light tawny-brown, shining and extended below the belly for some distance, the tip being pointed and bisected.

Legs.—Except the brown coxae, uniformly yellow; quite bare except for some minute spines on the tibiae; tarsi brown on upper side.

Wings.—Pale grey, iridescent; 4th longitudinal vein, after quitting the posterior cross-vein, running nearly straight to the wing border; anterior cross-vein placed at one-third of the discal cell. Stigma yellowish brown; 3rd costal segment nearly twice the length of the 4th, but is rather difficult to judge; 3rd and 4th together rather longer than the 5th. Halteres pale yellow.

Described from one ♂ from Mergui and one ♂ (*type*) taken by Dr. Annandale in jungle at the base of the Dawna Hills, 1-iii-08, both specimens in the Indian Museum collection in fairly good condition.

N.B.—The blunted 3rd antennal joint and non-puffed-out head behind makes me place this species in *Verrallia*, but I do not perceive the distinct ocellar bristles which should also character-

ize this genus. One of the specimens (from Mergui) is gummed on cork, the vertex being almost invisible, and the bristles are not present in the second example, but may have been accidentally broken off. The head of the Dawna Hills specimen is however otherwise in perfect condition.

Verrallia plumbella, mihi, sp. nov.

♀. Darjiling District. Long. 3¼ mm.

Head.—Vertex black; fronto-facial groove of uniform width, with white shimmer. Proboscis yellow. Facets in front considerably larger than the others. Back of head only just projecting beyond the post-ocular orbit, grey with a whitish reflection. Antennae (missing).

Thorax and scutellum black, moderately shining; sides and metanotum apparently concolorous. Scutellum with a row of minute hairs on posterior border.

Abdomen.—Shining lead colour, with a few microscopic hairs; the base of each segment, narrowly in the centre and more broadly towards the sides, dead jet black; 6th segment the longest, bearing a thick blackish grey pointed genital organ, terminating in a long shiny brown ovipositor.

Legs.—(Middle pair missing). Black, barely shining; tips of femora rather narrowly, and base of tibiae broadly, reddish yellow. Base of tarsi yellowish brown, tips black, with a few hairs; claws small, pulvilli distinct and white. Legs microscopically pubescent and the fore femora with a few very small bristles below, near the tip.

Wings.—Quite clear. Stigma pale brownish yellow, stigmatic segment barely longer than following segment, anterior cross-vein just before middle of discal cell; 4th longitudinal moderately sinuous after quitting the posterior cross-vein.

Described from a single specimen in the Indian Museum taken by Dr. Annandale at Kurseong (5000 ft.), 5-vii-08.

Herr Kertesz has removed both of Thomson's species, *armatus* and *abscissus*, to *Verrallia* (on Becker's authority), in Ann. Mus. Hung., 1, 465. yet Thomson in his lengthy description of *armatus* distinctly says of the 3rd antennal joint "apice nostrato acuminato" but does not mention any pilosity of the 2nd joint. He mentions the very narrow postocular orbit of *armatus*. My present species appears to be distinct from both of Thomson's; *armatus* having very short brown antennae, rather smoky anterior portion of the wings and mainly black femora, this last character also being present in *abscissus* also.

Chalarus spurius, Fln.

This rather uncommon European species was found by me at Darjiling, 29-v-10, represented by a perfect ♂, the specimen being now in the Indian Museum.

It agrees perfectly with Mr. Verrall's description, with the sole exception that the wings might be more suitably termed rather dark greyish than blackish.

CONOPIDAE.

Conops mundus, mihi, sp. nov.

♂. Orissa. Long. 12 mm.

Head.—Pale lemon yellow; frons nearly half the width of the head. Vertex with a triangular subtransparent shining piece. Cheeks with shining silvery white reflections, when seen from below and in front; cheeks seen from behind, with a slight but distinct rufous tint. Back of head brown with a brilliant golden yellow stripe behind the middle of the eyes. Antennae bright ferruginous, apical half of 3rd joint black above; 2nd joint twice as long as 3rd, very minutely black spinulose on upper side. Proboscis brownish yellow, tip black, extending forwards to about the middle of the 2nd antennal joint.

Thorax.—Vandyke brown, with (viewed from behind) the humeral calli and immediately behind them, and also towards hind margin of dorsum golden yellow dusted. Viewed from in front, the whole dorsum is seen covered with golden yellow dust, except a short median broad stripe from the anterior margin and just in front of the wing roots. Sides of thorax rather lighter brown, almost ferruginous, and more shining, with a silvery stripe from the edge of the dorsum, in front of the wings, to the hinder margin of the sternopleura. The whole dorsum beset with numerous minute black bristles. Scutellum vandyke brown, metanotum and metapleura rich golden yellow dusted.

Abdomen.—Bright ferruginous brown; slightly narrowed on 2nd segment, hind margins of first two segments with a little white dust, more obvious towards the sides; 3rd segment gold dusted at sides of hind margin; 4th and 5th segments with gold dust on hind margins, and 6th and 7th segments and genital organs wholly gold dusted. Pubescence of abdomen very short and inconspicuous.

Legs.—Coxae and femora bright ferruginous brown, the former with silvery white reflections. Tibiae lighter in colour, the basal part whitish, all the tibiae with a slight thickening about the middle followed by a slight constriction. All the tibiae in certain lights appear glistening yellow. Tarsi concolorous, with a few black hairs at sides of each segment; pulvilli pale brownish yellow.

Wings.—Clear, costal cell pale dirty yellow; a black, rather well-defined streak on anterior border extending posteriorly as far as the 3rd longitudinal vein, and distally to about one-third of the 1st posterior cell. Halteres pale yellow.

Described from one ♂ in the Indian Museum taken by Mr. Kemp at Puri, Orissa Coast, 6—13-xi-10.

Physocephala albofasciata, mihi, sp. nov.

(Pl. xxxvii, figs. 13, 14.)

♂ ♀. Bombay Presidency. Long. 10—12 mm.

Head and front yellow, epistome paler and more livid; vertex with a brown V-shaped mark; proboscis red, extreme tip black. Sides of front, seen from above, brilliantly silvery white. Eyes brown. Antennae reddish tawny, 2nd joint one and a half times as long as 3rd; apical half of 3rd joint black. Vertex and back of head yellow, posterior orbit of eyes silvery white.

Thorax.—Tawny brown, dorsum and humeral calli cinereous grey, middle of dorsum dark brown. Side-stripe and metanotum shining silver grey. Scutellum tawny brown.

Abdomen tawny; 2nd segment narrow, of uniform width, 3rd widening suddenly. Posterior borders of segments silvery white; last two segments entirely tawny, with some short, irregular black hairs. The ♂ has a moderate-sized process under the 4th segment. In the ♀ the abdomen is a little darker, with more brown in it.

Legs all reddish tawny, with silvery white reflections on the outside of the tibiae; hind femora very slightly thickened.

Wings.—Clear, pale brownish yellow from the anterior border as far back as about the posterior cross-vein. Discal cell quite clear.

Described from 2 ♂ ♂ and 4 ♀ ♀ in the Indian Museum collection from Karachi, west coast of India.

Physocephala nigrofasciata, mihi, sp. nov.

(Pl. xxxvii, figs. 15, 16.)

♂. Koygar (Central Asia). Long. 13 mm.

Head yellow, not shining and without silvery reflections; proboscis of considerable length, much more than double the length of the head, black. Antennae tawny, tip dark brown. Back of occiput yellow; eyes brown.

Thorax.—Brown, dorsum black. Humeri and posterior border just above scutellum yellowish; metanotum black with yellow sides. Scutellum tawny brown.

Abdomen.—Reddish tawny, 2nd segment only moderately contracted, with yellow posterior border; 3rd and 4th segments with broad black, posterior borders, and some black hairs. Rest of abdomen reddish tawny, with a few black hairs; tip black. Process under 4th segment.

