DISTRIBUTIONAL RECORDS OF INDIAN MUSCOIDS, WITH DESCRIPTIONS OF TWO NEW SPECIES.

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(Plate II.)

Since the various parts of the Revision of the Indian Calyptrate Muscoids by Major Patton and myself have appeared, (Patton & Senior White, 1924; Senior White, 1924, 1925, 1926), the present author has accumulated considerable further distributional records, which are here set forth, as the majority are from places and localities difficult of access to the entomologist.

Ambadola is a village in the extreme north of the Vizagapatam Agency, about 1,200 feet elevation. The country is open, with some scrub jungle.

Artham Camp, now abandoned, was district headquarters during the construction of the Raipur-Vizianagram Railway. It is of about 400 feet elevation in plains country.

Anuppur, in Rewa State, is about 1,000 feet elevation, near the head waters of the Nerbudda and the Sone. The country is open.

Basta, in Orissa, is on the coastal plain near Balasore.

Chakadhapore, in Chota Nagpur, is a small town. Elevation about 800 feet.

Dangoaposi, in Chota Nagpur, Singhbhum District, is about 1,600 feet. The country is open.

Gidni, in Chota Nagpur, is on the boundary of Orissa and Bengal. Elevation about 300 feet.

Goilkera, Chota Nagpur, *circa* 1,600 feet. Open country.

Jaleshwar, Orissa. Coastal plain.

Jeraikela, Chota Nagpur, about 800 feet, in Sal forest country.

Jonk River, elevation about 600 feet, near the eastern edge of the Chattisgarh Division of the Central Provinces.

Komarada, on the plains of Madras, about 3 miles north of Artham Camp.

Manharpur, Chota Nagpur, a small town, about 800 feet.

Posoita, Chota Nagpur, a station in heavy Sal forest, about 1,100 feet elevation.

Santragachi, about 5 miles south-west of Howrah, Lower Bengal.

Sarandha, a tunnel pierces the range of this name in heavy Sal forest, about 1,400 feet.

Tanga Manda, a station, in Bamra State, Chota Nagpur. Elevation about 800 feet. Country forested.

Titlagahr, Patna State, about 800 feet. In open rice country.

The other localities mentioned are all well known.

Muscinae.

Morellia hortensis Wied.

Wied., *Anal. Ent.* 49, 101 (1824).

Artham Camp, Parvatipuram District, 21-xii-25, 1 ♂.
Jeraikela, Chota Nagpur, 9-viii-28, 1 ♂.

Musca nebulo Fab.

Fab., *Ent. Syst.*, IV, p. 321, 35 (1784). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 563, pl. xxx, fig. 3, pl. xxxii, fig. 29 (1924).

Vizagapatam, 3-9-vii-26, 3 ♂ 2 ♀.
Artham Camp, Parvatipuram District, 29-xi-25, 1 ♂.
Delhi, 31-x-27, 3 ♂ 6 ♀.
Jeraikela, Chota Nagpur, 9-vii-28, 3 ♀.
Santragachi, Bengal, 19-vii-28, 1 ♂ 4 ♀.

Musca vicina Macq.

Macq., *Dipt. Exot.* supp. 4, p. 226, 19 (1850). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 563, pl. xxx, fig. 2, pl. xxxii, fig. 28 (1924).

Vizagapatam, 3-9-vii-26, 1 ♀.
Kasauli, Simla Hills, 29-vii-27, 1 ♂ 1 ♀.
Santragachi, Bengal 19-vii-28, 1 ♂ 4 ♀.

Musca sobens Wied.

Wied., *Ausser. Zweifl. Ins.*, II p. 418 (1830). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 565, pl. xxx, fig. 5, pl. xxxii, fig. 31 (1924).

Vizagapatam, 3-9-vii-26, 2 ♂ 12 ♀.
Artham Camp, Parvatipuram District, 22-xii-25, 1 ♂.
Goilkera, Chota Nagpur, 1-15-vi-26, 1 ♀; 13-16-vii-26, 2 ♂.
Jeraikela, Chota Nagpur, 9-vii-28, 1 ♂ 3 ♀.
Jaleshwar, Orissa, 11-vii-26, 1 ♀.
Santragachi, Bengal, 19-vii-28, 1 ♀.

Musca vetustissima Wlk.

Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 566, pl. xxx, fig. 6, pl. xxxii, fig. 32 (1924).

Artham Camp, Parvatipuram District., 14-xi-25, 1 ♀; 19-22-xii-25, 3 ♂ 10 ♀.

Musca ventrosa Wied.

Wied., *Ausser. Zweifl. Ins.*, II p. 656 (1830). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 568, pl. xxx, fig. 10, pl. xxxii, fig. 37 (1924).

Artham Camp, Parvatipuram Dist., 22-xii-25, 1 ♀.
Goilkera, Chota Nagpur, 28-viii-28.

Musca pattoni Aust.

Aust., *A. M. N. H.*, (8) V, p. 114 (1910). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 570, pl. xxx, fig. 15, pl. xxxii, fig. 41 (1924).

Artham Camp. Parvatipuram District, 14-xii-25, 1 ♂ (specimen with very narrow frons and 5 radial hairs) ; 19-22-xii-25, 1 ♂ 5 ♀.

Shillong, Khasi Hills, 11-12-x-26, 1 ♂ 1 ♀.

Posoita, Chota Nagpur, 30-viii-28, 2 ♂ (one with 3 and 5 radials on left and right wings respectively, one with 4 on each wing).

Musca spinohumera Awati.

Awati, *Ind. Journ. Med. Res.*, IV, p. 138 (1916). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 571, pl. xxx, fig. 14, pl. xxxiii, fig. 43 (1924).

Artham Camp, Parvatipuram District, 21-xii-25, 1 ♀.

Musca planiceps Wied.

Wied., *Anal. Ent.*, 48, 100 (1824). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 575, pl. xxxi, fig. 23, pl. xxxiii, fig. 51 (1924).

Artham Camp, Parvatipuram District, 15-xii-25, 1 ♂.

Goilkera, Chota Nagpur, 1-15-vi-26, 1 ♂.

Musca crassirostris Stein.

Stein in Becker, *Mitt. Zool. Mus. Berlin*, II, p. 99, 137 (1903). Patton & Senior White, *Rec. Ind. Mus.*, XXVI, p. 577, pl. xxxi, fig. 26, pl. xxxiii, fig. 42 (1924).

Komarada, Parvatipuram District, 28-xi-25, 1 ♂ (males following in swarms whilst walking through reaped rice fields).

Artham Camp, Parvatipuram District, 19-21-xi-25, 12 ♂ 3 ♀.

Passeromyia heterochaeta Villen.

Villen., *Bull. Soc. Ent. Fr.*, 1915, p. 225 (fig.).

Goilkera, Chota Nagpur, 28-viii-28, 1 ♀ (in railway carriage that had been standing some days in the station).

Orthellia lauta Wied.

Wied., *Ausser. Zweifl. Ins.*, II, p. 410, 44 (1830).

Artham Camp, Parvatipuram District, 29-xi-22-xii-25, 14 ♂ 26 ♀.

Anuppur, Rewah State, 9-xii-28, 1 ♂.

Orthellia latifrons Mall.

Mall., *A. M. N. H.*, (9) XII, p. 508 (1923).

Artham Camp, Parvatipuram District, 28-xi-22-xii-25, 7 ♂ 5 ♀.

Orthellia obscuripes Stein.

Mall., *A. M. N. H.*, (9) XII, p. 505 (1923).

Anuppur, Rewah State, 9-xii-28, 1 ♂, which, with some reservation, I attribute to this species.

Orthellia siamensis Mall.

Mall., *A. M. N. H.*, (9) XII, p. 509 (1923).

Artham Camp, Parvatipuram District, 22-xii-25, 1 ♂.
Darjiling, 11-vi-26, 1 ♂.
Jeraikela, Chota Nagpur, 9-vii-28, 3 ♂.

Stomoxys calcitrans Linn.

Linn., *F. Suec.*, (ed. ii), p. 467, 1900 (1761). Brun., *Rec. Ind. Mus.*, IV, p. 68 (1910).

Goilkera, Chota Nagpur, 28-viii-28, 1 ♀.
Santragachi, Bengal, 19-vii-28, 1 ♀.

CALLIPHORINAE.

Calliphora aucta Wlk.

Wlk., *Dipt. Saund.*, p. 334, (1856). S. White, *Rec. Ind. Mus.*, XXVIII, p. 129 (1926).

Darjiling, 9-vi-26, 1 ♀ (on window); 11-vi-26, 1 ♂ 3 ♀ (in garden).

Lucilia pulchra Wied.

Wied., *Ausser. Zweifl. Ins.*, II, p. 406 (1830). S. White, *Rec. Ind. Mus.*, XXVIII, p. 130 (1926).

Artham Camp, Parvatipuram District, 29-xi-19-xii-25, 5 ♀.

Lucilia inducta Wlk.

Wlk., *Dipt. Saund.*, p. 335 (1856). S. White, *Rec. Ind. Mus.*, XXVIII, p. 130 (1926).

Darjiling, 4-vi-26, 1 ♀.

Lucilia albopilosa S. W.

S. White, *Rec. Ind. Mus.*, XXVIII, p. 130 (1926).

Darjiling, 4-vi-26, 1 ♂.

Lucilia cuprina Wied.

Wied., *Ausser. Zweifl. Ins.*, II, p. 654 (1830). S. White, *Rec. Ind. Mus.*, XXVIII, p. 131 (1926).

Santragachi, Bengal, 17-19-vii-28, 2 ♂ 2 ♀.

Chrysomyia megacephala Fab.

Fab., *Syst. Ent.*, IV, p. 317, 18 (1794). S. White, *Rec. Ind. Mus.*, XXVIII, p. 132 (1926).

Goilkera, Chota Nagpur, 13-16-vii-26, 7 ♀.

Chrysomyia combrea Wlk.

Senior White, *Rec. Ind. Mus.*, XXVIII, p. 133 (1926).

Shillong, Khasi Hills, 12-x-26, 1 ♂.

Caiusa indica Surc.

Surc., *Arch. Mus. N. H. Paris*, (5) VI, p. 53 (1920).

Komarada, Parvatipuram District, 12-x-25, 1 ♂ (at food).

Bengalia jejuna Fab.

Fab., *Ent. Syst.*, IV, p. 312, 1 (1794). S. White, *Rec. Ind. Mus.*, XXVIII, p. 137 (1926).

Raipur, Central Provinces, 18-ii-26, 1 ♀.
Basta, Orissa, 13-v-28, 1 ♀ (at light).
Jeraikela, Chota Nagpur, 9-vii-28, 1 ♂ 1 ♀.

Bengalia lateralis Macq.

Macq., *Dipt. Exot.*, II, iii, p. 277, 1 (1843). S. White, *Rec. Ind. Mus.*, XXVIII, p. 137 (1926).

Uluburu, Keonjhar State, 30-ix-28.

Bengalia martin-leakei, sp. nov.

(Plate II, figs. 1, 2.)

15 mm. 1 ♂. *Head* : frons orange-brown, parafrontalia paler, ashy, the whole rather less than one-third of head width. Parafacialia paler greyish, with black flecks opposite the antennal roots, at middle and (large and less distinct) on each side of mouth opening. Antennae dark brown, third segment grey pollinose. Palpi yellow with black bristles. *Thorax* : mesonotum and scutellum light coffee brown, without distinct paler lateral margins. Pleurae almost concolorous. *Abdomen* : Yellow with black marginal hind bands, broad on segments ii and iii. *Legs* brown, meta-tarsi paler, apical tarsal segments blackened. Front femora armed with six spines on basal third, closely set, the first short, on very prominent tuberosity. *Wings* infuscated. Squamae grey.

The male genitalia are very similar to *lateralis* Macq., but the bifurcation of the anterior claspers is a perfectly distinct feature. The posteriorly directed process on the posterior claspers common to *lateralis* and *siamensis* S. W. is here reduced to a vestige.

In my key to the genus (Senior White, 1924), the new species runs to couplet 5, separating on the more basal situation, closer apposition and stronger character of the front tibial spines from *siamensis*, to which it appears most closely allied.

Unique type from Rayagada, Vizagapatam Agency Tracts, 1-x-25, 1 ♂. In my own collection. I have much pleasure in dedicating this

species to Col. A. Martin Leake, *V.C.*, *F.R.C.S.*, Chief Medical Officer of the Bengal-Nagpur Railway, as a mark of appreciation of his never failing interest in the purely scientific side of my work in his Department.

Bengalia hastativentris S. W.

S. White. *Spol. Zeyl.*, XII, p. 306 (1923).

Delhi, 5-viii-27, 1 ♀.

Bengalia bezzii S. W.

S. White, *Spol. Zeyl.*, XII, p. 306 (1923).

Chakhadapore, Chota Nagpur, 6-vii-28, 1 ♀.

Rhiniinae.

Pollenia pilisquama S. W.

S. White, *Rec. Ind. Mus.*, XXVI, p. 84 (1924).

Shillong, Khasi Hills, 12-x-26, 2 ♂.

The type of this species came from Ceylon, and the present is yet another record of the similarity of the Ceylon and Shillong dipterous faunas.

Strongyloneura viridana Tnsd.

Tnsd., *Rec. Ind. Mus.*, XIII, p. 197 (1917).

Artham Camp, Parvatipuram District, 14-xii-25, 1 ♀.

Strongyloneura coerulana Tnsd.

Tnsd., *Rec. Ind. Mus.*, XIII, p. 198 (1917).

Artham Camp, Parvatipuram District, 14-15-xii-25, 1 ♂ 1 ♀.

Strongyloneura nebulosa Tnsd.

Tnsd., *Rec. Ind. Mus.*, XIII, p. 197 (1917).

Goilkera, Chota Nagpur, 13-16-vi-26, 1 ♂.

Metallea divisa Wlk.

Wlk., *Dipt. Saund.*, p. 333 (1856). S. White, *Spol. Zeyl.*, XIII, p. 114 (1924).

Titlagahr, Patna State, 11-xii-26, 2 ♀ (the legs and abdomen are rather darker than in southern specimens).

Jeraikela, Chota Nagpur, 9-vii-28, 1 ♀.

Idiella mandarina Wied.

Wied., *Asser. Zweifl. Ins.*, II, p. 350 (1830). S. White, *Spol. Zeyl.* XIII, p. 111 (1924).

Goilkera, Chota Nagpur, vi-26, 1 ♂.

Stomorhina dsicolor Fab. var. **nigripes** S. W.

S. White, *Mem. Dept. Ag. Ind.* (Ent. Ser.) VII, p. 167 (1922).

Darjiling, 11-vi-26, 1 ♂, is intermediate between the type and the variety.

SARCOPHAGINAE.

Sarcophaga pes-helicis, sp. nov.

(Plate **II**, fig. 3.)

9 mm. 1 ♂. *Head*: frontal width about half an eye-breadth. Frontals diverging. Facials numerous and strong. Genals strong, black. Three clear rows of post-ocular black cilia. Frontal stripe dark brown. Parafrontals together about as wide as frontal, these and face dark silvery grey with black reflections at their junction. Antennae black, third joint about 2½ times second. Palpi black. *Thorax*: ground colour bluish-grey, more yellowish grey marginally. Acrostichals a weak prescutellar pair only. Dorso-centrals 2 : 3. *Abdomen*: ground colour as thorax, the black spots rather elongate. Second segment with marginals. GSi black with strong apicals; GSii black. Sternites outstandingly haired. *Legs:* Mid femora with comb and fringe of short hairs. Mid tibiae bare. Hind femora with long sparce fringe on posterior aspect. Hind tibiae with sparce double fringe. *Wings*: Vein I bare. Segments iii and v of costa sub-equal. *Genitalia* as figured on pl. II, fig. 3. Seventh sternite of *haemorrhoidalis* pattern. The specific name refers to the snail-like appearance of the median and two lateral processes of the aedoeagus.

Unique type: Darjiling, in garden, 11-vi-26, 1 ♂. In my own collection.

In my keys to the Oriental species (Senior White, 1924), the species on external characters runs to *josephi* Bött., separating on the presence of marginals on the second abdominal segments. On genitalia characters it runs to couplet 38 of the key, from the two species contained in which it is amply distinct.

In describing a new species from the Himalayas it is always necessary to make sure that the form is not a member of the Palaearctic Fauna. By my key to these species it runs to *discifera* Kram., from which the genitalia at once distinguish it.

It is noteworthy that in the Darjiling area, which in almost every family of the Diptera has one of the richest faunas in the World, in the Sarcophaginae, beside this evidently very rare form, much collecting has only yielded two common and wide-spread Palaearctic species.

Sarcophaga haematodes Mg.

Mg., *Syst. Besch.*, V, p. 29 (1826). S. White, *Rec. Ind. Mus.*, XXVI, p. 230 (1924).

Darjiling, 4-7—vi-26, 3 ♂ 1 ♀.

Sarcophaga walayari S. W.

S. White. *Rec. Ind. Mus.*, XXVI, p. 231 (1924).

Posoita, Chota Nagpur, 30-viii-28, 2 ♂, in heavy *Sal* forest.

This is the first record of the capture of this species since the original unique type from Malabar, over 2,000 miles south-west of the present record. The structure of the genitalia make the conspecificity certain, but I would add to my original description as follows :—Lateral verticals may be present or absent ; 3rd. abdominal segment with strong marginals ; costal bristle present or absent. The rediscovery of this species in heavy forest strengthens the opinion expressed in my 1924 paper, p. 234, that this is a heliophobic species confined to deep forest.

Sarcophaga annandalei S. W

S. White, *Rec. Ind. Mus.*, XXVI, p. 233 (1924).

Goilkera, Chota Nagpur, 12-15-vi-26, 1 ♂.

This station is about 1,600 feet up in the hills of the Singhbhum District, in very different country to Pusa, the nearest record. The present one sheds no further light on the distribution.

Sarcophaga knabi Park.

Park., *Proc. U. S. Nat. Mus.*, LIV, p. 96 (1917).

Artham Camp, Parvatipuram District, 14-21-xii-25, 3 ♂.
Titlagahr, Patna State, 10-xii-26, 1 ♂.
Chakadharpore, Chota Nagpur, 7-vii-28.
Ambadola, Vizagapatam Agency Tracts, 15-iii-29, 1 ♂.

Sarcophaga knabi Park. var. **flavipalpis** S. W

S. White, *Rec. Ind. Mus.*, XXVI, p. 235 (1924).

Artham Camp, Parvatipuram District, 29-xi-21-xii-25, 3 ♂.
Titlagahr, Patna State, 10-xii-26.
Chakadharpore, Chota Nagpur, 7-vii-28.
Sarandha Forests, Chota Nagpur, 14-vii-26, 1 ♂.
Posoita, Chota Nagpur, 30-viii-28, 1 ♂.
Ambadola, Vizagapatam Agency Tracts, 15-iii-29, 3 ♂.

These records indicate that this species and its variety are generally distributed in the Eastern Ghats of the Carnatic, in the Chota Nagpur Hills, and even up toward the Eastern Central Provinces.

Sarcophaga albiceps Mg.

Meig., *Sys,.Besch.*, V, p. 22 (1826). S. White, *Rec. Ins. Mus.*, XXVI, p. 236 (1924).

Shillong, 12-x-26, 1 ♂.
Ambadola, Vizagapatam Agency Tracts, 15-iii-29, 3 ♂.

Sarcophaga hirtipes Wd. var. **orchidea** Bött.

Bött., *Ann. Mus. Nat. Hung.*, XI, p. 375 (1913).

Artham Camp, Parvatipuram District, 28-xi-14-xii-25, 5 ♂.
Titlagahr, Patna State, 10-xii-26, 2 ♂.
Sarandha Forests, Chota Nagpur, 14-vii-26, 1 ♂.
Shillong, Khasi Hills, 11-x-26, 1 ♂.
Gidni, Bihar, 11-viii-28, 1 ♂.
Chakadhapore, Chota Nagpur, 7-vii-28, 2 ♂.
Andamans, August, 1928, 4 ♂ (Sewell).

These records show the Malayan form of this species to be widely distributed in the Northern Carnatic and the Chota Nagpur Hills, *i.e.*, in the triangular space formed by the lines leading to Bhimavaram and Palamau of text-fig. 1 of my 1924 paper.

Sarcophaga orientaloides S. W.

S. White, *Rec. Ind. Mus.*, XXVI, p. 244 (1924).

Artham Camp, Parvatipuram District, 19-22-xii-25, 3 ♂.
Ambadola, Vizagapatam Agency Tracts, 15-iii-29, 1 ♂.
Goilkera, Chota Nagpur, 1-15-vi-26, 1 ♂.

These records extend the known distribution over the Eastern Ghats and the Chota Nagpur Hills. It probably exists all over the hill areas of the Carnatic.

Sarcophaga crinita Park.

Park., *Proc. U. S. Nat. Mus.*, LIV, p. 92 (1917).

Dangoaposi, Chota Nagpur, 3-xi-25, 1 ♂.

Sarcophaga futilis S. W.

S. White, *Rec. Ind. Mus.*, XXVI, p. 246 (1924).

Artham Camp, Parvatipuram District, 15-xii-25, 1 ♂.
Chakadhapore, Chota Nagpur, 7-vii-28, 1 ♂.
Tanga Manda, Bamra State, 12-ix-28, 1 ♂.
Posoita, Chota Nagpur, 30-viii-28, 1 ♂.

The Eastern Ghats record from Artham Camp is very isolated. The others extend its Bihar and Orissa distribution.

Sarcophaga martellata S. W.

S. White, *Rec. Ind. Mus.*, XXVI, p. 247 (1924).

Artham Camp, Parvatipuram District, 14-xii-25, 1 ♂.
Titlagahr, Patna State, 10-xii-26, 1 ♂.
Jonk River, Central Provinces, 18-iii-29, 1 ♂.

These records fit in well with my hypothesis of a Carnatic centre of distribution for this species.

Sarcophaga dux Thoms. var. **harpax** Pand.

Pand., *Rev. Ent. Fr.*, XV, p. 189 (1896). S. White, *Rec. Ind. Mus.*, XXVI, p. 250 (1924).

Dangoaposi, Chota Nagpur, 3-xi-25, 1 ♂.
Santragachi, Bengal, 18-19-vii-28, 2 ♂.
Chakadhapore, Chota Nagpur, 7-vii-28, 1 ♂.
Ambadola, Vizagapatam Agency Tracts, 15-iii-29, 1 ♂.

It is extremely curious that only the *harpax*-form has been seen in four years random collecting. The only Madras record is within 5 miles of the Orissa frontier.

Sarcophaga ruficornis Fab.

Fab., *Ent. Syst.*, IV, p. 314, 6 (1794). S. White, *Rec. Ind. Mus.*, XXVI, p. 251 (1924).

Manharpur, Chota Nagpur, 5-ix-26, 1 ♂.

Sarcophaga fuscicauda Bött.

Bött., *Ent. Mitteil.*, I, p. 168 (1912).

Artham Camp, Parvatipuram District, 29-xi-21-xii-25, 2 ♂.

This record stands isolated. The nearest are Madras (Guindy), about 500 miles south, and Dacca, about 600 miles north-east.

Sarcophaga karnyi Hardy.

Hardy, *Proc. Linn. Soc. N. S. W.*, LII (4), p. 454 (1927).

This species, described from Java three years after my 1924 '*Revision*,' was unknown to me personally until I received a small collection from the Andamans made by Lt.-Col. R. B. Seymour Sewell in August, 1928, among which I was at once able to recognize Hardy's species. The details are : MacPherson Strait, Station B. vii, 1 ♂ 1 ♀ *in cop.* Viper Island, Station B. xi, 1 ♂ 1 ♀ *in cop.* There are 4 more ♂♂, without exact locality, in the same collection.

This discovery led me to re-examine the Indian Museum material recorded in my '*Revision*,' by which I found that the 6 ♂♂ from Port Blair, Andamans, 15-ii-15-iii-15 (Kemp), the 2 ♂♂ from Mergui, and the Sarawak ♂ from Beebe's collection therein recorded as *fuscicauda* are really *karnyi*. Annandale's Rangoon specimen, 25-ii-08, I cannot decide about, but it seems nearer to Hardy's than to Böttcher's species.

From the above data it appears that the Indian species, (or possibly variety), does not reach Burma or the Andamans, where it is replaced by the Javanese form. This raises the question of the conspecificity of *fuscicauda* (type) from Formosa with *hutsoni* Park. from Ceylon (type) and South India. I have not seen Böttcher's type, and in sinking *hutsoni* in *fuscicauda* relied on Böttcher's figure. This, though good enough to illustrate a very distinct new species, is not sufficiently detailed when such a species is suspected of consisting of more than one variety, and until Böttcher's type is re-examined the matter must remain in doubt. If I have erred, I have done so in good company, for Parker's

specimen from Oahu, Hawaii, referred to in my '*Revision*,' is *karnyi* and not *fuscicauda*, (*i.e.*, the Indian form). There are also closely allied if not identical Australian forms. Text-figure 2 of my 1924 paper is now invalidated.

Sarcophaga hæmorrhoidalis Fall.

S. White, *Rec. Ind. Mus.*, XXVI, p. 255 (1924).

Darjiling, 3-13-vi-26, 13 ♂.

Sarcophila cinerea Fab.

Fab., *Ent. Syst.*, IV, p. 331 (1794). S. White, *Rec. Ind. Mus.*, XXVI p. 257 (1924).

Vizagapatam, 3-9-vii-26, 1 ♂ 2 ♀.

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Senior White (1924). "A Revision of the Sarcophaginae of the Oriental Region." *Rec. Ind. Mus.*, XXVI, pp. 193-283.

Senior White (1925). "A Revision of the sub-family Rhiniinae in the Oriental Region." *Rec. Ind. Mus.*, XXVII, pp. 81-96.

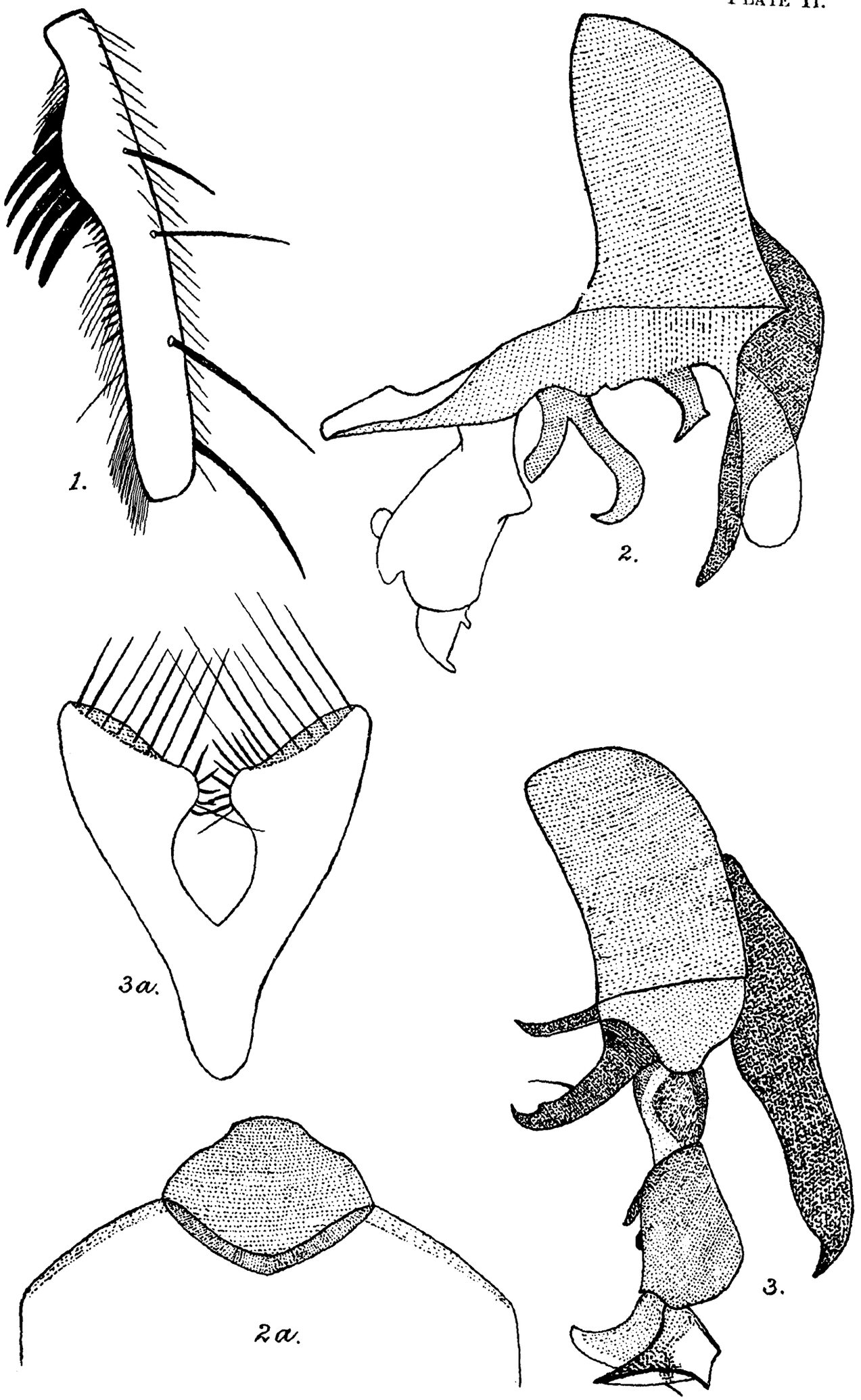
Senior White (1926). "A Revision of sub-family Calliphorinae in the Oriental Region." *Rec. Ind. Mus.*, XXVIII, pp. 127-140.

EXPLANATION OF PLATE II.

FIG. 1.—Front tibia of *Bengalia martin-leakei*, sp. nov.

FIGS. 2, 2*a*.—♂ genitalia of *Bengalia martin-leakei*, sp. nov.

„ 3, 3*a*.—♂ genitalia of *Sarcophaga pes-helicis*, sp. nov.



INDIAN MUSCOIDS.

NEMATODE PARASITES OF PIGS IN BENGAL.

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INTRODUCTION.

The helminths enumerated below were collected from the alimentary tract of pigs slaughtered at the Calcutta abattoirs. The intestines were brought to the Laboratory intact, within two or three hours of the animals being killed, so that most of the worms were alive when collected. They were well washed in saline and immediately fixed, so they were in a good state of preservation when examined.

Despite the fact that *Ascaris lumbricoides* is known to be a very common parasite of pigs in Bengal, only a single small female was found in forty-four small intestines examined. Accordingly, if such a common parasite as *Ascaris* was only encountered once, it is probable that rarer parasites have been missed altogether, and although several new species have been added to the known parasites, the list given below is probably by no means a comprehensive one for Indian pigs.

In the following paper I have made a very free use of Baylis' "Manual of Helminthology," since this represents the most recent and most reliable summary of the present state of our knowledge regarding many of the species discussed below.

List of species found.

NEMATODA.

Ascaridae.

Ascaris lumbricoides Linn., 1758.

Cruziidae.

Cruzia orientalis, n. sp.

Trichuridae.

Trichuris suis (Schrank, 1788).

Spiruridae.

Arduenna strongylina (Rudolphi, 1819).

Physocephalus sexalatus Molin, 1860.

Gnathostomidae.

Gnathostoma doloresi Tubangui, 1925.

Strongylidae.

Oesophagostomum dentatum (Rudolphi, 1803).

Oesophagostomum longicaudum Goodey, 1925.

Oesophagostomum conicum, n. sp.

Oesophagostomum suis, n. sp.

Bourgelatia diducta Railliet, Henry and Bauche, 1919.

Globocephalus urosubulatus (Alessandrini, 1909).

Globocephalus connorfilii Lane, 1922.

Globocephalus samoensis (Lane, 1922).

ACANTHOCEPHALA.

Macracanthorhynchus hirudinaceus (Pallas, 1781).

Ascaris lumbricoides Linn., 1758.

As mentioned in the introduction one specimen of a small female of this species was found in forty-four small intestines examined.

Cruzia orientalis, n. sp.

This worm was found in twelve out of forty-nine pigs; it was always in the caecum and large intestines, and it was never present in very large numbers. The total number of worms of this species recovered was thirty-six males and seventy females.

In general appearance and in most of its anatomical details it is very similar to *Cruzia tentaculata*, which Travassos (1922) described in great detail; it is therefore proposed only to describe those points in which the present species differs from the above worm.

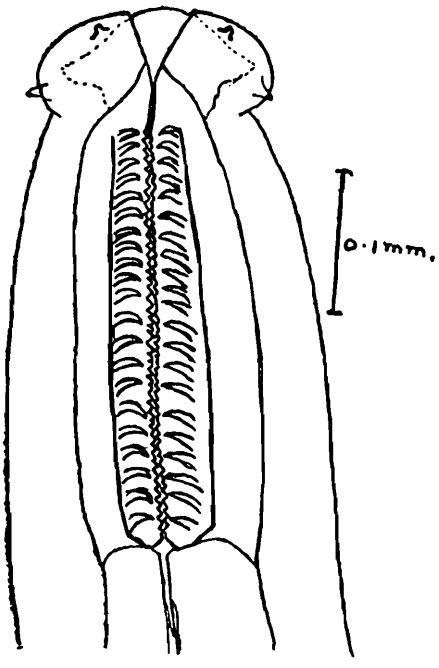

FIG. 1.—*Cruzia orientalis*, n. sp. Anterior end, ventral view.

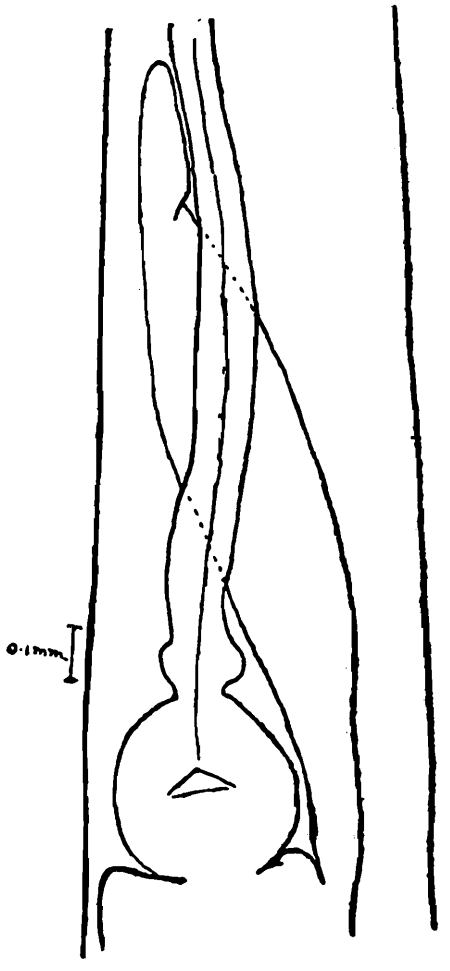

FIG. 2.—*Cruzia orientalis*, n. sp. Region of oesophago-intestinal junction, showing diverticulum.

The two subventral lips are marked off from the body of the worm by a deep groove, which is apparently not present in *C. tentaculata*. The dorsal lip is apparently the same shape as in *C. tentaculata* but its lateral borders are more deeply notched, so that the lateral angles project more markedly (fig. 1). In this species the chitinous vestibule or pharynx is of considerably greater length than it is in *C. tentaculata*, and in Travassos' figure only eleven or twelve rows of teeth are shown,

these diminish in size from before backwards, whereas in the present species there are nineteen to twenty-three rows of teeth and they all appear to be of equal size (fig. 1). The oesophagus and diverticulum are considerably longer than in *C. tentaculata* (fig. 2).

Male.—The arrangement of the caudal papillae differs slightly from that described by Travassos. This author mentions three groups of papillae each consisting of three pairs, *viz.* preanal, adanal, and postanal groups. The preanal and adanal groups in the present species are similar in position to those described and figured for *C. tentaculata.* But on each side of the tip of the tail in the material before me there are four papillae instead of three and they are arranged in two straight rows diverging from behind forwards. The most posterior pair of these papillae are pointed, and the three anterior pairs are pedunculated with enlarged tips, similar to but smaller than those of the preanal and adanal groups of *C. tentaculata* (fig. 3). The spicules and gubernaculum are identical in size and shape with those of *C. tentaculata.*

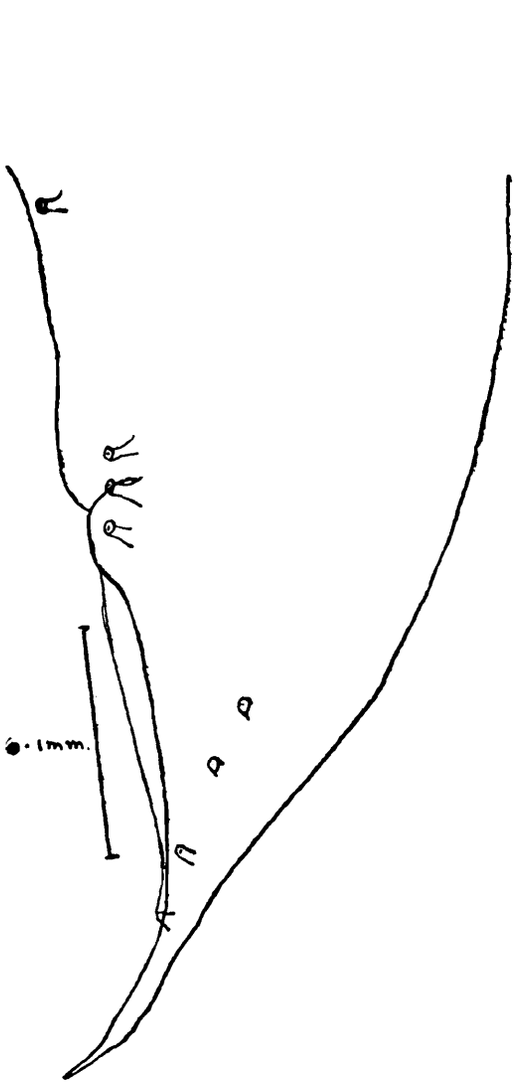

FIG. 3.—*Cruzia orientalis*, n. sp. Tail of male, lateral view. Only the most posterior of the preanal papillae is shown.

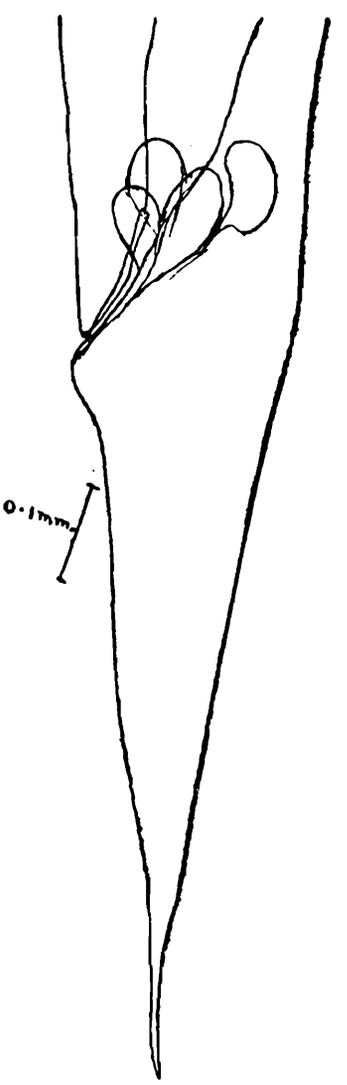

FIG. 4.—*Cruzia orientalis*, n. sp. Tail of female.

Female.—The female of this species only differs from the female of *C. tentaculata* in being slightly larger. Figure 4 has been included to illustrate the peculiar rectal glands, which are characteristic of the genus.

Discussion.—The species of this genus hitherto described are *C. tentaculata* (Rud. 1819) from *Didelphys* spp. in North and South America, and *C. mexicana* Khalil, 1927, from an unknown Mexican lizard, so that the known distribution of the genus is very limited. The present worm is very close to the other species in anatomical details, but the differences are considered sufficient to separate it from the earlier species, and, in addition to this, there is the different host in a very widely separated locality. It is, therefore, proposed to name it *Cruzia orientalis*, n. sp.

Canavan (1929) recorded what he considered to be *C. tentaculata* from *Didelphys virginiana* in the United States of America, but he mentioned a different arrangement of the papillae near the tip of the tail from that figured by York and Maplestone (1926). A more striking difference to which he does not refer, but which is evident from Canavan's figure, is that the preanal papillae are much closer together in his material than they are in *C. tentaculata* or in *C. orientalis*, for in both of these species the most anterior of these papillae is a little in front of the base of the unextruded spicule, whereas in Canavan's figure the most anterior papilla is about opposite the middle of the unextruded spicule. Some of the dimensions given by Canavan also differ from those given by Travassos (1922) for *C. tentaculata*, so it is considered that in all probability *C. tentaculata* of Canavan is a new species for which the name *C. americana* is proposed. In support of this view Travassos (1922) in a footnote says it is not improbable that the worm recorded from *D. virginiana* in North America is different from the South American species.

Type specimens of *Cruzia orientalis* from the caecum and large intestine of the domestic pig are in the Indian Museum, Calcutta.

The following table gives the principal differences between the various species of the genus *Cruzia*.

TABLE 1.

	C. tentaculata.	*C. mexicana.*	*C. orientalis.*	*C. americana.*
Length, males and females	8—16	10·5—12·5	13—17·9	9—11
Pharynx, length	0·106—0·156	0·172	0·240—0·320	0·180
No. rows teeth	12—15	?	19—22	..
Oesoph. length	1·0—1·9	1·43—1·52	2·34—2·95	..
Oesoph. bulb diameter	0·31—0·48	0·27—0·3	0·28—0·38	..
Diverticulum, length	0·9—1·2	0·7	1·09—1·96	1·07
Distance from anus to tip of tail, female.	0·8—1·0	0·78	0·69—0·71	0·8
Spicules, length	0·87—1·165	0·81	0·86—1·03	0·93—0·96
Gubernaculum, length	0·197—0·243	0·12	0·180—0·220	0·13
Eggs	0·120 × 0·056—0·063	0·065—0·049	0·120 × 0·056—0·060	..
Pairs of papillae—				
Preanal	3	2	3	3
Adanal	3	3	3	3
Postanal	3	5	4	3

NOTE.—In this and all other tables in the paper the measurements are in millimetres,

Arduenna strongylina (Rudolphi, 1819).

This species was found in the stomachs of twenty-five out of forty-nine pigs, and a total number of over three hundred worms was recovered. Although all the specimens were examined none approaching the size of the larger species *A. dentata* (v. Linstow, 1904) were found. There seems, however, to be some slight disagreement amongst various workers regarding the arrangement of the caudal papillae in the male.

In Yorke and Maplestone (1926) the figure of the tail of *A. strongylina* shows four pedunculated papillae on the right side, fairly close together in a single line some distance in front of the cloaca, and on the left side the papillae are in two pairs somewhat widely separated. They also show three pairs of small papillae on the ventral surface of the tail. In

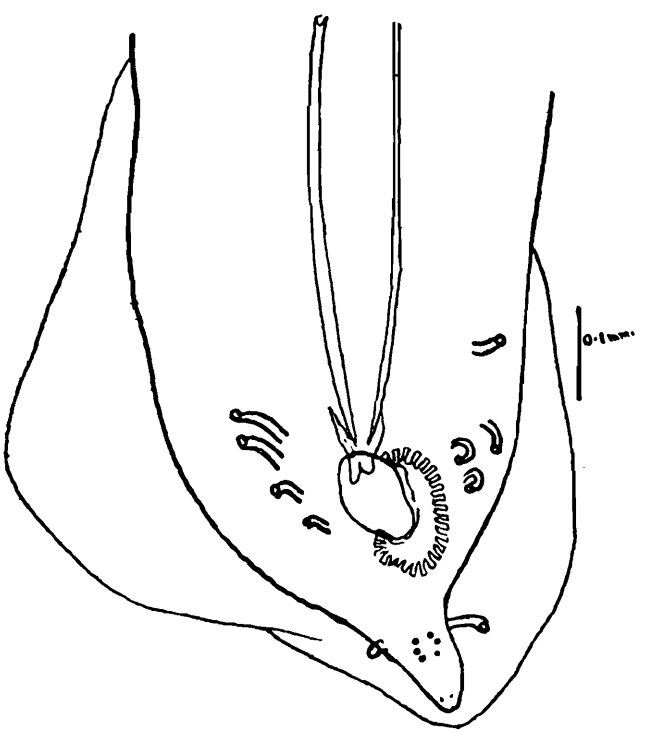

FIG. 5.—*Arduenna strongylina.* Tail of male, ventral view.

Baylis (1929) the drawing by Foster shows four pedunculated papillae much nearer the cloaca on both sides of the tail, and he does not indicate any small papillae on the tip of the tail at all. In figure 5 I have shown the condition present in my examples and it will be seen that the four papillae on the right side of the cloaca are in a row and quite close to it, and on the left side there is a group of three papillae opposite the cloaca with a single papilla somewhat further forward, while on the ventral surface of the tail proper there are four pairs of small papillae. This arrangement of papillae was observed in two specimens in which the tail was cut off for examination. The only papillae regarding which all are in agreement are the pair of pedunculated papillae situated behind the cloaca. The most reasonable explanation of this disagreement seems to be that the caudal papillae of this species are subject to a certain amount of variation.

Physocephalus sexalatus (Molin, 1860).

Specimens of this worm were found in the stomachs of twenty-six out of forty-nine pigs, and a total of over three hundred and fifty worms were examined.

The size of the worm given by Baylis (1929) is, male 6—13 mm. in length, and female 13—22·5 mm. in length. In the present collection fifteen mature female worms were found about 9 mm. in length. Detailed examination of these small specimens revealed no difference except that of size between them and the larger specimens, and the eggs they contained were of the normal dimensions. Another point is that no males of a correspondingly small size were found, therefore, it is considered that the range of size for mature females of *P. sexalatus* should be extended to 9—22·5 mm.

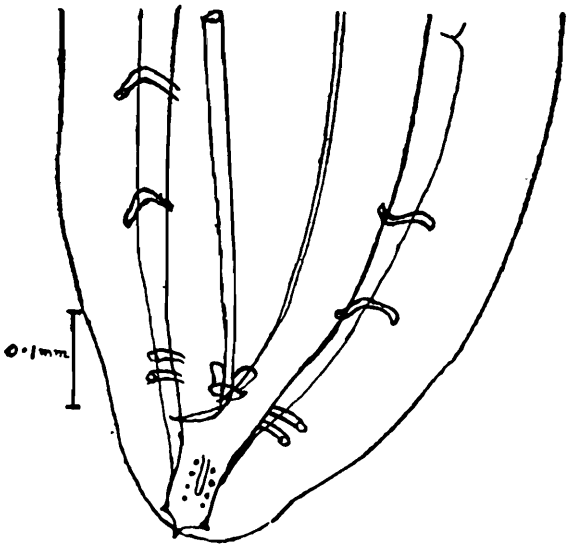

FIG. 6.—*Physocephalus sexalatus*. Tail of male, ventral view.

Baylis (1929) gives the dimensions of the eggs as 0·034—0·039 mm. by 0·015—0·017 mm., but eggs, containing embryos, taken from worms of the present material were more uniform in size and slightly smaller, measuring 0·031—0·033 mm. by 0·014—0·016 mm.

A drawing of the tail of the male has been included because none appears to be readily available, there being none in Baylis' book, and the actual appearance of the papillae is not what one would anticipate from his written description, which is as follows. " The male has four pairs of pedunculate preanal papillae and four pairs of shorter postanal papillae." The following is the description of the papillae derived from the examination of several specimens in which no variation was noted. The caudal papillae of the male consist of two pairs of pedunculate papillae on each side. One pair are fairly widely separated and lie some distance in front of the cloaca, the other pair are close together and are on a level with the cloaca. On the ventral surface of the narrow tail there are two rows of small papillae with a raised elongate oval structure between them. The tip of the tail ends in a sharp cuticular point, which projects beyond the end of the caudal alae ; and a little in front of the tip, where an angle is formed on each side by the sudden narrowing of the tail, there is a small sharp papilla (fig. 6).

Gnathostoma doloresi Tubangui, 1925.

Tubangui (1925) described *Gnathostoma doloresi*, a new species from the pig in the Philippine Islands, but he had no males in his collection. This worm is probably a fairly common parasite of pigs in the East for it was found eleven times in the stomachs of forty-nine pigs examined by me. Only one or two worms as a rule were present in each case and they were never together in one cavity as is the case with *G. spinigerum* in cats, where frequently several worms are found living in a single large thick-walled cyst. But even the small number of *G. doloresi* present must be very serious, even if not at times fatal, to their hosts as the worms cause extensive damage to the stomach wall in which they burrow deeply. Altogether ninteen mature females, seven males, and one immature female were obtained.

The males and females are similar in general appearance as the tails of both sexes curve ventrally (fig. 7). The males are smaller than the females, but this is not a certain point of distinction, because there is considerable variation in the size of both sexes so that the largest males are bigger than the smallest females. The cuticular inflation begins about the junction of the anterior and middle-thirds and it is more marked on the dorsal surface. The head bulb is surmounted by two lateral deeply trilobed lips and there are two papillae on each side of the head near its anterior border. The head bulb is armed with ten rows of backward-curving hooks ; this number of rows seems to be constant for the species, for there were ten rows in all the present specimens, and Tubangui gives the same number in his description. The body spines are essentially as Tubangui describes them, but very few with as many as seven points were seen. It is not quite correct to describe the spines of the anterior rows as having the maximum number of points ; a more accurate description is, that the first two or three rows contain spines with three or four points only ; proceeding posteriorly the number of points gradually but irregularly increases until the maximum number is reached about opposite the level of the cervical papillae, which lie about the fifteenth to the eighteenth rows of spines from the anterior end. Immediately after the cervical papillae are passed the spines become three-pointed again, with a long central point and two small lateral points. The lateral points gradually diminish as one proceeds posteriorly until they finally disappear, and the single-pointed spines become narrower and narrower until they are eventually replaced by fine hair-like spines, which continue to the extreme posterior end of the worm.

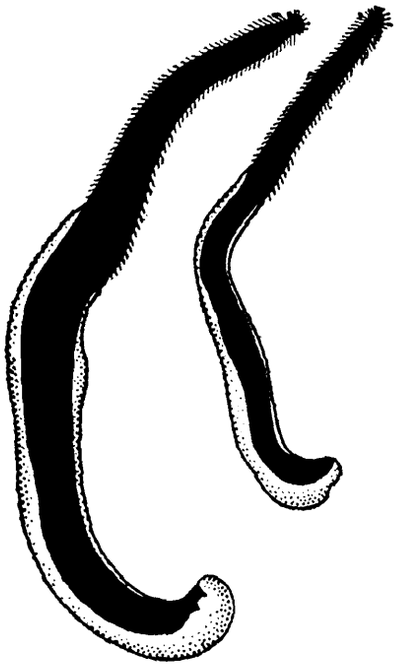

FIG. 7.—*Gnathostoma doloresi.* From a photograph of a male and female. Approximately twice natural size.

The internal anatomy of the worm is quite typical of the genus and as it has been already described by Tubangui (1925) it is not proposed to repeat it here.

Male.—The tail of the male curves ventrally, and owing to its great thickness it cannot be properly examined without cutting it off (fig. 8).

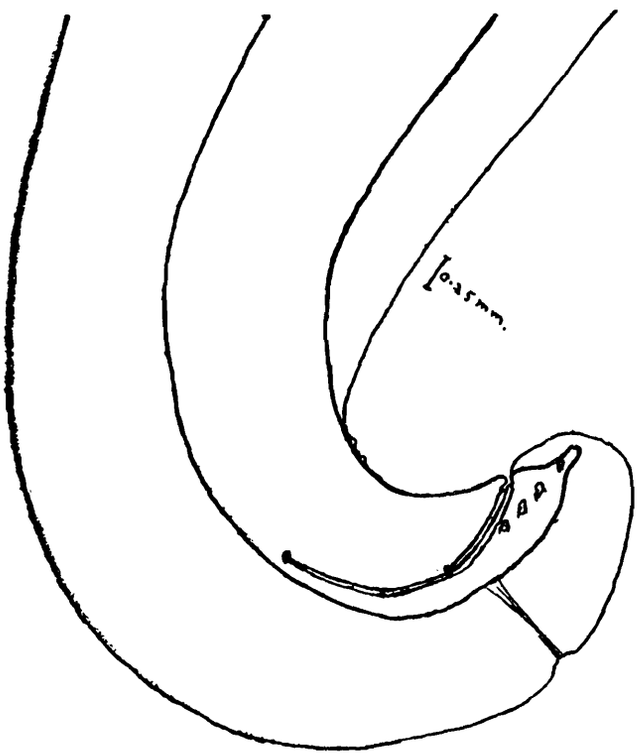

FIG. 8.—*Gnathostoma doloresi.* Tail of male, lateral view.

The ail bears a pair of narrow caudal alae supported by four very thick pedunculate papillae on each side, and there are two smaller additional papillae on each side between the bases of the second and third, and third and fourth pairs of large papillae, and there are two crescentic prominences behind the cloaca (fig. 9). This portion of the worm is

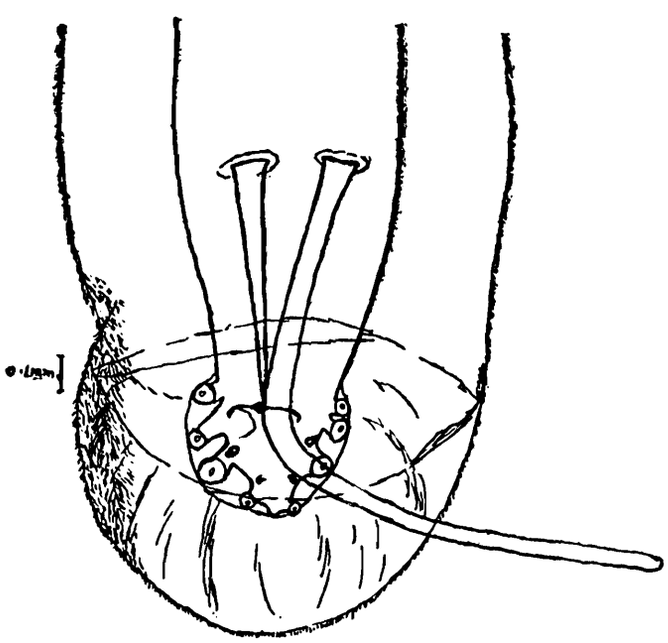

FIG. 9.—*Gnathostoma doloresi.* Tail of male, ventral view. The spines, which cover the entire surface, are only shown on the left side.

very similar to that of *G. spinigerum*, except that it is much larger and the tail is surrounded by the large cuticular inflation. The spicules are stout, curved, and unequal and they taper evenly from base to tip, ending

in blunt points. In cross section the spicules are seen to be circular, and to consist of a central core surrounded by a clear chitinous layer. There is no gubernaculum.

Female.—Tubangui (1925) has already described the female of this species from the four specimens that he had at his disposal, so I will not repeat it in detail here. Although his description of the tail, *viz.*, " Tail rounded with two terminal papillae " agrees fairly well with the appearance of my material, Tubangui's drawing of this portion of the worm shows three small points of equal size. The two appearances of the female tails as seen by me are depicted in figs. 10 and 11, the differences being apparently due to whether the tail is lying flat or whether the

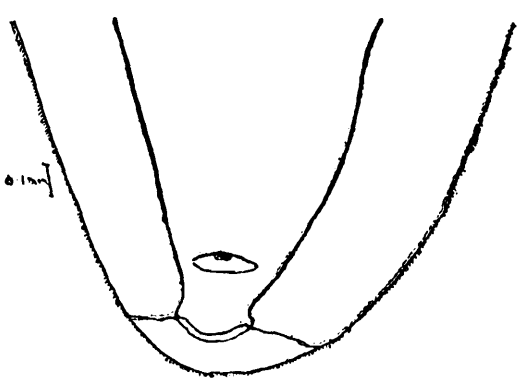

FIG. 10.—*Gnathostoma doloresi.* Tail of female, ventral view. The tail is flattened out.

lateral borders are rolled in a little on each side. The lateral view of the tail shows a deep sulcus in the cuticular inflation giving access to the anus (fig. 12).

Tubangui gives the length of the female worm as 30—41 mm. In my material there appear to be two distinct size strains of the worm, which are otherwise identical. Thirteen of the females were obtained from eight pigs and they varied from 43—52 mm. in length, and in one of the above pigs four females were accompanied by two males which measured 35 and 38 mm. in length respectively. In the other six cases in which worms were found six females, although mature, only measured 27—31 mm. in length, and the five males accompanying them were 19·7 to 21 mm. in length. In no instance were small and large worms found in the same pig. Tubangui gives the size of the eggs as 0·06—0·063 by 0·037 mm., whereas the eggs removed from the uterus of a large female of my collection measured 0·064—0·067 mm. by 0·031—0·34 mm., and in the smaller females the eggs measured 0·052—0·060 by 0·031—0·033 mm. The eggs from both small and large worms were of the same type as in Tubangui's specimens with a thickened cap at each pole, and they contained a segmented morula. This state of development applies to eggs at the time they are deposited, for one undamaged female was found with some eggs adhering to the external surface near the vulva.

The finding of two distinct sizes of worms in different pigs and the fact that small and large worms were never found together in the same host at first suggests that two species are being dealt with. But the measurements given by Tubangui for the females come exactly in the gap left between the small and large worms of my material; it is true that there are differences in the sizes of the eggs but they are not

considered of sufficient magnitude to use as a specific character. Considerable differences occur in the eggs of *G. spinigerum*, for I have found the eggs of this species to measure 0·064—0·068 by 0·032—0·036 mm., whereas Baylis and Lane (1920) give the dimensions as 0·060 by 0·035

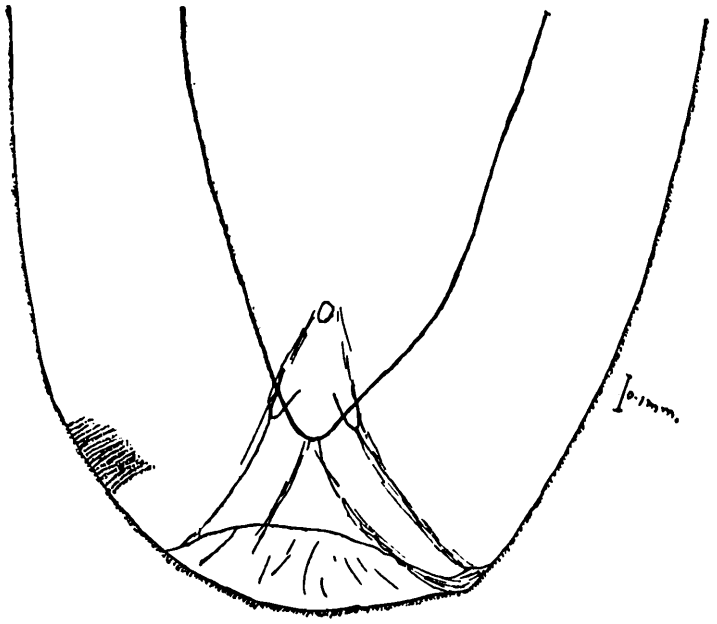

Fig. 11.—*Gnathostoma doloresi*. Tail of female, ventral view. The tip of the tail is rolled slightly inwards laterally.

mm. and Heydon (1929) finds they are 0·065 by 0·037 mm., therefore it is obvious that slight differences in size of eggs cannot be utilised as a specific character in this genus. In the males it was found that the spicules were of the same length in both the small and large specimens. In view of the above facts it is considered that *G. doloresi* is a species that shows considerable size variation.

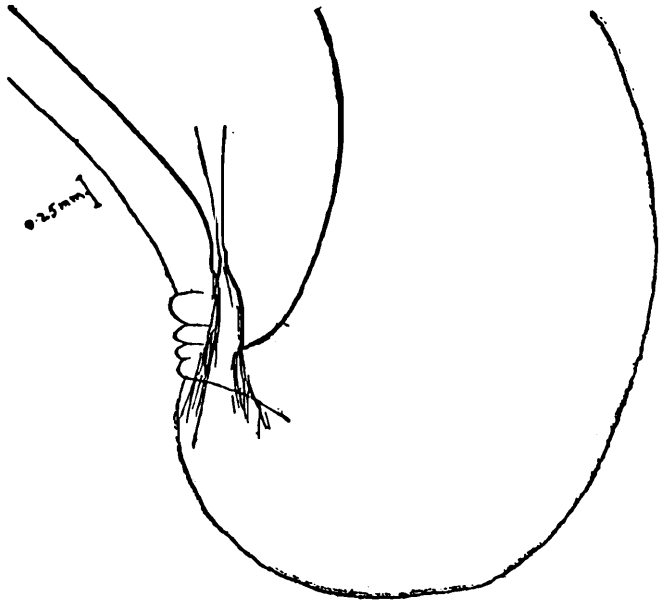

Fig. 12.—*Gnathostoma doloresi*. Tail of female, lateral view.

Heydon (1929) disagrees with Chandler (1925) and Baylis and Lane (1920) who stated that the eggs of *G. spinigerum* contain larvæ while

still in the uterus of the parent worm. I am able to support Heydon's contention regarding *G. doloresi*, because the eggs found adhering to the external surface of an undamaged female were only in the stage of early segmentation.

Specimens of *Gnathostoma doloresi* Tubangui, 1925, and the type of the male of this species are in the Indian Museum, Calcutta.

TABLE 2.

Dimensions given by Tubangui compared with the dimensions of my large and small worms.

	Tubangui, female.	Large worms.		Small worms.	
		Male.	Female.	Male.	Female.
Length	30—41	35—38	43—52	20—21	27—31
Max. diameter of worm.	..	1·4—1·66	2·6—2·8	0·9—1·2	1·3—1·5
Diameter of inflation.	3·14—3·37	1·7—2·6	2·7—4·9	1·1—1·76	1·46—2·02
Head bulb length	0·4—0·46	..	..	0·317	0·356—0·396
Diameter	0·75—0·85	0·693	0·891—1·01	0·634	0·772—0·832
Dist. from ant. end to nerve ring.	0·75	..	1·38	0·832	1·04
Oesophagus length	6—7	..	..	3·9	5·7
Dist. anus to tip of tail.	..	..	0·336	..	..
Vulva to tip of tail.	Behind middle	..	16—19	..	10·4—10·9
Spicules, length.	..	1·85—2·07 0·64—0·66	..	1·85—2·08 0·6—0·7	..
Eggs	0·06—0·063 × 0·037	..	0·064—0·067 × 0·31—0·034	..	0·052—0·06 × 0·033—0·031

Oesophagostomum dentatum (Rudolphi, 1803).

This species was found in eighteen out of forty-nine pigs examined. The number of worms was never great, as only eighty-four females and eighteen males were found altogether.

Oesophagostomum longicaudum Goodey, 1925.

The difference between this species and *O. dentatum* was not recognised at first, so that it is impossible to say how many pigs carried this parasite, but five males and seventy-one females were found among the collection originally labelled *O. dentatum*, and as there were eighteen males and eighty-four females of the latter species it is probable that *O. longicaudum* is nearly as common as *O. dentatum* in India.

In his description of *O. longicaudum*, Goodey (1925) says that the leaf crowns are exactly the same as in *O. dentatum*, although he recognises the different shape of the buccal capsule. It is true that the elements of the leaf crowns have the same number in both species, but their attachment to the buccal capsule is different. In optical section the buccal capsule of *O. dentatum* appears as a more or less rectilinear body with rounded extremities, and both leaf crowns arise from near the posterior ends of the inner surface and sweep inwards and forwards from this point. Optical section of the buccal capsule of *O. longicaudum* shows it to be larger than the capsule of *O. dentatum*, and its posterior ends are more widely separated than its anterior ends. From the anterior end a hook-like process extends inwards and backwards; this process is of course a circular ridge projecting into the lumen of the capsule. The leaf crowns arise from near the posterior end of the inner border of the buccal capsule, and from here they pass inwards and forwards to come in contact

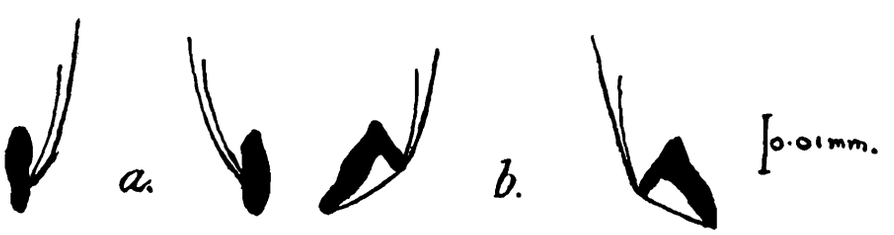

FIG. 13.—(*a*) *Oesophagostomum dentatum.* (*b*) *Oesophagostomum longicaudum.* Optical section of mouth capsules showing origin of leaf crowns.

with the edge of the anterior ridge, and it is only anterior to this point that the elements of the two leaf crowns are distinct from each other (fig. 13). The internal diameter of the buccal capsule of *O. dentatum* varies from 0·036—0·042 mm., and is uniform for the whole of its depth, whereas the internal diameter of the buccal capsule of *O. longicaudum* is 0·040—0·044 mm. at its anterior end and 0·056—0·064 mm. at its posterior end. These differences in the buccal capsules of the two species are quite distinctive and are readily recognised when they are once appreciated.

Goodey only had a few immature specimens of *O. longicaudum* to examine, and they were among a collection of *O. dentatum* which were also immature, so he expresses the view that his measurements of the new species are probably smaller than the corresponding dimensions would be in adult worms, but from the following table 3, in which the measurements of the species given by Goodey (1924 and 1925) and those found by me in the present collection are compared, it is seen that Goodey's measurements for the new species are correct for mature worms.

Goodey notes that the handle of the gubernaculum in *O. longicaudum* is shorter than it is in *O. dentatum* in relation to the length of the blade, the two portions being approximately in the proportion of 1 : 2 in the former and of 1 : 1 in the latter. This was found by me to be substantially correct, but there was a considerable degree of variation in the two measurements, which made this character unreliable. The total length of the gubernaculum was found, however, to be a more reliable guide, because in *O. longicaudum* it varied between 0·104—0·120 mm. with an average of 0·114 mm., and in *O. dentatum* it varied between 0·116—0·136 mm. with an average of 0·129 mm., there thus being very little overlapping in the two species.

I have measured twenty females of *O. longicaudum* and forty females of *O. dentatum*. The worms of the first species varied between 8·33—10·36 mm. in length, and among them three worms, containing eggs, were found which measured 9·06—9·74 and 10·36 mm. in length. The forty specimens of *O. dentatum* varied between 9·69—14·48 mm. in length, six of these worms were below 9·89 mm. in length and did not contain eggs, but the one next in size, which was 10 mm. in length, contained eggs as did the remaining thirty-three worms which were longer than this. Apparently female *O. dentatum* reach maturity when about 10 mm. in length and this is a fairly well defined point, but in the case of *O. longicaudum* such a clear demarcation between immature and mature females does not seem to exist, for between the two mature worms, which were 9·06 and 9·74 mm. in length, there were four specimens intermediate in size which did not contain eggs, and also between the worms which were 9·74 and 10·36 mm. in length there were four specimens with no eggs in the uterus.

The distance from vulva to anus, and from the anus to the tip of the tail is greater in *O. longicaudum* than it is in *O. dentatum*. Goodey, who only had a few immature *O. longicaudum* to examine, gives the distance from vulva to anus as 0·46—0·40 mm., and the distance from anus to tip of tail as 0·38—0·46 mm., whereas the same author gives the corresponding dimensions of *O. dentatum* as 0·35 and 0·36—0·38 mm. respectively. With a larger number of worms, some of which were mature, I have found the distance from vulva to anus to be 0·41—0·52 mm., and from anus to tip of tail to be 0·36—0·37 mm. in *O. longicaudum*, and the corresponding measurements in *O. dentatum* were 0·28—0·39 mm. and 0·25—0·43 mm. respectively. If these two measurements are added together and the distance from the vulva to the tip of the tail is thus given, the difference is even more striking, for a shorter distance from vulva to anus is often compensated for by a longer tail and *vice versâ*, it is thus found that in *O. longicaudum* the distance from the vulva to the tip of the tail is 0·812—0·990 mm., and in *O. dentatum* it is 0·534—0·792 mm., so that it appears that this measurement in *O. longicaudum* is always greater than 0·800 mm. and in *O. dentatum* it is always less than 0·800 mm.

The eggs of *O. longicaudum* removed from the uterus of a single female were 0·048—0·052 by 0·028—0·031 mm., and those of *O. dentatum* measured at the same time were found to be 0·070—0·074 by 0·040 mm.

TABLE 3.

Comparison between my and Goodey's measurements for the two species O. dentatum and O. longicaudum.

	O. dentatum Goodey (1924)	My *O. dentatum*	*O. longicaudum* Goodey (1925)	My *O. longicaudum*
Length—				
Male	8—10	8·38—10	8—10	6·56—8·85
Female	11—14	9·69—14·48	..	8·33—10·36
Diameter of buccal capsule	..	0·036—0·042	..	Ant. 0·04—0·044 Post. 0·056—0·064
Spicules, length . .	1·15—1·3	1·15—1·32	0·9—0·95	0·78—0·88
Gubernaculum, length .	0·14	0·116—0·136	..	0·104—0·120
Vulva to anus	0·36—0·38	0·28—0·39	0·46—0·46	0·41—0·52
Anus to tip of tail . .	about 0·35	0·25—0·43	0·36—0·38	0·36—0·47
Vulva to tip of tail . .	..	0·53—0·79	..	0·81—0·99
Eggs	0·07—0·074 × 0·04—0·042	0·07—0·074 × 0·04	..	0·048—0·052 × 0·028—0·031

Comparison between Goodey's measurements and those taken by me and given in the above table clearly shows that although Goodey was only dealing with immature material the dimensions he gives are essentially correct. *O. longicaudum* has only been recorded once before in a pig in New Guinea, and on this occasion it was mixed with *O. dentatum*. As it has now been found in Inda, also in company with *O. dentatum*, it seems probable that more careful examination of collections of *O. dentatum* in other parts of the world will reveal the presence of *O. longicaudum* among them.

Oesophagostomum conicum, n. sp.

This worm was found in nine out of forty-nine pigs but it was never present in large numbers as only seven males and seventy females were found altogether. It was present in the caecum and large intestine.

The external appearance of the anterior end is quite distinctive as the worm is relatively broad in proportion to its length ; it tapers towards the anterior end from about the level of the cervical papillae, and there is no distinct mouth collar (figs. 14 and 15). There are three papillae on each side of the mouth, but the sub-dorsal and sub-ventral papillae are only very slightly more prominent than the lateral papillae. The ventral cervical groove is deep and the anterior cuticular lip of the groove overhangs it (fig. 15). It is situated relatively far forward, being well

in front of the narrowest part of the oesophagus. The cervical papillae are slightly asymmetrical and are situated opposite where the oesophagus commences its posterior bulbar enlargement (fig. 14).

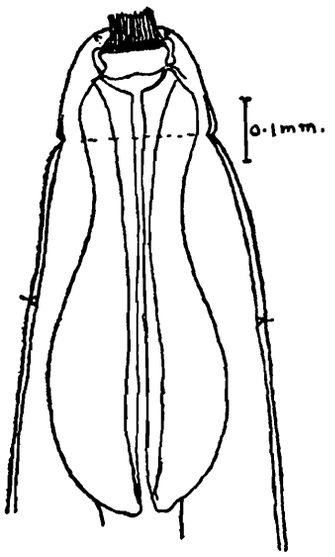

FIG. 14.—*Oesophagostomum conicum*, n. sp. Anterior end, dorso-ventral view.

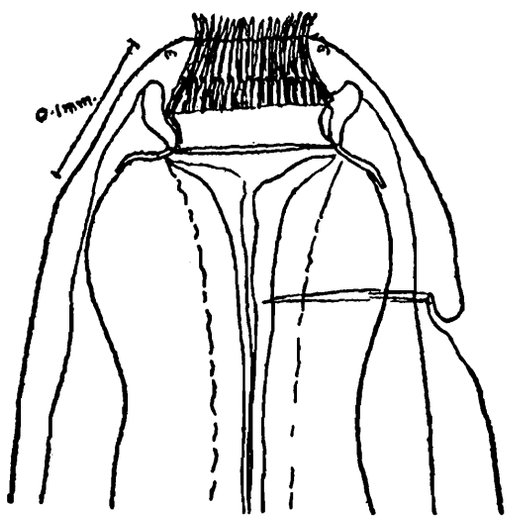

FIG. 15.—*Oesophagostomum conicum*, n. sp. Anterior end, lateral view.

The buccal capsule is relatively broad and massive compared with most other members of the genus. It is circular in outline (fig. 16) and in optical section it is comma-shaped with the broad end anterior (fig. 15). There is a distinct groove encircling its innner surface slightly anterior to the middle, from which both leaf crowns appear to arise. The leaf crowns each consist of thirty elements. The anterior end of the oesophagus is surmounted by a thin plate of chitin, which in optical section appears as a tail-like extension of the comma-shaped capsule

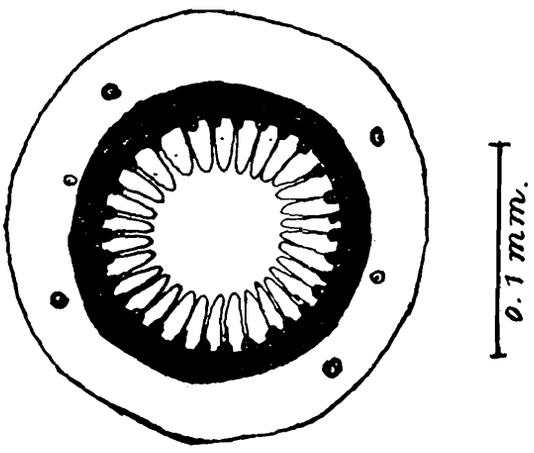

FIG. 16.—*Oesophagostomum conicum*, n. sp. Buccal cavity, end on view.

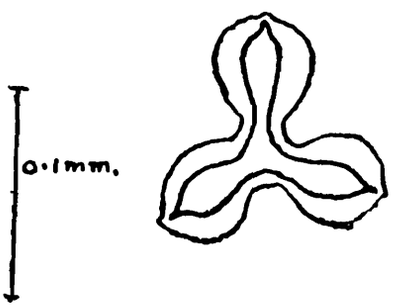

FIG. 17.—*Oesophagostomum conicum*, n. sp. Anterior end of oesophagus, end on view.

(fig. 15). The oesophagus is relatively broad with a distinct oesophageal funnel. The inner surface of the oesophagus has a chitinous lining

throughout its length, and in the region of the funnel there are three chitinous ridges projecting into its lumen (fig. 17).

Male.—The bursa conforms to the type for the genus, but the tips of the ventral rays project slightly beyond its edge and the dorsal ray shows a considerable degree of individual variation (figs. 18 and 19). The edge

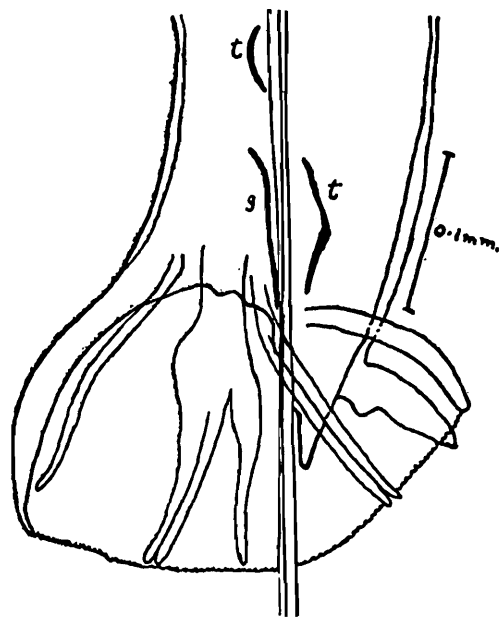

Fig. 18.—*Oesophagostomum conicum*, n. sp. Tail of male, lateral view.

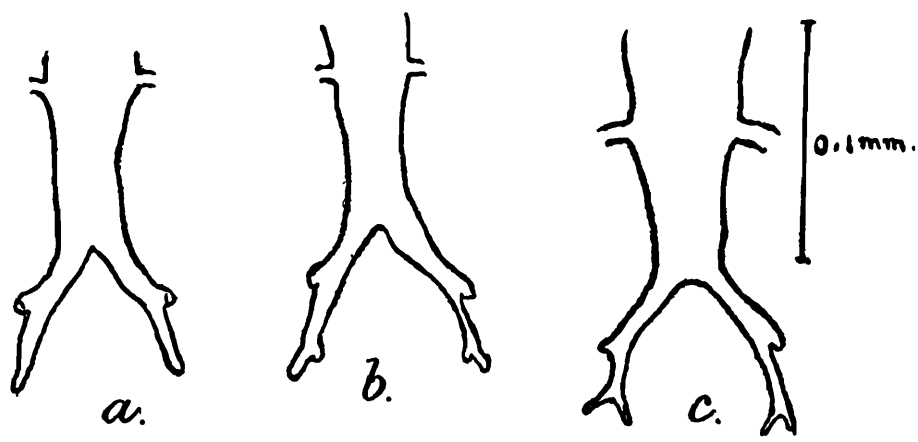

Fig. 19.—*Oesophagostomum conicum*, n. sp. Dorsal ray, showing variation in branching of tips.

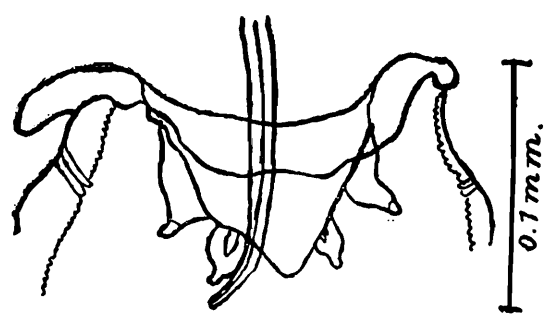

Fig. 20.—*Oesophagostomum conicum*, n. sp. Genital cone, male.

of the bursa is finely serrated, each serration corresponding with a striation on the bursa. The ventral genital cone consist of a central triangular lobe with two long fleshy papillae on each side of it (fig. 20). The

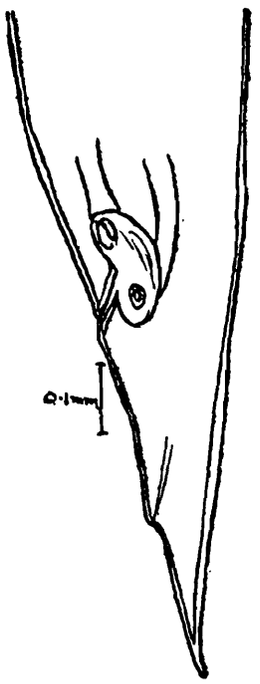

FIG. 21.—*Oesophagostomum conicum*, n. sp. Tail of female, lateral view.

gubernaculum and spicules are of the usual type, and the telamon is well developed, the parts of it which are easily made out being a curved piece on the dorsal side of the spicules anterior to the gubernaculum, and an angular chitinous plate opposite the gubernaculum on the ventral side of the spicules (fig. 18).

Female.—The posterior end of the female is straight and tapering, similar to that of *O. dentatum*, except that the distances between the vulva and anus, and anus and tip of tail are different in this species. There is a short vagina running inwards and forwards to end in a kidney-shaped ovejector, very similar to that of *O. dentatum* (fig. 21).

Type specimens of *O. conicum*, n. sp. are in the Indian Museum, Calcutta.

Oesophagostomum suis, n. sp.

This species was by far the commonest of all the Oesophagostomes present in the pigs examined, as it was found in forty-three out of forty-

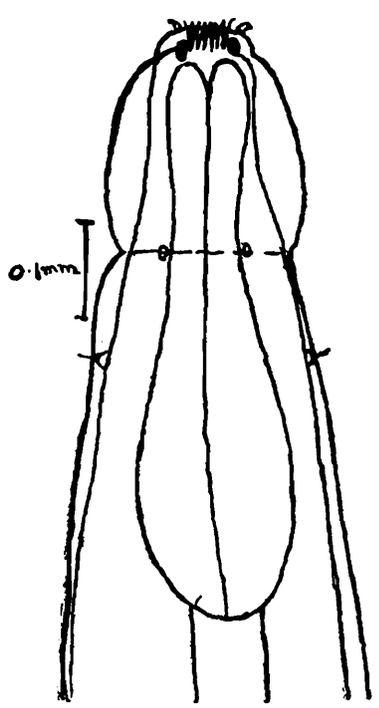

FIG. 22.—*Oesophagostomum suis*, n. sp. Anterior end, dorso-ventral view.

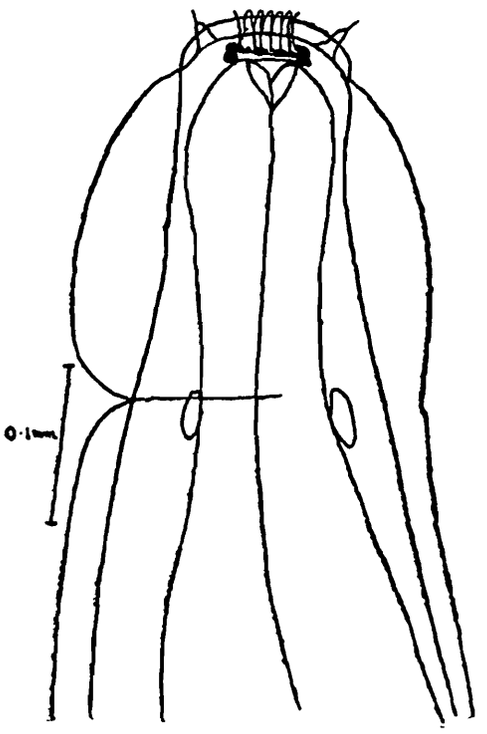

FIG. 23.—*Oesophagostomum suis*, n. sp. Anterior end, lateral view.

nine animals. It was in the usual site for this genus, *viz.* the caecum and large intestine, and many hundreds of specimens were recovered.

In external appearance the anterior end of the worm is very like that of *O. dentatum* (figs. 22 and 23). The cephalic papillae on each

side of the mouth are similar to those of *O. dentatum*. The nerve ring and excretory pore are opposite the cervical groove, and the cervical papillae are symmetrically placed, slightly more anteriorly than they are in *O. dentatum*, in relation to the posterior oesophageal bulb and the cervical groove (fig. 22). The buccal capsule and its appendages are quite characteristic and distinct from those of *O. dentatum*. In optical section the capsule presents a slightly irregular outline due to two grooves which encircle it, one on the inner surface and one on the outer surface about its centre. The two leaf crowns arise from the internal surface of the capsule at the level of the groove, the elements of the external numbering fourteen and of the internal twenty-eight (fig. 24). The oesophagus is of the typical shape for the genus and it is slightly expanded anteriorly. There is a definite oesophageal funnel at the anterior end, which is lined with chitinous material (fig. 23).

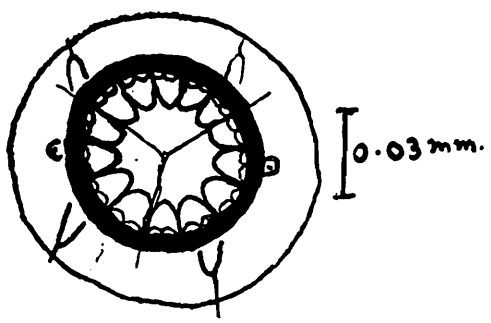

FIG. 24.—*Oesophagostomum suis*, n. sp. Buccal cavity, end on view.

Male.—The male characters are typical of the genus and, therefore, call for little special description. The spicules and gubernaculum are of the usual type, and the telamon does not seem to be very well-developed, as all that could be seen of this structure was a faintly chitinized bar in the ventral wall of the spicule canal opposite the gubernaculum (fig. 25).

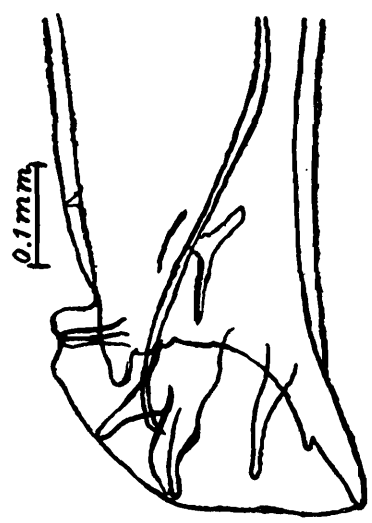

FIG. 25.—*Oesophagostomum suis*, n. sp. Tail of male, lateral view.

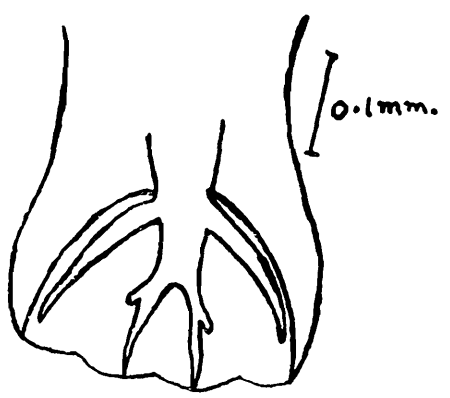

FIG. 26.—*Oesophagostomum suis*, n. sp. Dorsal ray.

FIG. 27.—*Oesophagostomum suis*, n. sp. Genital cone, male.

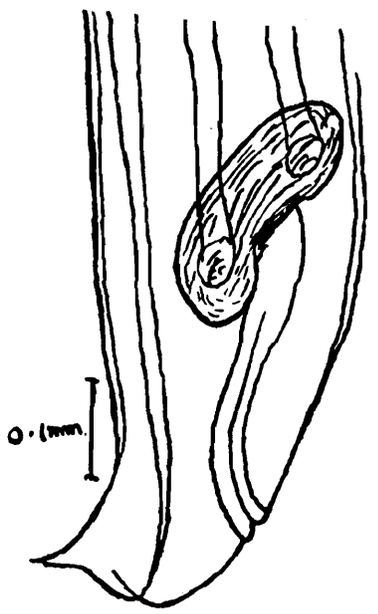

FIG. 28.—*Oesophagostomum suis*, n. sp. Tail of female, lateral view.

The ventral genital cone consists of a central broadly rounded body ending in a fine tip, and on each side there is a large conical fleshy papilla and a small rounded papilla more centrally placed (fig. 27).

Female.—The tail of the female is very characteristic as the ventral surface begins to curve dorsally immediately behind the vulva, so that the anus is only very slightly posterior to but a considerable distance dorsal to this opening. The dorsal curve continues behind the anus and the tail ends in a sharp point which is directed dorsally (fig. 28). The vagina is relatively long and it runs forwards to end in a typically kidney-shaped ovejector which receives the two uterine tubes.

Type specimens of *Oesophagostomum suis* have been placed in the Indian Museum, Calcutta.

TABLE 4.

Dimensions of the two new species O. suis and O. conicum.