Legs.—All reddish tawny; coxae black. *Wings* pale grey, with a blackish band reaching to the tip of the wing, and downwards into the discal cell; costal cell clear. Halteres reddish tawny.

Described from a single ♂ in the Indian Museum collection taken at Koygar, on the Yarkand Expedition.

N.B.—This might almost be put in the genus *Conops* so moderately contracted is the base of the abdomen.

Physocephala annulifera, mihi, sp. nov.

(*Conops annuliferus*, Big. nom. nud.)

♀. Assam. Long. 8 mm.

Head.—Deep yellow, slightly reddish above antennae, slightly livid on vertex. A large black triangular mark on frons, apex downwards, the base incurved. Antennae dark reddish brown; tips of 1st and 2nd joints a little pale below, 2nd joint minutely pubescent. Proboscis light shining brown, about twice the length of the head, tip shining black. Eyes bright chesnut brown, posterior margins silvery white tomentose. Back of head brown, livid towards vertex.

Thorax.—Wholly dull black; humeral calli and sides of thorax with a very little whitish dust. Scutellum and metanotum dark brown.

Abdomen.—Dark brown, lighter on 2nd and base of 3rd segment, these parts being much contracted; 3rd, 4th and 5th segments with a moderately wide gold-dusted posterior border; 6th segment gold dusted on dorsum. Genital apparatus somewhat withdrawn; consisting of an upper curved plate, a pair of claspers (apparently), and a narrow intermediate organ, all dark brown, shining and bare. Whole abdomen bearing minute black hairs.

Legs.—Coxae black, silvery white dusted. Femora reddish brown, hind pair somewhat thickened on basal half, apical half darker. Tibiae reddish brown, with silvery white dust; fore pair darker; posterior pairs attenuated towards base; hind pair lighter in colour on basal half. Tarsi dark brown. All the legs microscopically pubescent.

Wings.—Almost clear. A blackish colour from (on the costa) the base as far as just beyond tip of 2nd longitudinal vein; this colour extending posteriorly as far as the 3rd longitudinal vein where it sharply terminates but is continued into the basal half of the 1st posterior cell, the outer edge of the coloured part being perpendicular but without a clear-cut limit. The 1st posterior cell closed some distance before border. Anterior cross-vein just beyond centre of discal cell, which is just half as wide at base as at distal end. Halteres blackish.

Described from a single ♀ in good condition in the Indian Museum collection, from Margherita, Assam.

N.B.—I retain the specific name under which Bigot left it, but it seems inappropriate.

Physocephala sepulchralis, mihi, sp. nov.

♀. Assam. Long. 14 mm.

Head.—All black except the face and underside of the head, which are bright chrome yellow, the colour sharply delineated in a line across the base of the antennae. The extreme underside of the head, below the eyes, the mouth and the proboscis are black,

the latter extending barely beyond the epistoma. Antennae all black; 2nd joint two and a half times as long as the 1st; 3rd elongate, with a two-jointed style, the first joint cup-shaped, the second pointed; the 3rd antennal joint, with its style about two-thirds as long as the 2nd joint. Seen from in front and below, the 3rd joint is a little greyish on the inner side. A very dull dirty luteus yellow subtubercular oval piece on the vertex, most obvious from behind.

Thorax.—With scutellum, metanotum and sides wholly black.

Abdomen.—Wholly black; 1st segment with a few stiff black hairs at the sides; 2nd segment distinctly contracted (about half as wide as the 3rd and 4th segments), dull yellowish brown on hind margin and a little grey dusted at the sides; 3rd segment with hind margin barely whitened, and with a little grey dust at the sides posteriorly. Remainder of abdomen black, bare; genital organs small, black.

Legs.—Very dark reddish brown, nearly black. Coxae black; hind pair brilliantly shining silvery white, seen from behind; the colour to a great extent passing across the posterior part of the metasternum. Anterior coxae silvered to a less extent. Femora with a broad black median ring filling two-thirds of their length, the middle pair with distinct but short black hairs behind. Tibiae flattened behind at the tips, where they exhibit silvery reflections viewed from above. Tarsi black, pulvilli grey below.

Wings.—Dark grey; anterior part from costa to 3rd longitudinal vein more or less darker brown, varying in intensity in different parts. Halteres yellowish orange.

Described from one ♀ from the Lushai Hills (3600 ft.), 14-iv-(? 1909). In the Indian Museum.

Zodion, montanum, mihi, sp. nov.

♀. Darjiling. Long. 5 mm.

Head.—Frons above antennae dark reddish brown on upper part; when viewed from below two large oval whitish grey dust spots are visible. Vertex and back of head nearly black, the latter with black hairs, the whole of the frons, face and vertex being hairy. Face, cheeks, mouth and epistoma yellow, with (seen from below) a silvery white sheen. Proboscis black. Antennae black, underside of 2nd joint, which is bristly, yellow, underside of the bare 3rd joint red at base.

Thorax.—Ash-grey, covered (with the scutellum also) with short black hairs. Dorsum and scutellum in certain lights appear black, except humeral calli. Sides of thorax also appear partly black if viewed from different directions.

Abdomen.—Mainly ash-grey, covered with rather short black hair; forepart of most of the segments black, the colour extending round the sides and also posteriorly in the middle of the dorsum. Extreme tip of abdomen shining black. Genitalia small, black, shining, hairy.

Legs.—Black, pubescent. Coxae with silvery white sheen in front. Anterior femora yellow at base below, hind pair with more than the basal half yellow; knees and base of tibiae narrowly yellow. Anterior metatarsi rather yellow.

Wings.—Nearly clear, yellowish at base. Halteres yellow.

Described from a single perfect specimen captured by me a Darjiling, 30-ix-08, and now in the Indian Museum.

PHORIDAE.

Phora basalis, mihi, sp. nov.

♂. Assam. Long. 2⅓ mm.

Head.—Frons blackish from vertex downwards, the colour merged with the reddish brown lower part just above the antennae. Four rows of bristles, set in socket-like circles, the lowest row containing only the two middle ones; the others with four in each. Of these three rows the two middle bristles in the 1st (upper) row are nearer together, and those of the 3rd row further apart than the middle bristles of the 2nd row, where all four are equidistant. Antennae reddish yellow, dark, arista microscopically pubescent; palpi yellowish with 5 or 6 strong bristles towards the tips and some rows of stiff hairs on each side. Three strong bristles on each cheek, in a row, from just below the antennae, some smaller ones on the epistome. Eyes dark brown, microscopically pubescent, fringed with a row of moderately long bristles.

Thorax.—Reddish yellow, minutely pubescent, some strong bristles on each side of the dorsum and several towards the posterior margin, apparently irregularly placed. Scutellum concolorous, very broad, bare, except for a strong curved bristle near each end, and a very minute one immediately above it; no trace of other bristles.

Abdomen.—Basal third reddish yellow, slightly streaked with black, remainder blackish; moderately hairy especially towards the yellowish sides. Belly yellowish brown with some few hairs. Genitalia reddish yellow, small conical, tip narrowed, rather considerably hairy.

Legs.—Pale reddish yellow, minutely pubescent. Coxae bristly towards tips. Femora bare of strong bristles, but the hind pair bear a row of very small ones towards the tip below. This pair has a slight whitish reflection on the inner side in certain lights. Fore tibiae with 4 or 5 strong bristles on outer side; middle pair with two diverging bristles on hinder side, a little below the base, and also one or two at tip (possibly others may have been broken off). Hind tibiae with a row of very short bristles on front side, a row of longer ones on hinder side and several stronger ones on outer side, also two strong ones at tip.