	O. suis.		*O. conicum.*	
	Male	Female	Male	Female
Length	6·87—8·75	8·85—11·4	6·87—7·91	8·2—9·1
Diameter	0·297	0·375—0·475	0·317—0·336	0·455—0·495
Cervical groove from ant. end	0·237	0·218—0·237	0·158—0·164	0·158—0·178
Cervic. papillae from ant. end	0·360	0·328—0·376	..	0·460—0·480
Diameter of buccal capsule	0·04—0·044	..	0·080	0·082
Depth of buccal capsule	0·016	0·016	0·040	0·040
Oesophagus, length	..	0·436—0·495	..	0·673—0·713
Gubernaculum length	0·122	..	..	..
Spicules, length	1·3	..	0·832	..
Vulva to anus	..	0·614—0·792	..	0·317—0·356
Anus to tip of tail	..	0·356—0·515	..	0·237—0·257
Vagina, length	..	0·218—0·257	..	0·060—0·064
Eggs	..	0·056—0·060 × 0·028—0·033	..	0·060—0·032

Bourgelatia diducta Railliet, Henry and Bauche, 1919.

This worm was very common, being present in large numbers in forty-two out of forty-nine pigs and a total number of many hundreds of specimens were recovered.

Examination of the ample material demonstrate that the original description is somewhat inadequate, so a redescription is given below.

There are three papillae on each side of the mouth, the lateral pair being larger than the four sub-ventral papillae. The buccal capsule is large and is composed of two separate rings of chitin. In optical section the posterior ring of the capsule appears large and thick and there is a notch on its antero-internal surface into which the smaller anterior ring

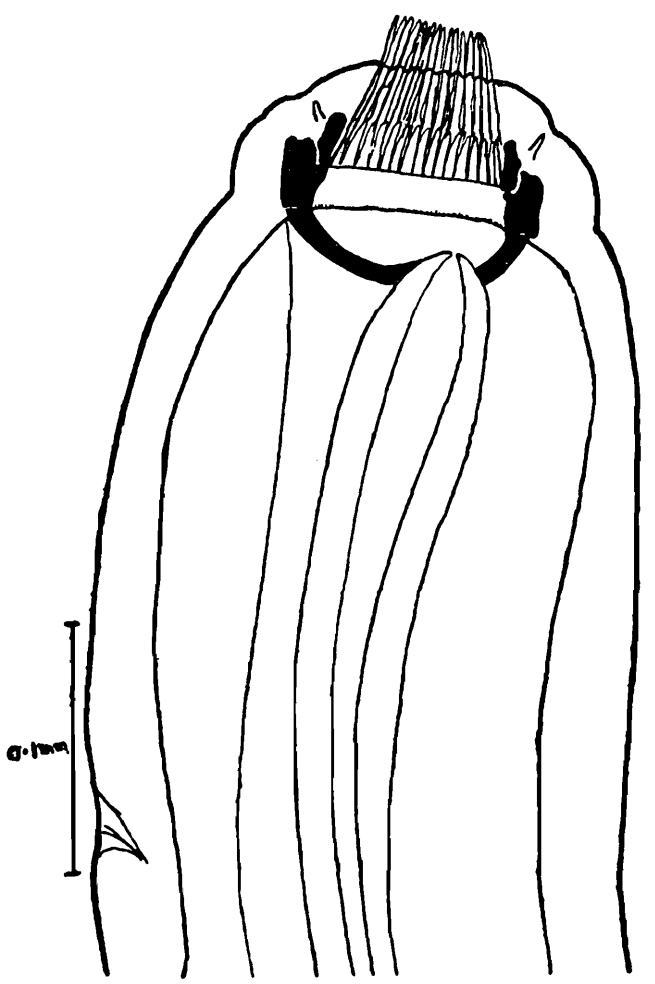

FIG. 29.—*Bourgelatia diducta.* Anterior end, lateral view.

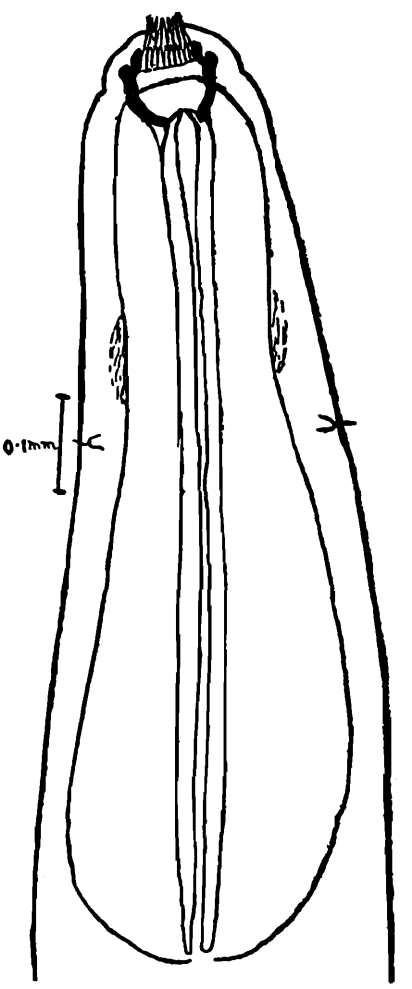

FIG. 30.—*Bourgelatia diducta.* Anterior end, dorso-ventral view.

fits (fig. 29). There are two leaf crowns which appear to arise from the projecting edge of the notch on the posterior ring of the capsule (fig. 29). There are twenty-one elements in the external leaf crown and at its origin from the capsule the internal leaf crown consists of the same number of elements, but the tips of the internal crown are bifid. This character can only be appreciated if an anterior view of the mouth is obtained (fig. 31). Seen from this aspect it is noted that the buccal capsule is more or less divided into twenty-one portions corresponding with the origins of the external leaf crown. These portions are marked by a groove on the external surface from which a faint line runs centrally

through the thickness of the capsule wall. Each element of the internal leaf crown appears to arise from two almond-shaped pieces of chitin, which lie partly embedded in the wall of the buccal capsule and partly projecting from its inner surface (fig. 31).

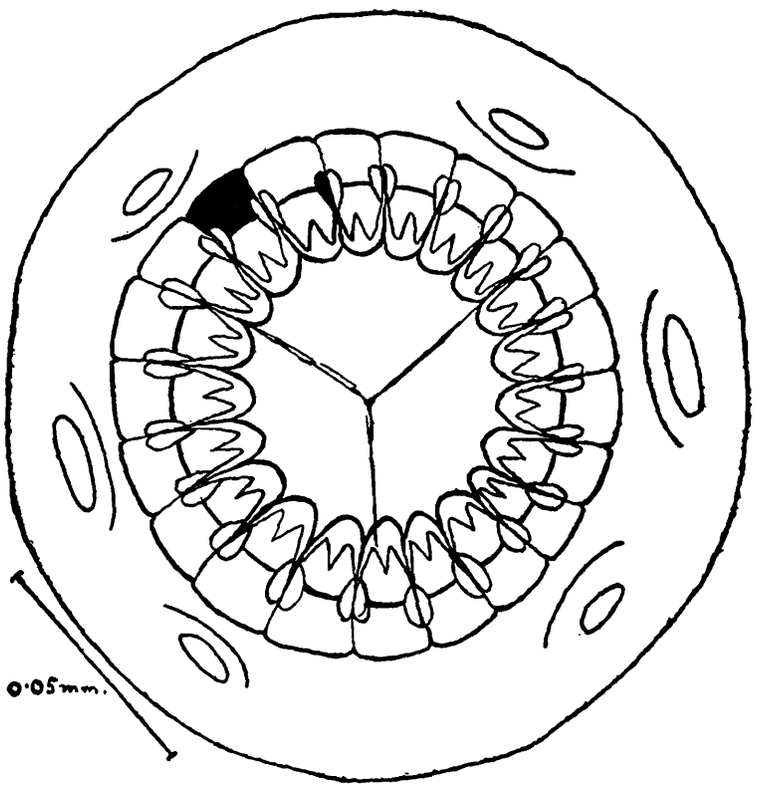

FIG. 31.—*Bourgelatia diducta.* Buccal cavity, end on view. A single section of the internal and external portions of the capsule is darkened.

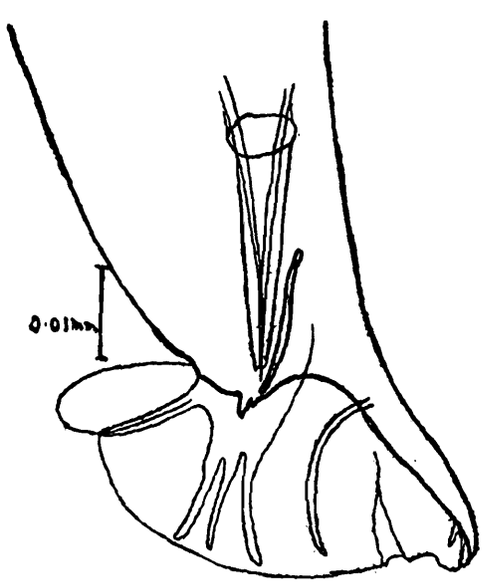

FIG. 32.—*Bourgelatia diducta.* Tail of male, lateral view.

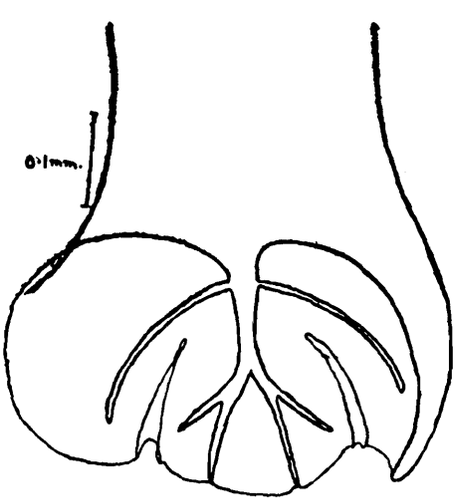

FIG. 33.—*Bourgelatia diducta.* Dorsal ray.

The oesophagus is lined for its whole length by a thick chitinous layer. Anteriorly this oesophageal lining projects in the form of a cone into the extremely broad oesophageal funnel (figs. 30 and 31). The opening of the oesophagus into the funnel is much nearer the dorsal than the ventral surface (fig. 29).

Male.—The tail of the male is surrounded by a bursa the rays of which present the same formula as in the genus *Oesophagostomum* (figs. 32 and 33). The bursa itself, however, has special characters. Where the tips of the ventral rays reach the edge of the bursa there is a deep notch which divides off a small ventral lobe on each side, and there are two deep folds in the bursal membrane between the dorsal ray and the externo-dorsal rays on each side, which differentiate a dorsal lobe from the lateral lobes (figs. 32 and 33).

FIG. 34.—*Bourgelatia diducta.* Genital cone, male.

The ventral genital cone consists of a long central pointed structure with a large papilla on each side of its base (fig. 34). The spicules appear

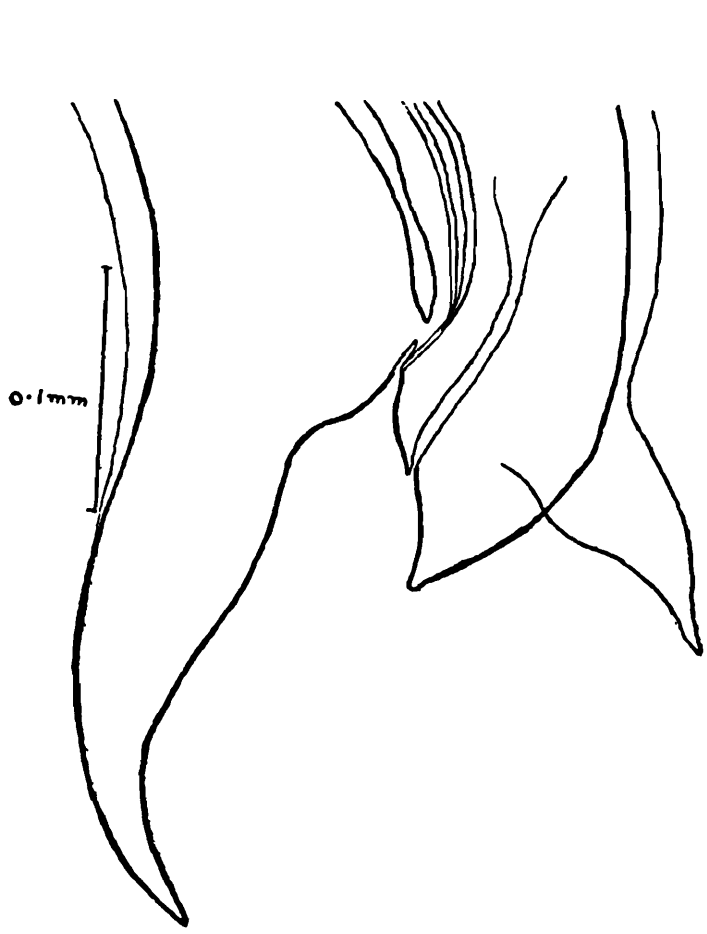

FIG. 35.—*Bourgelatia diducta.* Tail of male, lateral view, showing separate openings of spicular canal and anus.

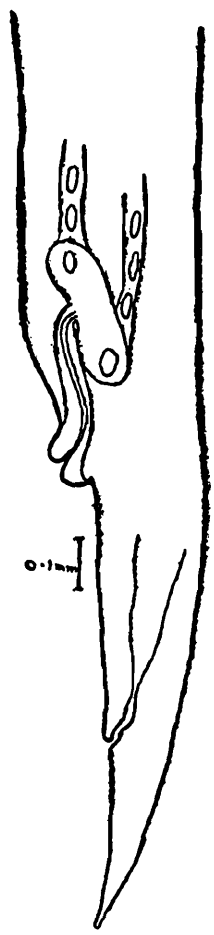

FIG. 36.—*Bourgelatia diducta.* Tail of female.

to emerge through a separate canal dorsal to the intestinal opening (fig. 35).

The spicules are equal, straight and alate. In the original description the gubernaculum is said to be inconspicuous, and in the drawing it is shown as an indefinite, more or less ring-shaped structure, which is situated rather farther forward than is usually the case with this organ. In the present material, many specimens of which were examined, the ring-like structure appears to be the oblique anterior opening of a chitinous funnel-shaped canal surrounding the spicules, and which is probably an exceptionally well-developed telamon. The gubernaculum is a definite structure similar in shape and in position to this organ in the genus *Oesophagostomum* (fig. 32).

Female.—The posterior end of the female is straight and it ends in a sharp point, and the vulva, which has prominent lips, opens a short distance anterior to the anus. A fairly long vagina runs anteriorly to end in a kidney-shaped ovejector similar to that seen in Oesophagostomes (fig. 36).

TABLE 5.

Principal measurements of B. didacta.

	Male.	Female.
Length	8·85—10·67	10·0—12·24
Buccal capsule, diameter	0·068—0·070	0·068—0·072
depth	0·036—0·040	0·036—0·040
Oesophagus, length	0·851—0·951	0·931—0·107
Cervic. papillae from ant. end	0·396—0·415	0·436—0·475
Ex. pore from ant. end	0·268—0·320	0·308—0·344
Spicules, length	1·12—1·24	....
Gubernaculum, length	0·148—0·160	....
Telamon, length	0·240—0·260	....
Vagina, length	....	0·204—0·260
Vulva to anus	....	0·535—0·554
Anus to tip of tail	....	0·297—0·376
Ovejector, length	....	0·232—0·272
Eggs	....	0·058—0·060 × 0·036—0·038

This worm was originally recorded from a pig in Annam by Railliet, Henry and Bauche (1919), and until the present occasion the only other record of its occurrence is by Smit and Notosoediro (1927) in pigs in

Java. The finding of this worm in three Eastern countries, and its great frequency in Indian pigs indicates that in the East at all events it is probably a much commoner parasite than the few records of its occurrence would lead one to suppose.

The Genus *Globocephalus* Molin, 1861.

This genus was reviewed by Cameron (1924), and his conclusions were that *G. urosubulatus* (Alessandrini, 1909) was a species which exhibited a wide range of variation in the size of the sub-ventral teeth, and that *G. connorfilii* Lane, 1922 was a synonym of this species. He also considered it possible that *G. samoensis* (Lane, 1922) may be the same species as *G. longemucronatus* Molin, 1861, because Molin may have missed the teeth owing to his specimens having their mouth cavities filled with debris, but that this point needs further investigation before it can be established as a fact.

Another new species of *Globocephalus* was described under the name *Characostomum amucronatum* by Smit and Notosoediro (1927) from pigs in Java ; the name of this species was changed to *G. amucronatus* by Smit and Ihle (1928). The originals of these two papers have not been available to me but according to Baylis (1929) the distinguishing characters between *G. urosubulatus* and *G. amucronatus* are as follows :—

G. urosubulatus.—Length, male 4·4—5·5 mm. ; female 5—7·5 mm. Sub-ventral teeth usually small, simple. Length of spicules 0·54—0·59 mm. Length of tail in female 0·18—0·23 mm.

G. amucronatus.—Length of male about 5 mm. ; female 6—7 mm. Subventral teeth variable in size, triangular. Length of spicules about 0·7 mm. Length of tail in female 0·132—0·166 mm.

In the course of the present work I have examined the mouth capsules of over two thousand specimens, and have taken measurements of seventy worms, and I have come to the conclusion that there are two different types of mouth capsule, and two different types of teeth, and that the same type of teeth is always associated with the same type of capsule, although both types of teeth show a considerable variation in size.

In the first type, in which the capsule is more or less globular, the teeth are triangular and they arise from the posterior part of the ventral wall of the capsule, the posterior border of the tooth running to the extreme posterior edge of the capsule where it joins the oesophagus (fig. 37, *a* and *b*). The second type of capsule is narrower and is consequently more cylindrical or funnel-shaped and the teeth arise somewhat further forward on the ventral wall of the capsule ; they are more in the nature of longitudinal ridges with a curved outline, and the posterior border always fuses with the capsule wall some distance anterior to its junction with the oesophagus (fig. 37, *c* and *d*). The teeth of both types are variable in size and also in formation, in some cases they appear to be homogeneous chitinous structures, but in others the tip of the tooth is formed by a colourless point of chitin, between which and the tooth proper there is a clear line of demarcation. In some of the specimens, with the narrower capsule and more anterior teeth, they are represented by faint longitudinal ridges not surmounted by a point, and in extreme cases even these faint ridges are absent.

In the subsequent discussion continued reference will have to be made to the above two types of mouth capsule and teeth, so it is proposed to refer to the type with a globular capsule and basal triangular teeth as " Type A ", and the type with a narrower capsule and more anterior teeth as " Type B ".

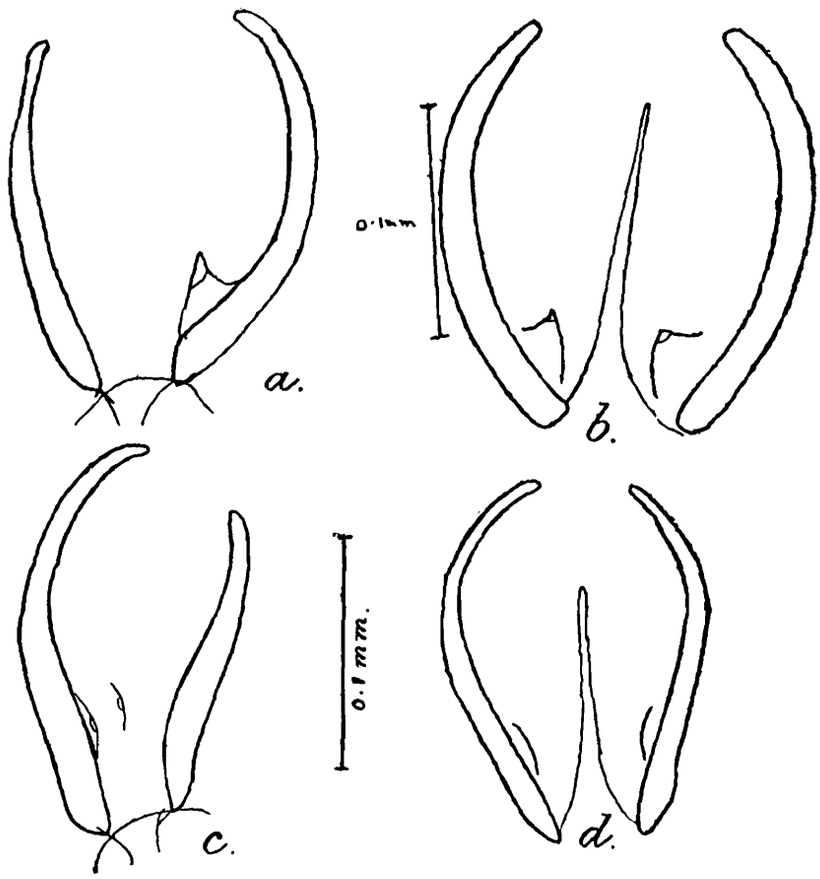

FIG. 37.—(*a*) *Globocephalus urosubulatus.* Buccal capsule, lateral view.
(*b*) *Globocephalus urosubulatus.* Buccal capsule, dorso-ventral view.
(*c*) *Globocephalus connorfilii.* Buccal capsule, lateral view.
(*d*) *Globocephalus connorfilii.* Buccal capsule, dorso-ventral view.

Turning to other points of difference between Types A and B it is found that Type A is generally stouter than Type B although there is slight overlapping in extreme cases. In measurements of the capsule, the depth and maximum diameter of Type A are generally greater than in Type B, although reference to the table below indicates that there is considerable overlapping in these dimensions between the two types. But an important and reliable point is that the maximum diameter of Type A capsules is situated about the middle of the capsule on account of its rather globular shape, whereas the maximum diameter of the Type B capsules is much nearer the anterior end on account of its somewhat funnel-shaped contour. The length of the spicules in Type A is invariably greater than in Type B, but differences in the length of the female tail in the two types was not found a reliable character.

Although the differences between these two types of worm are slight they appear to be constant, and consequently it is considered that Smit and Notosoediro (1927) are correct in dividing into two species the worms that have hitherto been regarded as variants of *G. urosubulatus ;* but

it is unfortunate that they have chosen as the type of their new species *G. amucronatus*, worms, which from their description more nearly correspond with figures 3, 4 and 5 by Alessandrini (1909), and figures 1 and 2 by Cameron (1924) of the same species. It is true that the length of the spicules, *viz.* 590μ given by Alessandrini, and 0·55 mm. given by Cameron agree with the length of the spicules in my Type B worm, which seems to be the same as *G. urosubulatus* by Baylis (1929), whereas the length of the spicules, *viz.* 0·7 mm. by Smit and Notosoediro (1927) nearly agrees with the length of the spicules in my Type A, which appears to be *G. amucronatus* following the description of Baylis (1929) after Smit and Notosoediro. It should be borne in mind, however, that neither Alessandrini nor Cameron recognised two species of worm, so it is possible that they gave the length of the spicules from one type and drawings of the mouth capsule of the other type.

As there seems to be such general agreement among previous workers regarding the shape of the buccal capsule and teeth of *G. urosubulatus vide* the drawings of Alessandrini (1909), Cameron (1924), and v. Linstow (1897), it would seem preferable to consider *G. amucronatus* (Smit and Notosoediro, 1927) as a synonym of *G. urosubulatus*, and to take *G. urosubulatus* of Baylis (1929) after Smit and Notosoediro as another species.

Lane (1922, 1923) described a new species *G connorfilii*, and among the distinguishing characters he gave were the facts that the buccal capsule was longer than broad, and that the teeth were rudimentary. Cameron (1924) did not consider these differences reliable so he made *G. connorfilii* a synonym of *G. urosubulatus*. The above examination of a large number of worms has established the fact that Lane's points are valid, and that in the males with the type of buccal capsule described by him the spicules are always shorter than they are in the type with the broader capsule. Reference to figures 50 and 51 by Lane (1923) makes it clear that he was dealing with my Type B. It is true that the length of the spicules, *viz.* 0·275 mm. given by Lane (1922) is considerably less than that found by me in my series, but this difference serves to emphasise rather than to invalidate the difference between Lane's species and *G. urosubulatus*. It is therefore considered justifiable to re-erect *G. connorfilii* Lane, 1922 as a valid species.

Tubangui (1925) described some worms from pigs in the Philippine Islands, with a cylindrical buccal capsule and no sign of teeth, and, regarding the absence of teeth as of more importance than differences in the shape of the buccal capsule, he tentatively referred his worms to *G. longemucronatus* Molin, 1861, but he suggested the possibility that his material may represent a new species. Reference to figures 2*a* and 2*b* by Tubangui make it clear that he was dealing with my Type B for my examination of a large amount of material has shown that extreme examples exist in which no ridges or teeth are visible, and from these forms all degrees of variation exist up to worms with definite ridges surmounted by a chitinous point forming a tooth, and this gradual variation in prominence of the teeth makes it impossible to separate them into different species. Therefore it is considered that *G. longemucronatus* Molin, of Tubangui, 1925, is an extreme example of *G. connorfilii* (Lane,

1922) in which no teeth are visible. Figures 21 A and B by Yorke and Maplestone (1926) purporting to be *G. longemucronatus* are also obviously those of my Type B or *G. connorfilii*.

TABLE 6.

Measurements of G. urosubulatus and G. connorfilii from the present material.

	G. urosubulatus (my Type "A")		*G. connorfilii* (my Type "B")	
	Male	Female	Male	Female
Length . .	3·99—4·69	4·74—6·87	4·01—4·99	4·1—6·52
Diameter, max.	0·297—0·376	0·336—0·475	0·237—0·336	0·297—0·455
Internal diameter of capsule	0·084—0·108	0·096—0·140	0·068—0·092	0·084—0·108
Depth of capsule .	0·140—0·168	0·152—0·200	0·120—0·168	0·152—0·212
Anus to tip of tail . .	..	0·120—0·196	..	0·128—0·212
Spicules, length . . .	0·852—0·931	..	0·455—0·594	..

Globocephalus samoensis (Lane, 1922).

This worm was present in small numbers in five pigs. It is quite a definite species and is easily separated from the other two by its markedly globular buccal capsule even if the teeth are obscured by dèbris. Over fifty specimens were obtained and in the majority of cases the large bicuspid teeth are clearly visible, but in a few instances the buccal cavity was filled with dèbris, and in a few others there was some degree of distortion of the capsule, which rendered the teeth invisible or difficult to see, but as the teeth were clearly visible in all the clean and undamaged specimens, which represented the great majority, there was no reason to suppose that the teeth were absent in the few dirty or distorted examples. Cameron (1924) suggested the possibility that *G. samoensis* is the same as *G. longemucronatus* and that Molin failed to see the teeth owing to the presence of dèbris in the mouth cavity. The present observation lends support to Cameron's view, but it is not considered that enough material has yet been examined to definitely establish the fact that worms with this type of buccal capsule do not exist without teeth.

The tail of the female in *G. samoensis* ends in a bluntly rounded extremity which is surmounted by a fine hair-like process, whereas the tails of *G. connorfilii* and *G. urosubulatus* taper evenly from just behind the anus to the fine tip of the tail.

The following table shows that my measurements and those of Lane (1922) for this species are in close agreement.

TABLE 7.

Comparison of my measurements with those by Lane of G. samoensis.

	G. samoensis.	
	Lane.	My measurements.
Length, male	4·5—5·5	4·17—5·72
Length, female	5·25—5·6	5·31—6·72
Tail, female	0·07—0·1	0·084—0·124
Spicules, length	0·38—0·41	0·376—0·495

The length of Molin's material, *viz.* 7—8 mm. is greater than the maximum of the above measurements but the difference is not sufficiently marked to exclude the possibility of their unity as a species.

Cameron (1924) pointed out that the question of generic and specific names in this genus were considerably involved, and it is clear from consideration of the subsequent publications regarding the species of the genus *Globocephalus* that the matter has been still further complicated. The following summary is suggested as the most reasonable solution, in the light of existing knowledge.

Type species.—G. longemucronatus Molin, 1861. Length of male 7 mm.; female 8 mm. Buccal capsule definitely globular, teeth absent. Female tail ends in a mucronate tip.

Other species.—G. samoensis (Lane, 1922).

Synonyms.—Crassisoma samoense Lane, 1922. *Raillietostrongylus samoensis* (Lane, 1922) Lane, 1923.

Length, male 4·2—5·7 mm.; female 5·25—6·72 mm. Buccal capsule definitely globular, with large bicuspid sub-ventral teeth. Length of spicules 0·038—0·49 mm. Length of female tail 0·07—0·12 mm., ending in a mucronate tip. (May be identical with *G. longemucronatus.*)

G. urosubulatus (Alessandrini, 1909).

Synonyms.—Crassisoma urosubulatus Alessandrini, 1909. *Characostomum amucronatum* Smit and Notosoediro, 1926. *Globocephalus amucronatus* Smit and Ihle, 1928.

Length, male 3·99—5 mm.; female 4·74—7 mm. Buccal capsule more or less globular, with triangular sub-ventral teeth of variable size arising from base of capsule. Length of spicules 0·7—0·93 mm. Length of female tail 0·120—0·196 mm., ending in a tapering point.

G. connorfilii Lane, 1922.

Synonyms.—G. urosubulatus of Baylis, 1929. *G. longemucronatus* of Tubangui, 1925.

Length, male 4·01—5·5 mm.; female, 4·1—7·5 mm. Buccal capsule narrow, cylindrical or slightly funnel-shaped, with or without sub-ventral ridges which may or may not be surmounted by chitinous tips. Length of spicules 0·45—0·59 mm. Length of female tail 0·13—0·23 mm., ending in a tapering point.

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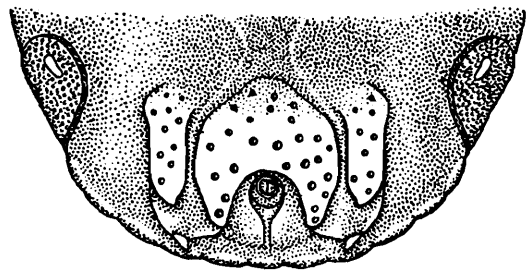
A NOTE ON MONSTROSITIES OBSERVED IN IXODID TICKS.

By M. SHARIF, *M.Sc., F.R.M.S., F.L.S., Officiating Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plate III.)

Neumann,[1] Senevet,[2] Warburton and Nuttall,[3] Nuttall,[4] and Robinson[5] have from time to time described and figured a number of abnormalities observed in ticks: some of those recorded by the last three workers were of Indian origin. While going through a big collection[6] of ticks belonging to the Indian Museum, I came across a number of abnormalities, of which fourteen, and an additional abnormal phenomenon, are described and figured here, as they appear to be sufficiently striking to be placed on record.

I am greatly indebted to Lt.-Col. R. B. Seymour Sewell for revising my manuscript. The text-figures illustrating this paper are all Camera lucida drawings and were finished from my pencil sketches by Babu Subodh Mondul, who with Babu S. C. Mondul has prepared the photographs accompanying this paper. I am thankful to these artists of the Zoological Survey of India for the care they have taken in making true and faithful delineations of the specimens.



TEXT-FIG. 1.—*Hyalomma* (*Hyalomma*) *aegyptium* ♂. Abnormal: posterior portion of the venter, × 23.

Specimen 1.

In text-fig. 1 I depict a monstrosity in a ♂ (1223/18) of *Hyalomma* (*Hyalomma*) *aegyptium* (Linnaeus). This specimen was captured on the 14th February, 1926, by Veterinary Assistant Surgeon S. N. Sinha on a cow at Nawadah in the Gaya district, Bihar, in company with other normal specimens. The adanal shields are larger than usual and are fused with each other, as in the male of *Margaropus winthemi* Karsch, in front of the anus, which is more posterior in position than in normal specimens. The adanal and accessory shields are less chitinised than

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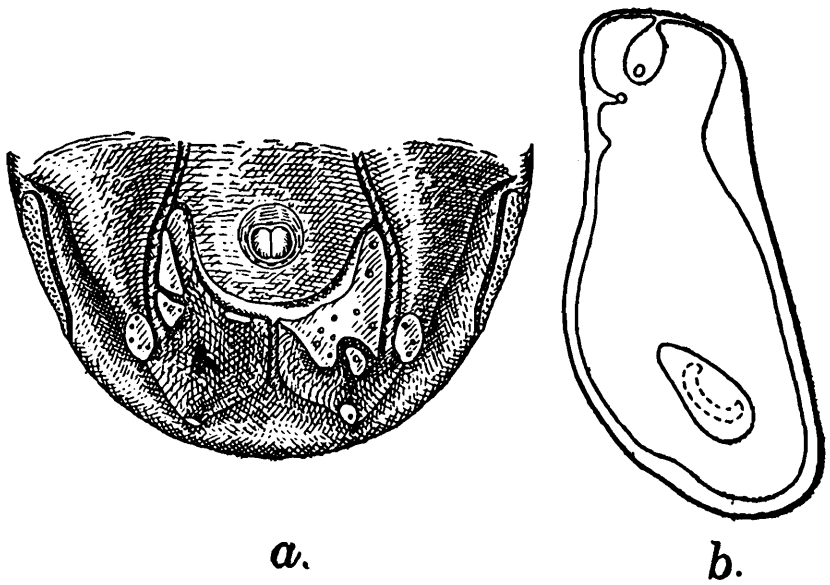
[1] Neumann, *Arch. Parasitol.* II, pp. 463-465 (1899).
[2] Senevet, *Bull. Soc. Hist. Nat. Afriq. Nord*, XIII, p. 95 (1922).
[3] Warburton and Nuttall, *Parasitology* II, pp. 70-76 (1909).
[4] Nuttall, *Parasitology* VII, pp. 250-257 (1914).
[5] Robinson, *Parasitology* XII, pp. 175-179 (1920).
[6] Results embodying this collection were published in *Rec. Ind. Mus.* XXX, pp. 217-344, pls. viii, ix (1928).

in the normal male, which is illustrated by Warburton and Nuttall in *Parasitology* II, p. 71, text-fig. 17 (1909).



Text-fig. 2.—*Hyalomma* (*Hyalomma*) *aegyptium* ♂. Abnormal: (*a*) posterior portion of the venter, × 30; (*b*) right spiracle, × 80.

Specimen 2.

Text-fig. 2 illustrates a deformity in a ♂ (1227/18) of *Hyalomma* (*Hyalomma*) *aegyptium* which was found on a bullock at Seoni in the Jubbulpore district, Central Provinces, on the 28th January, 1926, and was presented to the Indian Museum by the Veterinary Adviser to the C. P. Government. The right adanal shield is very much reduced in size and is represented by two rudiments. The left adanal shield is larger than the normal and is of irregular form. It is bilobed posteriorly and has a small additional plate behind it between the two lobes. The right subanal shield is underdeveloped. The right posterior portion of the body is slightly underdeveloped and the scutum in that region is raised as if forming a pseudo-scutum. The tail portion of the right spiracle is shorter and much broader than the normal. A normal spiracle of the ♂ is illustrated by me in *Bull. Agric. Res. Inst. Pusa* No. 152, pl. v, fig. 21 (1924).

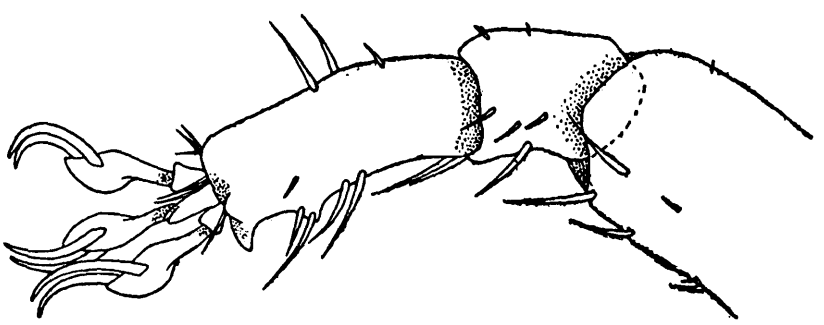
Specimen 3.

In a ♂ (1224/18) of *Hyalomma* (*Hyalomma*) *aegyptium* (pl. iii, fig. 1), which was taken off a bullock by Veterinary Assistant Surgeon H. H. Singh at Bhabua in the Shahabad district, Bihar, there are only two legs on the left side; the third and the fourth legs are totally absent and there are no indications as to whether they were originally present. Coxa II on the left side is shorter and broader than the normal. The arrangement of the legs on the right side is normal.

Specimen 4.

In a ♂ (1225/18) of *Hyalomma* (*Hyalomma*) *aegyptium* (pl. iii, fig. 2), which was collected at Katni in the Jubbulpore district, Central

Provinces, on the 17th January, 1926, and was presented to the Indian Museum by the Veterinary Adviser to the C. P. Government, there are three legs on the right side; the fourth leg is missing, and so also is the spiracle of that side. The anterior pointed portion of the right adanal shield is absent. The right accessory and subanal shields are slightly under-developed as compared with their fellows on the opposite side of the body. The posterior grooves on the scutum are irregular in outline and are broader and more shallow than in the normal. The right margin of the scutum opposite the spiracle is broken.



TEXT-FIG. 3.—*Hyalomma* (*Hyalomma*) *aegyptium* ♂. Abnormal: tarsus IV with three feet, × 60.

Specimen 5.

Text-fig. 3 illustrates a unique monstrosity in a ♂ (1237/18) of *Hyalomma* (*Hyalomma*) *aegyptium* which came from the same lot as specimen 4. The distal portion of the tarsus of the left fourth leg does not taper as in the normal condition but is of uniform breadth throughout. It possesses three complete feet of normal size in place of the usual one. There is an additional tarsal spur close to the middle foot. A normal tarsus of the fourth leg is illustrated by me in *Rec. Ind. Mus.* XXX, p. 304, text-fig. 35*a* (1928).

Specimen 6.

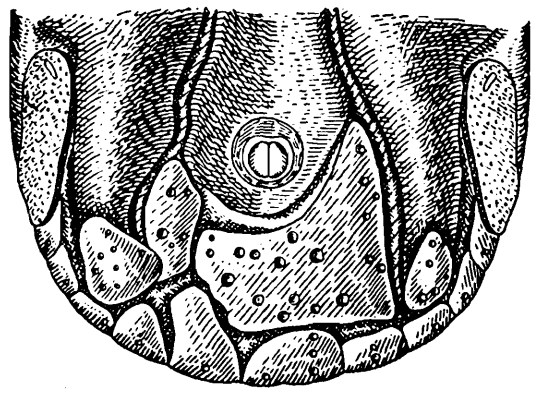
In a ♀ (1229/18) of *Hyalomma* (*Hyalomma*) *aegyptium* (pl. iii, fig. 3), coming from the same lot as specimens 4 and 5, there are only two legs on the right side; legs III and IV are missing, as also is the spiracle of that side. Coxa II of the right side is shorter than the normal. The legs on the left side are all normal.

Specimen 7.

In a ♀ (1226/18) of *Hyalomma* (*Hyalomma*) *aegyptium* (pl. iii, fig. 4), which was taken off a dog at Patur in the Akola district, Central Provinces, and is the gift of the Veterinary Adviser to the C. P. Government, there are three legs on the left side. The empty space between legs II and IV indicates that it is the third leg that is missing. The second leg of the same side, though preserving the normal number of segments, is underdeveloped and is considerably shorter. The right side shows the normal arrangement and proportions of the segments of the legs.

Specimen 8.

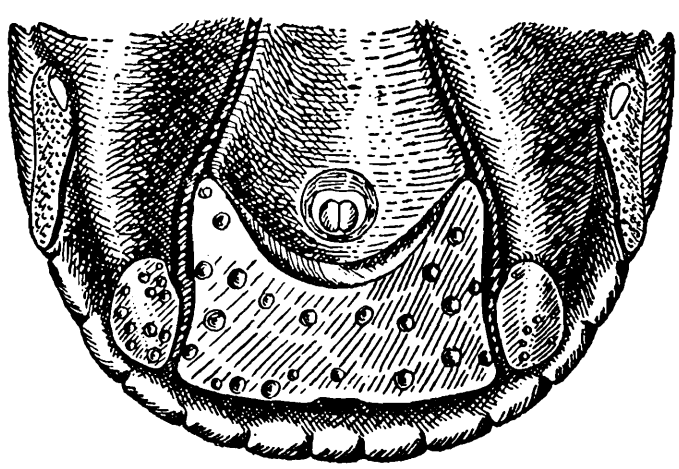
In a ♀ (1228/18) of *Hyalomma* (*Hyalomma*) *aegyptium* subsp. *isaaci* Sharif (pl. iii, fig. 5), which was captured on a mare by Veterinary Assistant Surgeon P. Topno at Chatra in the Hazaribagh district, Bihar, on the 7th March, 1926, there is a narrow elongated false scutum with numerous fine punctations, lying behind the scutum proper and fused with it anteriorly. The false scutum is shorter than the body and as a result of this the dorsum of the abdomen is thrown into laterally running folds.



TEXT-FIG. 4.—*Hyalomma* (*Hyalommina*) *hussaini* ♂. Abnormal : posterior portion of the venter, × 30.

Specimen 9.

Text-fig. 4 shows an abnormality in a ♂ (1230/18) of *Hyalomma* (*Hyalommina*) *hussaini* Sharif, which was collected from a bullock at Akola, Central Provinces, on the 29th January, 1926, and was presented to the Indian Museum by the Veterinary Adviser to the C. P. Government. The ventral shields are of unequal size ; the right adanal shield is smaller but the left is considerably larger than usual. The right accessory shield is larger than the normal one, which is shown on the left side. The first and second scutes on the right side, counting from the median one, are larger in size and the median scute is fused with the



TEXT-FIG. 5.—*Hyalomma* (*Hyalommina*) *kumari* ♂. Abnormal : posterior portion of the venter, × 40.

adjacent scute of the left side. The venter of a normal ♂ is illustrated by me in *Rec. Ind. Mus.* XXX, p. 315, text-fig. 39*a* (1928).

Specimen 10.

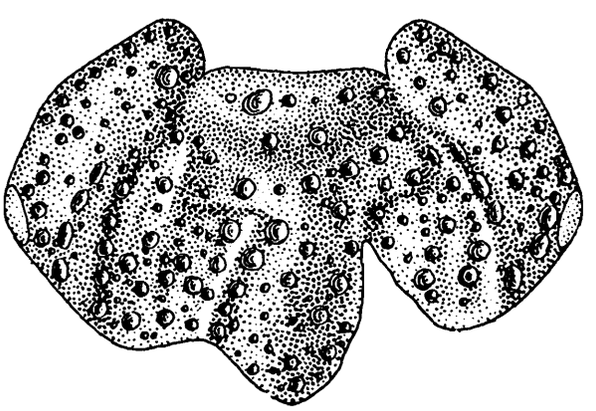
In text-fig. 5 I have depicted a deformity in a ♂ (1231/18) of *Hyalomma* (*Hyalommina*) *kumari* Sharif, which was collected off a dog at Sasaram in the Shahabad district, Bihar, by Veterinary Assistant Surgeon D. Prashad on the 9th February, 1926. The two adanal shields, which are otherwise of normal size and form, are fused with one another behind the anus. In the normal male the two shields are separated by the median post-anal groove.

Specimen 11.

A ♂ (1232/18) of *Rhipicephalus sanguineus* (Latreille) (pl. iii, fig. 6), which was found on a dog at Daltonganj in the Palamau district, Bihar, on the 15th August, 1925, by Veterinary Assistant Surgeon N. D. Singh, possesses only three legs on the right side. The first leg is missing and as a result the axis of the capitulum is inclined towards the right side.

Specimen 12.

In a ♀ (1233/18) of *Rhipicephalus sanguineus* (pl. iii, fig. 7), which was presented to the Indian Museum by Dr. H. H. Marshall labelled " R 33 " but with no other data, there are three legs on the right side ; leg IV is missing. On the left side the third leg is only represented by the coxa and a small bud attached to it. In the fourth leg of the left side the distal five segments are smaller than the normal and the foot is absent.



TEXT-FIG. 6.—*Rhipicephalus sanguineus* ♀. Abnormal: scutum, × 53.

Specimen 13.

Text-fig. 6 shows a deformity in the scutum of a ♀ (1234/18) of *Rhipicephalus sanguineus*, which was collected from a dog at Chaibasa in the Singhbhum district, Bihar, on the 21st September, 1926, by Veterinary Assistant Surgeon G. S. Dehuri. The posterior portion of the scutum is underdeveloped and as a result there are three lobe-like processes in the hinder margin. The normal female with its scutum is illustrated by Cunliffe in *Parasitology* VI, p. 377, text-fig. 4 (1914).

Specimen 14.

A ♀ (1235/18) of *Rhipicephalus haemaphysaloides* Supino (pl. iii, fig. 8) which, along with other specimens, was taken off infected calves

in the Vaccine Institute, Belgaum, Bombay Presidency, on the 22nd November, 1926, by Dr. J. L. Pinto, possesses three legs on the right side ; the fourth leg is missing. The axes of the capitulum and the scutum are slightly inclined towards the right side.

Specimens 15.

Fig. 9 of plate III illustrates an interesting phenomenon, hitherto unrecorded, in *Rhipicephalus sanguineus* (Latreille) (1236/18) which came from a lot collected from a goat at Sasaram in the Shahabad district, Bihar, by Veterinary Assistant Surgeon D. Prashad, on the 18th September, 1925. The male has with its proboscis pierced the dorsum of the abdomen of the female [1] just behind the scutum and is holding the body of the female with its legs. The only two possible explanations for this curious phenomenon are : either that the hungry male had pierced the body of the female for sucking blood, or that the male had failed to find the female genital aperture and had pierced the body with a view of copulating at that spot. The first explanation seems to be more reasonable and is supported by a personal observation of mine of an identical phenomenon in *Aponomma gervaisi* var. *lucasi* Warburton. In September, 1925, I brought a large number of specimens of *A. gervaisi* var. *lucasi* from the Zoological Gardens, Calcutta, and placed them for a day in a large tube on my laboratory table. The next day when I returned to the laboratory I found that a male had pierced the body of a replete female just near the anus. I killed the couple by pouring boiling water on them and preserved them in spirit. These two specimens were, however, later on unfortunately lost.

[1] These two specimens reached me well preserved in rectified spirit along with other specimens of this species. Apparently the two specimens were instantly killed in this condition by pouring boiling water on them in a tube ; a process which was recommended to the various collectors of ticks by me in a circular letter.

EXPLANATION OF PLATE III.

Hyalomma (*Hyalomma*) *aegyptium* (Linnaeus). Abnormal.

FIG. 1.—Male, venter: × 7.

„ 2.—Male, venter: × 7.

„ 3.—Female, venter: × 7.

„ 4.—Female, venter: × 7.

Hyalomma (*Hyalomma*) *aegyptium* subsp. *isaaci* Sharif. Abnormal.

FIG. 5.—Female, dorsum: × 3.

Rhipicephalus sanguineus (Latreille). Abnormal.

FIG. 6.—Male, venter: × 7.

„ 7.—Female, venter: × 7.

Rhipicephalus haemaphysaloides Supino. Abnormal.

FIG. 8.—Female, venter: × 7.

Rhipicephalus sanguineus (Latreille).

FIG. 9.—Male piercing the dorsum of the female: × 7.

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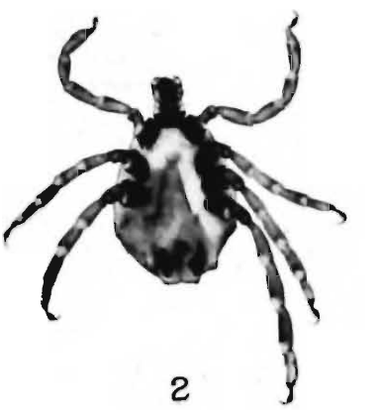

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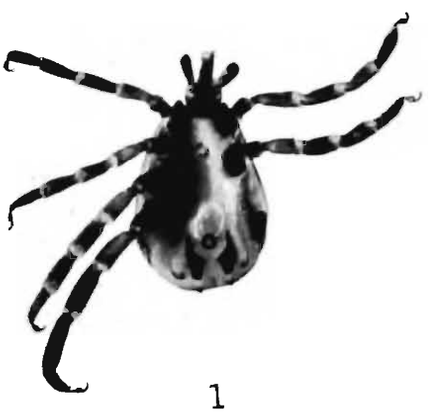

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Subodh Mondul photo.

MONSTROSITIES IN TICKS.

FURTHER NOTES ON BOPYRID ISOPODS PARASITIC ON INDIAN DECAPODA MACRURA.

By B. CHOPRA, *D.Sc., F.I.S., Zoological Survey of India, Calcutta.*

(Plates IV-VI.)

Since the publication of my paper on the Indian Bopyridae in 1923[1], a number of specimens belonging to this family have been added to the collection of the Zoological Survey of India. They were for the most part got together by Dr. S. W Kemp, formerly Superintendent, Zoological Survey of India, in the course of his work on various Caridea in 1925[2], shortly before his departure from India. Some of these Bopyrids belong to species already known to occur in Indian waters and the present records do not add materially to our knowledge of their distribution or range ; there are others that are of interest on account of their distribution, or from the point of their hosts, in so far as they are now being recorded from hosts belonging to genera or even families altogether different from those that they were hitherto known to parasitize. There are also a number of other forms that are new to science and are described here for the first time. Among these may be mentioned a species of *Pseudione* Kossmann, a genus that is recorded from Indian waters for the first time, and two species of *Diplophryxus* Richardson, a genus that was so far known from only one species. I give below a table (pp. 114, 115) showing the names of the species represented in the present collection with the names of the hosts they infest and notes on the distribution of the genera to which they have been assigned.

By their excellent report on the Epicaridea of Dr. Th. Mortensen's collections Messrs. H. F. Nierstrasz and G. A. Brender à Brandis[3] have quite recently made a very useful addition to our knowledge of the Indo-Pacific Bopyridae. With most of the views expressed by these eminent carcinologists I am in full agreement, but in one or two cases I have not been able to agree with them. They believe, for instance, that the two closely allied genera *Probopyrus* and *Palaegyye* cannot be distinguished from one another and must, therefore, be combined under the former name. For reasons given elsewhere (*vide* pp. 127, 128) I am unable to accept this suggestion. In the same way I am unable to agree with the Dutch authors that Hay's *Synsynella* is distinct from *Bopyrella* Bonnier.

In the terminology of the various parts I have employed the same terms as I used in 1923, with the exception that I have called the lateral parts of the thoracic somites the " anterior " and the " posterior lateral plates " instead of epimera and pleura. Nierstrasz and Brender à Brandis, in their report on the Siboga-Expedition[4],

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[1] Chopra, *Rec. Ind. Mus.* XXV, pp. 411-550, pls. xi-xxi (1923).

[2] Kemp, *Rec. Ind. Mus.* XXVII, pp. 249-343 (1925).

[3] Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* LXXXVII, pp. 1-44 (1929).

[4] Nierstrasz and Brender à Brandis, *Siboga-Exped. Rep.* XXXII b, pp. 57-121, pls. iv-vii (1923).

Name of parasite.	Name of host.	Locality.	Remarks on hosts and distribution, etc.
Hemiarthrus nigrocinctus Chopra	*Periclimenes amymone* deMan ...	Nancowry Harbour, Nicobar Is.	Genus known to infest several families of Caridea; in the Palaemonidae now known to live on *Typton*, *Periclimenes* and *Leander*. Genus common in Europe, along both coasts of North America and in the Indo-Pacific region; one species recorded near Cape Point, South Africa.
	Leander tenuicornis (Say) ...	Nicobars; and Port Blair, Andaman Is.	
Hemiarthrus filiformis, var. *attenuata* Chopra	*?Alpheus paralcyone* Coutiére ...	Port Balir, Andaman Is. ...	
Diplophryxus jordani Richardson	*Leander tenuicornis* (Say) ...	Kilakarai, Gulf of Manaar ...	Genus previously known from Japan and Mergui Archipelago only as a parasite of *Leander serrifer* Stimpson; now known from the western parts of the Bay of Bengal also. Besides *Leander* (fam. Palaemonidae) genus now known to infest Gnathophyllidae and Crangonidae also.
Diplophryxus richardsoni, sp. nov.	*Pontophilus lowisi* Kemp ...	Port Blair, Andaman Is. ...	
Diplophryxus kempi, sp. nov. ...	*Gnathophyllum fasciolatum* Stimpson.	Port Blair, Andaman Is. ...	
Palaegyge pica Chopra ...	*Palaemon* sp.	Travancore	Genus known to live mostly on *Palaemon*, only one species known to infest the allied genus *Leander*. Occurs in the fresh and estuarine waters of the Malay Archipelago and other islands in the Indo-Pacific region, in India, in the West Indies and in Central America.
Palaegyge prashadi Chopra ...	*Palaemon lamarrei* H. M.-Edwards.	Delta of the Ganges ...	
Palaegyge abhoyai Chopra ...	*Palaemon* sp.	Delta of the Ganges ...	

Bopyrella nierstraszi, sp. nov. ...	*Hippolysmata vittata* Stimpson	Port Blair, Andaman Is ...	Genus now known to infest Hippolytidae (*Hippolysmata*, *Tozeuma* and *Latreutes*) and Alpheidae (*Alpheus* and *Synalpheus*). Known to occur extensively in the Indian Ocean both in the Arabian Sea (Karachi) and the Bay of Bengal, as far south as the Friendly Islands in Oceania; in the Indo-Pacific in the Strait of Formosa; and in the Atlantic along the coast of N. America and in the West Indies.
Pseudione indica, sp. nov ..	*Pontophilus plebs* Kemp ..	Port Blair, Andaman Is. ...	Genus known to have a very wide range of distribution, occurring almost all over the three great Oceans. Most of the species infest different families of the Anomura but among the Macrura the Pandalidae, the Nematocarcinidae and the Crangonidae are known to be parasitized.
Bopyrus squillarum, var *bimaculatus* Chopra	*Leander serrifer* Stimpson ..	Bombay	Genus known to infest *Leander* only and lives in almost all the seas of Europe, Black Sea, Arabian sea, Delta of the Ganges, Bay of Bengal and the eastern parts of the Indo-Pacific region.
Bopyrina sewelli, sp. nov. ..	*Chlorotocella gracilis* Balss ..	Nancowry Harbour, Nicobar Is.	Genus known to infest Hippolytidae (*Hippolyte*. *Thor* and *Gelastocaris*), Palaemonidae, subfamily Pontoniinae (*Periclimenes*, *Urocaridella* and *Harpilius*) and Pandalidae (*Chlorotocella*). Genus known from the British Isles, Atlantic Coast of North America, Mediterranean Sea, Arabian Sea along the Indian coast, Bay of Bengal and the Pacific Coast of North America.

had called the anterior portions as the " coxal plates " and the posterior as the " posterior lateral plates." They have used the same terms in their subsequent works.[1] I am, however, not convinced that the anterior portions represent the true coxopodites of the thoracic appendages. In the same way I have described the first free thoracic somite (which morphologically is believed to be the second) as the first segment, as is done by almost all workers on the taxonomy of the Isopoda.

Most of the illustrations accompanying this paper have been prepared under my supervision by Babu A. C. Chowdhury, the gifted artist of the Zoological Survey of India, while some on Plate V are from the pen of his equally talented colleague Babu S. C. Mondul. My best thanks are due to the artists for the care with which they have done their work.

Most of the hosts were identified by Dr. S. W. Kemp at the time he was engaged in working out the taxonomy of the different families to which they belong and for this my thanks are due to him. His notes and revisions of the various families of Caridea, published in the *Records of the Indian Museum* have been a source of great help to me in understanding the distribution and the affinities of the various Decapoda with which I have been dealing.

Col. R. B. Seymour Sewell, Director, Zoological Survey of India, has gone through the manuscript and has made several valuable suggestions, for which I am very thankful to him.

All the type-specimens are the property of the Zoological Survey of India and are preserved in the collections of the Indian Museum at Calcutta.

GENUS **Hemiarthrus** Giard and Bonnier.

1923. *Hemiarthrus*, Chopra, *Rec. Ind. Mus.* XXV, p. 426.
1926. *Phxyxus*, Nierstrasz and Brender à Brandis : in Grimpe and Wagler's *Die Tierwelt der Nord- und Ostsee* X. e_1, p. 35.

For reasons fully explained in 1923 I have adopted the generic designation of *Hemiarthrus* in preference to the preoccupied name of *Phryxus* Rathke. Nierstrasz and Brender à Brandis[2] have, however, retained the latter designation on the score of its being older and in more common use. This plea is untenable according to the rules of zoological nomenclature and the retention of the name *Phryxus* will, in my opinion, only add further confusion. Rathke's *Phryxus* dates only from 1843, whereas Rafinesque[3] in his *Analyse de la Nature* is said to have used the name for insects of the group Hemiptera as far back as 1815. This name is, however, said to be no more than a *nomen nudum*, and though according to the present-day rules of nomenclature it cannot be employed any more in zoology, Hübner used it again in 1820[4] in his *Verzeichniss*[5] as a generic

[1] Nierstrasz and Brender à Brandis, *Bijdr. Dierkunde* XXIV, pp. 1-8, 1 pl. (1925); and in Grimpe and Wagler's *Die Tierwelt der Nord- und Ostsee* X. e_1 : I. Epicaridea, pp. 1-56 (1926).

[2] Nierstrasz and Brender à Brandis, *Siboga-Exped. Rep.* XXXII b, p. 108 (1923).

[3] I have not been able to see this work, and have taken this reference from Sherborn's *Index Animalium*, part XIX, p. 4928 (1929).

[4] Hübner's *Verzeichniss* was published in parts and the pages containing a reference to *Phryxus* were probably issued according to Sherborn and Prout [*Ann. Mag. Nat. Hist.* (8) IX, pp. 179, 180 (1912)] in 1820.

[5] Hübner, *Verzeichniss bekannter Schmettlinge*, p. 137 (1816-1827).

designation for Lepidoptera of the " Stamm Deilephilae," with *Phryxus livornica* Petiver as its type-species. Thus it is clearly seen that though there may perhaps be some justification for ignoring the use of the name *Phryxus* by Rafinesque, its use by Hübner in Lepidoptera can on no account be overlooked. In any case the retention of this name in Crustacea is not permissible according to the rules of zoological nomenclature.

Hemiarthrus nigrocinctus Chopra.

1923. *Hemiarthrus nigrocinctus*, Chopra, *loc. cit.*, pp. 432-435, pl. xi, figs. 1-3.

I have examined six additional specimens of this species from the Andamans and the Nicobars in the Bay of Bengal. All the specimens are adult females and five of them are accompanied by their males. The Andaman specimens were collected by Dr. S. W. Kemp, while those from the Nicobars were brought back by Lt.-Col. R. B. Seymour Sewell, formerly Surgeon Naturalist on board the Royal Indian Marine Survey Ship " Investigator."

The present specimens agree very closely, in most respects, with those described in 1923 and there cannot be any doubt of their identity. The colour band round the thorax of the female, on which the name of the species is based, however, differs considerably from what has been previously described and figured. In all the present specimens the band is altogether missing on the ventral side, while on the dorsal even it is very much restricted. In one specimen only (C 1403/1, from Nancowry Harbour, Nicobars) the band is present on the entire dorsal surface ; in all the rest it is present near the two margins only and leaves a large gap in the mid-dorsal region. Near the margins the band is bent in a posterior direction. Further, in all the specimens the band is formed of reticulations of a dark brownish colour between which the pale yellowish surface of the body can be seen. In examples previously described the band is more or less of a uniform consistency. With relation to the thoracic constriction the band occupies the same position as that previously described. The last oostegite of the shorter side of the body is coloured dark brownish in most of the specimens.

The males also agree closely with those described in 1923.

With reference to the colour band *H. nigrocinctus* appears to be in an unstable condition. In examples examined in 1923 the band is a very prominent feature of the species, and, except for a small gap in the mid-ventral region, encircles the thorax completely. In the Nancowry specimen the band is not of a uniform consistency, but is formed of reticulations, is continuous on the dorsal surface and is altogether absent on the ventral. In the other five examples now examined, the band is of the same nature as in the Nancowry specimen, but is even further reduced—it is totally absent ventrally and on the dorsal surface even is quite obliterated about the mid-dorsal region. The last oostegite of the shorter side of the body is in most specimens pigmented, but may sometimes be colourless. It would thus appear that the pigmentation in *H. nigrocinctus* is undergoing reduction.

As is usual in this species the parasite is attached on the ventral surface of the host, being held in position by the first three pleopods and

the side plates of the host. The flat dorsal surface of the parasite is apposed to the ventral surface of the host, its anterior end pointing towards the " tail " of the prawn. The small colour spots on the posterior pleopods of the Bopyrid can be seen faintly in the natural position.

H. nigrocinctus was hitherto known from a number of specimens parasitic on *Periclimenes elegans* (Paulson) collected in the Andaman Islands, and one example from the Jack and Una Islands in the Mergui Archipelago, living on the allied species *P. demani* Kemp. Out of the present specimens four are from the Nicobars, while two were collected in the Andamans. All these specimens except one (C 1403/1) from the Nicobars are parasites of *Leander tenuicornis* (Say), while the remaining example was found living on *Periclimenes* (*Ancylocaris*) *amymone* de Man. The present record, therefore, extends the range of *H. nigrocinctus* both geographically and from the point of the hosts. It must, however, be observed that *P. amymone*, the host of one of the specimens in the Nicobars, is somewhat closely allied to *P. elegans* and *P. demani*, the hitherto known hosts of the species. The case of *Leander* is, however, more interesting. This genus, or even the subfamily to which it belongs—Palaemoninae of the family Palaemonidae—was not hitherto known to be infested by *H. nigrocinctus*, or, indeed, by any other species of *Hemiarthrus*. *H. nigrocinctus*—as also the doubtful *H. typtonis* Giard and Bonnier, of which no description, except the name of the host, is available—was already known to live on members of the Pontoniinae of the family Palaemonidae, but the present is the first record of a *Hemiarthrus* living on a Palaemonine prawn.

C 1403/1	Coral Reef, N. E. of Octavia Bay, Nancowry Harbour, Nicobars.	" Investigator," Nov., 1929.	1 ♀ and ♂ on *Periclimenes amymone* de Man.
C 1449/1	East and North side, Nancowry Harbour, Nicobars.	" Investigator "	On *Leander tenuicornis* (Say).
C 1450/1	East Coast, Camorta Island, Nicobars.	" Investigator," Oct., 1921.	,,
C 1451/1	Off Naval Point, Nancowry Harbour, Nicobars.	R. B. Seymour Sewell, Dec., 1922.	,,
C 1452/1	Off Pier, Ross Island, Andamans : 10-12 fms.	S. Kemp, Feb., 1915.	,,
C 1453/1	Off Pier, Ross Island, Andamans : 3-4 fms.	,,	,,

Hemiarthrus filiformis Chopra.

1923. *Hemiarthrus filiformis*, Chopra, *loc. cit.*, pp. 435-438, pl. xi, figs. 4-6.

var. **attenuata** Chopra.

1923. *Hemiarthrus filiformis*, var. *attenuata*, Chopra, *loc. cit.*, pp. 438, 439, pl. xi, fig. 7.

There are two specimens of this variety in the present collection, both are ovigerous females and one is accompanied by its male. Both the specimens are smaller in size than those described in 1923, being 3·4 and 3·0 mm. long and 2·7 and 2·2 mm. broad respectively. The females agree in almost all respects with the published account of the

variety, but the outer rami of the pleopods are somewhat oval in outline, and the last abdominal segment, especially in the larger of the two specimens, is distinctly notched posteriorly.

The single male specimen, that accompanies the larger of the two females, has the typical appearance characteristic in this variety. It is somewhat curved and its proportions, therefore, cannot be accurately measured, but it has the usual thin and attenuated appearance. The tapering abdomen is truncated posteriorly and, though all its segments appear to be fused, the lateral undulations of the margins seem to mark off some of the segments. The large " pleural lamellae " on the first two abdominal somites have the usual form and structure.

The two specimens now examined are from the Andamans and are parasites of an Alpheid, resembling *Alpheus paralcyone* Coutière, the same host from which this species has already been recorded.

C 1454/1	Off Pier, Ross Island, Andamans.	S. Kemp, Feb., 1915.	1 ♀ and ♂ on ? *Alpheus paralcyone* Coutière.

Genus **Diplophryxus** Richardson.

1923. *Diplophryxus*, Chopra, *loc. cit.*, pp. 442, 443.

Besides the genotype, *D. jordani* Richardson, the genus *Diplophryxus* is now known from three species, two new forms being described in the present paper. Though there are some remarkable points of difference in which the three species differ from one another, all of them conform, in most of the important characters, to the generic definition, as given in 1923. The condition of the thoracic legs in the female is somewhat different in the three species. In *Diplophryxus jordani* all seven legs are present on the non-deformed side of the body, though all, except the first, are small and feeble ; on the deformed side only the first leg is developed. In *Diplophryxus kempi*, sp. nov. the reduction has gone considerably further ; there is one leg, as usual, on the deformed side of the body, while on the other only two (or three) legs are present. In *Diplophryxus richardsoni*, sp. nov., on the other hand, the reduction is much less than in the type-species ; all seven legs are present on the shorter side of the body, while even on the other side three or four legs are developed.

The abdominal appendages, which present the most characteristic feature of the genus, also show some modification in the three species. The typical condition, as seen in the genotype, appears to be that there are two biramous pleopods on each side of the first four abdominal somites, so that each somite has four pleopods of two rami each. The pleopods on each side of the abdomen are arranged in two series, one on the margin of the pleon more or less on the dorsal surface, and the second in a more ventral position and partly covered over by the swollen incubatory pouch. Each pleopod—at least of those of the dorsal series—arises as a uniramous structure and is divided into the usual two rami at some distance from the abdomen. In *D. richardsoni* the condition is similar, though the stalk-like basal portion of the dorsal pleopods is considerably reduced, and is flattened like the rami themselves. The pleopods of the ventral series are also reduced and their

exact arrangement is not clearly seen in the single specimen that I have examined. In *D. kempi* the two pleopods of one side have probably united into one, and there is, for all practical purposes, a single quadriramous pleopod, with all the rami appearing to arise from more or less the same point.

In the arrangement of the oostegites also there is some difference between the three species. In this respect *D. jordani* and *D. kempi* resemble one another, but the third species, *D. richardsoni*, differs from these in so far as the oostegites of the non-deformed side of the body are still further reduced.

The genus *Diplophryxus* was so far known from a single species, *D. jordani* Richardson, a parasite of *Leander serrifer* Stimpson (family Palaemonidae), from Japan and the Mergui Archipelago. This species has now been met with considerably further west, in the Gulf of Manaar, living on a different species of *Leander*. The other two species were collected in the Andamans and are parasites of two different families of the Caridea, *D. richardsoni* of the Crangonid shrimp *Pontophilus*, while *D. kempi* lives on the genus *Gnathophyllum* of the family Gnathophyllidae.

The three species of *Diplophryxus* may be distinguished from one another with the help of the following key :—

I. Pleopoda of each side arranged in a dorsal and a ventral series, those of the dorsal series with a uniramous basal peduncle ; all seven legs present on non-deformed side of body.	
A. Only first leg present on deformed side of body ; ventral pleopods well developed ; basal peduncle of dorsal pleopods prominent	*D. jordani* Richardson.
B. Three or four legs present on deformed side of body ; ventral pleopods poorly developed ; basal peduncle short and flattened	*D. richardsoni*, sp. nov.
II. Pleopoda of each side arising together so that each pleopod provided with four rami ; only two or three legs present on non-deformed side of body	*D. kempi*, sp. nov.

Diplophryxus jordani Richardson.

(Plate IV, fig. 1.)

1923. *Diplophryxus jordani*, Chopra, *loc. cit.*, pp. 443, 444.

A single ovigerous female specimen, unaccompanied by its male, is in the collection, having been collected by Dr. Kemp in the Gulf of Manaar. It is considerably larger in size than the one examined in 1923, its greatest length and breadth being 7 mm. and a little less than 5 mm. respectively. The remarkable colour pattern of the species referred to by Miss Richardson[1], and described by me, is clearly brought out in the present example also, and is illustrated in the accompanying figure (Plate IV, fig. 1).

The present specimen agrees in almost all points with the original description of the species, as also with the specimen previously examined by me. Besides other characters, the large biramous and long-stalked

[1] Richardson, *Proc. U. S. Nat. Mus.*, XXVII, p. 51 (1904).

pleopods—two pairs on each somite, or two biramous pleopods on each side of the somite—are a very characteristic feature of this species, and these are very well seen in the present example. The pleopods are arranged in two more or less definite series. On each side of the somite there is a large, biramous, long-stalked pleopod, which can be clearly seen from the dorsal surface, and another similar pleopod is attached in a more ventral position and is visible only from the ventral side of the body. Both the pleopods are more or less subequal in size, and the rami of the two pleopods of one side are also subequal. The pleopods of the shorter side of the body are considerably smaller than those on the other, but even on this side the two pleopods are of about the same size. The stalk-like portions of the ventral pleopods have not been seen. There is, however, one rather important point in which the Gulf of Manaar specimen differs from those previously described. The terminal abdominal segment of the female has so far been described as small and posteriorly rounded. In the present example it is quite large, being considerably larger than any other abdominal segment, and is somewhat pointed posteriorly. The accompanying illustration brings this out clearly.

D. jordani has so far been recorded from Misaki in Japan and Una Island in the Mergui Archipelago ; the present record of the species from the Gulf of Manaar extends its range westwards very considerably. Further, the species was so far known to live on *Leander serrifer* Stimpson (*Palaemon serrifer* of Miss Rathbun and some other American carcinologists) ; the present specimen is a parasite of *L. tenuicornis* (Say), a species that does not appear to be very closely related to the previously known host. *L. tenuicornis*, it will be noticed, harbours another parasite also, *Hemiarthrus nigrocinctus* Chopra, which is even generically different from *D. jordani*.

C 1404/1 Kilakarai, Gulf of Manaar. S. W. Kemp, Feb., 1913. 1 ♀ on *Leander tenuicornis* (Say).

Diplophryxus richardsoni, sp. nov.

(Plate IV, figs. 2, 3.)

Of the two *adult females* that I have examined the larger one is 2 mm. long and a little less than 1·5 mm. broad, while the other is 1·6 and 1·0 mm. in its greatest length and breadth respectively. The body is asymmetrical in outline, one side being considerably more swollen and longer than the other ; the asymmetry, however, is much less marked than in *D. jordani* Richardson, the only other species of the genus that was so far known. Even the two present specimens differ from one another in this respect, the larger one being markedly more asymmetrical than the other. The animal is whitish in colour and has no characteristic colour-pattern.

The head, as is usual in the genus, is deeply sunk in the thorax and is partly surrounded, on the posterior and lateral borders, by the first thoracic somite. It is more or less rounded in outline and is somewhat longer than broad. The anterior margin is practically straight, while the posterior is regularly and deeply rounded. A pair of very minute eye-spots appears to be present close behind the anterior margin.

The first thoracic somite, as has already been mentioned, encircles the head on the sides and posteriorly. The segmentation of the thorax can only be made out with a considerable amount of difficulty, the lines of demarcation between the various somites being very faint and indistinct. The first five somites are closely crowded together behind the head and are short in length ; the last two are long, but even in this case the lines of demarcation have not been clearly made out. There are some rather prominent ridges on the thorax and these obscure the true segmentation very considerably.

The abdomen is broader than long, and the segments of which it is composed are considerably fused on the dorsal surface. The lines of demarcation between the various somites are very indistinct and only some of them can be traced. The abdomen appears to be formed of five somites only, the last of which is a small conically tapering process projecting beyond the penultimate somite.

The head, on the ventral surface, is completely covered over by the swollen incubatory pouch, and nothing has been made out of its structure or that of the mouth parts. The incubatory cavity not only covers the ventral side of the thorax and head completely, but projects along the sides also and can thus be partly seen from the dorsal surface of the animal. The disposition and the arrangement of the oostegites cannot be clearly made out, but most of the incubatory pouch seems to be formed of the first oostegite of the longer side of the body. On the shorter side a number of reduced oostegites can be seen by the side of the swollen pouch, especially in the larger of the two specimens. All the seven legs are present on the shorter side of the body, and some of those belonging to the anterior somites are closely crowded together. On account of the first thoracic segment encircling the head, the leg of this segment, on the shorter side of the body, lies near the anterior margin of the head. On the longer side of the body the exact number of legs has not been made out, but there are certainly more than one. In the larger specimen there are two legs placed on the anterior margin of the body by the side of the head, another near the posterior extremity of the incubatory pouch, while a fourth seems to be placed about half way along its length. In the type-specimen the leg near the posterior extremity of the incubatory pouch has not been seen, but it is possible that it has dropped off owing to an accidental injury. The legs are normal in size and have the usual structure.

The first four abdominal somites have two pairs of pleopods on each somite, a pair, or two biramous pleopods, on each side of the segment. As in *Diplophryxus jordani* the pleopods are arranged in two series, one placed in a more or less dorsal position and visible from above, and the other on the ventral side of the abdomen. Of the dorsal series each pleopod arises as a uniramous, stalk-like structure and divides into two rami after running for a little distance from the abdomen. The basal uniramous portion is also flattened out, and, except in the first pleopod, the two rami are more or less subequal in size. The pleopoda of the shorter deformed side of the body are somewhat larger than those on the other. In the ventral series the pleopods are greatly reduced, and the rami of each appear as small leaf-like structures, more or less pointed

at the tip. The stalk-like origin of the pleopods cannot be clearly seen. The rami of the last pair of the ventral pleopods can be seen from the dorsal surface of the animal and superficially appear like uropods sticking out from behind. The last segment does not appear to carry any appendages.

The male is not known.

Locality.—The two specimens that I have examined are parasites of *Pontophilus lowisi* Kemp (family Crangonidae) and were collected by Dr. Kemp in the Andamans. Both are ovigerous females, large masses of eggs being seen in the closed incubatory cavity, and are without their males. They are attached to the abdomens of their hosts lying between the anterior four pairs of pleopods, having, as is usual, their heads pointing towards the posterior extremity of the host.

C 1455/1	Ross Channel, Port Blair, Andamans.	S. W. Kemp, Feb., 1921.	1 ♀ on *Pontophilus lowisi* Kemp. TYPE.
C 1456/1	„	„	1 ♀ on *Pontophilus lowisi* Kemp.

The present species differs in some respects from *D. jordani*, the type-species of the genus. The more important points of difference are as follows :—

1. There are at least three or four legs on the longer side of the body.
2. All the legs are normally developed.
3. The incubatory lamellae of the shorter side of the body do not appear to be crowded together at the anterior end of the body.
4. The pleopods of the ventral series are reduced.

In most other characters, however, the present species shows such an unmistakable resemblance to *D. jordani*, that there can hardly be any doubt of its generic identity. The arrangement of the head and the thoracic somites is clearly like that of a typical *Diplophryxus*, while the form and the disposition of the pleopods leave no doubt about the inclusion of this species in Miss Richardson's genus. The incubatory cavity also, as is usual in this genus, is formed mostly by the oostegites of the swollen side of the body.

Diplophryxus kempi, sp. nov.

(Plate IV, figs. 4-8.)

The greatest length of the body in the single adult *female* that I have examined is 2·8 mm., while the greatest breadth at about the level of the third thoracic somite is a little over 3 mm. Owing to the presence of the greatly swollen incubatory pouch, which extends considerably beyond the posterior extremity of the body, the greatest length of the animal, however, is very nearly 4 mm. The body is highly asymmetrical, and one side of it is very much more swollen and longer than the other. The segmentation is also greatly affected by this asymmetry, but is for the most part distinct, especially on the thoracic region. The colour of the animal is uniformly pale yellowish, except for a large patch of a warmer tint on the dorsal surface of the swollen incubatory cavity

adjoining the body proper. There are no characteristic colour spots on the body either on the dorsal or the ventral surface.

The head is distinct from the thorax, the line of demarcation between it and the thorax being clearly distinguishable. It is deeply sunk in the thorax, and is completely enclosed laterally by some of the anterior thoracic somites. It is a little broader than long, and has its posterior margin broadly rounded. The anterior lamina is totally wanting, and the anterior border, owing to the presence of the encircling anterior thoracic somites, which extend somewhat along the anterior margin also, is more or less irregular in outline. In the anterior portion of the head there is a small heart-shaped area formed by shallow grooves. Eyes seem to be totally absent.

The thoracic segments are quite distinct on the shorter side of the body, while on the other side the lines of demarcation vanish on the dorsal surface of the large incubatory pouch. They are, however, quite distinct throughout their length on the surface of the thorax itself. As already mentioned some of the anterior thoracic somites extend on the sides of the head and more or less enclose it. The first somite is very narrow, but its lines of demarcation are distinct throughout. It encloses the head completely on the sides and also to a considerable extent anteriorly. A pair of legs are placed at the anterior ends of this somite ; these, as seen in the accompanying illustrations (Pl. IV, figs. 4, 5) appear to arise from the middle of the anterior margin of the head, and are placed close to one another. In the illustration the left leg (on the left side of the figure) is clearly seen, while the other one is bent under the head and only its base is visible. The second thoracic somite is somewhat longer than the first, and like the latter encloses the head completely on the sides. The leg at the end of this segment on the left side of the body is partly concealed by the oostegite, but its outline can be made out ; on the other side the leg is not visible. The third somite is still longer than the second, and near the margins runs anteriorly like the two segments preceding it. On the shorter side of the body it does not seem to have any leg at its extremity, while on the other side its outline is not clearly visible beyond the limits of the thorax proper. The second and third somites (and to some extent the fourth also) form a sharp angle at the margin of the thorax on the deformed side of the body, before running in an anterior direction. This is clearly brought out in the enlarged drawing of the anterior end of the animal. The next three somites, 4th—6th, are somewhat longer than the third and are, more or less, subequal. These somites extend straight from margin to margin, except for the fourth, which on the deformed side of the body helps to form the sharp angle described above. The last thoracic somite is mostly covered over by the abdomen and its dorsally bent appendages, but a trace of it can be faintly made out near the margin on the longer side of the body.

The abdomen is rather short and in the single specimen that I have examined is somewhat bent over on the dorsal side. The abdominal appendages are greatly spread out and cover almost entirely the dorsal surface of the abdomen. For these reasons the segmentation of the abdomen has not been made out, nor its exact dimensions determined.

The head appendages and the mouth parts have not been seen.

The incubatory cavity is very much swollen, and forms not only the ventral surface of the animal, but extends on the sides and forms a considerable part of the dorsal surface also. It exclusively forms the larger side of the body, and a great deal of it can be seen from the dorsal surface of the animal. In the present condition of the specimen it has a wide opening in about its middle, but judging from the broken oostegites it seems likely that the cavity, if open at all, had originally a very small aperture. The incubatory pouch seems to be formed for the most part by the greatly enlarged first oostegite of the longer side of the body ; the remaining oostegites of this side are probably very greatly reduced and cannot be seen in the specimen. On the shorter side four or five oostegites are present ; the first, as seen in figure 5 on plate IV, projects anteriorly beyond the head and is partly turned over it dorsally, the remaining oostegites are applied as small thin plates, partly overlapping one another, on the side of the incubatory pouch, near its anterior end. The last of these is considerably larger than those preceding it. Owing to the extreme asymmetry of the body, and the consequent displacement of most of the body parts I have not been able to make out the exact number and the disposition of the thoracic legs. As described above the first leg is present on both sides of the body ; on the shorter side it is clearly visible, while on the other it is partly concealed by the head and the first oostegite. On the shorter side the leg of the second somite is also partly visible, being somewhat covered over by the oostegite ; the corresponding leg on the other side of the body does not appear to be present. I have also been able to make out faint traces of the third leg on the short side of the body. Beyond this no legs seem to be present. It thus appears that on the deformed side of the body only the first leg is present, while on the other the first two, or perhaps three, have been made out. The first leg has the usual structure and is provided with a strong claw.

The abdomen, as already mentioned, is very much turned over on the dorsal side of the body, with the result that it partly covers the posterior portion of the thorax, and its own segmentation is also entirely concealed. The leaf-like pleopods are spread out on all sides, and are very prominent, when the animal is seen from the dorsal surface. A large number of these foliaceous structures can be seen from the dorsal surface alone, and there are several that are entirely ventral in position. When detached from the abdomen each pleopod is seen to have four rami, all arising from more or less the same point. All the rami of one pleopod are of about the same size, and each ramus is a long, narrow, leaf-like structure. The pleopoda on the longer side of the body are considerably larger than those on the other. There are four such pleopods on each side of the abdomen, and the uropods appear to be altogether absent.

The *male* is long and rather narrow. It is 1·25 mm. long, and at the level of the third thoracic somite is a little less than 0·3 mm. broad. It is whitish in colour, and has no characteristic markings on its surface.

The head is more or less circular in outline, and is definitely separated from the thorax, the line of demarcation between it and the first thoracic somite being quite distinct. It is rather narrow, its breadth being considerably less than that of the thorax. The anterior margin is broadly

rounded, while the posterior is more or less straight. A pair of minute black eyes is distinctly seen in the anterior half of the head, and placed behind these near the posterior margin is another pair of pigment spots, looking somewhat like the eyes. Ventrally the mouth parts are greatly reduced and their structure can hardly be made out. The antennules are very well developed, and extend considerably beyond the anterior margin ; they appear to be formed of two large segments only. The distal segment has setae at its tip, and the basal one also carries a few hairs at its antero-internal angle. The antennae are greatly reduced and can be faintly made out a little behind the antennules.

The thoracic somites are all distinctly separated from one another, and their lines of demarcation are well defined. At the margins the somites are deeply cleft, so that the animal has an appearance of being somewhat loosely articulated. Except for the first two somites, which are slightly shorter than the rest, all the thoracic segments are subequal in length. The seven pairs of thoracic legs are well developed, and have the usual structure. Each is provided with a strong claw.

The pleon is long, narrow and tapering. It is only a little less than a third of the total length of the body, and is considerably longer than broad. Even at its broadest point it is a little narrower than the thorax and it tapers posteriorly, where it is somewhat broadly rounded. All the somites of which the abdomen is formed are fused together and there appears to be no trace of segmentation either on the dorsal or ventral surface or along the margins. Pleopods or uropods are totally wanting.

Locality.—A single specimen, an ovigerous female, accompanied by its male, parasitic on *Gnathophyllum fasciolatum* Stimpson (family Gnathophyllidae) was collected by Dr. Kemp in the Andamans. The Bopyrid is an abdominal parasite of the shrimp, living between the first three legs, and the forwardly bending " tail." The male was found inside the incubatory cavity of the female, but may have possibly got there accidently.

C 1457/1	Port Blair, Andaman Islands.	S. W. Kemp	1 ♀ and ♂ on *Gnathophyllum fasciolatum*, Stimpson. TYPE.

Though conforming with the generic definition in almost all important particulars *Diplophryxus kempi* differs in a few material respects from *D. jordani*, the type-species of the genus. The most important difference lies in the shape and the arrangement of the pleopods in the two species. In *D. jordani* there are two pleopods on each side of the first four abdominal somites ; each pleopod is biramous, and the two pleopods do not arise at the same point. In *D. kempi*, though there are also four rami on each side of the somite, all the four appear to arise at the same point. Thus the pleopods in the present species have an appearance of being quadriramous instead of two biramous pleopods, as is the case in Miss Richardson's species. It can, however, be easily supposed that the condition of the pleopods in *D. kempi* has been somehow derived from that in *D. jordani ;* in both the condition is essentially similar as there are four rami on each side of the somite. Further the long stalk-shaped peduncle in the pleopod of *D. jordani* is absent in the present species.

Another point of difference between the two species is the greater reduction of the thoracic legs in the genotype. In the latter all the seven legs are present on the shorter side of the body, while only the first leg is present on the deformed side. In *D. kempi* the condition is the same so far as the deformed side of the body is concerned, but on the shorter side there are only two (or perhaps three) legs present. All the legs, except the first, are reduced in both the species.

Except for these differences there is, however, such a marked resemblance between the present species and the genotype that there can hardly be any doubt of their being congeneric. The shape of the head, encircled by some of the anterior thoracic somites, the reduced leaf-like oostegites of the shorter side of the body overlapping one another and applied to the side of the incubatory cavity near its anterior end, the reduced thoracic legs, and the double pleopods on the first four abdominal somites—to mention only a few of the more important characters—all show unmistakably a very close resemblance with Miss Richardson's *Diplophryxus jordani*. The males in the two species are also similar, the completely fused abdomen, showing no trace of segmentation and devoid of all appendages, being characteristic of both.

Genus **Palaegyge** Giard and Bonnier.

1923. *Palaegyge*, Chopra, *loc. cit.*, pp. 480-486, and 541.
1929. *Probopyrus*, Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* LXXXVII, pp. 17, 18 (*partim*).

I pointed out in 1923 that the species included in the genus *Palaegyge* resemble very closely those described under the generic name of *Probopyrus* Giard and Bonnier, and in some cases it is difficult to distinguish them from one another. In the same year Nierstrasz and Brender á Brandis[1] had already referred to this difficulty, but had come to the conclusion that the two genera could be distinguished from one another on the characters of the males. They have, however, thought it advisable now to combine the species of the two genera under the designation of *Probopyrus*, on the score that even the males cannot be separated from one another. With this view I am unable to agree, for, though the two genera are very similar and in some cases difficult to distinguish from one another, in the vast majority of cases they can be separated by a more or less definite set of characters. It is difficult to pick out one character which may always be relied on for distinguishing all the species of one genus from all the species of the other, but with the help of a number of characters taken together most of the species of the two genera can be separated off. There are some species of *Palaegyge* that are very similar to certain species of *Probopyrus*, but there are others, on the other hand, that are so different from them that including them in the same genus would be taxonomically unsound. Taking as an example the type-species of the two genera, *Probopyrus ascendens* (Semper)[2] with its rounded body in the female, with the lateral plates of

[1] Nierstrasz and Brender à Brandis, *Siboga-Exped. Rep.* XXXII b, pp. 89-91 (1923).
[2] Giard and Bonnier, *Bull. Sci. France Belgique* XIX, pp. 55-63, pls. ii, iii (1888). A good description and illustrations of this species are also given by Bonnier in *Trav. Stat. Zool. Wimereux* VIII, pp. 345, 346, pl. xxxii, figs. 7-9 (1900).

the abdominal somites and the uropoda altogether absent, with the terminal abdominal somite entire and with all the abdominal somites in the male fused with one another, and *Palaegyge borrei* Giard and Bonnier,[1] in which the form is considerably asymmetrical, the somites of the abdomen have distinct lateral plates, the uropods are present, the last abdominal somite is deeply cleft, and the abdominal somites of the male are distinct, it does not appear probable that these can be congeneric. The shape of the terminal abdominal somite of the female is, in most cases, a good character for differentiating between the species of the two genera : in *Palaegyge* the posterior margin is more or less deeply cleft, while it is entire in *Probopyrus*, only one or two American species[2] constituting an exception to this rule. The two genera may generally be distinguished from one another with the help of the following characters :—

Palaegyge.	*Probopyrus.*
Female :	*Female* :
1. Form of body generally markedly asymmetrical.	1. Form of body generally rounded.
2. Lateral plates of abdominal somites generally present.	2. Lateral plates of abdominal somites never present.
3. Last abdominal somite cleft posteriorly.	3. Last abdominal somite generally entire posteriorly.
4. Rudimentary uropods generally present.	4. Uropods never present.
Male :	*Male* :
5. Abdominal somites generally distinct.	5. All abdominal somites never distinct.