Wings.—Pale yellowish; 3rd longitudinal vein reaches just beyond the middle of the wing, rather widely forked; 1st longitu-

dinal reaches to a little before the middle of the wing. The two upper light veins almost parallel, nearly straight, 3rd slightly curved, 4th parallel to hinder border of wing for some distance. Halteres yellowish brown.

Described from one ♂ in the Indian Museum collection taken by Major Hall at Sylhet, 23-ii-05.

Phora aequidistans, mihi, sp. nov.

♀. Darjiling District. Long. nearly 2½ mm.

Head.—Reddish yellow. Frons microscopically pubescent, with three straight rows of four strong bristles each, and a fourth row consisting of the two middle ones only. All the bristles almost equidistant and of uniform size; their insertion marked by a small circular impression on the frons. Eyes brown, posterior orbit with an almost complete row of rather short bristles, which are shortest on the vertex. Ocelli distinct, without tubercle; two strong bristles just below the lower corner of each eye. Antennae reddish yellow, shortly oval; arista apical, concolorous, barely thickened at base, microscopically pubescent. Palpi reddish yellow, with about six stiff bristles on each at the tip. Proboscis reddish, bare. Back of head reddish yellow, bare.

Thorax.—Reddish yellow, microscopically pubescent; a row of rather short bristles of unequal length round the sides and posterior edge of the dorsum. Scutellum concolorous, broad, quite bare, except for the four equidistant strong bristles on the posterior margin. Sides of thorax and metanotum concolorous. A pair of bristles on each side just below the shoulders and a second pair below these, adjacent to the fore coxae.

Abdomen.—Blackish; 1st segment reddish yellow with narrow black posterior margin; 2nd segment the longest; sides of segments showing a tendency to form pale spots; posterior margin of 6th (?) segment broadly yellow, with five or six bristles on under side. Ovipositor pale, conical, with a few hairs. Belly mainly blackish, bare.

Legs.—Yellow ochre, pale, microscopically pubescent throughout, the tarsi becoming brown towards the tips, and the tips of the hind femora above narrowly blackish. Fore coxae with black bristles about the broad tips, all femora destitute of bristles. Fore tibiae with a bristle on the outer side, a little below the base; middle pair with a bristle just below the base on the outer side and several at the tip; hind tibiae with two on the inner side, about the middle, and two strong ones at the tip, where, in addition, are some smaller ones, whilst there is a close-lying row of extremely short ones on the outer side, all the tarsi minutely spiny.

Wings.—Distinctly yellow, rather iridescent. Costal spines small, a double row to end of 1st longitudinal vein, the single row continued to end of 3rd longitudinal vein which terminates just before the middle of the wing and is so narrowly forked as to

appear simple unless very closely examined. The 1st longitudinal vein bent upwards beyond half its length, ending close to tip of 3rd. The four light veins about equidistant, very slightly sinuous. Halteres reddish yellow.

Described from a perfect ♀ in the Indian Museum collection, taken by Dr. Annandale at Kurseong (5000 ft.), 3-vii-08.

Phora rufithorax, mihi, sp. nov.

♀. Assam. Long. 2½ mm.

Head.—Front ferruginous brown, with three rows of equidistant bristles and a 4th (lowest) row of only the two middle ones placed rather closely together. Ocelli on a small blackish spot, not appreciably elevated, on vertex. Eyes black, microscopically pubescent, with a fringe of strong bristles, which in some places are longer than in others. Antennae and palpi yellow, latter with strong bristles at tips. Two or three bristles on cheek, pointing downwards.

Thorax.—Bright reddish brown, minutely pubescent; a row of six or seven strong bristles along the sides of the dorsum from the shoulders to the scutellum, and some others are placed, apparently irregularly, on the posterior part of the dorsum. Sides of thorax concolorous, with a few short bristles below the root of the wing. Scutellum of average size, concolorous, slightly blackish at base in the middle, with four strong, equidistant bristles on posterior margin. Metanotum reddish yellow at sides, blackish behind, lightly grey dusted.

Abdomen.—First two segments bright rufous brown, the second blackish towards the sides. Remaining segment mainly black, with a distinct, moderately wide pale yellow posterior border; the segments being a little reddish at the base, in the middle. Belly reddish brown, the black colour of the dorsum extended over the sides.

Legs.—Pale yellowish brown, microscopically pubescent. All coxae with several strong bristles at tip. Femora bare of bristles, hind pair black at tip. Fore tibiae with a single bristle in front, just before the middle, and a row of minute ones in front, towards the tip. Middle tibiae with a row in front of minute ones, and another similar row on outer side, in addition to two strong divaricate ones near the base on the outer side, and a few at tip. Hind tibiae with three less strong bristles on outer side, and two or three near tip. Tarsi minutely bristly, rather darker.

Wings.—Pale yellow, costal bristles, short, closely set, in two divaricate rows as far as the end of the 3rd longitudinal vein which attains the middle of the wing and is narrowly forked, the bifurcation somewhat elongated; 1st longitudinal with a sharp bend upwards at half its length, terminating beyond three-fourths of the costal cell. Of the discal veins the first 3 are only slightly sinuous, the first two being nearly parallel, slightly diverging towards the ends, but converging again at tips; 4th rather more

sinuous; none of them quite attain the wing margin. Halteres brownish.

Described from one ♀ in the Indian Museum collection from Sylhet, 10-iv-05, taken by Major Hall.

Phora bifasciata, Walk.

Redescription.

♀. Lower Eastern Himalayas and Celebes. Long. 3½ mm.

Head.—Frons entirely black, barely shining, with four rows of reclinate bristles; the upper row (vertical) of four nearly equidistant ones, the 2nd of four nearly equidistant ones, of which the middle pair are placed distinctly higher up on the frons, the row thus taking the form somewhat of a broad arch; the 3rd row of four equidistant ones forming a curve, the convex side downwards, the lowest row of only the two middle ones. Ocelli whitish, placed directly on the frons. Eyes microscopically pubescent, posterior orbit with a row of stiff, rather short bristles; two strong bristles below the lower corner of the eye. Antennae with 1st joint rather large, oval, reddish yellow, slightly darkened at tip, and with a slight microscopic grey pubescence; arista black, long, microscopically pubescent. Palpi reddish yellow, with six black bristles at tip. Proboscis reddish yellow, practically bare, large and fleshy. Face below level of antennae yellow; mouth border black, shining, with a shining black spot just above. Back of head blackish.

Thorax.—Coal black, finely pubescent, some strong bristles towards the sides of the dorsum, and a row of six on its posterior margin, directed horizontally backwards, as are also the four strong equidistant spines set on the extreme margin of the black scutellum, which is of average size, with a slight whitish reflection. A few bristles on the shoulders of the thorax and two just above each fore coxa.

Abdomen.—Dull black, almost bare, rather crumpled in appearance, but the segments distinctly visible. First segment wholly, basal half of 2nd (which is the longest segment) and the whole 5th segment, yellowish, with a little whitish reflection. Ovipositer long, conical, pale yellow, with some soft black hairs. Belly marked similarly to upper side.

Legs.—Pale dirty yellow, minutely and uniformly pubescent. Fore coxae with three strong, equal-sized bristles at tip, middle coxae with a number at tip of different lengths, those on the surface being also larger than on the fore pair, hind pair very large and flattened, nearly white, with only a few very small bristles at tip. Femora without any sign of a bristle; rather less than the apical half of hind pair, black on both outer and inner sides; extreme tip orange below. Fore tibiae with a single strong bristle on inner side, just before the middle; middle pair with longitudinal rows of very minute bristles, one of which is sinuous. There are two

divaricate bristles on the hinder or outer side, a little below the base, and both a long and a shorter spur at the tip. Hind tibiae deep black, minutely spinose, and with a strong bristle on outer side before the middle, and with two spurs at tip. Tarsi black, with some minute bristles.