Besides the species enumerated in 1923 as belonging to the genus *Palaegyge* a few others have recently been described by Nierstrasz and Brender à Brandis either as *Palaegyge* or under the generic designation of *Probopyrus*. Of these *Palaegyge marina*,[3] *Probopyrus latilamellaris*[4] and *Probopyrus oviformis*[5] appear to be members of the genus *Palaegyge*, while *Probopyrus semperi*[6] and *Probopyrus bithynis* Richardson var. *gigas*[7] seem to be referrable to *Probopyrus*. *Probopyrus dubius*[8] does not appear to be either a *Palaegyge* or a *Probopyrus*, but in my opinion must be referred to some other genus.

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[1] Giard and Bonnier, *Bull. Sci. France Belgique*, XIX, pp. 63-70, pls. iv, v (1888).

[2] In *P. floridensis* Richardson [*Bull. U. S. Nat. Mus.* LIV, pp. 555, 556 (1905)] there is sometimes a minute depression in the middle of the posterior margin of the terminal somite and in *P. panamensis* Richardson [*Proc. U. S. Nat. Mus.* XLII, pp. 523, 524 (1912)] this goes a step further and becomes a small rounded notch in the posterior margin. Recently van Name [*Zoologica, New York*, VI, pp 481, 482 (1925)] has shown the same character in *P. bithynis* Richardson.

[3] Nierstrasz and Brender à Brandis, *Siboga-Exped. Rep.* XXXII b, p. 91, pl. vi, figs. 18*a-c* (1923).

Nierstrasz and Brender à Brandis, *ibid*, pp. 93-94, pl. vi, figs. 19*a-d* (1923).

[5] Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* LXXXVII, pp. 22-24 (1929).

[6] Nierstrasz and Brender à Brandis, *ibid*, pp. 18-20 (1929).

[7] Nierstrasz and Brender à Brandis, *ibid*, pp. 20, 21 (1929).

[8] Nierstrasz and Brender à Brandis, *ibid*, pp. 24, 25 (1929).

Palaegyge pica Chopra.

(Plate V, figs. 7-9.)

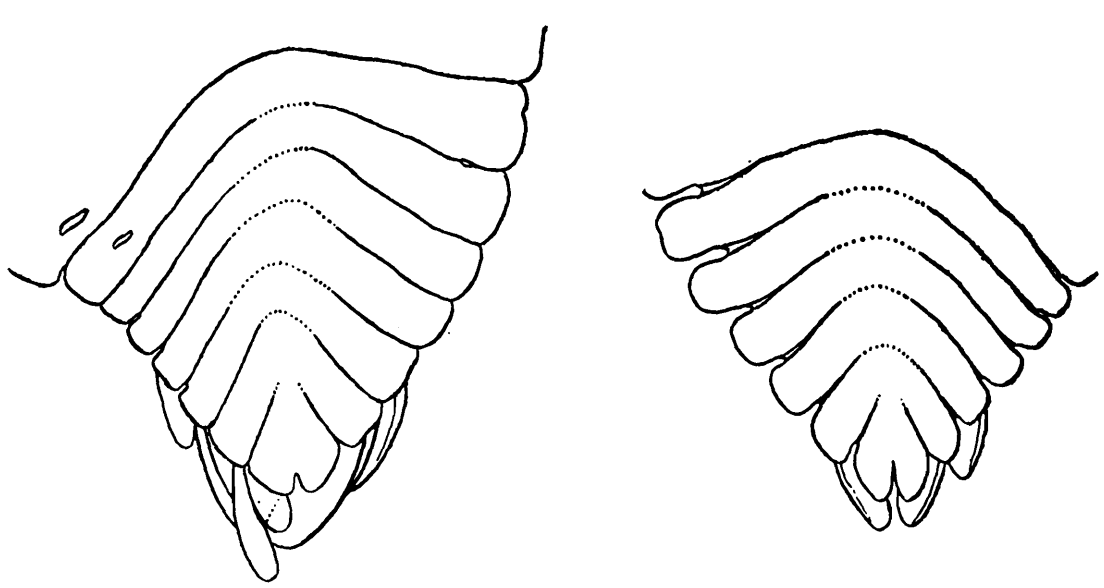
1923. *Palaegyge pica*, Chopra, *loc. cit.*, pp. 503-506, pl. xviii, figs. 5-9.

Two specimens—ovigerous females, accompanied by their males—of this interesting species have recently been added to the Museum collection. Though they agree with the type-specimens in most of the important characters, and are beyond much doubt referable to the present species, there are, however, certain characters in which they show noticeable differences from the latter.

Both the present specimens are considerably larger than those described by me in 1923. Whereas the largest specimen previously examined was 6·2 mm. long and 5·2 mm. broad, the present examples are as much as 9·0 and 8·1 mm. long and 8·2 and 6·8 mm. broad respectively. Both are markedly asymmetrical. The colour pattern, though conforming to the type, is considerably faded, especially so in the smaller of the two specimens. The body is more yellowish and the dark spots are far less conspicuous, and in the smaller specimen are in places barely visible. On the ventral surface the pigment spots are somewhat conspicuous.

The head in the larger specimen is somewhat broader than long, and in shape, etc., agrees with the published description. In the smaller specimen, however, its length almost equals the breadth and the posterior margin is less broadly rounded. Eyes are absent in both the specimens.

In the arrangement and the disposition of the thoracic somites and the various parts and appendages of these the present specimens agree with the published description of the species, except that in the smaller example the second thoracic somite is somewhat shorter in the middle line than those succeeding it.



TEXT-FIG. 1.—*Palaegyge pica* Chopra. Dorsal view of abdominal region of two female specimens showing shape of terminal somite ; drawn to same magnification: × 11.

The abdomen is as usual small, but compared with the length of the body is somewhat proportionately longer than in the previously described

specimens. It is broader than long, and in the shape and the arrangement of its somites agrees with the published account. The last somite is in the form of a long triangle, but the posterior margin is more clearly notched than in most of the previously described examples. The accompanying text-figure shows the exact shape of the posterior margin of the terminal somite. The pleopods in both the examples are much larger in size than those in the specimens examined in 1923. In the larger of the two present specimens the pleopods of the two sides meet in the middle line, or even slightly overlap one another, while in the smaller specimen the pleopods of the two sides of the anterior pairs are placed wide apart from one another, while some of the posterior ones meet those of the other side in the middle line. The endopodites are longer than the outer rami, and in both the specimens some of the posterior pleopods project considerably beyond the margins of the abdomen. Uropods similar to those already described are present in the usual position.

The *males* are whitish in colour, and the three discontinuous bands of pigment running longitudinally on the thorax, that were described in 1923, cannot be made out in the present specimens. Both the males are larger than those previously described, being 2·4 and 1·8 mm. long respectively. The larger of the two specimens agrees in all respects with the published description of the species, but the smaller one shows some important differences. It is considerably narrower than the type-specimen, its breadth at the level of the third thoracic somite being about $\frac{1}{3}$ the total length of the body, while in the type the breadth is about half of the total length. As already described the head, on the dorsal surface, is drawn out posteriorly in the first thoracic somite, but the posterior margin is rounded and not angular. The thoracic segments are more deeply cleft and are widely separated from one another. The abdomen is somewhat longer than broad, and all its somites are distinct both laterally and dorsally. All the six segments can thus be made out; the first four are large and conspicuous; the fifth is small and appears as a pair of projections, one on each side of the terminal segment, near its base; and the last segment is a finger-like projection regularly rounded posteriorly. Ventrally three (or perhaps four) pairs of pleopods appear to be present. The uropods are wanting.

Palaegyge pica was so far known to infest *Leander potamiscus* Kemp, and had been collected only in Portuguese India, in the Sanguem river at places where the water is subject to tidal influence. The two specimens now described were collected in Travancore in places where the water is either definitely brackish, or is strongly subject to the influence of the tides. The host is also different in the present case, being an undetermined species of *Palaemon*.

C 1458/1	Kurumbil Kayal, Travancore.	H. S. Rao, Jan., 1928.	1 ♀ and ♂ on *Palaemon* sp.
C 1459/1	Mundattalkari, Travancore.	H. S. Rao, Jan., 1928.	,,

Palaegyge pica was so far the only example of a member of the genus *Palaegyge* living on a host other than a *Palaemon*; now it is known to live on this genus also. The Palaemonine genera *Leander* and *Palaemon* are so very closely allied to one another that it is sometimes difficult to

distinguish one from the other, and some carcinologists have discussed the advisability of considering the former as only a subgenus of the latter.

Though the specimens described above differ in some respects—notably in the character of the male abdomen—from the type-specimens, the resemblance between the two is so great that there cannot be any serious doubt of their generic position.

Palaegyge prashadi Chopra.

1923. *Palaegyge prashadi*, Chopra, *loc. cit.*, pp. 486-489, pl. xv, figs. 6-11.

About half a dozen specimens of this common deltaic form have recently been found in the Indian Museum collection. They are parasites of the common prawn *Palaemon lamarrei* H. Milne-Edwards, and were collected in the salt-water lakes round about Calcutta. These lakes are extensive stretches of brackish water connected with the tidal flow of the Hooghly, and their water varies greatly with the season in its salinity, etc. In the months of December and January the water is ordinarily strongly saline.

I have nothing to add to the detailed description of this species that has already been published.

C 1460/1	Salt Water Lakes, near Calcutta.	? Jan., 1909.	6 specimens on *Palaemon lamarrei*.
C 1461/1	Tollyganj, near Calcutta.	B. L. Choudhary, Dec., 1910.	1 ♀ and ♂ on *P. lamarrei*.

Palaegyge abhoyai Chopra.

1923. *Palaegyge abhoyai*, Chopra, *loc. cit.*, pp. 497-499, pl. xvii, figs. 6-10.

A single specimen, an ovigerous female with its male, parasitic on the same species of undetermined *Palaemon*, as the one from which this Bopyrid was originally described, is in the collection. It was collected at Tollyganj, near Calcutta.

The specimen agrees in all respects with the types.

C 1462/1	Tollyganj, near Calcutta.	B. L. Choudhary, Dec., 1910.	1 ♀ and ♂ on *Palaemon* sp.

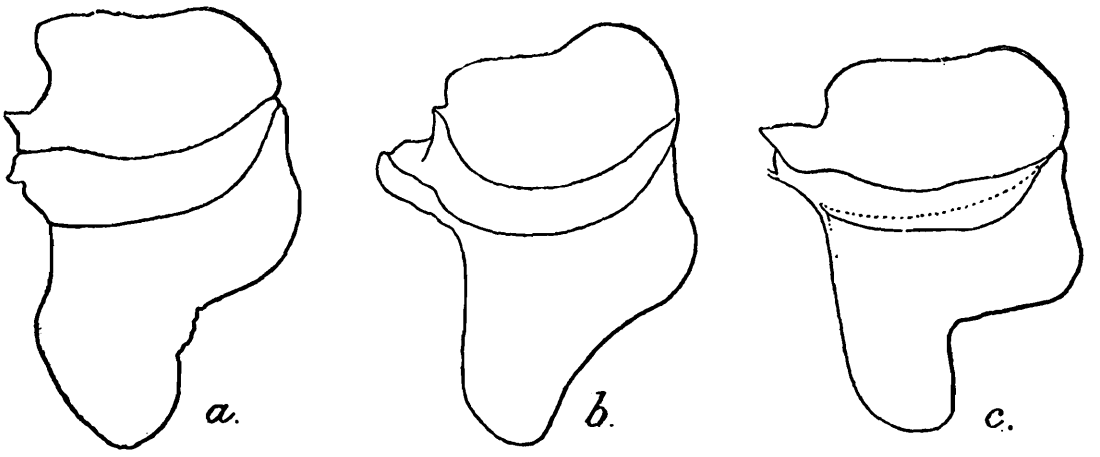
Palaegyge bengalensis Chopra.

1923. *Palaegyge bengalensis*, Chopra, *loc. cit.*, pp. 501-503, pl. xviii, figs. 1-4.
1929. *Probopyrus bengalensis*, Nierstrasz and Brender à Brandis, *loc. cit.*, pp. 21, 22.

Palaegyge bengalensis was so far known to live only in the Gangetic Delta on the common estuarine prawn *Palaemon malcolmsonii* H. Milne-Edwards ; it has now been recorded by Nierstrasz and Brender à Brandis from Bangkok as a parasite of the closely allied *P. carcinus* Fabricius. The latter species is known to be parasitized in India and Java by another species of *Palaegyge*, *P. buitendijki* Horst, which, however, seems to be nearly related to *P. bengalensis*.

The Dutch authors have pointed out some characters in which they believe their specimen differs from my account of the species published in 1923. The first oostegite was illustrated by me in fig. 3 on plate xviii, and the caudal lobe is there seen to be posteriorly rounded ; in the

Bangkok specimen it is described as narrow. For purposes of comparison I figure here the first oostegite of the three allied species *Palaegyge*



TEXT-FIG. 2.—First oostegite of *a. Palaegyge buitendijki* Horst ; *b. P. bengalensis* Chopra ; and *c. P. alcocki* Chopra, showing the shape of the posterior lobe ; all drawn to same magnification : × 6.

alcocki Chopra, *P. buitendijki* Horst and *P. bengalensis* Chopra. It will be seen that the caudal lobe is posteriorly rounded in all the three species, but it is much broader in Horst's species than in the other two, and that it is the narrowest in *P. bengalensis*. It is quite usual to find this lobe folded and the exact shape can only be seen after strightening out the fold completely.

In *P. bengalensis* the uropods are placed considerably in advance of the posterior extremity of the pleotelson, near the line of demarcation between it and the fifth somite, almost exactly in the situation mentioned by Nierstrasz and Brender à Brandis. On re-examining some of my specimens I find that in structure also these appendages agree more or less closely with the description given by the Dutch authors. In the type-specimen the trilobed structure is not clearly seen, but in some of the other examples the median lobe is quite distinct, and in one is considerably larger than the lateral lobes. Though I have no doubt that these structures represent the true uropods of the other species, I am unable to homologise their structure with similar appendages in other Bopyrids. In several species the uropods are placed well in advance of the posterior margin of the pleotelson, in a position similar to that figured by Nierstrasz and Brender à Brandis for *Palaegyge latilamellaris*.[1] In the genotype, *Palaegyge borrei* Giard and Bonnier, even the uropods, as seen from the figures[2] of this species, appear to be placed near the line of demarcation between the fifth abdominal somite and the pleotelson.

Genus **Bopyrella** Bonnier.

1923. *Bopyrella*, Chopra, *loc. cit.*, pp. 467-469, and 540, 541.
1927. *Bopyrella*, Chopra, *Bull. Madras Govt. Mus.* (n.s.) I, pp. 1-4.
1929. *Bopyrella*, Nierstrasz and Brender à Brandis, *loc. cit.*, pp. 29-36.

In 1923 I discussed at length the view that Hay's *Synsynella* cannot be maintained as a distinct genus, for it shares with *Bopyrella* almost

[1] Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* LXXXVII, p. 21, fig. 23 (1929).

[2] Giard and Bonnier, *Bull. Sci. France Belgique* XIX, pl. v, fig. 7 (1888) ; also Bonnier, *Trav. Stat. Zool. Wimereux* VIII, pl. xxx, fig. 10 (1900).

all the characters on which it was erected. The principal character, according to Hay, which separates *Synsynella* from all the other genera of Bopyridae, is the fusion of the head with the thorax in both the sexes; this character is, however, present in Bonnier's genus also. Nierstrasz and Brender à Brandis have now tried to show that the two genera can be distinguished from one another by an altogether different character, namely, the fusion in the female of *Synsynella* of all the thoracic somites with one another on the middle of the body. In the genotype *Synsynella deformans*, Hay described all the thoracic somites, except the first and the second, as distinct, and I found a similar condition in my specimens which appeared to be only a subspecies of Hay's form. The Dutch authors, however, believe that what Hay and I considered as the lines of demarcation between the various somites are merely folds of the chitinous skin, and that the thoracic somites are really fused in the mid-dorsal region in our specimens. With this I am unable to agree. Hay has described the thoracic segments, except the first and the second, as distinct and his photographs also bring out this point more or less clearly, and unless a re-examination of his specimens for this character shows a different condition there appears to me to be no justification for believing that his *Synsynella* is characterized by a fusion, on the dorsal surface, of all the thoracic somites.

I have also carefully re-examined the type-specimens of my *Bopyrella deformans* subspecies *indica* for this character. One of the two type-specimens is unfortunately in a damaged condition now, but the posterior region of the thorax is intact, and on this the last lines of demarcation can be traced more or less clearly throughout the dorsal surface. The anterior part is damaged but even on this, parts of some of the lines can be seen. In the other type-specimen all the thoracic lines, except the first, can be distinctly made out. The second line, as is to be expected, is obliterated about the middle of the body, but all the others are clear throughout the dorsal surface. The lines of demarcation are quite distinct from lines of the chitinous covering, which are more superficial and can generally be recognized without much difficulty.

It will thus be seen that the only character on which Nierstrasz and Brender à Brandis have separated *Synsynella* from *Bopyrella*, viz., the fusion on the dorsal surface of all the thoracic somites in the female, does not seem to hold good in the case of the type-species of Hay's genus, nor is it applicable to its Indian variety as described by me. Until this question of fusion of the thoracic somites in Hay's type-specimens is definitely settled, I believe it is best to consider his *Synsynella* as a synonym of Bonnier's *Bopyrella*. It is possible that what the Dutch authors have described as *Synsynella* is quite distinct from *Bopyrella*, but Hay's *Synsynella* (unless a re-examination of his material shows to the contrary) is characterized by distinct thoracic somites in the female.

Nierstrasz and Brender à Brandis have described, in the paper cited above, a new genus, under the name of *Prosynsynella*, which is very closely allied to *Bopyrella* (and *Synsynella*). The principal character, which separates this genus from the allied genera, is that in the male the head

is not fused with the thorax, the line of demarcation between it and the first thoracic somite being quite distinct. All the thoracic somites in the female are also fused medially.

A number of new species have recently been described by Nierstrasz and Brender à Brandis under *Bopyrella*. Most of these species are from the West Indies, but two have been recorded from eastern waters : *Bopyrella choprae*[1] from the Bay of Bengal and the Strait of Formosa, and *Bopyrella megatelson*[2] from the Gulf of Siam. The genus has thus a very wide range of distribution, being met with in several places in all the three great oceans. In the Pacific it has been recorded from the Strait of Formosa ; in the Indo-Pacific region and the Indian Ocean it is known from several places from the Friendly Islands, Oceania, in the south-east to as far as Karachi in the Arabian Sea on the west side ; in the Atlantic it has been recorded along the coast of North America and in the West Indies.

The host distribution of the genus has now also been extended. It was previously known to infest the Alpheid genera *Alpheus* and *Synalpheus* only. Nierstrasz and Brender à Brandis have now recorded it from a number of genera of the family Hippolytidae also, *viz.*, *Hippolysmata* Stimpson, *Tozeuma* Stimpson and *Latreutes* Stimpson.

To this genus I have assigned with some doubt another species, *Bopyrella nierstraszi*, described as new in this paper. The female in this species agrees in all material respects with a typical *Bopyrella*, except for the fact that the abdominal somites are perhaps a little more distinct than is usually the case in the genus. The male, however, differs in one very important respect, namely, that the head is quite distinct from the thorax. In this respect the species resembles *Prosynsynella* Nierstrasz and Brender à Brandis, but differs from it in that all the thoracic somites, except the first, are quite distinct in the female.

Bopyrella nierstraszi, sp. nov.

(Plate V, figs. 1-6.)

The single *adult female* that I have examined is 5·3 mm. long from the middle of the anterior border of the head to the posterior extremity, and is about 4 mm. broad at the level of the third thoracic somite. As is usual in the genus, the body is slightly asymmetrical, the left side being shorter than the right. The body has no characteristic pigmentation on the dorsal or the ventral surface. It is pale yellowish in colour, but there is a brownish area running all round the thorax a little inside the margins. The head and the abdomen are not coloured. Ventrally parts of some of the oostegites are pigmented in a dark brownish shade, while the rest of the surface is pale yellowish. The head as seen on the dorsal surface is partly fused with the thorax, the line of demarcation between it and the first thoracic somite being altogether absent. The line between the first and the second somite is also somewhat indistinct on the middle of the body. The head appears to be somewhat raised

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[1] Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* LXXXVII, pp. 29, 30 (1929).

[2] Nierstrasz and Brender à Brandis, *ibid*, pp. 31, 32 (1929).

above the general surface of the body and is more or less rounded in shape. The anterior margin is prolonged into a very narrow frontal lamina, which is straight in outline. The posterior portion of the head is broadly rounded. A pair of small indistinct eyes in the form of a number of minute dark spots aggregated together are present, one at each antero-lateral corner of the head.

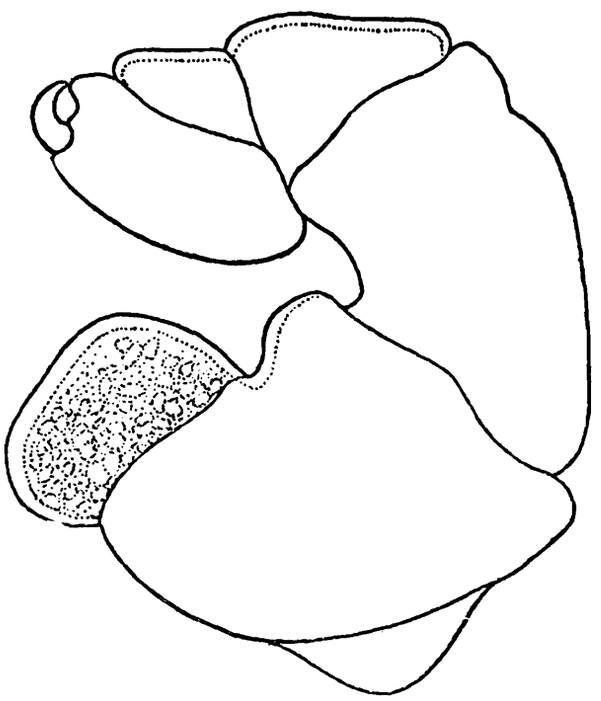
All the thoracic somites are very clearly defined on the dorsal surface. The first appears to be very short ; the second is also somewhat shorter than the third. The remaining somites are subequal in length. The ovarian bosses are very clearly seen on the first four somites, and are, as usual, separated from the " anterior lateral plates " by distinct sutures. These plates are rather narrow on the first four somites, while on the last three, especially on the longer side of the body, they are fairy broad. The posterior lateral plates on the first four somites are quite prominent.

The abdomen is slightly longer than a third of the total length of the body, and is almost as broad as long. The somites of which it is formed are very clearly demarcated along the sides by deep clefts. On the dorsal surface also the first four somites are more or less clearly separated from one another and their lines of demarcation, except on the mid-dorsal region, are quite distinct ; the fifth and the sixth, though distinct along the margins, appear to be fused together dorsally, and the line between them cannot be made out. The last somite appears to be quite large, and its posterior margin is more or less straight and entire.

The head, seen from the ventral surface, after removing the maxillipeds and the first oostegites, is considerably broader than long. The mouth parts and the head appendages are greatly reduced. The antennules and the antennae are placed just behind the anterior margin, and are minute, insignificant structures ; the former appear to be three-segmented, the terminal segment being the smallest. The antennae are formed of two segments only, the basal is large and massive, while the terminal is somewhat rounded. The maxillae have not been clearly seen, while the mandibles have the usual stout and curved appearance. The posterior lamina of the head is broadly rounded in the middle, and of the two lateral lobes the outer, as usual, is larger than the inner. Both are pointed at the tip and have their margins entire. The maxilliped is about one and a half times as long as broad, and has the usual shape. The palp is somewhat deeply set in the anterior side near its internal angle, and is crowned with a number of long hairs. The hairs are longer than usual, and some of them are as long as the palp itself. They bear small secondary hairs. There appear to be 7 or 8 long hairs on the palp, 4 or 5 on the dome-shaped apex, and the rest on the sides. There are also three long hairs on the anterior margin of the maxilliped external to the palp and another three or four on its inner side.

The incubatory cavity is widely open, and the ventral surface of the thorax is seen to be raised in large fleshy ridges. The first oostegite has the usual shape ; the anterior margin is more or less straight and has only a slight depression about the middle. The posterior portion is large and is drawn out at its postero-external angle into a rather small

lobe, rounded at its extremity, and fringed with hairs along its inner margin. The internal crest is fairly well developed, and has four or five prominent lobes near its proximal end. The remaining oostegites have the usual shape, and those of the last pair carry fairly long hairs



TEXT-FIG. 3.—*Bopyrella nierstraszi*, sp. nov. Thoracic leg of female: × 135.

along the posterior margins. The legs have the usual structure, and the basal segment is provided with a large scaly boss. The claw is fairly well develpoed.

The abdominal structures are somewhat reduced, and the exposed surface of the abdomen is raised in transverse fleshy ridges. The pleopods, on account of their poor development, do not cover the entire surface of the abdomen but leave a considerable part of it exposed in the median region. The pleopods of the first pair approach one another in the middle line, but the posterior ones recede from one another more and more, till those of the last pair are placed quite near the margins of their respective sides of the body, and almost the entire breadth of the abdomen separates one from the other. All the pleopods are biramous and their rami subequal. The uropods seem to be totally absent.

The *male* is short and stumpy, being slightly less than twice as long as broad. It is 1·3 mm. long from its anterior end to the posterior margin of the last abdominal somite, and is about 0·7 mm. broad at the level of the third thoracic somite. There are no characteristic colour markings on any part of the body. The sides of the thorax are very faintly rugose.

The head is distinct from the thorax and is more or less semi-circular in shape. The anterio margin is regularly rounded, while the posterior is prominently drawn backwards, about its middle, in the anterior margin of the first thoracic somite. Eyes are present near the antero-external angles in the orm of a number of small pigment spots. Ventrally the head appendages and the mouth parts are very much reduced, and except for the two pairs of antennae the other structures can hardly

be made out. The antennules and the antennae appear to be formed of three segments each, but in the case of the latter it is difficult to make out the segments clearly.

The thoracic somites are all distinct and clearly demarcated. The legs are well formed, each having a large propodus and a strong claw.

The abdomen is considerably broader than long, and the somites of which it is formed are clearly demarcated along the sides. On the dorsal surface, however, the lines of demarcation between the somites are totally obliterated. All the six somites are clearly seen along the margins, and the last somite does not reach as far behind as the posterior end of the fifth. The posterior margin of the last somite is entire and somewhat rounded. On the ventral surface the first five somites have thin plate-like structures diminishing in size progressively in an antero-posterior direction. They are more or less oval in shape, and are arranged in parallel rows one behind the other, one plate on each side of the somite. On account of their position these structures appear to be comparable with the pleopods of other Bopyrids. The last somite seems to carry no appendages.

Locality.—The single specimen, a male and a female, that I have seen was collected by Mr. R. P. Mullen at Port Blair in the Andaman Islands. The parasite was found living in the right branchial chamber of *Hippolysmata vittata* Stimpson, a Caridean shrimp of the family Hippolytidae. The incubatory cavity had only a few embryos in it.

C 1464/1 Port Blair, Andaman Islands. R. P. Mullen. 1 ♀ and ♂ on *Hippolysmata vittata* Stimpson. TYPE.

As will be seen from the description given above, the female in the new species agrees in almost all material respects with the generic definition of *Bopyrella*, the only noteworthy difference being that the abdominal somites are a little more distinct from one another than is usually the case. In this respect *B. lata*, recently described by Nierstrasz and Brender à Brandis[1] from the West Indies, shows a similar condition : the abdominal somites in this species are marked off from one another perhaps a little more distinctly than even in the Indian form. It is in the character of the male, however, that *B. nierstraszi* differs from all the other species of *Bopyrella*. The head is quite distinct from the thorax, there being a definite line of demarcation between it and the first thoracic somite. The abdomen is also provided with a number of thin plate-like structures that appear to be comparable with pleopods. In the latter character, however, *B. nierstraszi* resembles *B. mortenseni* Nierstrasz and Brender à Brandis from the West Indies, in which the male has similar structures on the abdomen.

Nierstrasz and Brender à Brandis have recently[2] set up a new genus under the name of *Prosynsynella*, which though very closely resembling *Bopyrella* and *Synsynella* Hay (which I consider only a synonym of the former), differs from these in having the head in the male distinct from the thorax. In this character *B. nierstraszi* resembles very closely

[1] Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* LXXXVII. pp. 34, 35 (1929).

[2] Nierstrasz and Brender à Brandis, *ibid*, pp. 36, 37 (1929).

Prosynsynella hayi, the type-species of the Dutch authors' genus. The females in the two are, however, quite different and the male in *P. hayi* also has no appendages.

In the possession of pleopod-like appendages, and in some other characters also, the present species seems to come very close to *B. mortenseni* Nierstrasz and Brender à Brandis.[1] The general outline of the female in the two is more or less similar, the posterior lobe of the first oostegite has a similar shape in both and the males have similar appendages on the abdomen. Both are parasites of the Hippolytid genus *Hippolysmata*, the West Indies species of *H. wurdemanni* (Gibbes) and *B. nierstraszi* of *H. vittata* Stimpson. The differences between the two, however, are equally noteworthy. The head in the female of the Indian species, though fused with the thorax, is more or less marked off from the rest of the body ; the abdominal somites are more distinct and the pleotelson is not rounded posteriorly. In the male of *B. nierstraszi* the shape of the body is altogether different, being broadest in the middle and tapering slightly both anteriorly and posteriorly ; the head is quite distinct from the thorax and the abdomen is much broader than in the allied species.

Bopyrella choprae,[2] another species described by Nierstrasz and Brender à Brandis, as a parasite of *Hippolysmata vittata*, the same host on which *B. nierstraszi* is known to live, is also from the Indo-Pacific region, having been obtained from the Nicobar Islands in the Bay of Bengal and the Strait of Formosa in the China Sea. Its male is unknown. It differs from the present species in having a much broader body, a broader abdomen, the somites of which show greater fusion, and in the posterior lobe of the first oostegite having a different shape.

Genus **Pseudione** Kossmann.

1881. *Pseudione*,[3] Kossmann, *Zeitschr. Wiss. Zool.* XXXV, p. 663, pl. xxxiii, fig. 17.
1899. *Pseudione*, Sars, *Crust. Norway* II, pp. 200, 201.
1900. *Pseudione*, Bonnier, *Trav. Stat. Zool. Wimereux* VIII, p. 292.
1905. *Pseudione*, Richardson, *Bull. U. S. Nat. Mus.* LIV, pp. 522, 523.
1929. *Pseudione*, Nierstrasz and Brender à Brandis,[4] *Siboga-Exped. Rep.* XXXIIb, pp. 70-72.

Though several authors have tried to give a satisfactory diagnosis for the hetrogeneous assemblage of species grouped under the generic designation of *Pseudione*, the definition proposed by Sars is the only one that is applicable to most of the species. Nierstrasz and Brender à Brandis have also adopted this definition more or less entirely and without any material emendations.

Nierstrasz and Brender à Brandis, in the paper cited above, have discussed very ably the limits of the genus *Pseudione*, and have tried to arrange the numerous species that have been placed under it in more

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[1] Nierstrasz and Brender à Brandis, *Vidensk. Medd. Dansk Naturh. Foren.* pp. 30, 31 (1929).

[2] Nierstrasz and Brender à Brandis, *ibid*, LXXXVII, pp. 29, 30 (1929).

[3] Only a few references, in which either the position of the genus has been discussed or its definition given, have been included in this synonymy.

[4] According to Nierstrasz and Brender à Brandis the genus *Cryptione* Hansen is a synonym of *Pseudione*.

or less definite and well-marked groups. On account of the material differences between the various members of the genus, and on account of the large number of species that it contains, such a grouping must involve a certain amount of overlapping, but the practical utility of this arrangement cannot be over emphasised.

I have described below a new species under the name of *Pseudione indica*. It is a parasite of a marine Cragonid and constitutes the first record of the occurrence of a member of this genus in the Bay of Bengal. According to the grouping proposed by Nierstrasz and Brender à Brandis, the species belongs to the " group *b*," which is characterised in the female by the possession of well-developed pleural plates on the abdominal somites, and the absence of separate anterior lateral plates (coxal plates) on the thorax.

The genus *Pseudione* has a very wide range of distribution, having been met with in almost all the seas of the world. In the Atlantic it is known from as far north as the coast of Norway to the Gulf of Mexico in the south ; in the Pacific it has been recorded from several places along the coast of North America, from Puget Sound to the Galapagos Islands. In the Indo-Pacific region it is met with in the Philippines to places over 12° south of the Equator on the lower side. The new Indian species is from the Andaman Islands in the Bay of Bengal.

The members of the genus *Pseudione* appear to be cosmopolitan in the choice of their hosts also, living on several families of the Anomura and the Macrura. Most of the species are parasites of the Anomura, but there are a few that are known to infect certain genera of the Caridea also. Amongst the latter may be mentioned *P. affinis* Sars,[1] and *P. hoylei* (Giard and Bonnier),[2] parasites of two species of *Pandalus* (family Pandalidae), and *P.* elongata (Hansen)[3], a parasite of *Nematocarcinus* of the family Nematocarcinidae. The new species described by me is a parasite of the Cragonid genus *Pontophilus* Leach.

Pseudione indica, sp. nov.

(Plate VI, figs. 1-5.)

The single *adult female* that I have examined is more or less regularly oval, and is only slightly asymmetrical in shape, the right side of the body being somewhat shorter than the left. It is small in size, the length of the body from the anterior margin to the posterior extremity of the abdomen, excluding the backwardly projecting appendages of the terminal somite, is 2 mm., while the breadth at the level of the third thoracic somite is about 1·2 mm. The body is whitish in colour, except for the middle of the thorax on the dorsal surface, where it is somewhat pale yellowish. There are no characteristic colour markings ; on the last two or three thoracic and the first two abdominal somites, however, there are a few dark pigment spots a little on the inside of the margin. The ventral surface is totally white.

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[1] Sars, *Crust. Norway* II, pp. 201, 202, pl. lxxxv, fig. 1 (1899).

[2] Bonnier, *Trav. Stat. Zool. Wimereux* VIII, pp. 308, 309, pl. xix (1900). Giard and Bonnier originally described this species as a *Palaegyge.*

[3] Hansen, *Bull. Mus. Comp. Zool. Harvard* XXXI, pp. 112-115, pls. iii, iv, (1897). Hansen originally described this species under his new genus *Cryptione.*

The head is quite distinct from the thorax and is considerably broader than long. The anterior margin is regularly and broadly rounded. A pair of dark conspicuous eyes is present, one on each side near the antero-lateral corners, a little behind the anterior margin.

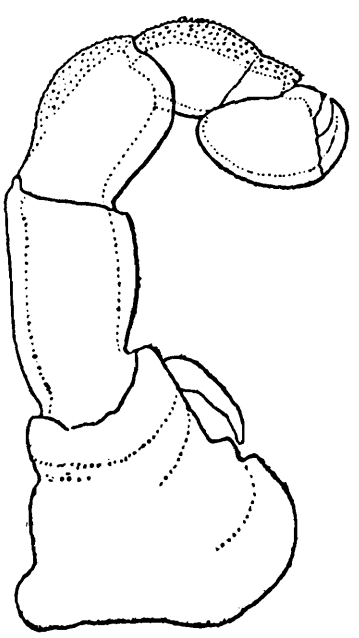
The lines of demarcation between the thoracic somites are not deeply impressed on the dorsal surface, and some of the posterior ones can hardly be made out on the middle of the body. The first somite is short in the mid-dorsal region, and the line between it and the second somite can be made out throughout its length. The second is almost twice as long as the first, and is only a little shorter than those succeeding it. The lines of demarcation between all the somites can be faintly made out under high magnification. The segmental margins are deeply cleft and all the somites can be made out clearly on the sides. Each segmental margin is cleft into two parts by a distinct notch. In the first four segments the anterior part of the margin is larger than the posterior, but in the remaining segments the two parts are subequal. This arrangement is better seen on the longer side of the body. The ovarian bosses can only be made out very indistinctly, and the lateral plates are very poorly developed. On the first four somites the latter do not appear as distinct structures, while on the last three they are better developed and appear as small plates on the sides of the segmental margins.

The abdomen is considerably broader than long, and is clearly seen to be formed of six somites, which are clearly differentiated and well separated from one another on the sides. The lines of demarcation between them are, however, for the most part very indistinct, and can be made out with some difficulty only—especially those between the first two or three somites. The first five somites have well-developed pleural plates, which are lamellar in shape, and are quite separated from one another. On the sides, especially the right side, the first three somites point outwards and somewhat forwards, while the next two are backwardly directed. The terminal somite is a small, somewhat rounded structure, and falls considerably short of the one preceding it.

On the ventral surface the two pairs of antennae and the mouth parts are very greatly reduced, and their shape and structure can hardly be made out. The two maxillipeds do not meet one another in the middle line, but leave a wide gap between them. They are somewhat broad in shape, each being only a little longer than broad. The dome-shaped palp is well developed, and is placed a little away from the antero-internal angle. It is markedly constricted near the base and carries a number of long hairs, but the exact number and disposition of these is somewhat difficult to make out clearly. Besides the smaller hairs there appear to be about eight or ten long hairs, more or less evenly distributed along the margins. There are also two or three other long hairs on the antero-internal angle, and one a little below it along the internal margin. The anterior and the external margins are hairy.

The large incubatory cavity is not completely roofed over by the five pairs of oostegites, which leave a large gap in the mid-ventral region. The ventral wall of the thorax is considerably swollen, but there does not appear to be any regular ridging. The oostegites of the first pair are small, and have the usual shape. They are longer than broad and

are formed of the usual two portions, of which the anterior one is rather small. The anterior margin is concave about the middle and the internal crest is rather poorly developed. The posterior portion is drawn out into the usual lobe, which is quite large and regularly rounded. There are no hairs on the inner margin of the posterior lobe. The remaining oostegites are more or less circular or oval in outline and, except for those of the last pair, do not approach one another in the middle line. The latter are considerably longer than broad, and that of the right side of the body overlaps its companion on the left, and covers a part of the abdomen also. The seven pairs of thoracic legs occupy the usual



TEXT-FIG. 4.—*Pseudione indica*, sp. nov. Thoracic leg of female : × 150.

position along the thoracic margins. There is no boss on the basal segment, but the outer margins of the ischium, merus and carpus are strongly scaly ; the propodus has a few short hairs at the point where it meets the dactylus and the latter is strongly developed.

The pleopods are considerably reduced, and occupy only a portion of the ventral surface of the abdomen. They are placed near the margins of the body and leave quite a large gap in the middle, where the surface of the abdomen appears to be raised in slight ridges. There are five pairs of biramous pleopods decreasing in size antero-posteriorly. The pleopods of the anterior pairs are more or less oval, plate-like structures, and in the first two the endopodite and the exopodite are subequal in size. In the remaining three pairs the exopodite becomes progressively longer and narrower, while the endopodite gets smaller and smaller, till in the pleopods of the fifth pair the former becomes a long and narrow finger-shaped appendage projecting beyond the margin of the abdomen, while the endopodite is a minute structure, squarish or rounded in outline, at the base of the outer ramus. The terminal somite carries the uniramous uropods, which are long and narrow structures like the exopodite of the last pleopods, and are sticking out at the posterior extremity of the abdomen. The pleopods and the uropods are quite smooth.

The *male* is not known.

Locality.—The single female specimen that I have seen is a parasite of the Crangonid shrimp *Pontophilus plebs* Kemp, and was collected in the Andaman Islands in the Bay of Bengal. The parasite was found in the branchial chamber of the host and had only a few eggs in its incubatory cavity.

C 1463/1	Mouth of Brigade Creek, Port Blair, Andaman Islands.	S. W. Kemp, Feb., 1921.	1 ♀ on *Pontophilus plebs* Kemp. TYPE.

Another species of *Pontophilus*, *P. lowisi* Kemp, also collected in the Andamans is infected by an altogether different Bopyrid that has been described in this paper under the name of *Diplophryxus richardsoni*, sp. nov.

Though a number of species of the genus *Pseudione* have already been described from the Indo-Pacific region, *P. indica* is the first species to be recorded from Indian waters.

Genus **Bopyrus** Latreille.

Bopyrus squillarum Latreille.

1923. *Bopyrus squillarum*, Chopra, *loc. cit.*, pp. 519, 520, and 541, 542.
1929. *Bopyrus squillarum*, Nierstrasz and Brender à Brandis, *loc. cit.*, pp. 26, 27.

In 1923 I expressed the opinion that, with the possible exception of *Bopyrus xiphias* Giard and Bonnier, all the species of this genus described by Giard and Bonnier were only synonyms of *B. squillarum*. *B. xiphias* was only doubtfully included in the synonymy of the latter species in so far as the abdomen of its male has a different shape and the first oostegite of the female is also somewhat different. In their report on the Siboga Expedition Epicaridea, Nierstrasz and Brender à Brandis considered most of Giard and Bonnier's species as distinct; they are now of the opinion that the views expressed by me were correct. They have also now shown that even *B. xiphias* is only a synonym of *B. squillarum*, for they have obtained a specimen of *B. squillarum* the male of which has its abdomen intermediate in form between that of *B. xiphias* and a typical *B. squillarum*. The same is the case with the first oostegite also. It is now clear, therefore, that the genus *Bopyrus* contains only two species: *B. squillarum* Latreille (with its Indian variety *bimaculatus* Chopra), a parasite of a number of species of *Leander* occurring in the Northern Atlantic, the North Sea, the English Channel, the Mediterranean Sea, the Black Sea, the Arabian Sea, the Delta of the Ganges and the Bay of Bengal, and *B. stebbingi* Nierstrasz and Brender à Brandis, a parasite of an unknown host and occurring in the eastern parts of the Indo-Pacific region.

Nierstrasz and Brender à Brandis have now rightly adopted the name of *B. squillarum* in place of Giard and Bonnier's designation of *fougerouxi*.

var. **bimaculatus** Chopra.

1923. *Bopyrus squillarum*, var. *bimaculatus*, Chopra, *loc. cit.*, pp. 520-522, pl. xix, figs. 6-11.

Two additional specimens of the Indian variety of *B. squillarum*, collected as long ago as 1911, have recently been found in the Indian

Museum collection. They are ovigerous females accompanied by their males, and agree in all important characters with the description published in 1923. Except for the fact that the two dark spots on the dorsal surface of the female abdomen, to which the specific name refers, are very faint, there is hardly any recognisable difference between the present examples and those previously described.

C 1465/1	Bandra, near Bombay.	J. W. Caunter, Feb., 1911.	2 ♀♀ and ♂♂ on *Leander* prox. *serrifer* Stimpson.

The Bopyrids were found attached to the branchial wall of the host in the usual position, with the dorsal surface apposed to the bodywall, and the anterior end pointing towards the posterior extremity of the host. The large incubatory cavity with its mass of eggs could be seen through the host's carapace, and the dark ring formed all round the marsupium by the pigment spots on the oostegites was clearly visible.

The occurrence of this Bopyrid near Bombay extends the range of the species considerably, as all the previously described examples came from the eastern part of the Indo-Pacific region. *Leander serrifer* it may, however, be noted is a common species all over the Indo-Pacific region from Hong Kong in the east to the coast of Africa in the west.

Genus **Bopyrina** Kossmann.

1923. *Bopyina*, Chopra, *loc. cit.*, pp. 522-524, and 542, 543.
1929. *Bopyrina*, Nierstrasz and Brender à Brandis, *loc. cit.*, pp. 39-42.

Nierstrasz and Brender à Brandis set up in 1925[1] a new genus under the name of *Bopyrinella*, based on a single species parasitic on *Thor floridanus* Kingsley, collected off Curaco Island in the Caribbean sea. This species of *Thor* was already known to be infested by a species of *Bopyrina*, *B. thori* Richardson, from the neighbouring coast of Florida. The new genus, as stated by the authors themselves, is very closely allied to *Bopyrina*, and except for the fact that the female is said to have an additional pleopod, the two genera are indistinguishable from one another. The fifth pleopod in *Bopyrinella* is, however, said to be greatly reduced.

The genus *Bopyrina* has a very wide range of distribution, and, besides the localities enumerated in 1923, is now known to occur also along the Pacific coast of North America (*B. striata* Nierstrasz and Brender à Brender) and further east in the Indian Ocean than it was so far known to live. The new species described in this paper is from the Nicobar Islands in the Bay of Bengal.

To the list of hosts that *Bopyrina* was hitherto known to parasitize may now be added another genus of the Pontoniinae, *viz.*, *Harpilius* Dana, the host of *B. choprae* Nierstrasz and Brender à Brandis, and the Pandalid *Chlorotocella* Balss, on which *B. sewelli*, sp. nov. is known to live. The genus is thus now known to infest members of three families, the Hippolytidae, the Palaemonidae (subfamily Pontoniinae) and the Pandalidae.

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[1]Nierstrasz and Brender à Brandis, *Bijdr. Dierkunde* XXIV, pp. 6, 7, pl. figs. 22-25 (1925).

Bopyrina sewelli, sp. nov.

(Plate VI, figs. 6-11.)

The *adult female* is highly asymmetrical, one side of the body being considerably longer and more swollen than the other. The greatest length of the body is 2·8 mm., while the breadth at the level of the third thoracic somite is 1·6 mm. On account of the marked asymmetry of form the head is very much pushed over to one side. The body is whitish in colour, and has no characteristic markings on the dorsal surface. The margin near the longer side of the body is, however, somewhat cream-coloured. The ventral surface is also white in colour, and the oostegites are without any pigment.

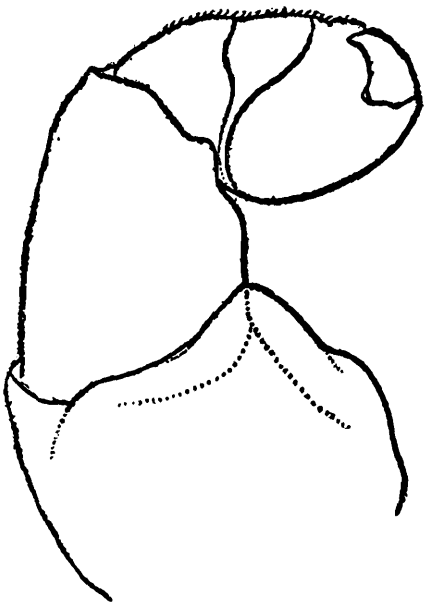
The head has a narrow anterior lamina which is slightly projecting in front of it, and is broadly rounded anteriorly. The antero-lateral angle on the longer side of the body is somewhat prominent, while that on the other side is barely discernable. A pair of very minute eye-spots is seen close behind the anterior lamina. The posterior margin of the head is more or less completely fused with the first thoracic somite and cannot be made out.

The thoracic somites are also considerably fused with one another in the mid-dorsal region of the body, but can be clearly made out along the margins, especially on the longer side of the body. As is usual, the first four segmental margins are broken up into two each by a distinct constriction, while the remaining three are entire. The lateral plates are very poorly developed, but can be faintly made out on the anterior parts of the first four somites. The ovarian bosses have not been seen. The last three somites are somewhat small.

The abdomen is quite large, and is almost as long as broad. The segments of which it is composed are considerably fused with one another on the dorsal surface, though they can be made out more or less clearly along the margins. On the shorter side of the body the marginal indentations marking off the somites are not very deeply impressed, but all the six somites can still be made out on this side. On the other side only four somites, including the large median terminal segment, can be distinguished. The last somite, which forms the posterior extremity of the body, is a comparatively large triangular structure, and has a slight notch about the middle of its posterior margin, which is otherwise regularly rounded.

The mouth parts and the head appendages are extremely reduced, and cannot be easily made out. The posterior lamina has a large median lobe, which is regularly and broadly rounded. Of the secondary lobes only one pair has been seen ; this is rather small, but has the usual shape. The maxillipeds are rather broad in shape, being only a little longer than broad. The basal triangular portion is proportionately small, and the palp at the antero-internal angle, which is such a prominent structure in other species of the genus, seems to be altogether absent. It seems to be represented by a very slight rising of the anterior margin, and carries a single short seta. There are no hairs on the rest of the anterior margin, though the internal margin is distinctly hairy. The muscles at the base of the anterior segment are very well developed.

The incubatory cavity is large, and is only very partially roofed over by the oostegites. The wall of the thorax is considerably swollen, especially on the shorter side of the body, but there are no distinct ridges. The oostegites of the first pair have the usual shape and structure. The anterior portion is much longer from side to side than in an antero-posterior direction, and has a distinct concavity along its anterior border. The internal crest is not strongly developed, and, except for a few small lobes near its proximal end, is entire. The posterior portion of the oostegite is prolonged into the usual posteriorly directed lobe, but the latter has its inner margin convex, instead of being concave as is usually the case. The outer margin is practically straight. In this respect the first oostegite of the present species resembles that of *B. giardi* Bonnier[1], or to some extent that of *B. abbreviata* Richardson.[2] The remaining oostegites are greatly reduced, and are so transparent, at least those on the swollen side of the body, that it is very difficult to make out their exact shape and disposition. The oostegites of the fifth pair do not completely enclose the incubatory cavity posteriorly. The legs are considerably reduced in size, but have the usual structure.



TEXT-FIG. 5.—*Bopyrina newelli*, sp. nov. Thoracic leg of female : × 250.

The boss on the basal segment is small, and does not bear any hair or scales. The ischium is large, the external margins of the merus and carpus are hairy, and the propodus and dactylus are well formed.

The abdomen has only four pairs of pleopods, which are uniramous in structure and are somewhat reduced in size. The pleopods decrease in size from the first to the fourth, and each has an ovalish outline. The pleopods of the two sides do not meet each other in the middle line. The last two pairs do not carry any appendages. The surface of the abdomen is raised in somewhat inconspicuous ridges, that can be seen in the middle of the abdomen between the pleopods of the two sides.

The *male* is small in size, being about 0·8 mm. long and a little over 0·2 mm. broad at the level of the third thoracic somite. The

[1] Bonnier, *Trav. Stat. Zool. Wimereux* VIII, p. 367, pl. xxxix, fig. 5 (1900).
[2] Richardson, *Bull. U. S. Nat. Mus.* LIV, p. 564, fig. 621 (1905).

body is white in colour, and has no characteristic colour-spots either on the dorsal or the ventral surface.

The head is more or less circular in outline, and is somewhat deeply sunk in the first thoracic somite. The anterior margin is straight, except for a minute depression about the middle. Posteriorly it is partly fused with the thorax, the line of demarcation between the two being more or less indistinguishable. A pair of minute eyes is placed a little behind the anterior margin. The antennules and the antennae are both well developed, and are of about the same size. Each appears to be triarticulate, and has its terminal segment fringed with setae. There is also a prominent hair on the second segment of the antennule at its anterior margin.

The abdomen is nearly one-third of the total length of the body, and is considerably longer than broad. The first three somites are distinct both dorsally and laterally; the fourth is distinct laterally, while dorsally its line of demarcation cannot be clearly made out. The fifth and the sixth somites are fused. The pleopods are absent. The terminal somite is a large posteriorly rounded structure, and carries a pair of prominent "anal spines," each bearing three hairs at its posterior tip.

Locality.—The single specimen that I have examined is a parasite of *Chlorotocella gracilis* Balss (family Pandalidae), and was collected by Lt.-Col. R. B. Seymour Sewell, then Surgeon-Naturalist on board the R. I. M. S. S. Investigator, at a depth of 13 fathoms in Octavia Bay, Nancowry Harbour, Nicobar Islands. It is a branchial parasite, having been found in the right gill-chamber of the host. The incubatory cavity of the parasite was full of a mass of eggs, which could be faintly seen through the host's carapace. This mass of eggs was not only filling the entire incubatory pouch of the Bopyrid, but was extending considerably beyond it on one side of the body, and was also covering up practically the entire surface of the abdomen.

C 1466/1	Octavia Bay, Nancowry Harbour, Nicobars: 13 fathoms.	R. B. S. Sewell, Oct., 1921.	1 ♀ and ♂ on *Chlorotocella gracilis* Balss. TYPE.

Bopyrina sewelli seems to be closely allied to *Bopyrina giardi* Bonnier, which it resembles in the general shape of the body, as also in that of the first oostegite of the female. The posterior lamina also has a single secondary lobe in both. But it differs from Bonnier's species in a number of well-marked characters. The abdomen in the female shows a clearer segmentation in the present species than it does in *B. giardi.* In the latter no trace of segmentation can be seen on the shorter side of the body, while on the other also only three somites, excluding the terminal, can be made out. In *B. sewelli* all the six somites can be made out on the margin of the shorter side of the body, while on the other, as in Bonnier's species, four somites are seen quite distinctly. Further there are well-defined pleopods in the Nicobar species, while in *B. giard* no abdominal appendages exist. The ridging of the abdomen is also very indistinct in the present species, while in Bonnier's form it is a very characteristic feature of the female abdomen. The maxillipeds of the two species, though superficially resembling in shape, also show some

difference ; in *B. giardi* there is a small palp without any setae, in *B. sewelli* the palp is practically absent and one seta is present. The males of the two species are also different in shape and proportions, that of the present species being considerably narrower, and having a larger abdomen. The segmentation of the abdomen is somewhat different in the two, and the " anal spines " are better developed in the present species.

EXPLANATION OF PLATE IV.

Diplophryxus jordani Richardson.

FIG. 1.—Female, dorsal view : × 8.

Diplophryxus richardsoni, sp. nov.

FIG. 2.—Female, dorsal view : × 30.

„ 3.—Abdominal region of same, ventral view, enlarged : × 45.

Diplophryxus kempi, sp. nov.

FIG. 4.—Female, dorsal view : × 12.

„ 5.—Head and anterior thoracic region of same, dorsal view, enlarged : × 24.

„ 6.—Pleopod : × 65.

„ 7.—Male, dorsal view : × 55.

„ 8.—Same, ventral view : × 55.

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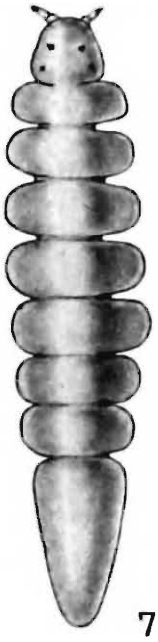

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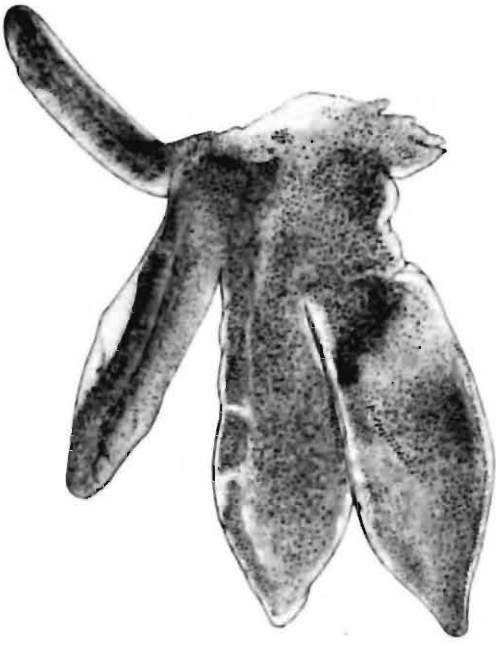

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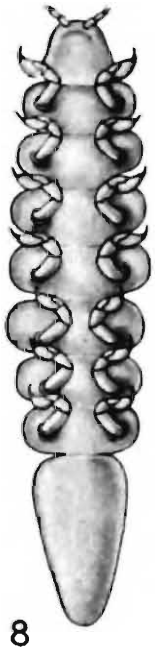

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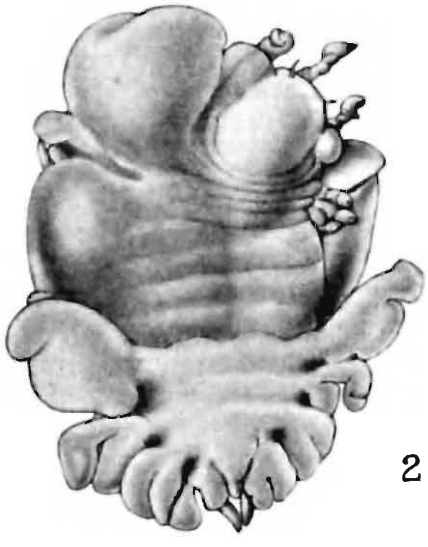

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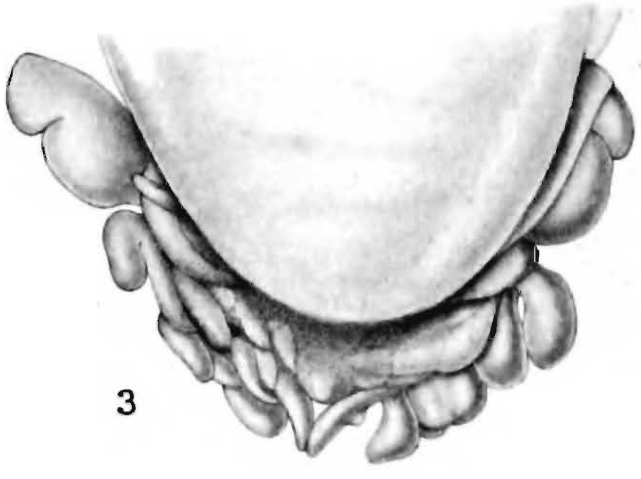

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A. Chowdhary del.

INDIAN BOPYRID ISOPODS.

EXPLANATION OF PLATE V.

Bopyrella nierstraszi, sp. nov.

FIG. 1.—Female, dorsal view : × 10.

„ 2.—Same, ventral view : × 10.

„ 3.—Left maxilliped, outer face : × 50

„ 4.—First left oostegite, inner face : × 40.

„ 5.—Male, dorsal view : × 50.

„ 6.—Same, ventral view : × 50.

Palaegyge pica Chopra.

FIG. 7.—Abdomen of female, ventral view : × 11.

„ 8.—Male, dorsal view : × 27.

„ 9.—Same, ventral view : × 27.

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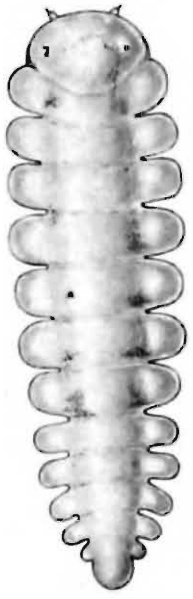

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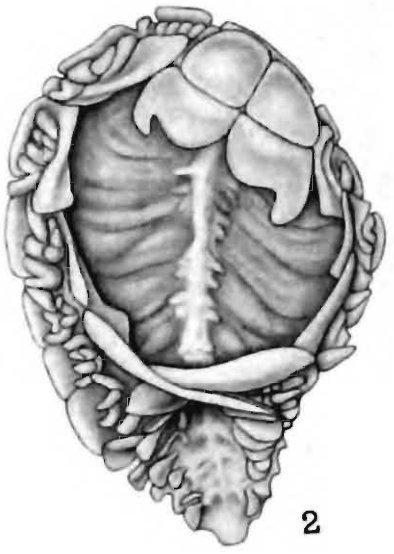

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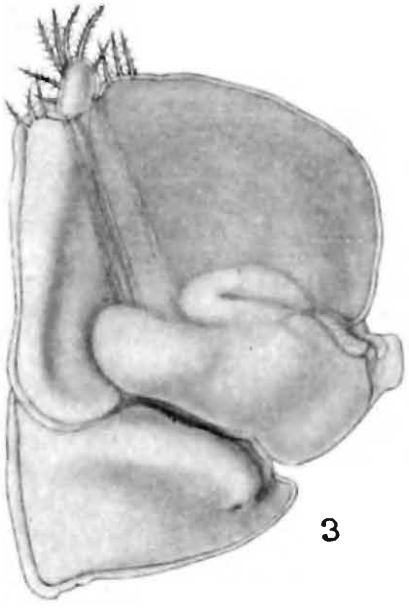

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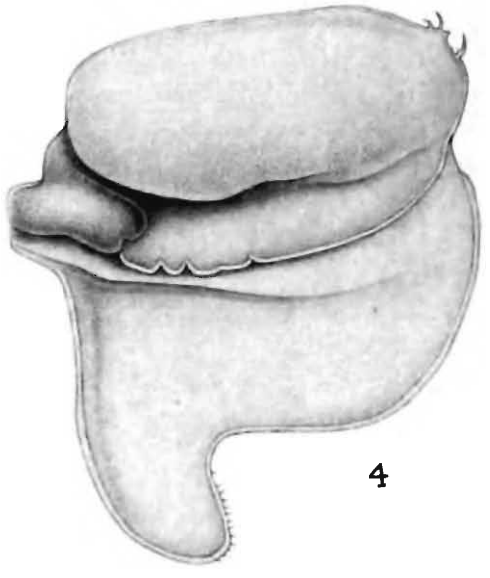

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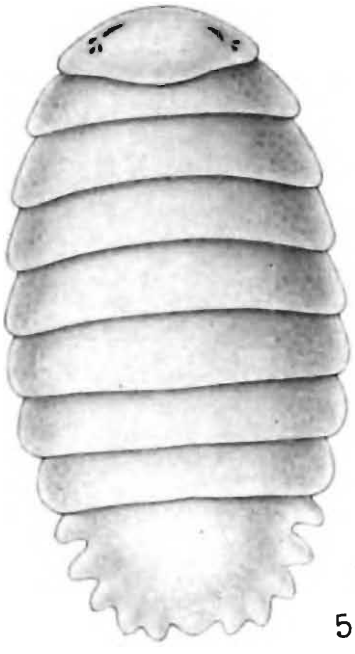

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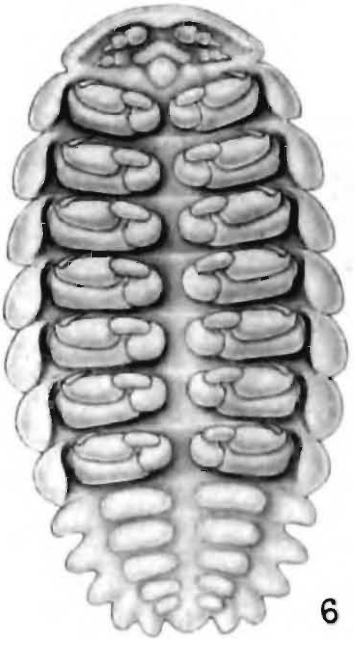

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S. C. Mondul & A. Chowdhary del.

INDIAN BOPYRID ISOPODS.

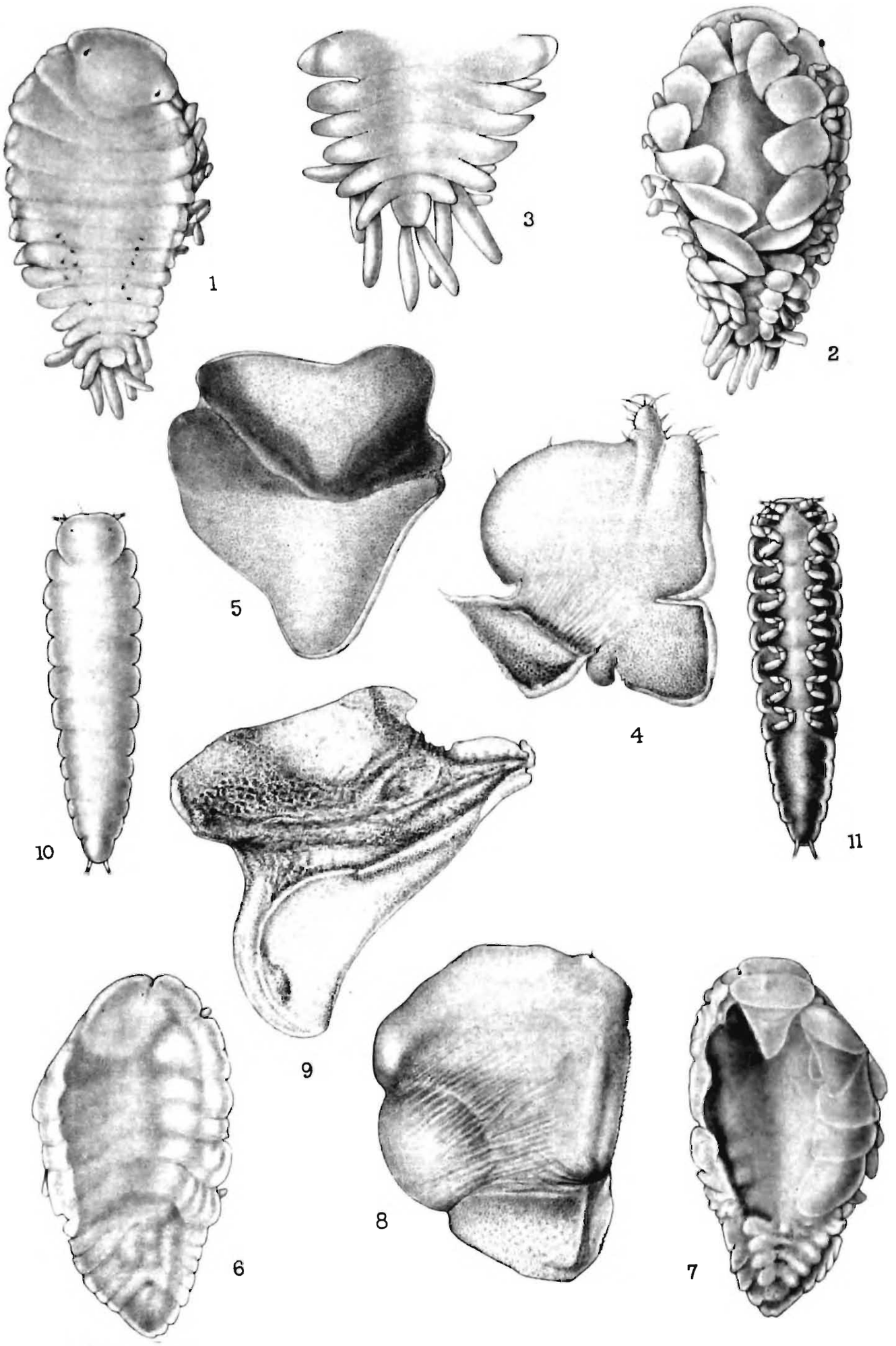
EXPLANATION OF PLATE VI.

Pseudione indica, sp. nov.

FIG. 1.—Female, dorsal view : × 26.
,, 2.—Same, ventral view : × 26.
,, 3.—Abdomen of female, dorsal view : × 40.
,, 4.—Right maxilliped, outer face : × 125.
,, 5.—First right oostegite, inner face : × 125.

Bopyrina sewelli, sp. nov.

FIG. 6.—Female, dorsal view : × 20.
,, 7.—Same, ventral view : × 20.
,, 8.—Right maxilliped, outer face : × 100.
,, 9.—First right oostegite, inner face : × 80.
,, 10.—Male, dorsal view : × 65.
,, 11.—Same, ventral view : × 65.



A. Chowdhary del.

INDIAN BOPYRID ISOPODS.

THE MECHANISM OF THE THROAT-FAN IN A GROUND LIZARD, *SITANA PONTICERIANA* CUV.

By C. P. GNANAMUTHU, *M.A., Lecturer in Natural Science, American College, Madura.*

(Plate VII.)

INTRODUCTION.

Gular appendages have been described more often in arboreal lizards than in terrestrial ones. As early as 1826, Thomas Bell (2) has written about the structure of the dewlap in the Iguanid *Anolis* sp. In 1908, Gandolfi (6) worked out the muscles of the tongue of Agamids and Iguanids, but did not trace their function with reference to the hyoid. In 1919, von Geldern (7) explained the mechanism of the throat-fan in the " Florida Chameleon " (*Anolis carolinensis*), but concerned himself only with the hyoid muscles as he believed them to be the chief factors in it, though he suspected that " the muscles of the tongue probably play a part in the action " He does not mention or criticize Bell's naive explanation but refers to Chemin's account (4) of the gular appendage of *Calotes versicolor* which I have not been able to obtain. In view of the systematic significance of the throat musculature of lizards, a study of the muscles of the hyoid and of the tongue in their relation to the throat appendage of this animal should be of interest.

My thanks are due to Prof. S. G. Manavala Ramanujam of the Presidency College Madras, for his guidance and encouragement, for allowing me the use of his college library and for going through my manuscript and preparations ; to Dr. B. K. Das of the University College, Calcutta, for the formula of the picro-indigo-carmine stain ; to Rev. Gaebler and Prof. L. Narasu for translations of German references ; to the Principal of the American College, Madura, for permission to carry on this research in the college laboratory ; and, finally, to the Zoological Survey of India, Calcutta, for the loan of literature unavailable at Madras.

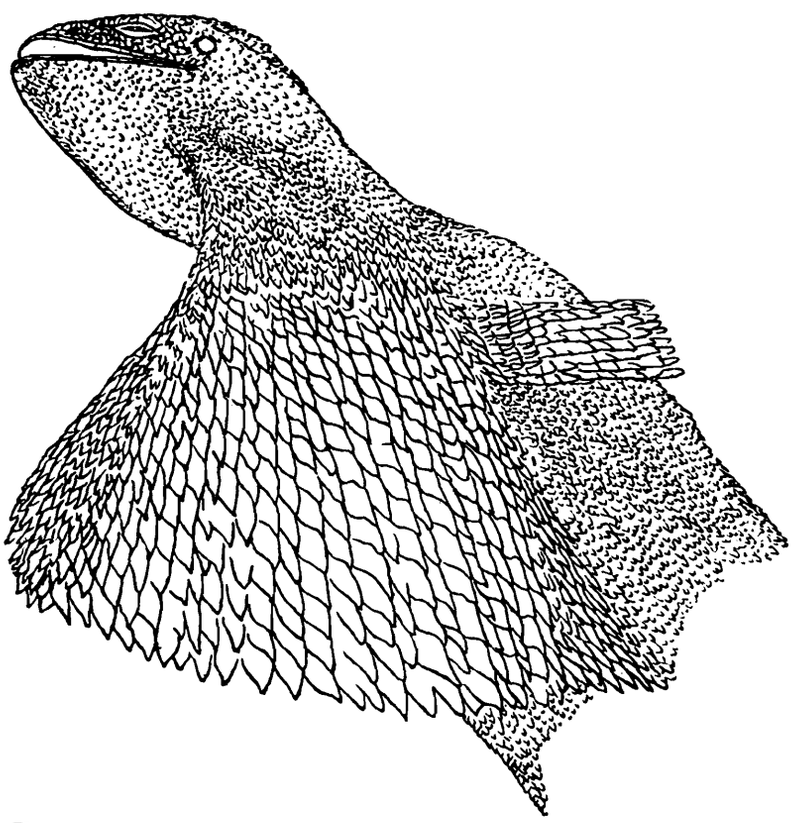
Sitana ponticeriana is purely a ground-lizard, having four toes, and is found all over India. It is more common in some districts than in others and frequents clumps of prickly herbs and cacti. As has been noted by Pycraft in his " Courtship of Animals " (1913), there is a strongly marked sexual dimorphism in this animal not only in size and build but also in the possession of a throat-fan in the male. Ordinarily the gular appendage in *Sitana* is folded fanwise under the breast but when the animal is excited, it is stretched out and again folded immediately—this process being repeated several times. In this process, the bright red and yellow colour-markings on the fan are alternately displayed and hidden. This action appears to depend not merely on the muscles of the hyoid but also involves the tongue muscles. These animals have been frequently observed in the field and no female was noticed by the author when the male was seen engaged in this display ; nor were

several individuals seen at any time to be engaged in a collective display of their coloured gular folds. Even specimens caught and held in the hand displayed their fans.

The throat muscles of several of these lizards were dissected and sections were made of the tongues from formaline-preserved specimens. The sections were cut about 8μ thick, stained in alcoholic borax carmine, followed by picro-indigo-carmine, cleared in xylol and mounted in balsam.

The Hyoid Apparatus.

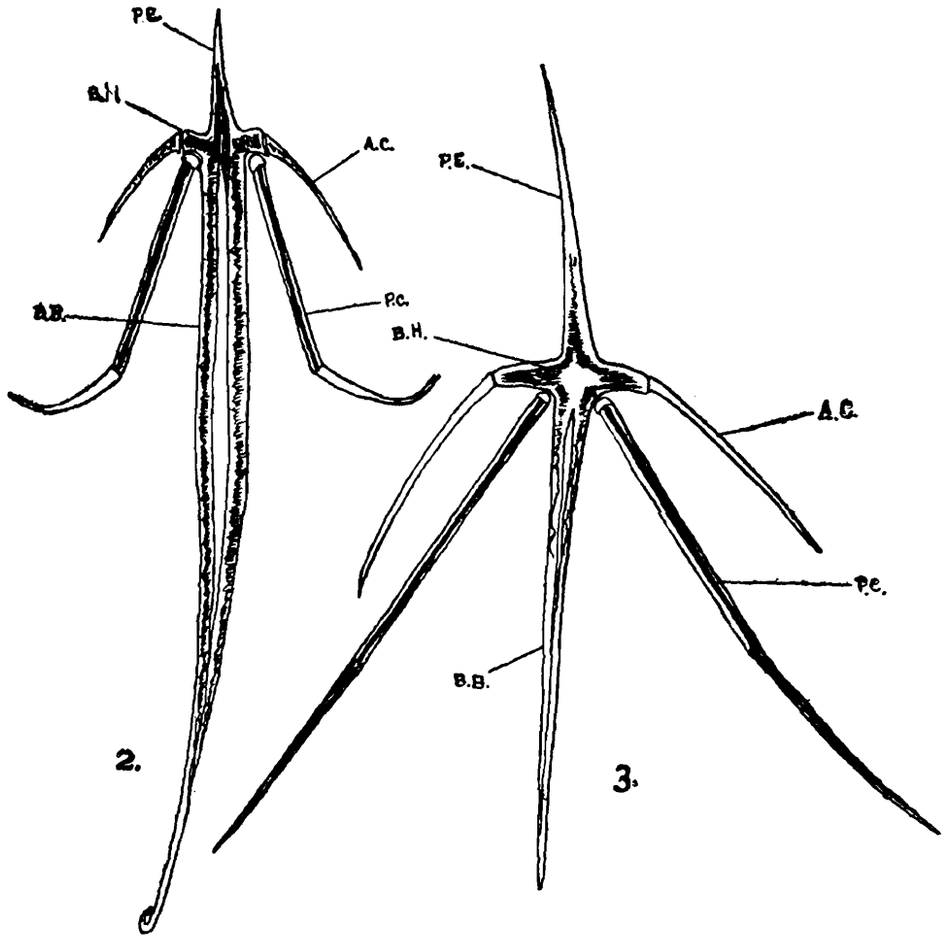
Text-figures 2 and 3 illustrate the hyoid apparatus of male and female *Sitana*. The difference between the hyoid apparatus of the two sexes will be obvious and are no doubt associated with the presence of the throat-fan in the male and its absence in the female. The hyoid of the male is nearly thrice as long and two-and-a-half times as large as that of the female. The wider basihyoid, the longer median process and the short weak basibranchials of the female are all unadapted to the function which they subserve in the male. It will, however, be noted that the hyoid apparatus of *Sitana* bears a general resemblance to that of *Anolis*. The basihyoid of *Sitana* is much more slender than that of *Anolis* and is cleft behind and continued into the basibranchial process which thus appears to be longer. The cleft of the basihyoid commences at



Text-fig. 1.—Male *Sitana* with gular appendage stretched.

about its level of articulation with the posterior cornu. In front the basihyoid is continued into a short pointed median process called by Geldern " processus entoglossus ", or by Gandolfi " the tongue bone " The two pairs of appendicular processes—the two visceral arches of Beddard (1)—lie nearly parallel as in *Anolis*, but in the latter the anterior

cornu nearly equals the posterior in size, as can be seen from Geldern's figures. There are also other minor features of difference as, for instance, the body of the basihyoid in *Sitana* is not so flat and broad as is figured for *Anolis*, but has its sides raised up so as to enclose a deep groove between them and consequently the anterior cornu of each side, which is attached to the raised-up side of the basihyoid, is more clearly dorsal to the basihyoid in *Sitana* than in *Anolis*. Beddard (1) describes a



TEXT-FIG. 2.—Hyoid apparatus of male *Sitana* (× 3). A.C. Anterior cornu ; B.B. Basibranchial ; B. H. Basihyoid ; P.C. Posterior cornu ; P.E. Processus entoglossus.

TEXT-FIG. 3.—Hyoid apparatus of female *Sitana* (× 7½). (Lettering as in fig. 2).

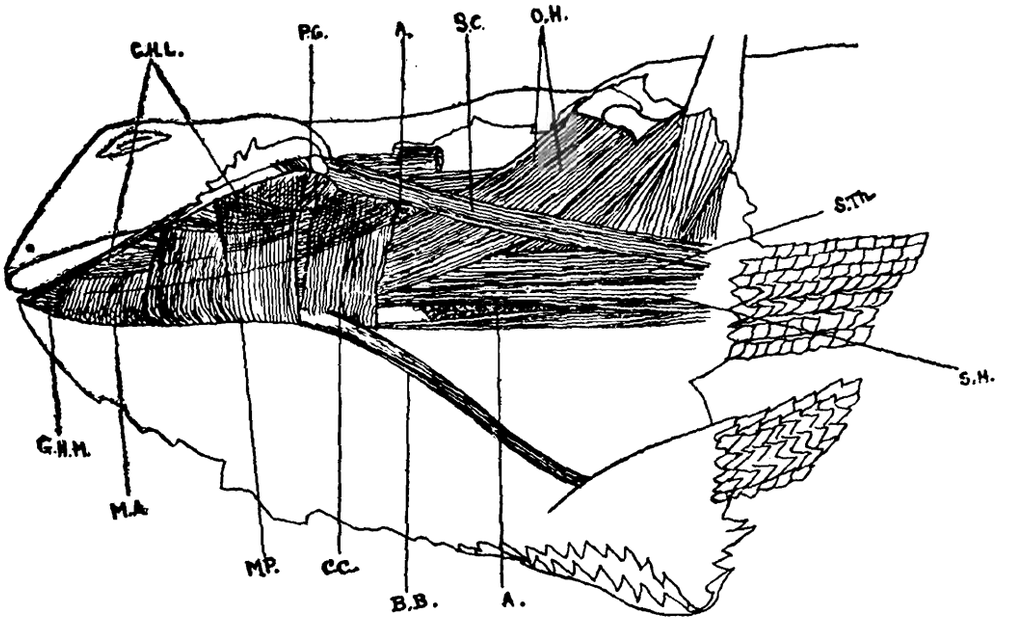
small piece in front of the anterior cornu in *Chlamydosaurus* and *Physignathus* and compares it to the thickened region of the hyoid of *Lacerta* figured by Parker, and suggests that if it were the remnant of an arch it could be homologised with the two hyoid arches of the Chelonia. In sections of the hyoid of *Sitana*, taken in front of the anterior cornu, a pair of very minute processes are seen. These are probably the reduced representatives of the thickenings figured by Parker for *Lacerta* rather than comparable to " the ossified segmented off bit " of Beddard in *Chlamydosaurus*.

MUSCLES OF THE HYOID.

1. *Sternohyoid* (S. H.) This, the anterior remnant of the rectus abdominis muscle of the lower vertebrate, has its origin on the sternum and

runs on either side of the basibranchial processes and ventral to the median portion of the sternothyroideus muscle. It is connected with the sternothyroideus by fascia, but it is inserted on to the most anterior part of the basibranchial processes, along with the omohyoid.

2. *Sternothyroideus* (S. Th.). This is a broad flat muscle springing from the sternum and being inserted all along the hind edge of the posterior cornu.

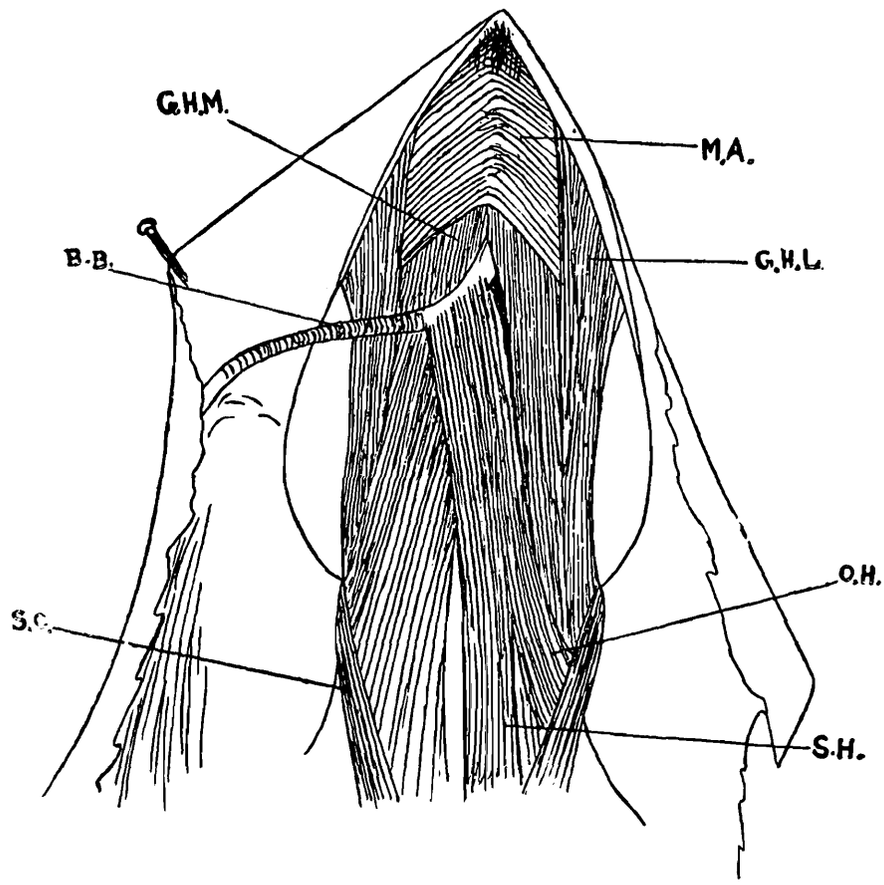


TEXT-FIG. 4.—Superficial muscles exposed (× 3). A. Adipose bodies; B.B. Basibranchial; C.C. Constrictor colli; G.H.L. Geniohyoideus, lateral bundle; G.H.M. Geniohyoideus, median bundle; M.A. Mylohyoideus anterior (M.A. profundus lies just below it); M.P. Mylohyoideus posterior; O.H. Omohyoideus; P.G. Pterygoideus; S.C. Sternocleidom; S.H. Sternohyoideus; S.Th. Sternothyroideus.

3. *The omohyoid* (O. H.) is a fairly thick flat double muscle. It starts from the anterior border of the scapula, runs obliquely in an anterior and ventral direction, parallel to the posterior cornu, to which it is attached along its outer border, and is finally attached along with the sternothyroideus to the basibranchial process.

4. *The geniohyoideus* (G. H.) ties the hyoid anteriorly to the lower jaw. This in most lizards exists as many bundles which weave into the mylohyoid (*vide infra*) running transversely between the two rami of the mandible. There are four such divisions of the geniohyoideus in *Sitana*, which run between the corresponding portions of the mylohyoid. The most posterior is a short bundle, which, rising from the hind portion of the lower jaw and running dorsal to the last strip of the mylohyoideus, becomes attached to the curving end of the posterior cornu. This muscle has been regarded by Geldern and other earlier writers as a separate muscle and termed " Mandibulohyoid " and " Ceratomandibularis " It may, however, be pointed out that it is not unlike the two other muscles in front of it, which are similar to it in their course and function and which have been called geniohyoideus ; in this paper, therefore, the ' Mandibulohyoid ' of Geldern has been considered as a part of the geniohyoideus. The next bundle is very slender and lies under the first. The other two are fairly thick, the last and median being stoutest.

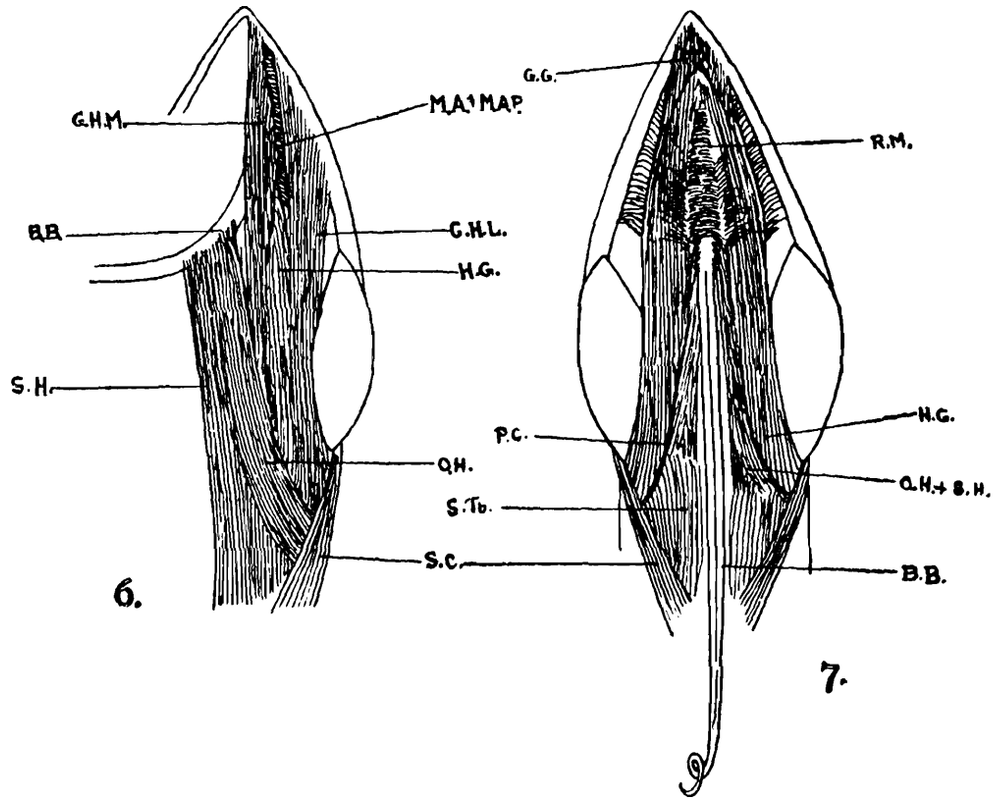
5. *The ceratohyoideus* (C. H.) is one of the factors of the hyoid mechanism and was held by Geldern to play the principal part in it. It is a short muscle which originates along the dorsal border of the posterior cornu and running forwards gets inserted on the anterior cornu. In its distal part the anterior cornu is almost surrounded by the fibres of this muscle. The latter becomes ligamentous anteriorly and is attached to the proximal part of the anterior cornu and the basihyoid.



TEXT-FIG. 5.—Dissection from ventral side. B.B. Basibranchial ; G.H.L. Geniohyoideus, lateral bundle ; G.H.M. Geniohyoideus, median bundle ; M.A. Mylohyoideus anterior ; O.H. Omohyoid ; S. C. Sternocleidom ; S.H. Sternohyoideus.