Wings.—Rather deeply yellow; the double row of divaricate costal spines rather small. Costal vein distinctly thickened about its middle part; 1st and 3rd longitudinal veins approximately parallel, the latter attaining just the middle of the wing, where it is moderately widely forked; the 1st longitudinal ending close to the tip of the 3rd. The four discal veins nearly straight. nearly parallel and barely attaining the margin. Halteres pale yellow.

Redescribed from two perfect ♀ ♀ in the Indian Museum collection, one taken by Dr. Annandale at Sukna (500 feet), at the base of the Eastern Himalayas, 2-vii-08, the other by Lieut.-Col. Hall at Sylhet in Assam, 29-v-05.

N.B.—There can be practically no doubt that the examples described above are Walker's species, although Mr. Brues classes that with other species which he considers unrecognizable. One of Walker's apparent discrepancies is in that author stating it to be "yellowish white beneath." The very large pale yellow coxae cover up so much of the sides of the thorax and the bulk of the belly, that unless the legs are somewhat spread out, the species has the appearance described by Walker. I conclude that his remark as to the tip of the abdomen being yellow refers to the rather conspicuous ovipositer which is of this colour, but pale. The wings are distinctly yellow, not "cinereous"; this being the only real discrepancy, as his "elevated sides" to the abdomen are evidently caused by the sinking in of the middle part of the upper surface, for this is actually the fact with the Assam specimen and it probably is not a natural state.

PHORHYNCHUS, mihi, gen. nov.

Allied to *Phora*, but differing by the presence of a long elbowed proboscis; the 2nd joint rather longer and stouter than the 1st which is about as long as the width of the head. It is hard, cylindrical, 2nd joint slightly compressed, shining, tip bluntly conical. Palpi large, bristly. Frontal bristles wholly reclinate.

Phorhynchus ater, mihi, sp. nov.

♀. Ceylon. Long. 4½ mm.

Head.—Vertex and frons shining black. A vertical row of four bristles in a straight line, the middle two rather closer together, just behind the three conspicuous yellowish white ocelli; a 2nd row, straight, of four, across the middle of the frons; a 3rd slightly curved row of four (convexity downwards), and two others close together on the lowest extremity of the frons. Eyes black,

with a fringe of black bristles on posterior orbit. Antennae reddish yellow, 3rd joint very large, conical, with long yellow miscroscopically pubescent arista. Palpi reddish yellow, large, with six black spines. Proboscis reddish yellow.

Thorax.—Black, very slightly shining, minutely pubescent; shoulders and posterior corners at the edges narrowly tawny or yellow. Two humeral bristles, one post-humeral, two or three stiff ones on lower anterior corner of thorax; a pair of dorso-central, wide apart, a few on lateral margins, a strong one on each posterior corner of dorsum; and four on hind margin of scutellum, the outer pair placed towards the base.

Abdomen.—Wholly black, minutely pubescent; belly similar, genitals small, yellowish.

Legs.—Coxae and femora black, more or less yellowish at their juncture; tibiae and tarsi mainly yellowish, former (especially the hind pair) with a blackish tinge. Legs microscopically pubescent.

Wings.—Pale brownish yellow; viewed in certain directions vitreous and highly iridescent. Costa with minute spines as far as tip of 3rd vein, which is forked near its tip, which itself barely reaches beyond the middle of the wing. First discal vein very faint at base, rather strongly curved upwards, meeting anterior margin at upper corner of the rather squared wing tip; 2nd discal vein straight, ending at lower distal corner of wing; 3rd and 4th discal veins gently bisinuate.

Halteres, stem yellowish, clubs blackish.

Described from a few ♀ ♀ in my collection (including *type*) from Namunukuli, Ceylon, February 1910 [*Green*].

Table of oriental species of **Aphiochaeta.**

A	Scutellum with four distinct bristles (in *ferruginea* outer pair always weaker, sometimes very considerably so).	
B	Abdomen with first three segments black, the remainder yellow	*apicalis*, Brues.
BB	Abdomen mainly blackish or quite black: except in *ferruginea* which has it generally reddish or brownish yellow with an admixture of black of varying degree, sometimes to the extent of the whole surface.[1]	
C	Only two proclinate bristles ..	*tibialis*, Brues.
CC	Four proclinate bristles (the lower pair often weak in *ferruginea*).	
D	The 3rd longitudinal vein ending at about the middle of the wing: 1st longi-	

[1] This is an unsatisfactory definition, but the species is a difficult one on account of its great range of variation to include in a table, whatever characters are used.

divaricate bristles on the hinder or outer side, a little below the base, and both a long and a shorter spur at the tip. Hind tibiae deep black, minutely spinose, and with a strong bristle on outer side before the middle, and with two spurs at tip. Tarsi black, with some minute bristles.

Wings.—Rather deeply yellow; the double row of divaricate costal spines rather small. Costal vein distinctly thickened about its middle part; 1st and 3rd longitudinal veins approximately parallel, the latter attaining just the middle of the wing, where it is moderately widely forked; the 1st longitudinal ending close to the tip of the 3rd. The four discal veins nearly straight, nearly parallel and barely attaining the margin. Halteres pale yellow.

Redescribed from two perfect ♀ ♀ in the Indian Museum collection, one taken by Dr. Annandale at Sukna (500 feet), at the base of the Eastern Himalayas, 2-vii-08, the other by Lieut.-Col. Hall at Sylhet in Assam, 29-v-05.

N.B.—There can be practically no doubt that the examples described above are Walker's species, although Mr. Brues classes that with other species which he considers unrecognizable. One of Walker's apparent discrepancies is in that author stating it to be "yellowish white beneath." The very large pale yellow coxae cover up so much of the sides of the thorax and the bulk of the belly, that unless the legs are somewhat spread out, the species has the appearance described by Walker. I conclude that his remark as to the tip of the abdomen being yellow refers to the rather conspicuous ovipositer which is of this colour, but pale. The wings are distinctly yellow, not "cinereous"; this being the only real discrepancy, as his "elevated sides" to the abdomen are evidently caused by the sinking in of the middle part of the upper surface, for this is actually the fact with the Assam specimen and it probably is not a natural state.

PHORHYNCHUS, mihi, gen. nov.

Allied to *Phora*, but differing by the presence of a long elbowed proboscis; the 2nd joint rather longer and stouter than the 1st which is about as long as the width of the head. It is hard, cylindrical, 2nd joint slightly compressed, shining, tip bluntly conical. Palpi large, bristly. Frontal bristles wholly reclinate.

Phorhynchus ater, mihi, sp. nov.

♀. Ceylon. Long. 4½ mm.

Head.—Vertex and frons shining black. A vertical row of four bristles in a straight line, the middle two rather closer together, just behind the three conspicuous yellowish white ocelli; a 2nd row, straight, of four, across the middle of the frons; a 3rd slightly curved row of four (convexity downwards), and two others close together on the lowest extremity of the frons. Eyes black,

with a fringe of black bristles on posterior orbit. Antennae reddish yellow, 3rd joint very large, conical, with long yellow miscroscopically pubescent arista. Palpi reddish yellow, large, with six black spines. Proboscis reddish yellow.

Thorax.—Black, very slightly shining, minutely pubescent; shoulders and posterior corners at the edges narrowly tawny or yellow. Two humeral bristles, one post-humeral, two or three stiff ones on lower anterior corner of thorax; a pair of dorso-central, wide apart, a few on lateral margins, a strong one on each posterior corner of dorsum; and four on hind margin of scutellum, the outer pair placed towards the base.

Abdomen.—Wholly black, minutely pubescent; belly similar, genitals small, yellowish.

Legs.—Coxae and femora black, more or less yellowish at their juncture; tibiae and tarsi mainly yellowish, former (especially the hind pair) with a blackish tinge. Legs microscopically pubescent.