Function of the muscles. The sternothyroideus serves to draw the posterior cornu and with it the rest of the hyoid and the tongue backwards, *i.e.*, in a caudal direction. The sternohyoid and omohyoid muscles being inserted on the basibranchials serve to draw them backward and thus withdraw or fold the fan, after it has been stretched. The sternothyroideus and to a slight extent the omohyoids counteract the forward draw of the geniohyoideus and thus make the posterior cornu a fixed point about which the rest of the hyoid apparatus moves in the extension of the throat-fan and to which the muscles moving the tongue are attached. Further, the ceratohyoidei having their origin in the fixed posterior cornu and being inserted on the anterior cornu and basihyoid draw these latter structures towards its origin, *i.e.*, the fixed posterior cornu ; the basibranchial processes being continuous with the basihyoid are consequently swung forwards whenever the ceratohyoideus contracts. The whole hyoid apparatus illustrates the principle of the first order of

levers ; the basihyoid and its processus entoglossus forming the short power arm, the long basibranchial processes the weight arm, the fulcrum being provided about the articulation of the basihyoid with the posterior cornu.



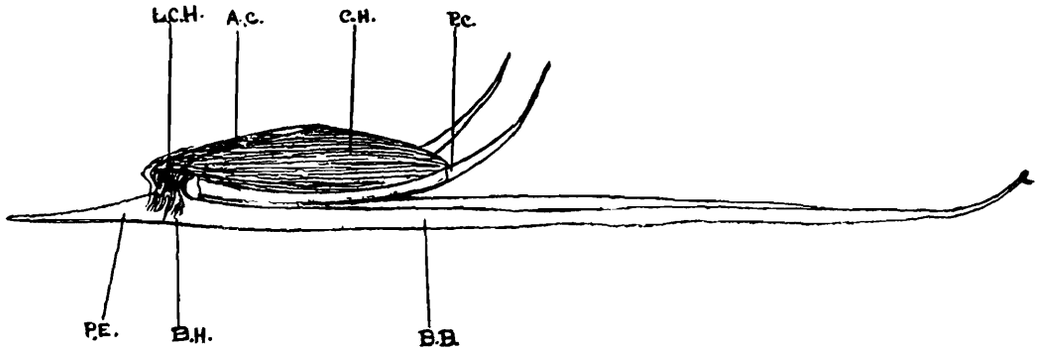
TEXT-FIG. 6.—View of deeper muscles. B.B. Basibranchial ; G.H.L. Geniohyoideus, lateral bundle ; G.H.M. Geniohyoideus, median bundle ; H.G. Hyoglossus ; M.A. Mylohyoideus anterior ; O.H. Omohyoideus, ; S.C. Sternocleidom ; S.H. Sternohyoideus.

TEXT-FIG. 7.—View of still deeper muscles. B.B. Basibranchial ; G.G. Genioglossus ; H.G. Hyoglossus ; O.H. and S.H. Omohyoid and sternohyoid cut ; P.C. Posterior cornu ; R.M. Ring muscle ; S.C. Sternocleidom ; S.Th. Sternothyroideus.

Constrictor colli (C. C.). Among the transverse muscles, the most superficial is the constrictor colli which Camp (3) figures in most lizards but it is only with difficulty made out in *Sitana*. Its fibres take their origin in the skin on the back of the neck, run down ventrally and extend as a sheet over the gorge, a little behind the mylohyoideus. This muscle aids in the process of swallowing.

The mylohyoideus (M. H.) is a transverse muscle running just beneath the skin on the ventral side of the head, between the rami of the mandible ; two portions can be distinguished, namely, a mylohyoideus anterior and a mylohyoideus posterior. In *Sitana* the fibres of the mylohyoideus posterior run transversely across from one ramus of the mandible to the other. This sheet of muscle is laterally interrupted by the two lateral bundles of the geniohyoideus. The third lateral bundle of the geniohyoideus lies under the mylohyoideus posterior, and the median bundle runs below the mylohyoideus anterior (text-figure 4). The mylohyoideus anterior is contiguous with the posterior, as in some Agamids, and its fibres run obliquely forwards to meet in a median raphe. Just below the mylohyoideus anterior is another thin sheet of muscle which Camp

has called mylohyoideus anterior profundus. Its fibres run obliquely backwards to meet in a median raphe. This muscle, though noticed



TEXT-FIG. 8.—Side view of hyoid apparatus. A.C. Anterior cornu ; B.B. Basibranchial ; B.H. Basihyoid ; C.H. Ceratohyoideus ; L.C.H. Ligamentous insertion of ceratohyoid ; P.C. Posterior cornu ; P.E. Processus entoglossus.

and described by Gandolfi, was left unnamed by him. Both Gandolfi and Camp found it to be present in Agamids and absent in the Iguanids. Camp has further found it in the Chameleons and is of opinion that it is additional evidence of the affinity between the two groups. The mylohyoideus, a breathing muscle in the lower vertebrates, not only aids breathing by pushing the tongue up and bringing the glottis into the nasopharyngeal groove but also assists swallowing.

THE MUSCLES OF THE TONGUE.

The hyoglossus (H. G.) is the most important of these. It is paired and fairly thick and takes its origin on the outer edge of the posterior cornu of each side, just dorsal to the attachments of the geniohyoideus and ventral to that of the ceratohyoideus. The hyoglossus of each side runs longitudinally, lying obliquely between the outer margin of the posterior cornu and the lateral margin of the tongue (*c.f.* pl. vii, figs. 1-4). The bony region of the posterior cornu first runs obliquely backwards and outwards and then takes a turn upward and outward in its distal part ; consequent on this, two regions can be distinguished, though feebly, in a cross section of the hyoglossus muscle—an inner and an outer. I shall first describe the course of the inner division.

The inner division of the hyoglossus runs horizontally parallel to the outer division. Towards the middle of the length of the tongue, the upper fibres of this inner division turn outwards and run obliquely over the outer division of the hyoglossus. Anteriorly more of these fibres assume this oblique course—some seven descend round the outer side of the outer division of the hyoglossus and become attached to its fascia, while some fibres get inserted into the side borders of the tongue, running across fibres of the genioglossus. In giving an account of the tongue muscles of Agamids other than *Sitana*, Gandolfi describes a " Ring Muskel um das Hyoglossus." I do not find such a muscle in *Sitana*. The muscle fibres which can be described as going round the outer hyoglossus are those of the inner division of the hyoglossus and as these rise from the posterior cornu, there is no muscle which has the same origin and course as Gandolfi describes for his " Ring Muskel um das Hyoglossus."

While the upper fibres of the inner division take this oblique course, the lower run close to the processus and become inserted on it. The set of upper fibres are separated from the lower by the " Ring muscle round the hyoid bone " (*vide infra*) passing outwards between them. This ring muscle encloses within it the lower part of the inner division of the hyoglossus, as well as the processus. The inner division of the hyoglossus thus has two insertions, one over and round the fascia of the outer division and another on the processus.

The outer division of the hyoglossus (*cf.* pl. vii, figs. 4 and 5) also has a part of its ventral fibres inserted on the processus along with the ventral portion of the inner division. Apart from this, the outer division runs forward to the extreme tip of the tongue and its fibres ascend into the dorsum of the tongue and in doing so cross the other muscles (*vide infra*) in a radiating manner. The function of the various divisions of the hyoglossi is obviously to draw in the tongue towards the posterior cornu. In such a retraction the fibres inserted on the processus will pull it back and thus swing open the throat-fan. The rest of the hyoglossus also will aid this, as in the front part of the tongue this muscle is bound to the processus by the other muscles which are attached to the fibrous extension from the " Ring muscle round the hyoid bone."

The Ring muscle (R. M.) (Gandolfi). The fibres of this muscle rise in the basihyoidal groove and run anteriorly for a very short distance. Where the basihyoid gives rise to the processus entoglossus, they take a lateral and downward course enveloping the processus on each side. The two lateral portions are separated in the middle line by a feebly developed " septum " formed by the fascial covering of the muscle. As the fibres of the ring muscle pass outwards and downwards round the processus, the lower part of the inner division of the hyoglossus becomes cut off on either side, as already described, and is thus enclosed between the ring muscle and the processus (*cf.* pl. vii, figs. 5 and 6). Immediately in front of the glottis this septum or fibrous plate takes a more dorsal position in the tongue (*cf.* pl. vii, figs. 6 and 7), the processus being still enclosed or surrounded by the ring muscle. This muscle has been distinguished by Gandolfi as the " Ring muskel um das Zungenbein ", but as no other " Ring muscle " is seen in *Sitana* I prefer to refer to this merely as the ring muscle. Towards the tip of the tongue this muscle passes into the connective tissue at the base of the front end of the tongue. As regards the function of this muscle in the tongue of Agamidae, Gandolfi conjectures that the contraction causes its fibres to thicken, which thus makes them exert a pressure all round ; that as the muscle is surrounded by almost inelastic connective tissue, it cannot expand ; and that as the motion towards the back is also impossible, the thickening of the muscle-fibres occurring during contraction manifests itself in a forward extension of the tongue.

This is improbable, for the muscles genioglossus and hyoglossus are responsible for the slight protrusion and retraction of the tongue that we can observe in Agamids. The course of the majority of the fibres is clearly circular and the muscle therefore must serve only to hold firmly on to the processus entoglossus and, because of its partial attachment to the basihyoid, it is able to fix the fibrous plate, so necessary for the play of the muscles which start from it.

The longitudinalis linguae (L. L.) is a muscle which takes its origin from the fibrous plate in front of the glottis and runs obliquely towards the surface of the tongue proceeding forwards to the tip below the papillae. By its contraction the tongue tip is curved or rolled up.

The transversalis linguae (T. L.) is a muscle whose fibres take their origin from the fibrous plate anterior to the glottis and pass laterally to the side borders of the tongue. This muscle serves to bring together the sides and makes the tongue narrower and thicker.

The genioglossus (G. G.) starts from the mandibular symphysis and its fibres get distributed to the tip and sides of the tongue as far back as the laryngeal region. The genioglossi of the two sides serve to draw the tongue forwards.

DISCUSSION.

Thomas Bell (1826) has described the extension of the throat-fan in *Anolis*, as the simple process of the hyoid being drawn back by the sternohyoid. According to him as the posterior tip of the basibranchial is fixed in the skin, it results in the basibranchials becoming arched on their lower side thrusting the skin fold downwards " like the ribs of an umbrella well opened " Unfortunately he did not study the musculature in detail and his theory though simple and attractive is untenable. Geldern, however, described the mechanism more correctly for the same animal. In *Sitana*, as in *Anolis*, the extension of the throat-fan is undoubtedly due to the levering action of the posterior part of the hyoid apparatus about a fixed fulcrum formed by the middle portion, the weight arm—the basibranchial processes—pushing the folded fan open. Geldern points out how in *Anolis* the ceratohyoideus by rising from the posterior cornu and being attached to the anterior cornu will pull these latter back and therefore the basihyoid also ; and though he did not work out the muscles of the tongue, believed that " they may play a small part in the action " The ceratohyoideus in *Sitana*, however, is slightly different. Its fibres run parallel to the anterior cornu from their origin of the posterior cornu and are inserted on the basihyoid and on the anterior cornu near its articulation with the former. This, it would be seen, gives a more effective pull upwards and backwards to the basihyoid.

Further, when the muscles of the tongue are worked out and studied in relation to those of the hyoid it is difficult to resist the conclusion that they, and especially the hyoglossus, take at least an equal share in the drawing back of the processus entoglossus and the basihyoid, and, therefore, in the extension of the fan. The hyoglossus besides being intimately connected with the basihyoid through other muscles—the Ring muscle for instance—has a ventral division of it inserted on the processus entoglossus and can retract the basihyoid to a considerable extent.

The folding of the fan is accomplished by the omohyoids and the sternothyroideus which pull the basibranchials upwards and backwards, aided by the relaxation of the other muscles, concerned in its protrusion. I find no trace of the muscle which Geldern found in *Anolis* and named myloceratoideus and which he describes as drawing the anterior cornu forwards during the retraction of the gular appendage.

I have been unable to obtain Chemin's article on the hyoid apparatus of *Calotes versicolor*, which Geldern criticises. In giving a resumé of Chemin's account of the hyoid mechanism, Geldern says, " the basihyoid is pulled ventrad by means of the sternohyoid (sternothyroideus ?) and the processus entoglossus is prevented from moving ventrad with the basihyoid by a band of tissue extending from one hyoglossus to the other and the basihyal would rotate as the fulcrum and swing the processus retrobasalis (basibranchials) forward " This view, however, cannot be supported by facts for the sternothyroidei, even in *Calotes*, are inserted on the posterior cornu as in most lizards and therefore the basihyoid cannot be pulled down except indirectly through its attachment with the posterior cornu and after all the sternothyroidei are more horizontal than oblique. Criticising Chemin's description Geldern says that " he cannot agree with the general statement that the mechanism in *Calotes* is essentially the same for all the Iguanidae. . . . Certainly it differs markedly in *Anolis*, where the processus entoglossus is not the arm of the lever and only acts as a hindrance to the production of the throat-fan " The processus entoglossus, though smaller in the male, must yet be regarded as playing a part in the mechanism of the throat-fan of *Sitana*, since it affords attachment for a part of the hyoglossus and forms with the basihyoid the power arm of the lever.

CONCLUSION.

1. The play of the gular appendage depends on the hyoid apparatus working as a lever through the muscles attached to it. Both the muscles of the hyoid and those of the tongue play a part. The basihyoid is pulled backwards not only by the ceratohyoideus but also by the hyoglossus through its attachment to the basihyoid process.

2. In its main features the mechanism of the dewlap in *Sitana* no doubt resembles that of the Iguanid *Anolis carolinensis*, described by Geldern. But this author paid no attention to the tongue muscles though he realised that they may play a part. In *Sitana*, undoubtedly, they do play an important part.

3. The similarity of the hyoid apparatus and the part it plays in the extention of the throat-fans in Lacertila need not necessarily be of systematic importance. Similarity of structure may have been possibly attained by similarity of functions. For one thing, the hyoid apparatus differs widely even among the Agamidae as, for instance, between *Calotes*, *Draco*, *Physignathus*, *Chlamydosaurus*, etc. Therefore, the similarity of this organ that exists in *Sitana*, an Agamid, and *Anolis*, an Iguanid, is not surprising.

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EXPLANATION OF PLATE VII.

FIG. 1.—Transverse section of tongue of *Sitana* through hind part.

„ 2.—Transverse section through joint of posterior cornu with basihyoid.

„ 3.—Transverse section through joint of anterior cornu with basihyoid.

„ 4.—Transverse section through beginning of processus entoglossus. B. H. Basihyoid (giving rise to processus entoglossus).

„ 5.—Transverse section through tongue in front of hyoid.

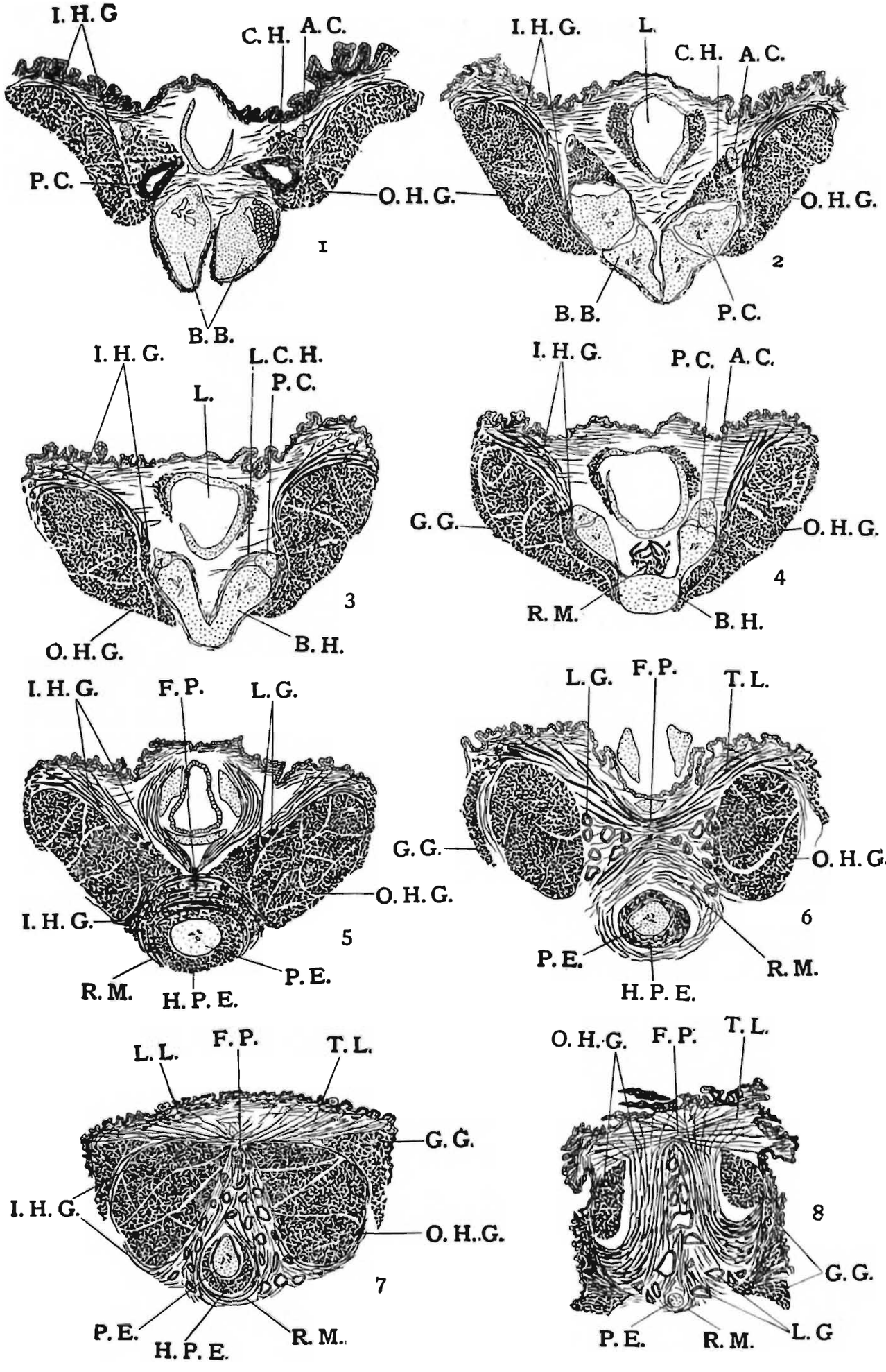
„ 6.—Transverse section of tongue through glottis.

„ 7.—Transverse section through front part of tongue.

„ 8.—Transverse section through tip of tongue.

EXPLANATION OF LETTERING.

A. C. Anterior cornu ; B.B. Basibranchial ; C.H. Ceratohyoideus ; I.H.G. Inner hyoglossus ; O.H.G. Outer hyoglossus ; P.C. Posterior cornu ; L. Larynx ; B.H. Basihyoideus ; L.C.H. Ligament of ceratohyoideus ; G.G. Genioglossus ; R.M. Ring muscle ; F.P. Fibrous plate ; H.P.E. Hyoglossus of processus entoglossus ; L.G. Vingual glands ; P.E. Processus entoglossus ; T.L. Transversalis linguae ; L.L. Longitudinalis linguae.



Anatomy of a Ground Lizard.

NOTES ON INDIAN BLEPHAROCERID LARVAE AND PUPAE WITH REMARKS ON THE MORPHOLOGY OF BLEPHAROCERID LARVAE AND PUPAE IN GENERAL.

By A. L. TONNOIR, *Entomological Research Station, Canberra, Australia.*

It is very surprising that so little work has been done on the Blepharocerids of the Indian area, for this family, as the collection of the larvae and pupae under report indicates, appears to be particularly well represented in this area. The collection, which was submitted to me for study from the Zoological Survey of India, was mainly made by Dr. S. L. Hora of that department. It contains the larval forms of no less than fifteen types which appear to belong to fifteen different species of six or seven genera ; the adults of two of these genera still remain to be discovered.

In 1869 (14) the first Blepharocerid was recorded from the Indian region as *Hammatorrhina bella* Loew from Ceylon. Only the male of this species is known, and it has apparently never been found again, for it has never been mentioned in the literature since. Its supposed larva was exhibited in 1891 at a meeting of the Entomological Society, London, by Gahan (11), but it was, unfortunately, never described and it is not known what became of the specimen.

In 1911, Brunetti (7) described two species ; *Blepharocera indica* from the Western Himalayas (Simla district) and *Apistomyia trilineata* from the Eastern Himalayas (Darjeeling). The description of the former is not at all satisfactory, and can be applied to the widely spread Palaearctic species *B. fasciata*, but as the author has not described the venation or the eye structure it is doubtful whether it belongs at all to the genus *Blepharocera*. The collection of larvae, which I have studied, contains several species of *Blepharocera*, and as the larva of this genus which I have seen from the Simla district—the type-locality of *B. indica* Brunetti—does not seem to correspond to that of *B. fasciata*, it may be assumed that Brunetti's species is probably distinct, but to settle this point a re-examination of the type of his species is necessary. *Apistomyia trilineata* is certainly a good species ; it is one of the many species of the genus which exist in India, as is clear from the larvae described below. There can be no doubt about the generic status of this species, but its unique type, which was stated by Brunetti to be a male, is on account of the wide frons and the small upper portion of large facets of the compound eyes certainly a female.

In 1916, S. P. Agharkar (1) described a species, *Philorus bionis*, and three larval types which he designated " A ", " B " and " C ", as these could not be connected with the adults of any known species. *Ph. bionis* is almost certainly referred to the wrong genus. *Philorus* was considered with much reason by Bezzi (2) as a purely Nearctic

genus, but the position of this genus is very unsatisfactory. No proper definition of the genus was given by Kellogg (12), who erected it for the three species, *bilobata* Loew, *yosemite* O.-S. and *ancilla* O.-S. All these three species possess a posterior basal cell, which Kellogg described as " A cross-vein between media and cubitus " ; Tillyard (16), however, has shown that the veins in the above description are not the true media and cubitus. No genotype was mentioned by Kellogg, but as *bilobata* was mentioned first (p. 199) it might be accepted as the type of the genus. Unfortunately, this very little known European species—it has not been found again since Loew's time—was transferred by Bezzi to the genus *Liponeura*, and later authors, including Bischoff (3), have confirmed this course. According to Bezzi, *Philorus* should be restricted to species with a long pedunculated Rs. fork, with a posterior basal cell and with bisected eyes approximated on the frons in both sexes. *Ph. bionis* does not show most of these important characters. In this species the fork of Rs. has a very short stem, the eyes are not bisected in either the males or females and the frons is wide in both the sexes ; the posterior basal cell, however, is present. It is clear, therefore, that Agharkar's species cannot be referred to the genus *Philorus*. On account of its pubescent, non-bisected, widely separated eyes, its short proboscis, its five-segmented palpi and its venation, which is almost identical with that of *Liponeura bilobata*, it might be placed in the genus *Liponeura*. It has, however, fourteen instead of fifteen-segmented antennae and the mandibles have been described as absent in both the sexes ; these latter organs, however, are not easy to detect and Agharkar may have overlooked them. From the imperfect figures of Agharkar it is difficult to judge the real structure of the male and female genitalia of *Ph. bionis*, but they do not seem to have anything in common with those of *Liponeura*. For ascertaining its true generic status a detailed examination of the types of *Ph. bionis* is, therefore, necessary. I discuss further the possibility of its belonging to a new genus which is so far mainly known in the immature stages and by only a few characters of the adult.

Before concluding this review of what is known to date of the Indian Blepharoceridae, mention must be made of the recent description of a species of *Hammatorrhina*—*H. pulchra* Edwards (8)—from Ceylon.

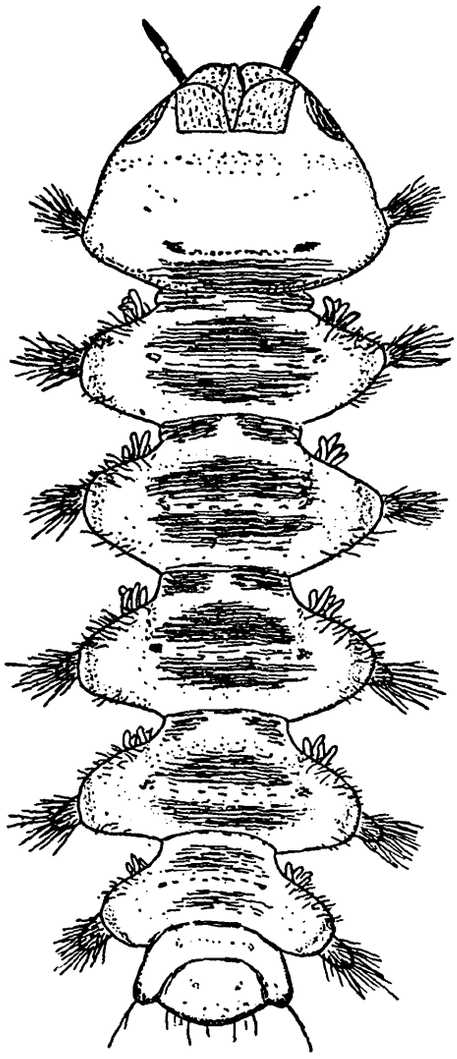
The collection of larvae which I had for study was, with one exception, not accompanied by specimens of the adult flies, and no definite identifications of the larvae could, therefore, be made. Under the circumstances, and as Agharkar has already described three larval forms under the letters " A ", " B " and " C ", I have thought it best to designate the new larval forms with letters starting with D. Nothing would be gained by giving them specific names and it would certainly increase the confusion in the nomenclature of this family. The adult forms, which are likely to be found later in India, would not, owing to the breeding of these organisms being difficult, be easy to connect with the described and named larvae. Nor is it advisable to name them according to their localities, as has been done in the past by Komárek and others, as several forms are sometimes found in one locality while the same forms are also known from different localities.

The collection consists of fifteen distinct types from different localities, as shown in the following table :—

NORTH-WESTERN INDIA.			
A. Kashmir.			
Nagaberan, 10,000 ft. ..	3 tubes	Larva A. Aghar.	*Blepharocera.*
H. Bion coll.		Larva A1 „	„
		Larva B „	*Euliponeura* ?
	not seen	Larva C „	*Euliponeura* ?
B. *Punjab.*			
Dalhousie (Outer Himalaya ranges).		Larva, pupa I	*Euliponeura.*
(*a*) Punj Pul Nullah,		Larva R1, R2	*Horaia.*
6,500 ft.		Larva, pupa O	*Apistomyia.*
S. L. Hora coll.		Larva K	Genus ?
May-June 1927.		Larva G	*Blepharocera.*
St. 1 & 3	1 tube	Larva P	*Apistomyia.*
		Pupa Q	Genus ?
(*b*) Krelnu Giri Nullah,		Larva R1, R2	*Horaia.*
6,500 ft.		Larva, pupa O	*Apistomyia.*
S. L. Hora coll.		Larva, pupa G	*Blepharocera.*
May-June 1927.		Larva, pupa I	*Euliponeura.*
St. 2	1 tube		
Chamba.			
Stream below power		Larva, pupa R1	*Horaia.*
house, 2,600 ft.		Larva, pupa D	*Blepharocera.*
S. L. Hora coll.		Larva, pupa E	*Blepharocera.*
May 1927		Larva L	*Apistomyia.*
St. 9	1 tube	Larva ?	
Simla.			
B. N. Chopra coll. St. 1	1 tube	Larva H	*Blepharocera indica* Brun. ?
NORTH-EASTERN INDIA.			
North-Bengal.			
Darjiling district,			
Pashok.			
(*a*) F. H. Gravely coll.	2 tubes	Larva R3	*Horaia.*
26-v-14 & vi-16		Larva M	*Apistomyia.*
		Larva ?	
Jhora stream, Tista bridge.			
(*b*) S. L. Hora coll. ..	1 tube	Larva R3	*Horaia.*
21-xii-26.			
Reo Jhora stream.			
S. L. Hora coll.			
18-xii-26 ..	1 tube	Larva R4	*Horaia.*
Assam.			
Dumpep (Khasi Hills).			
Pun-Wa-Sherra stream,			
S. L. Hora coll. ..	1 tube	Larva R1, R2	*Horaia.*
21-xi-26		Larva N	*Apistomyia.*
Burma.			
Kawngmu.			
5-xii-26	1 tube	Larva ?	*Blepharocera.*
6-xii-26	1 tube	Larva F	*Blepharocera.*
SOUTHERN INDIA.			
Nilgiris.			
S. L. Hora coll.			
21-x-26	1 tube	Larva J	Genus ?

Before describing the new forms, a few remarks are necessary on the larval forms described by Agharkar, the co-types of two of which I have had the opportunity of studying.

Larva A.

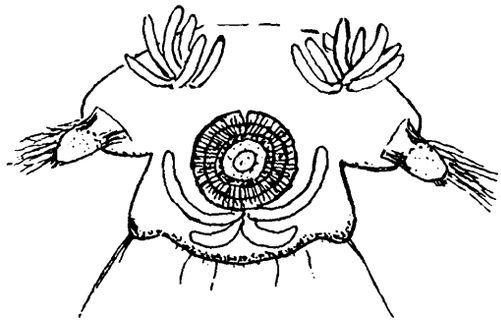


Text-fig. 1.—Larva A, dorsal view of last instar.

I give a new figure of this larva (fig. 1). The description of the antennae, as given by Agharkar, should be amended. The base and tip of the first segment and the base of the second are white. The general colouration is somewhat variable. The dorsum of each median division usually shows three ill-defined darker bands. The lateral ambulatory appendages are provided dorsally with the usual tuft of bristly hairs (not hair-like processes at the end of each). The gill-tufts are mostly composed of seven filaments (fig. 2), all of which are directed forwards.

The larvae A1 from the same locality, which Agharkar thought might belong to another species, do not differ essentially from larva A. They are specimens which had recently moulted and in consequence were not yet distended.

Agharkar mentions the possibility of larva A belonging to *Blepharocera indica* Brunetti, but this is not likely, as these larvae were collected in a far distant locality. Further, several species of the seven *Blepharocera*, as will be seen from the descriptions of the five larval forms described below, seem to exist in India. Of these, larva H, collected in the same district as *B. indica*, can, with some certainty, be referred to this species.

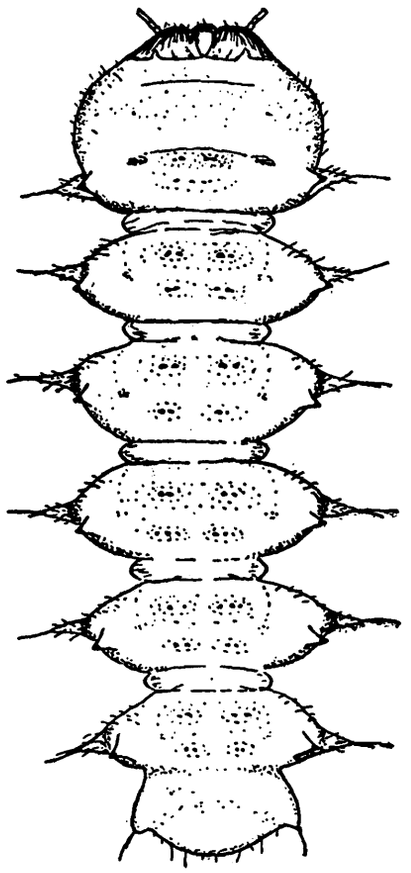


Text-fig. 2.—Larva A, ventral view of last segments of last instar.

I have no doubt that larva A belongs to the genus *Blepharocera*. I have compared it with some specimens of *B. fasciata* kindly sent me by Dr. Bischoff, and in spite of the variations in the larval forms of the latter species, I do not think that larva A belongs to it.

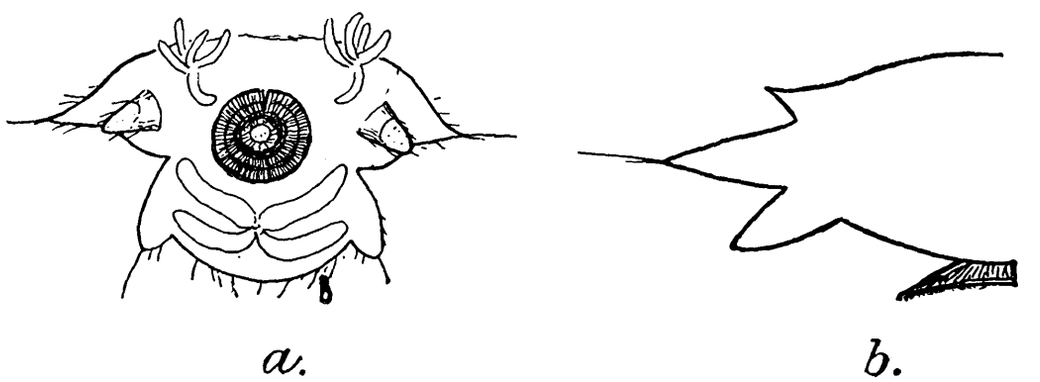
Larva B.

A new figure (fig. 3) of this species is also given. In the six specimens which I have examined there is no colour pattern of the type described by Agharkar. The general colouration is ochraceous-orange. The antennae are distinctly three-segmented, dark brown, with the base of the first two segments paler ; the second segment is about half as long as the third, and the first is somewhat shorter than the third. The head of this larva is remarkable in that the lateralia are not completely divided, as is the case in larvae of nearly all Blepharocerid genera except *Edwardsina*, some *Bibiocephala* species and *Philorus*. In this species, even in the large, nearly full-grown larva, the notch reaches only about one-third of the way to the base of the antennae. It measures 6 mm. Agharkar says that each division has four spines (meaning spinules), but the number of these spinules is very variable ; in the best marked specimens there are on each division four very slight tubercles, on each of which up to three small spinules can be distinguished, but sometimes they are completely absent on one or more of these tubercles ; the latter are also not always very distinct.



Text-fig. 3.—Larva B, dorsal view of a full-grown specimen.

The lateral feeling processes are directed outwards at right angles to the longitudinal axis of the body. They have, besides a scanty



Text-fig. 4.—Larva B.

a. Ventral view of last segments of a full-grown larva.

b. Diagram of a section of half of the median division of the body showing above the lateral spine, below the lateral feeling appendage and underneath the lateral ambulatory appendages.

pubescence, two long apical bristles ; the large side spines are placed just above the feeling processes. The two side lobes of the penultimate

segment are evidently the homologues of these processes ; this segment does not bear any ambulatory lateral processes. The ambulatory processes in this species are not much smaller than in other species ; they are, however, not visible from above owing to the lateral feelers extending just above them (fig. 4, *b*). The tracheal gill-tufts are usually composed of five filaments (at least in the last instar larvae), and only one of these is distinctly directed backwards (fig. 4, *a*).

This larva is possibly that of the species described by Agharkar as *Philorus bionis* discussed above. It shows strong affinities with *Liponeura* larvae owing to the presence of the lateral feeling processes, but otherwise it differs from all the described *Liponeura* larvae in the three-segmented antennae, the almost complete head capsule and the small number of gill-filaments. It is probably congeneric with larva I, described in detail below, which I have assigned to a new genus, *Euliponeura*, and to which probably *Ph. bionis* Agharkar also belongs. The special characteristic of larva B, however, is the almost complete head capsule ; this is a primitive character and is not found in larva I.

LARVA C.

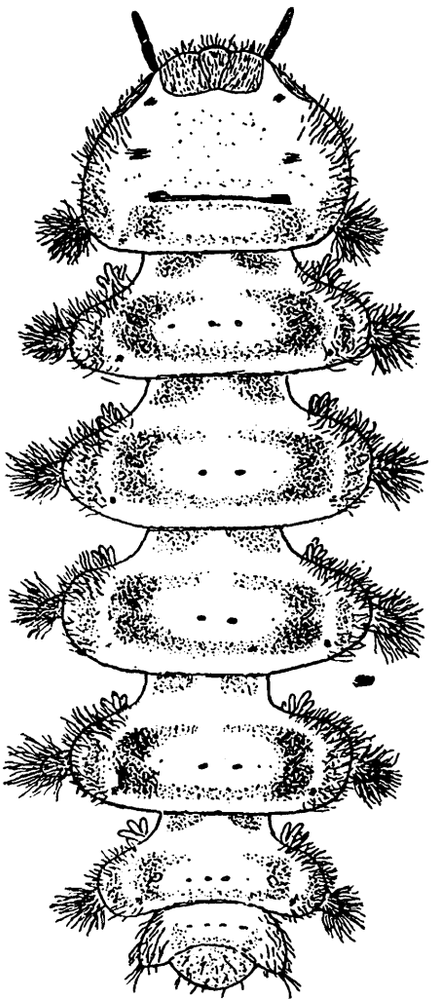
This larva, the unique specimen of which I have not seen, seems to differ specifically from the preceding one, though it evidently belongs to the same genus. Judging from Agharkar's description and drawings, it differs from larva B in the presence of two superposed lateral spines, just above the lateral feeling process, instead of one in the latter, and in having a single spiny bristle at the apex of the lateral feelers instead of the two found in larva B. The head capsule, so far as one can judge from the drawing, is almost complete, the lateralia are not divided by a complete cleft, but there is a small notch which does not extend to the base of the antennae.

LARVA D.

Locality : Chamba, Punjab. Stream below Power House, *alt.* 2,600 ft., Coll. S. L. Hora ; May, 1927. Seven specimens, five of which in the last instar are nearly full-grown, but do not show the pupal horns below the skin, and two specimens probably in the third instar.

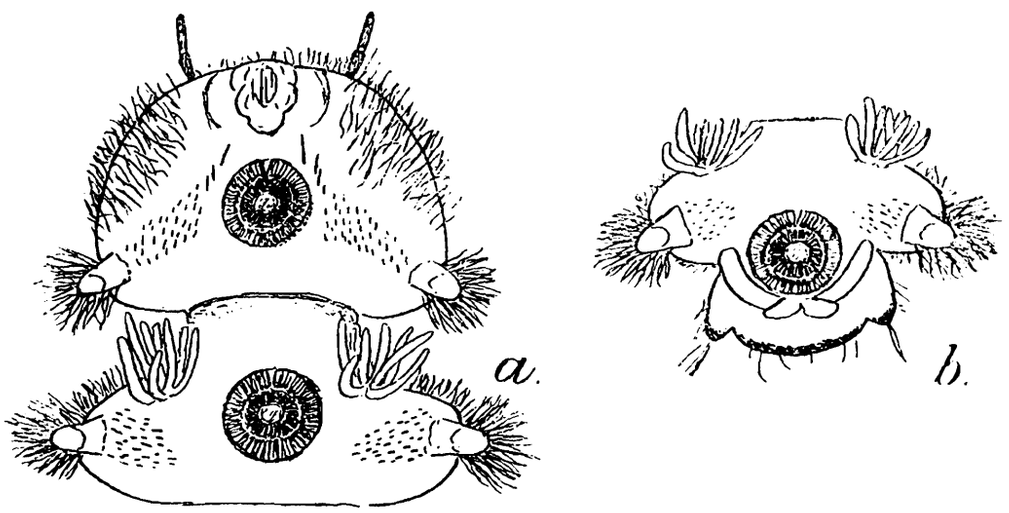
Length of the full-grown larva 6·5 mm. (fig. 5).

Head with incomplete capsule, the lateralia being split as usual. Antennae two-segmented, moderately long, segments sub-equal, black with a white portion between them which is the base of the second segment ; this white part is particularly soft ; sometimes the second segment has a constriction in its middle which makes the antennae appear three-segmented, as is sometimes found in larva A. The main divisions of the body do not show any trace of anterior secondary segmentation ; they are provided only with lateral ambulatory processes which, when seen from above, are subcylindrical, and more or less club-shaped when seen from below. They carry long hairs, similar to those of the body, but are overgrown by fungi and hence appear plumose and thick. The last body division has lateral ambulatory appendages on the foremost segment only, and a well marked



TEXT-FIG. 5.—Larva D, a full-grown specimen.

constriction between this segment and the next. There are no spines on the dorsum of the body, but a pair of dorsal median small dots and more or less large foveoles are present on the sides. The colouration is yellowish with a brown pattern as shown in fig. 5. This pattern is somewhat variable and sometimes the whole disc of the divisions is brown. The gill-tufts are relatively long with seven filaments placed anteriorly and all directed forwards (fig. 6, *a*, *b*). The sides of the segments on the ventral surface and near the base of the lateral appendages are provided with a group of small dark spinules. The two larvae in the third instar differ in the number of filaments, in the gill-tufts, which are only four, and in the less numerous spinules on the ventral surface of the body. The colour pattern is somewhat different; the disc has a pale patch in the middle and the lateral spots on the segments are absent. The disc of the divisions is provided with four transverse rows of small dark dots, the two anterior ones being well marked, while the others are rather indistinct. The third of these rows is apparently the only one that remains in larvae in the last instar.



TEXT-FIG. 6.—Larva D.

a. Ventral view of the first two divisions of a full-grown specimen.

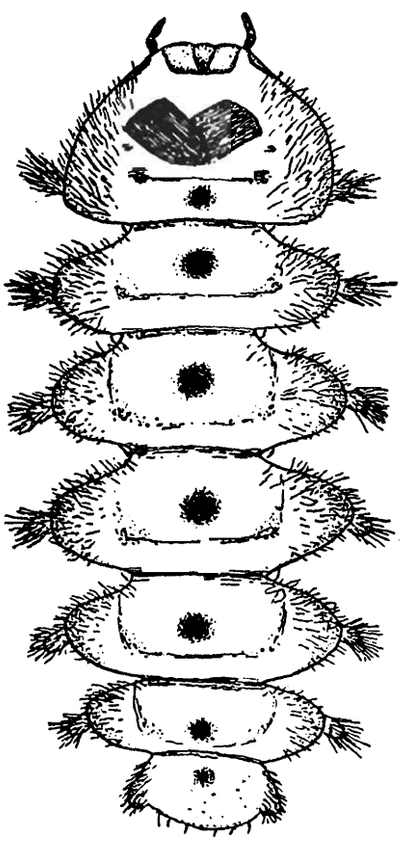
b. Ventral view of the last body division of a full-grown specimen.

This is the larva of a *Blepharocera* which is almost certainly specifically distinct from larva A, though the differences, except in the

colour pattern, as pointed out above, are slight. As a rule the colour pattern of Blepharocerid larvae is very variable in a given species and too much weight cannot be placed on this character for the differentiation of species, but when the difference is accompanied by a difference in the intimate texture of the integuments, as in the present case, this character becomes fairly reliable. In larva A, the integument on the disc of the median divisions and especially on their anterior half is very rugose, scaly and reticulated; it is this rugosity which forms the colour pattern. On the other hand, in larva D the integument of the disc, with the exception of a very faint punctation, which is nothing else than the pores of the very fine hairs covering the whole of the dorsum, is smooth. The integument in this larva is somewhat rugose only above and below the lateral foveoles where the colouration is darker than elsewhere. The antennae do not present any good differentiating characters, but the presence of dark spinules on the side of the divisions, when seen from below, is a feature which is not present in larva A; in the latter these spinules are very pale and small, and, therefore, not readily visible.

Larva E.

Same locality as the preceding one. Five specimens, four in the last instar, one apparently in the third instar.

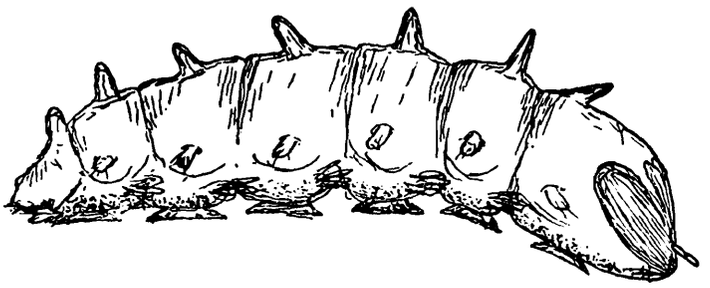


Text-fig. 7.—Larva E, dorsal view of a full-grown specimen.