Wings.—Pale brownish yellow; viewed in certain directions vitreous and highly iridescent. Costa with minute spines as far as tip of 3rd vein, which is forked near its tip, which itself barely reaches beyond the middle of the wing. First discal vein very faint at base, rather strongly curved upwards, meeting anterior margin at upper corner of the rather squared wing tip; 2nd discal vein straight, ending at lower distal corner of wing; 3rd and 4th discal veins gently bisinuate.

Halteres, stem yellowish, clubs blackish.

Described from a few ♀ ♀ in my collection (including *type*) from Namunukuli, Ceylon, February 1910 [*Green*].

Table of oriental species of **Aphiochaeta.**

A	Scutellum with four distinct bristles (in *ferruginea* outer pair always weaker, sometimes very considerably so).	
B	Abdomen with first three segments black, the remainder yellow	*apicalis*, Brues.
BB	Abdomen mainly blackish or quite black: except in *ferruginea* which has it generally reddish or brownish yellow with an admixture of black of varying degree, sometimes to the extent of the whole surface.[1]	
C	Only two proclinate bristles ..	*tibialis*, Brues.
CC	Four proclinate bristles (the lower pair often weak in *ferruginea*).	
D	The 3rd longitudinal vein ending at about the middle of the wing: 1st longi-	

[1] This is an unsatisfactory definition, but the species is a difficult one on account of its great range of variation to include in a table, whatever characters are used.

	tudinal vein ending near middle of costal cell.	
E	The 3rd row of frontal bristles in a nearly straight line and equidistant; costal spines very short and thickly placed.	*limbata*, Brues.
EE	The 3rd row of frontal bristles divided into two pairs, one pair each side, towards the eye corners; costal spines long and sparse.	
F	Wings nearly clear; legs brown ..	*rustica*, Brues.
FF	Wings yellowish; legs pale yellowish ..	*ferruginea*, Brun.
DD	The 3rd longitudinal vein ending much before the middle of the wing; 1st longitudinal vein ending near tip of 3rd vein.	
G	Abdomen blackish brown; 3rd longitudinal vein distinctly forked ..	*approximata*, sp. nov.
GG	Abdomen with whitish posterior margins to the segments; 3rd longitudinal barely forked, and at extreme tip only ..	*subfurcata*, sp. nov.
AA	Scutellum with only two strong bristles.	
H	Frontal groove and ocellar tubercle distinct.[1]	
I	Thorax reddish brown; brownish yellow never dark or blackish.	
J	Thorax without any distinct stripes.	
K	Abdomen yellow, with a large black spot towards each side	*latifasciata*, sp. nov.
KK	Abdomen black, only hind margins of segment very narrowly pale ..	*flavifacies*. sp. nov.
JJ	Thorax with three distinct dark longitudinal stripes.	*trilineata*, sp. nov.
II	Thorax blackish or brownish.	
L	The bristles in the side pairs forming the 3rd row placed vertically: long. $\frac{3}{4}$ mm.	*minutissima*, Brues.
LL	The above-mentioned bristles nearly transversely placed: long 1—1½ mm.	*rufipes*, Meig.
HH	Frontal groove and ocellar tubercle absent.	
M	The 3rd longitudinal vein ending considerably beyond middle of wing: two upper ocelli twice as far from each other as from the eyes ..	*planifrons*, Brues.
MM	The 3rd longitudinal vein ending at middle of wing: two upper ocelli equi-	

[1] This is a weak character as in some specimens, though present, both are less prominent. However, I follow Brues, having no better distinctive character to offer.

distant, placed so as to divide the vertex into three equal parts. .. *pallicornis*, sp. nov.

N.B.—Two species are not included in the above table.

(1) *A. inaequalis*, sp. nov., in the type specimen of which the scutellar bristles are broken off. If four are present it will separate from either, (*a*), *tibialis* (should my species have only two proclinate frontal bristles, a point I have been unable to decide with certainty), also by the black antennae and thorax; or from, (*b*), *rustica* (should my species have four proclinate bristles), by the yellow palpi and other characters. On the other hand, if there are only two scutellar bristles it will come near *minutissima* and *rufipes*.

(2) *A. flava*, Fln., recorded by Brues (as probably introduced) from Papua. No specimens are available for comparison and Schiner's description does not mention the scutellar bristles.

Aphiochaeta ferruginea, mihi.

Rec. Ind. Mus., vii, 83.

(Pl. xxxvii, figs. 17-23).

This species must be very near, perhaps identical with *A. circumsetosa*, Meij. (Tijd. v. Ent., liv, 348). I fully described my species only recently (Rec. Ind. Mus., vii, 83), but if it be synonymous with *circumsetosa* Dr. Meijere's name has priority. Some figures of this species are included in the plate accompanying this paper; these were by an oversight omitted when describing the species. In a short separate article in the present volume are embodied some notes of mine on the life-history of this species.

Aphiochaeta approximata, mihi, sp. nov.

♀. Calcutta. Long. 1 mm.

Head.—Blackish grey, frontal impressed median line distinct. The bristles are arranged as follows: two upper rows of four in each, the middle two in the upper row rather closer together: the 3rd row consists of two each side, forming a slightly curved line, the two middle ones wide apart. Barely below these middle ones are the upper two of a set of four proclinate smaller bristles arranged in a square, all the other bristles being declinate. Antennae dirty brownish yellow.

Thorax.—Blackish brown, rather thickly clothed with reclinate bristly hairs, the usual bristles about the wing bases and on the hind margin of the dorsum. Sides of thorax and the scutellum concolorous, the latter with four bristles on the hind margin.

Abdomen.—(Somewhat crushed by pin), dirty brown, apparently bare; belly lighter.

Legs.—Pale yellow, hind pair brown, tibial spines strong.

Wings clear. The 3rd longitudinal vein forks near its tip but very distinctly, and shortly after tip of 1st longitudinal vein. Of the discal veins the 1st ends about half-way between the tip

of the 3rd vein and the tip of the wing; the 2nd is very slightly curved upwards, ending some distance before the wing tip; the 3rd is slightly curved, ending just below the wing tip; the 4th is curved slightly downwards. Halteres pale yellow.

Described from a single ♀ in the Indian Museum taken in the Museum, 18-vi-08, by Dr. Annandale.

N.B.—Very near *subfurcata*, mihi, but easily distinguished by the very obvious forking of the 3rd longitudinal vein.

Aphiochaeta subfurcata, mihi, sp. nov.

♂. Bengal. Long. 1½ mm.

This species is considerably like *ferruginea*, yet structurally quite distinct. It will be sufficient to point out the points of difference.

The frons and face are mouse grey, occasionally reddish yellow in part or wholly; the arista is nearly bare. The thorax is mainly mouse grey, with two slightly darker but always indistinct, somewhat narrow dorsal stripes, and a large spot on each side exterior to them, these marks not being at all regular, there being, however, nearly always, some slightly darker markings.

The abdomen is almost consistently black, the segments having the posterior edges pale yellowish white, the 1st segment being sometimes considerably pale The most reliable character is in the always very narrow bifurcation of the 3rd vein which sometimes is so slight as to leave doubt as to its bifurcation at all. This vein moreover always ends very distinctly before the middle of the wing, the 1st longitudinal ending close to it. The auxiliary[1] vein (which I regard as the first faint vein close below the costa on the distal half of the wing) is always more distinct than in *ferruginea*. Of the four discal veins, the 1st is less curved than in *ferruginea*, it being parallel to the costa for the greater part of its length, the 2nd is nearly straight, the 3rd and 4th slightly sinuous. There are more small bristles round the root of the wing, and those on the palpi and fore coxae are relatively stronger. Lastly it is a very distinctly smaller species.

N.B.—A small series, representing apparently only the ♂ sex, bred in the Indian Museum simultaneously with specimens of *ferruginea* from examples of the same beetle, *Cybister limbatus*, F., emerging 20-vii-08.

Aphiochaeta latifasciata, mihi, sp. nov.

♂. Assam and Bengal. Long. 1⅔ mm.

Head.—Bright reddish ferruginous, including antennae and palpi, the latter bristly at tip. Front with 3 rows of 4 strong reclinate bristles each, with two anterior proclinate, rather smaller ones. Arista minutely pubescent, the usual post-ocular row of bristles, ocellar tubercle not obvious.

[1] Synonymous with "subcostal" or "mediastinal."

Thorax.—Concolorous, minutely pubescent. The usual bristles round the edge and posterior border of the dorsum, and at base of wing. Scutellum with two strong bristles.

Abdomen.—Concolorous, almost bare. Sides of 2nd, 3rd and 4th segment blackish, forming a large side spot. Sides of 2nd segment with a few short, bristly hairs, and some hairs at tip of abdomen. Belly almost a replica of the dorsal surface.

Legs.—Concolorous but paler. Coxae bristly at tip; femora bare of bristles, hind pair with a few short hairs below; tibiae (slightly damaged) apparently bearing only the apical spurs; hinder side of hind tibiae with a row of microscopic bristles.

Wings.—Very pale yellowish, strong veins yellow; costal spines of moderate length; 3rd longitudinal vein attaining fully the middle of the wing; 1st vein ending at middle of costal cell. Three or four bristles on extreme base of wing on posterior edge. The discal veins nearly as in *ferruginea*, the 2nd much more sinuous. Halteres reddish yellow.

Described from a ♂ from Sylhet taken by Lt.-Col. Hall, 8-iv-05, and a ♂ and ♀ from Madhupur, Bengal, 13 and 16-x-09 [Paiva], all in the Indian Museum.

N.B.—This species is closely allied to *ferruginea*, and at times I have thought it identical, as though nominally there should be only two proclinate bristles, there is in one of the above three specimens a lower very much smaller pair, hardly so large as the lower pair in *ferruginea*, a species in which this lower pair varies in size very considerably. The bristles are broken off the scutellum in two specimens, in the third they are present, only a single pair and of considerable size. The tips of the hind femora are not blackish but this is, of course, a weak character and specimens of this nature exist in *ferruginea*. The abdominal marking in the three specimens are consistent and the general appearance is that of a distinct though allied species.

Aphiochaeta flavifacies, mihi, sp. nov.

♀. Calcutta. Long. 1⅓ mm.

Head.—Frons (minutely pubescent), face, antennae, palpi, proboscis, bright yellow; ocellar tubercle distinct, black. Two pairs of frontal proclinate bristles; 1st and 2nd upper rows rather close together, 2nd row nearly straight; 3rd rather strongly curved, arranged in two pairs, the two central bristles converging, and barely above the line of the upper proclinate ones. Lower proclinate bristles very small.

Thorax.—Tawny yellow, minutely pubescent, the hairs barely longer towards posterior margin. Five marginal bristles, two dorso-central. Scutellum concolorous, two bristles.

Abdomen black, nearly bare; posterior margin of segments narrowly whitish; sides of abdomen here and there with a reddish tinge. Belly black. Ovipositor small, pale yellow, hairy.

Legs.—Uniformly pale dirty yellow, minutely pubescent. All tibiae practically without stronger bristles; middle pair with a single long apical spur, hind pair with two shorter ones of unequal length.

Wings clear; 1st longitudinal vein ends at three-fourths of the costal cell; 3rd vein distinctly but rather narrowly forked, ending distinctly before middle of wing. Costal spines long, about twelve in number, auxiliary vein lengthened, indistinct, quite clear of fore border; 1st discal vein very slightly curved, 2nd and 4th almost straight, barely bisinuate; 3rd considerably bisinuate; all attaining margin of wing. Halteres yellow.

Described from one ♀ in the Indian Museum from Calcutta, 5-ii-08, taken by Dr. Annandale.

Aphiochaeta trilineata, mihi, sp. nov.

♂. Calcutta. Long. 2 mm.

Head.—Entire frons (which is minutely pubescent), face, antennae, palpi, proboscis and back of head bright yellow. Ocellar tubercle distinct, black, frontal groove indistinct. Median pair of upper row of bristles close together; 2nd row slightly curved; 3rd row forming a gentle curve, on a level with the upper pair of the four proclinate bristles; the lower pair of the latter being much smaller. The various head bristles normal.

Thorax.—Wholly yellowish, minutely pubescent, with three wide longitudinal dark brown stripes, one central, the others running from the shoulders along the edge of the dorsum, but not quite meeting the central one on the posterior margin, where however, the middle stripe is continued on to the scutellum, leaving the latter with a wide yellow posterior border. Four or five strong marginal thoracic bristles; two dorso-central ones and two on the scutellum, with a minute stiff hair above each.

Abdomen.—Yellowish, nearly bare, with indistinct darker marks and two dorsal rows of squarish dark brown spots, two on each segment. Genitalia of two pieces (like two additional abdominal narrow segments), black, and a bilobed pale yellow appendage, the whole organ rather hairy.

Legs pale dirty yellow; posterior tibiae and tarsi slightly brownish. Middle tibiae with a row of close, minute black hairs and a single long apical spur, hind tibiae with an outer row of a few bristly hairs and two shorter apical spines.

Wings distinctly yellowish; a little iridescent towards tips. The 1st longitudinal vein ends midway between the humeral cross-vein and tip of 3rd vein, which is rather widely forked and ends just beyond middle of wing, both 1st and 3rd veins being distant from the border. Costal spines very short and close together. The auxiliary vein lengthened, rather indistinct, close to border of wing. Of the discal veins, the 1st is gently curved; 2nd and 3rd barely bisinuate, 4th nearly straight, all attaining wing-border but the 1st and 4th indistinct at base. Halteres brownish yellow.

Described from a unique ♂ in perfect condition in the Indian Museum taken by Dr. Annandale in Calcutta, 7-ii-08.

Aphiochaeta pallicornis, mihi, sp. nov.

♂. Darjiling District. Long. 1½ mm.

Head.—Frons shining black, very lightly pubescent; frontal groove and ocellar tubercle quite absent. First two rows of bristles with four each, the median pair of 2nd row placed much more forward than the outer ones. Third row consisting of a pair each side placed nearly vertically near the eyes, and only just above the level of the upper larger pair of the four proclinate bristles forming the 4th (lowest) row. Antennae and palpi bright reddish yellow. Eyes brown; post-ocular bristles normal.

Thorax shining black, with minute pale pubescence, and about 5 or 6 strong bristles on the sides of the dorsum in addition to a pair of dorso-central bristles. Scutellum concolorous with two bristles.

Abdomen dull black, with scarcely any pubescence. Genitalia withdrawn.

Legs black, minutely pubescent; broadly pale yellowish at junction of coxae and femora. Fore tibiae and tarsi yellowish, posterior tibiae and tarsi brownish yellow, with both a long and a short apical spur to each tibia. All the tibiae finely setulose, middle pair with a row of small bristles on outer side.

Wings brownish, posterior part rather lighter. The 1st longitudinal vein ending half-way between humeral cross-vein and fork of the 3rd longitudinal, which fork is very distinct and rather wide. Auxiliary vein merged in wing border; costal spines rather short. Discal veins gently curved, 2nd, 3rd and 4th barely bisinuate. Halteres black, stems yellow.

Described from a single specimen in the Indian Musem collection taken by Dr. Annandale at Kurseong (5000 ft.), 3-vii-08.

Aphiochaeta inaequalis, mihi, sp. nov.

♂. Nepal. Long. 1¼ mm.

Head.—Frons black, shining, slightly pubescent, frontal groove not obvious; ocellar tubercle distinct. Upper row of bristles normal, 2nd row curved, middle pair rather close together; 3rd row curved, middle pair apparently proclinate; two anterior bristles (small) proclinate. Antennae black; palpi yellowish.

Thorax.—Very dark brown, rather closely pubescent; with some marginal bristles. (Hind part of dorsum and the scutellum destroyed by the pin). Sides of thorax concolorous.

Abdomen.—Uniformly dull black, with short, very sparse pubescence. Genitalia small, retracted, yellowish.

Legs.—Fore pair light brownish yellow. Posterior legs brownish; hind femora blackish on outer side, yellowish brown on inner side, with black tips.

Wings.—Quite clear. Third longitudinal vein ends at middle of wing; fork rather small, but distinct; 1st longitudinal ends just beyond middle of costal cell, straight. Costa with a row of short bristles, and a second row of much longer ones set further apart. Auxiliary vein very indistinct. Of the discal veins, the 1st is moderately curved, 2nd gently bisinuate, 3rd and 4th nearly straight, all attaining border of wing. Halteres dark brown.

Described from a single specimen in the Indian Musem from Thamaspur, Nepal, 18—20-ii-08.

N.B.—This appears to be near the *A. sodalis* of Brues, described from New South Wales, and which he considers very close to, if not identical with, his *crassimana*, from New Guinea. My species differs in several characters from both of them and is conspicuous chiefly for the great difference in length of the two rows of costal bristles, from which it takes its name.

Hypocera marginata, mihi, sp. nov.

♀. South India. Long. 2½ mm.

Head.—Frons shining black, practically bare. The 1st row of bristles vertical; 2nd row of four equidistant ones curved upwards; 3rd row of only one each side; 4th row similar, the bristles placed one on each corner of the frons, which somewhat narrows in front Two smaller proclinate bristles in front. Frontal groove only visible for a short distance in front; ocellar tubercle absent. Antennae bright reddish orange, arista black, orange at base. Palpi pale yellow, with four or five strong bristles at tip. Eyes with the usual row of bristles, which continue round the lower corners. Back of head black.

Thorax.—Dorsum wholly black, except the posterior margin from one wing base to the other which is irregularly yellow; dorsum entirely covered with close short stiff black hairs, with several stronger bristles along the posterior margin, and a powerful long spiny bristle on each posterior corner. Sides dull black, with a faint bluish tinge. Scutellum blackish, with yellow margin and four spines, the outer upper pair less strong.

Abdomen dull black, bare, emarginations of segments barely pale; posterior border of 5th segment broadly yellow. Belly black. Ovipositor small, dark sub-conical, apparently of two segments.

Legs.—Uniformly yellowish, hind tarsi barely darker; hind femora towards the tips black. Fore tibiae with a row of very short bristles on outer side; posterior tibiae with a double row of longer ones, and some very small ones about the tips; the hind pair having some rows of microscopically small black hairs.

Wings.—Very pale brownish yellow, 3rd longitudinal vein barely reaching middle of wing. It is of uniform width to its tip where it is very slightly thickened, ending free, but with a faint fork issuing just before the tip, uniting it to the costa. The 1st longitudinal vein ends at two-thirds the length of the costal cell. Costal spines short. Of the discal veins, the 1st is

almost straight after its first bend; 2nd barely curved; 3rd nearly straight but very gently trisinuate; 4th straight; all attaining border but indistinct at base. Halteres white, stem yellow.

Described from a single specimen in the Indian Museum collection taken 21-xi-08 by Dr. Annandale at Tenmalai, Travancore State, S. India.

MYDASIDAE.

Cephalocera annulata, mihi, sp nov.

♂. Assam-Bhutan Frontier. Long. 15 mm.

Head.—Frons rather more than one-third of the head, with a small swelling each side of vertex, contiguous to the corners of the eyes. Proboscis short. The whole head moderately shining black, with rather thick and long whitish grey pubescence over frons and face except lower part of the latter. Occiput black, with whitish grey hair, which is longer on lower part of head. Antennae all black, long; 2nd joint very short, 3rd joint with an impressed constriction some distance before its tip; beyond the constriction the joint is slightly thickened. Style long, nearly as long as rest of antennae, black, with an impressed constriction at nearly one-third of its length, the style thickening apically except at extreme tip where it is slightly but obviously narrower.

Thorax black, a grey tomentose stripe at each side of the dorsum, a short one from each shoulder, narrowing rapidly and not reaching centre of dorsum; the middle of the posterior margin also grey tomentose. The whole dorsum covered with fine grey pubescence, which is a little longer below the shoulders and on the side stripes. Scutellum broad, extremely short, shining black, bare. Sides of thorax moderately shining black, with a little grey pubescence on the pleurae.

Abdomen shining black, posterior margins of all segments (indistinctly on the 1st segment) narrowly but clearly defined pale whitish yellow. Whole surface of abdomen with depressed pubescence, which is dark brown or blackish on basal half (or thereabouts) of each segment, and pale grey on apical half. Belly similar, the yellowish white bands passing over the sides of the segments and continued narrowly across the ventral surface. Genitalia comparatively small, black; a dorsal plate, a pair of moderately long finger-like claspers and some yellowish brown internal organs.

Legs black; shortly and normally grey pubescent; base of hind tibiae and tarsi slightly brownish yellow.

Wings pale grey, venation in exact agreement with Macquart's figure of *Cephalocera nigra* (Dipt. Exot. i, 2, pl. i, 3). Halteres black.

Described from 2 ♂♂ from Bhoirakund, Darrang District, Assam-Bhutan Frontier, 18—22-x-12 [*Kemp*]. In the Indian Museum.

EXPLANATION OF PLATE XXXVII.

FIG. 1.—*Haematopota albofasciatipennis*, sp. nov., wing.
,, 2.— ,, *striatipennis*, sp. nov., wing.
,, 3.—*Atherix caerulescens*, sp. nov., wing.
,, 4.—*Hyperalonia semifuscata*, sp. nov., wing.
,, 5.—*Exoprosopa vitrea*, Big. (probable appearance of abdomen in perfect specimens).
,, 6.—*Argyramoeba argentiapicalis*, sp. nov., wing.
,, 7.— ,, *gestroi*, sp. nov., wing.
,, 8.—*Pterodontia dorsalis*, sp. nov.
,, 9.— ,, ,, ,, wing.
,, 10.— ,, ,, ,, antenna.
,, 11.—*Atriadops nivea*, sp. nov., wing.
,, 12.—*Leptomydas indianus*, sp. nov., wing.
,, 13.—*Physocephala albofasciata*, sp. nov., abdomen, dorsal view.
,, 14.— ,, ,, ,, ,, side view.
,, 15.— ,, *nigrofasciata*, sp. nov., abdomen, dorsal view.
,, 16.— ,, ,, ,, ,, side view.
,, 17.—*Aphiochaeta ferruginea*, Brun., wing.
,, 18.— ,, ,, head, front view.
,, 19.— ,, ,, profile.
,, 20, 21.— ,, ,, abdomen, ♂.
,, 22, 23.— ,, ,, ,, ♀.

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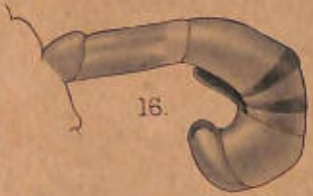
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D. Bagchi, del.

Beesons, Calla, Derby.

NEW ORIENTAL DIPTERA.

EXPLANATION OF PLATE XXXVII.

FIG. 1.—*Haematopota albofasciatipennis*, sp. nov., wing.
,, 2.— ,, *striatipennis*, sp. nov., wing.
,, 3.—*Atherix caerulescens*, sp. nov., wing.
,, 4.—*Hyperalonia semifuscata*, sp. nov., wing.
,, 5.—*Exoprosopa vitrea*, Big. (probable appearance of abdomen in perfect specimens).
,, 6.—*Argyramoeba argentiapicalis*, sp. nov., wing.
,, 7.— ,, *gestroi*, sp. nov., wing.
,, 8.—*Pterodontia dorsalis*, sp. nov.
,, 9.— ,, ,, ,, wing.
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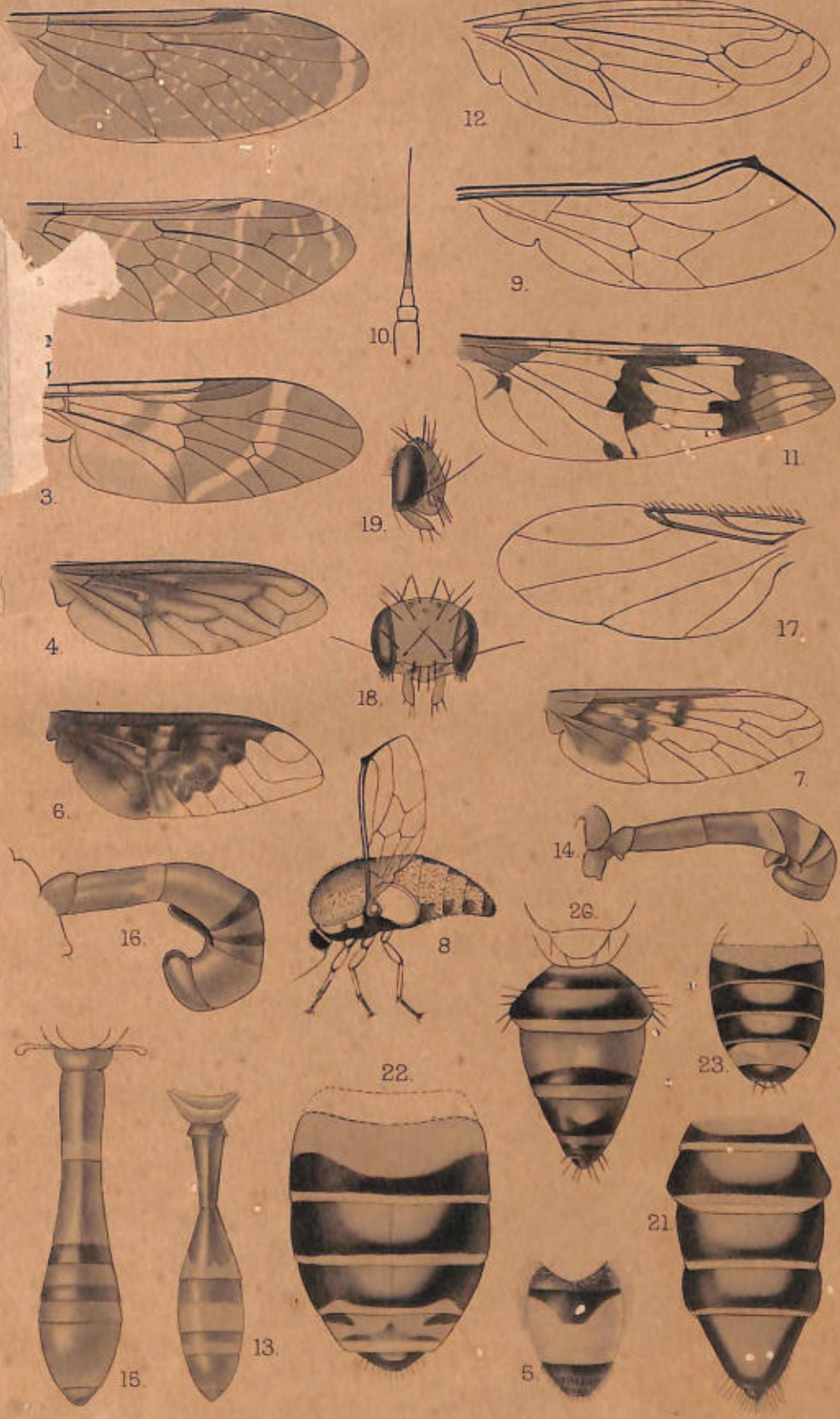
,, 12.—*Leptomydas indianus*, sp. nov., wing.
,, 13.—*Physocephala albofasciata*, sp. nov., abdomen, dorsal view.
,, 14.— ,, ,, ,, ,, side view.
,, 15.— ,, *nigrofasciata*, sp. nov., abdomen, dorsal view.
,, 16.— ,, ,, ,, ,, side view.
,, 17.—*Aphiochaeta ferruginea*, Brun., wing.
,, 18.— ,, ,, head, front view.
,, 19.— ,, ,, profile.
,, 20, 21.— ,, ,, abdomen, ♂.
,, 22, 23.— ,, ,, ,, ♀.



D. Bagchi, del. Bemrose, Calla, Derby

NEW ORIENTAL DIPTERA.

MISCELLANEA.

INSECTS.

NOTES ON THE LIFE HISTORY OF *Aphiochaeta ferruginea*, MIHI.—In the *Records of the Indian Museum* for February, 1912, I published a description of the above Phorid, and stated that two generations had been bred by me from a dead lizard, but that the notes made at the time had been mislaid.

After long-continued search these have at last been found and the present short report embodies them.

The lizard (*Calotes versicolor*, Daud.) was put alive into an ordinary pickle jar, the cork fitted so as to allow air to enter.

I had noticed two or three small flies about the jar for a couple of days before the lizard died, but cannot be sure they were the same species. The lizard died, to the best of my recollection, after two days' incarceration, and the young larvae were noticed the next day, when they were nearly a quarter of an inch long, so either the eggs must have been laid in the living lizard or they must have hatched and grown to that size in twenty-four hours.

The dead lizard was removed and a little cooked rice and a piece of roast duck put in.

The larvae pupated in about four or five days, coming to the top of the jar *outside* (the jar was left partly open), all round the edge of the cover. I picked them off and placed them in a glass-topped box. Practically all the flies emerged on one day, about a week after pupating.

The imagos had been out about five days, and on Sunday morning (August 4th, 1907) there were no signs of larvae. On Sunday evening I put in a small piece of roast duck, and on Tuesday morning (6th) some young larvae nearly one-fifth of an inch long were seen. About a hundred appeared, crawling with ease up the glass. They had two black hooks on the under surface of the head, resembling the tusks of a walrus. On Sunday the 11th four or five pupated; on Monday (12th) I draped up the top of the box and gave them no more food; six or eight more pupating the same day. On Tuesday (13th) three flies were found by 6 P.M., a number more pupating on Wednesday. Two days afterwards (16th) nearly all (150) pupated, but some young larvae (about a dozen) still remained This may have been due to restricted growth through being crowded out for want of food, as all that was left of the latter was liquid and bad smelling. Possibly a later emergence from the egg may have caused the delay in their development. The pupae were small, yellow and

soft. Some further larvae half grown had unsuccessfully endeavoured to pupate. I put in fresh food and left them to their own devices. There must have been numerous other larvae too small to be noticed (unless indeed, a 3rd generation sprang up from the three flies that emerged August 13th of which, by the way, the sexes were not noted), for by Sunday the 18th there were nearly a hundred fairly well fed up larvae. No further food was given.

On Tuesday (20th) from 40 to 50 pupated, on Thursday evening (22nd) three flies emerged and on Friday and Saturday (23rd, 24th) sixty more The rest appeared during the next three days and no further notes were kept.

Some figures of this species are included in the plate to my paper "New Oriental Diptera, I."

E. BRUNETTI.