Length of full-grown larva 5·5 mm. (fig. 7).

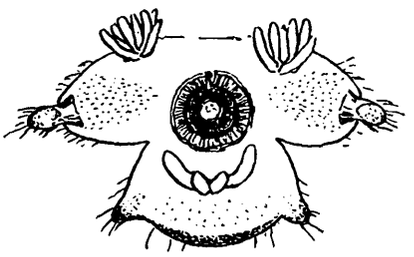
Antennae two-segmented, the segments sub-equal, tip of the first and base of the second white in the form of a white median ring. This larva resembles larva D in general, but the marks on the dorsum are different. The small spinules on the ventral surface are much more numerous, and the hairs on the body are perhaps not quite as long as in larva D. The general colouration of the dorsum is rather pale ochreous, darker on the disc, which has in addition a dark, round, very slightly raised tubercle; this is its main differentiating character from larva D. In a smaller specimen (4 mm. long) of the same instar the dorsal tubercle is about as high as long (fig. 8), while in a specimen 4½ mm. long the tubercle is still less prominent. It seems, therefore, that the tubercle is well developed at the beginning of the instar as depicted in fig. 8, but owing to the stretching of the skin becomes less prominent as the larvae grow. Larvae in the third instar about 3½ mm. long have the gill-tufts composed of only four filaments; the spinules on the under side

of the body are not numerous, numbering about twenty only on each side of the segments. The colouration is the same as in the full-grown



TEXT-FIG. 8.—Larva E, lateral view of a specimen at the beginning of the fourth instar.

larvae, and the dorsal tubercles are also very little developed. Seen from below, the last division shows a strong chitinisation of the posterior edge of the last segment and the side lobes. The anal gills at this stage, as can be seen in fig. 9, are very feebly developed.



TEXT-FIG. 9.—Larva E, ventral view of last segments of a full-grown specimen.

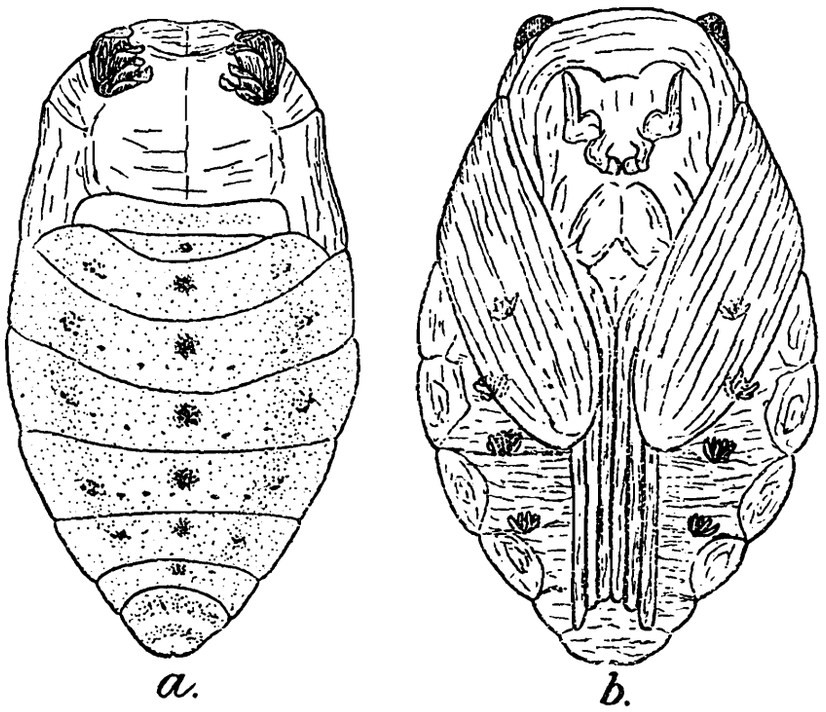
This larva belongs to a species which I believe to be different from larva D, although it was found in the same place as the latter, and in spite of the fact that, as has been pointed out by Bischoff (5), there are great variations in the morphological characters of the larvae of some species of this genus. According to Bischoff, for example, the form *armeniaca* Kom., with warts or tubercles on the dorsum, may be only a variety of *fasciata*, which exhibits these warts in much smaller numbers and only in the second instar. It seems to me, however, that a study of more material of *B. armeniaca* is necessary before Bischoff's contention is definitely proved. The fact that there appears to be no difference in the structure of the genitalia of *B. fasciata* typica and B. *armeniaca* does not mean that these two forms are not specifically distinct. In my study of Tasmanian Blepharoceridae I have shown that there may be only a trifling difference in the genitalia of the species which are quite distinct in their earlier stages, while in the Australasian Simuliidae I have found some series of species which are not distinguishable from each other in the adult stage by the structure of their genitalia, but the early stages of which are quite different; these forms in many cases were found breeding in the same spot, and cannot, therefore, be considered as races of the same species.

Larva E differs from larva D not only in the presence of the dorsal tubercle, but in the nearly complete absence of colour pattern, in the antennae having the tip of the first segment as also the base of the second white, and in the absence of the two small discal foveoles and more numerous spinules on the under side of the body.

PUPA E.

Some pupae collected in the same locality as larvae D and E, and illustrated in fig. 10, *a* and *b*, belong very likely to larva E on account

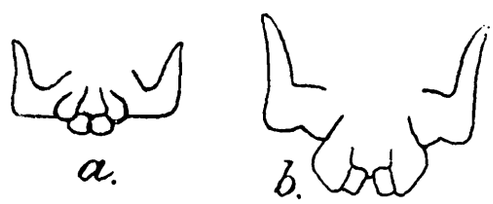
of the presence of small knobs on the disc of the abdominal segments. The breathing organs correspond to those of the enclosed pupae in one of the full-grown larva E, which is shown in fig. 7.



TEXT-FIG. 10.—Pupa E.
a. Dorsal view.
b. Ventral view.

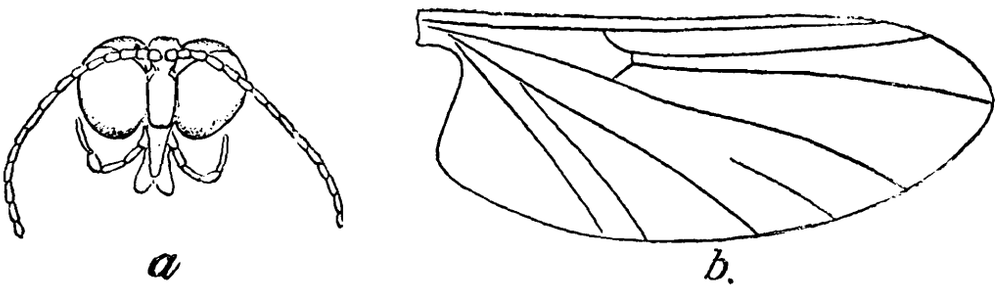
This pupa is of the usual type of the genus *Blepharocera*. The granulations are absent on the anterior part of the body, but cover all the abdominal tergites. The breathing organs are formed of four rather elongate lamellae, rounded at the tips and placed nearly perpendicularly on the body. The measurements of the large pupae are: length 4·5 mm., width 2·4 mm.

In the same lot there were five pupae of apparently the same species but in which the short, median knobs formed by the greater density of the granulations were not distinct. The structure of the under side and the shape of the head-sheath of these pupae, however, correspond to that of pupa E. None of these pupae had the imago very far developed. The wing was extracted from one of them, and is reproduced in fig. 12, *b*, the venation is of the type of *Blepharocera fasciata*. In none of the pupae is the genital organ of the imago sufficiently developed to determine the sex. The large pupae may be those of females and the small ones of males. The differences in the structure of the sheath of the mouth parts of both types of pupae are shown in fig. 11, *a* and *b*. On the dorsum there is no apparent difference as the median slight tubercles are not always present in the large pupae and the



TEXT-FIG. 11.—Pupa E.
a. Sheath of mouth parts of smaller specimen.
b. Sheath of mouth parts of larger specimen.

arrangement of the small foveoles does not seem to be constant. The head of the imago is not sufficiently developed in any of the large pupae to show the eye structure. The smaller pupae, numbering seven, are 3·9 mm. long and 1·8 mm. wide. All the mature imagines found in them are males. The head and wings, which are shown in fig. 12, *a* and *b* respectively, leave no doubt that



TEXT-FIG. 12.—Pupa E.
a. Head of male extracted from the pupa.
b. Wing venation of male fly extracted from the pupa.

they belong to a species of the genus *Blepharocera*. The eyes of the male dissected out of one of these pupae are just as in *Blepharocera jordani* Kell. and *B. osten-sackeni* Kell. from the United States of America. They are divided and the upper facet region is separated by a sharp line from the lower one. The difference in size between the facets is not very conspicuous; in the immature head the upper section is reddish and the lower one brown.

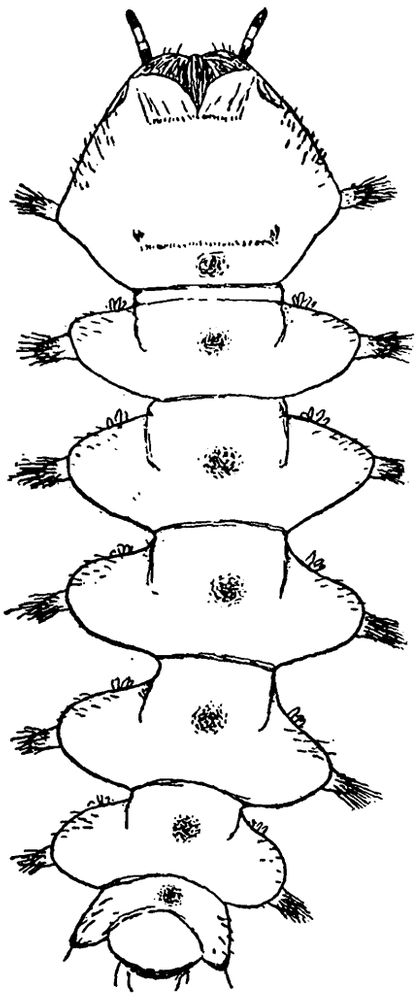
Both kinds of pupae may belong to the same species, the larger being the females and the smaller the males, and there would then be a sexual dimorphism in the mouth parts, or the larger pupae belong to larva E, and the smaller to larva D. Both of them, however, belong definitely to the same genus, and as the imago extracted from one of these pupae shows that it belongs to the genus *Blepharocera*, I have no hesitation in assigning the larvae and pupae referred to above to this genus.

A very interesting feature observed in these pupae was the presence in some of the very immature specimens of a small gill-tuft composed of the same number of filaments as in the larva (fig. 10, *b*) ventrally and on the anterior border of some of the abdominal segments. The two posterior tufts were free, the filaments being short, straight and directed forwards, while the two anterior tufts were covered by the wing sheath, the second only partially. In the immature pupae these filaments are full of a whitish substance, which has the same appearance after fixation in alcohol, in which the specimens were preserved, as it has in the preserved larvae. It is, therefore, possible that these gills are functional during the beginning of the pupal life, but that owing to the contraction of the imaginal abdomen inside the pupa, they soon loose all connection with it as metamorphosis proceeds; in more mature pupae they are present as quite transparent and empty structures. These gill-tufts are present in the pupae of genera like *Edwardsina* and *Neocurupira*, which I have examined, and are probably found in all the Blepharocerid pupae, but have apparently been overlooked up till now.

Larva F.

Locality: Kawngmu, Burma, 6th December, 1926. Eight specimens in the last instar. Collected on stones in a small stream, Coll. H. S. Rao.

This larva (fig. 13) resembles larva E in having the median rounded tubercles on the dorsum of all divisions. It belongs to the same genus, *Blepharocera*, but the two larvae which were found in widely separated localities appear to be specifically distinct.



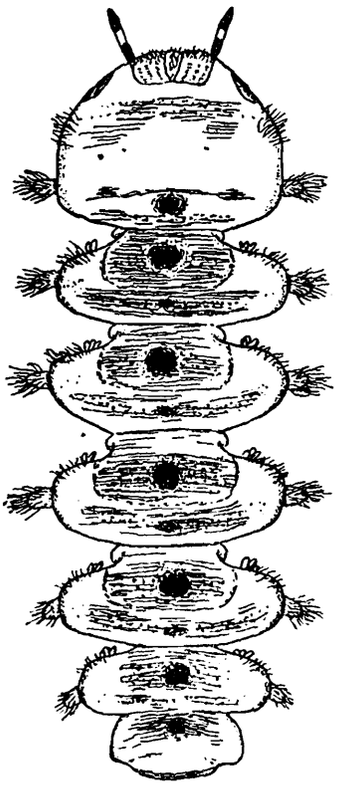
Text-fig. 13.—Larva F, dorsal view of a nearly full-grown specimen.

The following are the differentiating characters of larva F. The antennae have the first segment distinctly shorter than the second, the distal portion is largely white as also is the base of the second, and the two form a wide, white median ring across the antennae. The head capsule has only the anterior and median portion dark. The posterior part of the internal portion and the exterior part of the lateralia are nearly as pale as the body, the colouration of which is very pale yellowish. The median tubercles are light brown, and the edge of the last segment is dark brown and strongly chitinous. The pubescence on the body and on the lateral appendages is not very conspicuous. The gill-tufts are composed of six or seven filaments, all directed forwards. The spinules on the under surface of the divisions are not so numerous and so conspicuous as in larva E. The length of the body of a full-grown larva is 6 mm.

In a specimen in the pre-pupal stage the breathing horns of the pupa were to be seen distinctly under the skin; they were of the form usually found in the genus *Blepharocera*, and consisted of four elongated oval lamellae. The dorsal tubercles in this species do not seem to vary in height with the size of the larva; a specimen apparently at the beginning of the last instar (3·75 mm. long) did not show any more prominent tubercles than the full-grown larva. This is quite different from what was found in larva E, but may possibly be an individual variation. A specimen of a previous instar had the tubercles little developed. The very pale yellow dorsum of the body had a fine, even pubescence. The first segment of the antennae is equal to one-fourth of the second and is mainly white, as is the basal half of the second segment, which ends in a well-marked sensory seta. The gill-tufts consist of four filaments only. This larva is apparently in the third instar.

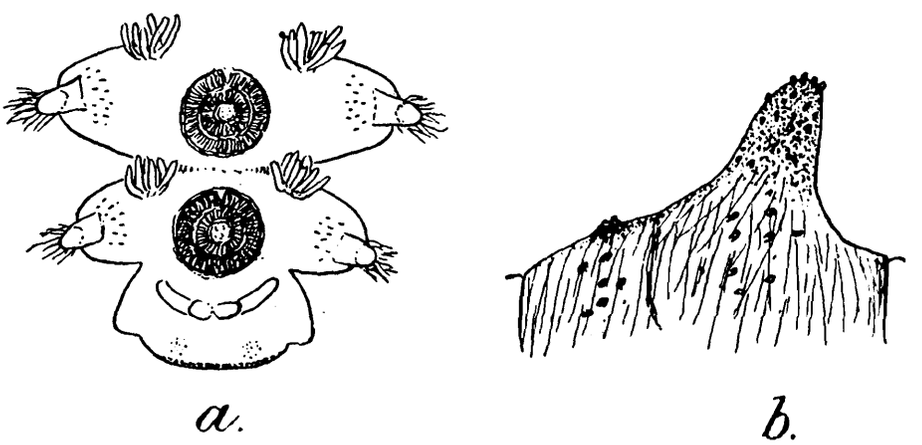
LARVA G.

Locality: Dalhousie, Punjab. Krelnu Giri Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1927. Numerous larvae of all sizes and of all instars.



TEXT-FIG. 14.—Larva G, dorsal view of a full-grown specimen.

This larva is somewhat similar to larva E, as it has dorsal tubercles. The tubercles in this form, even in the full-grown larva, are strongly marked being about as high as wide at the base or in some cases even higher (fig. 15 *b*). In a larva which has just moulted into the last instar, the dorsal tubercles are as well developed as those of larva E, shown in fig. 8, but they are dark, rugose, more pointed, and carry a number of spinules which are more conspicuous on the apex of the tubercles; those of the cephalic and anal divisions are noticeably smaller than the others, especially the former, which is a mere knob. The small tubercles on the posterior part of the median divisions are very little raised and are not always as distinct as shown in fig. 14; in some specimens they are quite rudimentary. The texture of the integument of this larva differs considerably from that of larva E, in having numerous strong granules; these are nothing more than the blunt spinules found in many Blepharocerid larvae. The marking is brown and is represented in fig. 14; the cephalic division, however, is nearly all pale. The antennae are longer than in larva E, and are differently coloured; the first



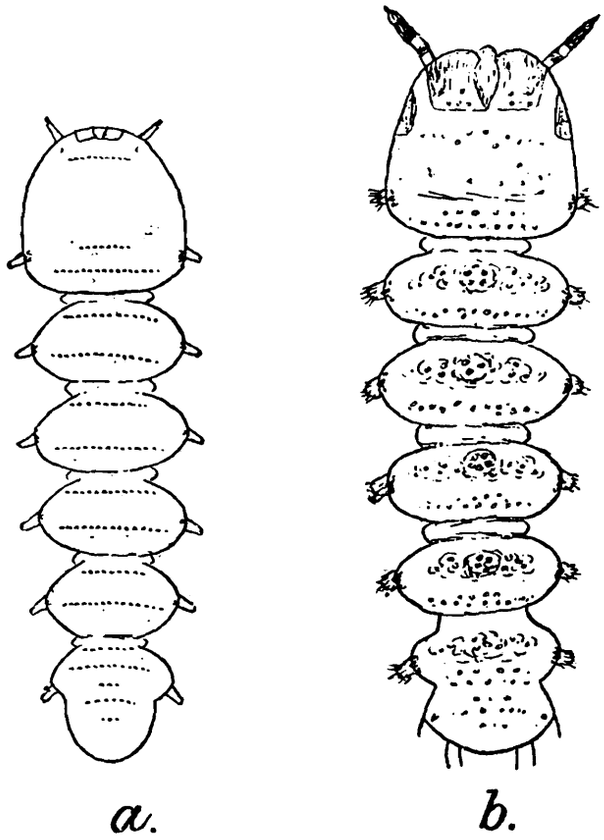
TEXT-FIG. 15.—Larva G.
a. Dorsal view of last segments of a full-grown specimen.
b. Lateral view of dorsal process of a full-grown specimen.

segment is completely dark, whereas the basal half of the second is white; its black distal half sometimes shows a more or less marked constriction which gives it an appearance of segmentation. The rest of the characters are as in larva E, but the spinules on the underside of the body are less numerous; the gill-tufts are composed of the same

number of filaments directed forwards. Fig. 14 shows a nearly full-grown larva, which is 5 mm. in length.

The first instar larva (fig. 16, *a*) has one-segmented, completely yellowish antennae; the lateral ambulatory appendages are of the type described by me for *Neocurupira chiltoni* (19, p. 23), in which there is a retractile group of hooks such as is found in many Blepharocerid larvulae. The median divisions carry on the dorsum two rows of very small, triangular spinules arranged in a very straight, transverse line on a slight, somewhat darker ridge; otherwise there is no distinct colour pattern. The sides of the division carry a small spinule (sometimes bifid) just above the lateral appendages. No gill-filaments, except the anal one, are present.

In the second instar (fig. 16, *b*) the dorsal tubercles are only very



TEXT-FIG. 16.—Larva G.

a. First instar. *b*. Second instar.

slightly raised and the dorsum is covered with transverse rows of strong blunt spinules. The antennae are two-segmented, but their colouration is different from those of the full-grown larvae. The body colour pattern is not fully developed. The ventral gills are formed of only one filament directed forwards. The third instar larva is very similar to that of the second except that the dorsal tubercles are well developed, almost as well as in the fourth instar; they are somewhat pointed and blackish and the general colour pattern is the same as in the full-grown larva. The posterior small dorsal tubercles are not present in the third instar, at least in the larvae which I have examined. The antennae are similar to that of instar 2 and there are four filaments in the ventral gills.

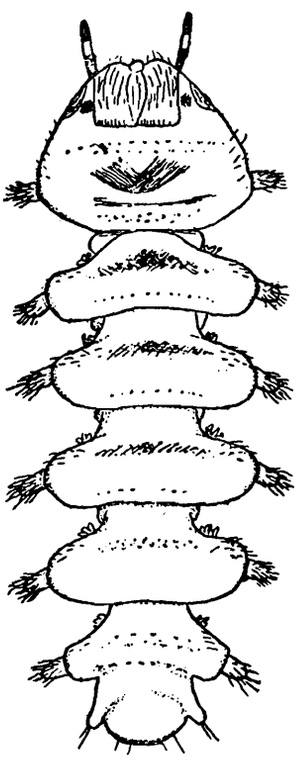
The same larvae were also found in Stations 1 and 3, Punj Pul Nullah, where they were more numerous. In the collection from both the localities there were few pupae which did not differ from the one shown in fig. 10, *a*, as belonging to larva E. They vary in length from 4 to 6 mm. There does not seem to be any dimorphism in the mouth parts between the larger and the smaller individuals. In some specimens, especially those from the Punj Pul Nullah, there is a distinct trace of tubercles on the discs of the abdominal segments. Unfortunately in none of these pupae were the imagines sufficiently developed for study of the morphological characters of the adult.

Larva G apparently belongs to a species of *Blepharocera* which is quite distinct from those described above. It has strong affinities with the larva of *Blepharocera armeniaca* Kom., which Bischoff (5, p. 963), after an examination of the Komárek material, considers as a subspecies of *B. fasciata.* Komárek (13) does not particularly mention the presence of transverse rows of granulations, but says that on the dorsum the colouration turns to brown on account of fine granulation. The main difference from *B. armeniaca* is in the antennae, which are much longer than in larva G, and which, according to Bischoff, are quite unsegmented. In *B. armeniaca* the posterior small tubercles are present also on the first two segments of the anal division which, therefore, has four tubercles instead of the two in larva G.

LARVA H.

Locality: Simla, Punjab. Coll. B. N. Chopra. Three specimens in the last instar, one in the pre-pupal stage.

Colouration very pale-yellow, with slight infuscation on the dorsum of the first three median divisions, on which there also is just a slight trace of a median tubercle. The head capsule for a specimen near pupation is remarkably large (fig. 17). The fronto-clypeus is completely visible from above. Antennae rather long, two-segmented; the first pale but darker distally; the second nearly twice as long as the first with the basal half white and the distal black. The dorsum of the body is rather bare, smooth, or with only small roundish granulations (blunt spinules), quite distinct from the pupal granulations visible through the skin; the larger granulations form two groups on each of the median divisions. In the anterior group they are more numerous and rather irregularly arranged, whereas in the posterior group they form a nearly regular transverse line. On the first three median divisions the dorsum is very slightly raised in the region of the anterior group of granules, and is darker. The under side of the body is like that of larvae D or E, and there are five spinules on the sides of the divisions. Gill-tufts, composed of seven



TEXT-FIG. 17.—Larva H, a full-grown specimen in pre-pupal stage.

filaments, all directed forwards. Length of body 5 mm. when fully extended after treatment in potash; other specimens 4 mm. long.

This larva of *Blepharocera* is very near larvae E and F, but I believe it to be specifically distinct from either on account of the presence of blunt spinules which give an appearance of granulation to certain parts of the integuments of the divisions. This larva may be that of *Blepharocera indica* Brun. which was found in the same district. In spite of the great variability of *B. fasciata* which has been shown to occur by Dr. Bischoff, I do not think that this larva belongs to that species; the shape of the last division, as I found on comparison of specimens and by reference to Dr. Bischoff's figures, is quite different from that of *B. fasciata.*

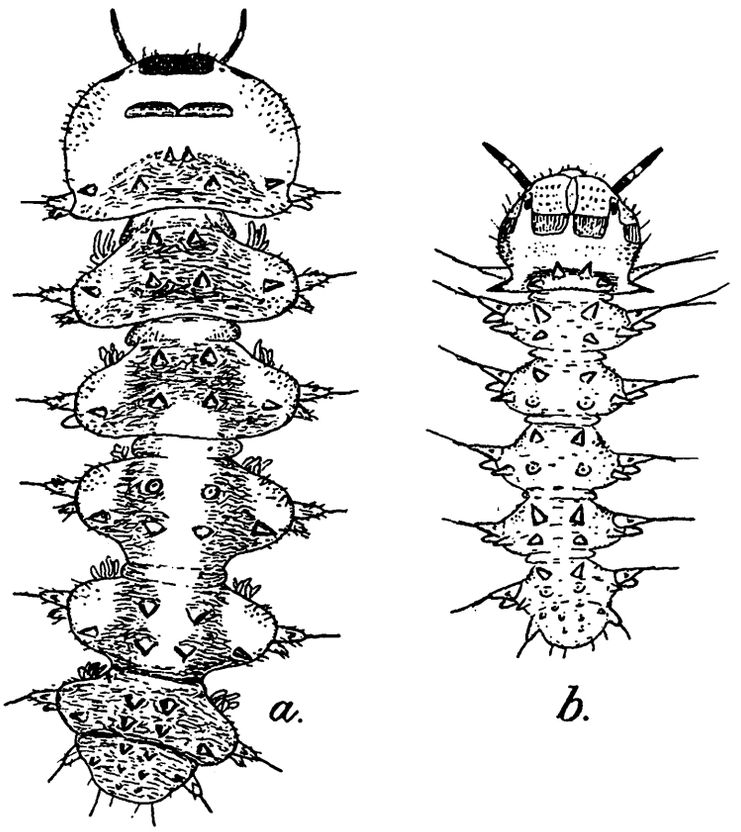
LARVA I.

Euliponeura horai, gen. et sp. nov.

Locality: Dalhousie, Punjab. Punj Pul Nullah and Krelnu Giri Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1927. Numerous larvae in second, third and fourth instars and a few pupae.

In the full-grown larva near pupation, which is 5 mm. long, the head capsule has, as usual, split lateralia. Antennae rather long, three-segmented, the segments being sub-equal; the base of the first is narrowly white, the base and tip of the second are also white, but the rest is black, and as a result the antennae have a ringed appearance. The colouration, however, is variable, as sometimes the whole antennae are black with the exception of the white narrow articulation between the second and the third segments. The colouration of the body is reddish-brown with the sides and a dorsal part on divisions 3-5 paler, somewhat yellowish. The lateral ambulatory appendages are placed below and somewhat behind the lateral feeling appendages, which are inserted laterally on the divisions and point perpendicularly to the axis of the body. The ambulatory appendages are rather short, conical and rather rounded at the end; they are not strongly chitinised, are rather pale in colour, and have fine hairs on their upper surface. The feeling appendages, which are of the same nature as the other protuberances of the dorsum, are separated from the body by actual constrictions; they are not fleshy but chitinised, though perhaps not so much as in some species of the genus *Liponeura.* They appear to be more strongly chitinous than the ambulatory appendages, at any rate their colouration is darker. They are conical, pointed, with a small number of fine hairs on the upper surface and one, sometimes two long bristles at the tip; it appears that these terminal bristles become easily detached. On the middle of the upper surface of these appendages, except on the first pair, there is a small conical projection ending in a sensory organ similar to that of the conical protuberances of the body. The anal division carries two pairs of feeling and one pair only of ambulatory appendages. The conical processes of the dorsum are arranged as shown in fig. 18,*a*, six on each of the cephalic and median divisions and only two small median ones on the last segment. They are rather horny and carry a sensory cone at the tip.

The dorsum is also provided with a large number of blunt spinules which are especially marked along the sides. The ventral gills are



TEXT-FIG. 18.—Larva I.

a. A full-grown specimen in pre-pupal stage.

b. A specimen at the beginning of the third instar.

composed of five filaments, three or four of which are directed forwards. The anal gills are normal.

The collection has a small number of larvae in the second and third instars, the smallest being 1·5 mm. long.

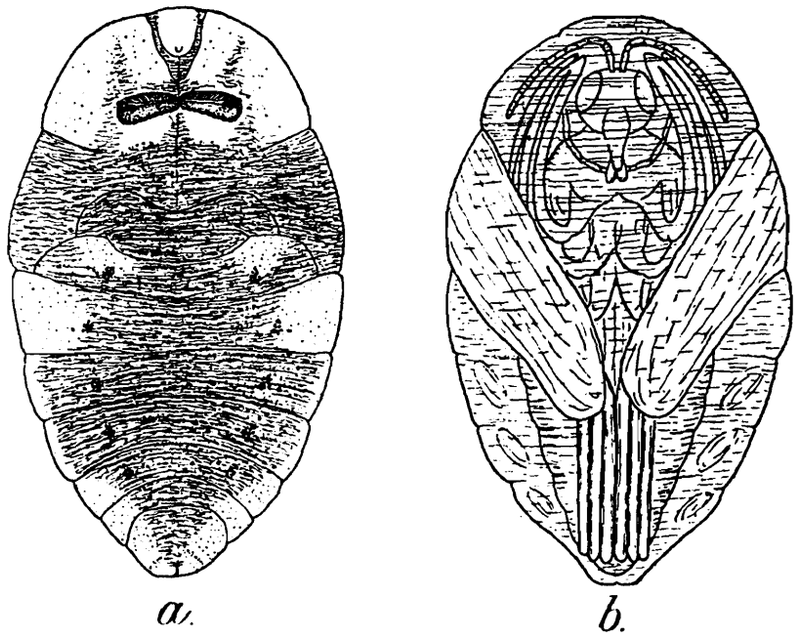
The second instar larva differs from the full-grown one in the antennae being two-segmented, the first segment being less than half as long as the second, which is white at the base and the tip ; the distal half of the second segment is evidently conical. The two kinds of lateral appendages and the dorsal, conical tubercles are similar to those of the full-grown larva, except that the last pair of dorsal cones is not distinct. There is only one filament in the ventral tracheal gills in this instar, and there is no distinct colour pattern.

The third instar larva (fig. 18,*b*) has two segmented antennae, with sub-equal segments ; the first is narrowly white at the base and tip and the second at the base only. The colour pattern, when the specimen is nearly fully extended, is similar to that of the full-grown larva. The ventral gills have three filaments, two directed forwards and one backwards. In this instar and the preceding one the lateralia of the head capsule are prolonged backwards by more or less chitinous pieces quite peculiar to this species ; only a slight trace of these is left in the last instar.

When the larva has not reached the end of an instar and when its body is not distended it has, as can be seen by comparison of figs. 18,*a* and *b*, a much more spiny aspect.

In one of the full-grown larvae (fig. 18,*a*) the peculiar breathing organs of the pupa, similar to those of a pupa found among the same material, were to be seen through the transparent skin, and I have, therefore, no doubt that the pupa here described belongs to the same species.

This pupa, which varies between 4 and 5 mm. in length and 2·5 to 3 mm. in width, is characterised by its colour pattern as depicted in fig. 19,*a*. Its unusual flatness and very peculiar breathing



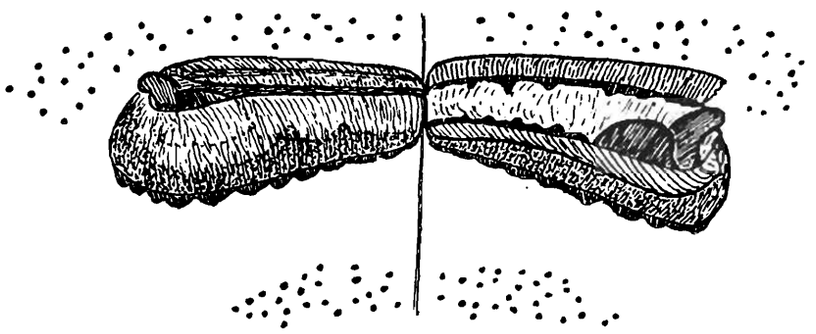
TEXT-FIG. 19.—Pupa I.

a. Dorsal view. *b*. Ventral view.

organs are very different from those of the other known pupae of the family. Its flatness, especially that of its anterior part, renders the dorsum of the head-sheath visible to a great extent from above. Its colouration is reddish-brown with yellow fasciae present mostly on the anterior part of the thorax, on the side, the base and the tip of the abdomen. This colour pattern varies to a certain extent, but corresponds generally to that represented in fig. 19,*a*.

The breathing organs are placed right against one another, as is usual in *Apistomyia* pupae, but in this case there is only one pair of lamellae, the internal ones; these are very small, and are enclosed in a sort of transparent, transverse, rounded envelope formed by the fusion of the two external lamellae. This envelope presents a narrow slit above through the outer end of which emerges the tip of the small inner lamellae, the slit being somewhat enlarged at this point. The transparent case is placed on a strongly chitinised, blackish base, with irregular corrugations; the base extends inside the case. In fig. 20 I have attempted to show these unusual breathing organs. The one on the left is represented in its natural condition, whereas the one on the right has been opened by pulling apart the lips of the longitudinal slit to

display the inside of the cavity enclosed in the case and the internal lamellae. The anterior lamella is wide and rounded, while the posterior

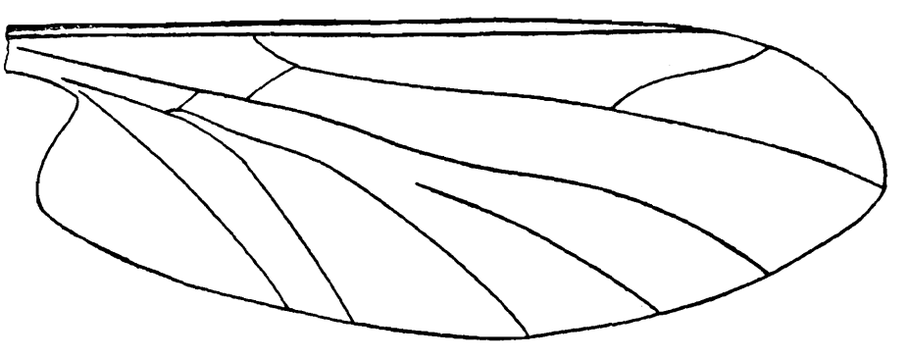


TEXT-FIG. 20.—Pupa I, breathing organs.

is narrow and curved outwards; the stigmatic opening is found at the bottom of the cavity alongside and behind the anterior lamella.

A couple of imagines were sufficiently developed inside these pupae to make out most of their morphological features.[1]

The venation is shown in fig. 21. It is similar to that of *Philorus*



TEXT-FIG. 21.—Wing venation of *Euliponeura horai*, sp. nov.

as the posterior basal cell is present and the fork of Rs. is short. The male has filiform, elongate, fourteen-segmented antennae; the eyes are widely separated, the frons is equal to half the height of the eyes; the ocellar tubercle is prominent, the eyes are not divided, and the upper facets are evidently not larger than the lower. The mouth parts are about as long as the height of the head; the palpi are elongate, five-segmented. A couple of apical tibial spurs are present only on the hind pair of legs; the claws are simple. In the female the fourteen-segmented antennae are somewhat shorter than in the male; the eyes are rather small, undivided, with all facets of equal size; the frons is as wide as the eyes; the ocellar tubercle is not very prominent. The mouth parts are as in the male, and the mandibles are present. The legs are as in the male.

The genitalia in both the sexes were not sufficiently developed for description of their structure.

The venation, the eyes, the mouth parts and the antennae are sufficiently characteristic for determining the generic position of this fly.

[1] While this paper was in the press Dr. Hora sent me an adult of another species of this genus; it is described further, in the addendum.

It does not agree with any of the known genera. The venation resembles that of *Philorus* in the presence of the posterior basal cell and the rather short fork of Rs., as in *Philorus yosemite* O.-S. and *Philorus ancilla* O.-S., but the eyes are neither divided nor touch each other. The undivided and widely separated eyes with equal facets in both sexes somewhat resemble those of *Liponeura*, but the new form differs from it in the fourteen instead of fifteen-segmented antennae, and in having a short fork of Rs. The early stages further differ from those of *Liponeura* in the three-segmented antennae of the full-grown larvae and with only five filaments in the gill tufts. The flat pupae of this genus, with very peculiar breathing organs, are quite different from those of *Liponeura*. Of all Blepharocerid larvae, larva I, in common with those of *Bibiocephala*, *Philorus* and *Liponeura*, possesses lateral feeling appendages.

In view of these differences I tentatively propose the generic name of *Euliponeura* for this form, the genotype being *E. horai*, sp. nov., the larval and pupal stages of which are described above. The imaginal specific characters such as colouration, structure of the genitalia, relative length of the segments of the antennae, palpi and legs are not available, and the wing venation, as given in fig. 21, would be the only character by which the species could be distinguished in the adult stage.

As has been remarked in the description of larva B, which is very probably the early stage of the fly described by Agharkar as *Philorus bionis*, this species may have to be included in this new genus. The larva differs from that of *Euliponeura horai* in the nearly complete head capsule; it otherwise agrees with the latter in having the three-segmented antennae (when fully grown), the presence of lateral feeling appendages and small number of filaments in the gill-tufts. It appears, therefore, probable that Agharkar's *Philorus bionis* might also belong to this genus, the only important difference between it and *Euliponeura horai* being the length of the fork of Rs. The absence of mandibles in the female of *Philorus bionis*, as stated by Agharkar, may be simply due to the fact that these organs are not easily detected.[1]

Larva C is very near the larva of *E. horai*, it only lacks the dorsal conical protuberances on the body, and I have no doubt that the two forms are congeneric.

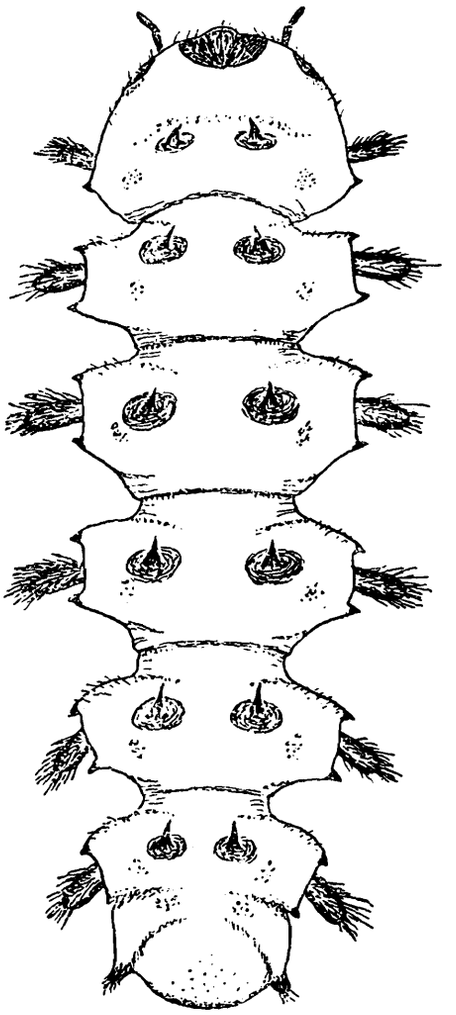
LARVA J.

Locality: Nilgiris, Southern India. From torrential stream below Benhope Bungalow in very rapid water on rocks. 21st October, 1925. Coll. S. L. Hora. Four specimens; three in the last instar, one in the third.

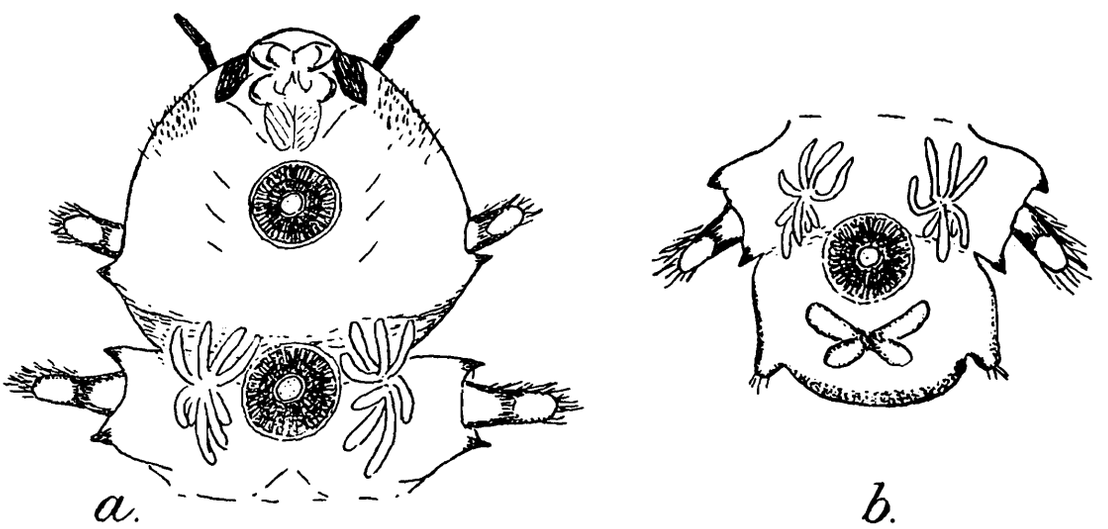
Length 6½ mm. The general colouration is ochreous brown without definite markings; the posterior margin and sides of divisions are darker, the edge of the last segment and the lobes are blackish. The integument is more strongly chitinised than in *Blepharocera* larvae in

[1] As has recently been pointed out by Edwards (10, p. 35) the mandibles may be absent in one species but present in another species of the same genus; their presence or absence, therefore, does not constitute a generic character.

general. The head capsule is divided; the lateralia are far apart; and the limit between the capsule and the rest of the cephalic division is not well defined. The mouth parts are normal. The antennae are two-segmented, the segments being sub-equal and both black. The armature of the body is composed of a pair of very strong and erect black spines inserted on a brown, round, strongly chitinous disc (fig. 22). These spines are sub-vertical and longer than the lateral appendages, except the first and the last pair which are shorter. The sides of the cephalic division have one spine on the posterior corners, the other divisions two spines, one anterior and one posterior to the base of the lateral ambulatory appendages. The pubescence of the body is small and inconspicuous, except laterally and on the anterior and posterior margin of the divisions. Above the dorsal discs there is a row of small foveoles. Lateral appendages sub-cylindrical, strongly chitinous, black anteriorly, and posteriorly with fine hairs on the tip and dorsum, which are paler in colour. The gill-tufts are usually composed of eight filaments, four directed forwards and four



TEXT-FIG. 22.—Larva J, a full-grown specimen.



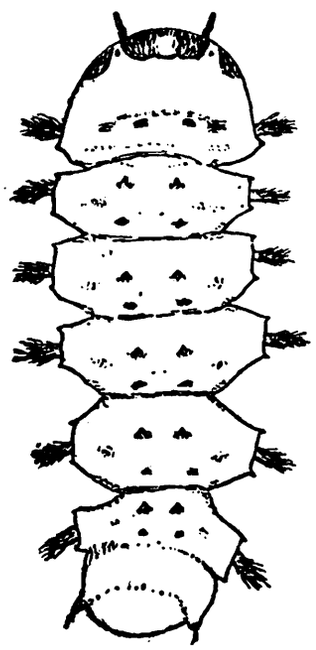
TEXT-FIG. 23.—Larva J.

a. Ventral view of first two divisions. *b*. Ventral view of last division.

backwards, and arranged as depicted in fig. 23,*a*, *b*. The anal gills are small. When recently moulted, the dorsal spines are more

or less pale and proportionately longer than in the full-grown larvae here depicted.

In the same tube was a larva, about 4 mm. long, which can be referred without any doubt to the same species. Its lateral appendages are also hairy dorsally and at their tips, and there is a pair of spines on the side of each median division. The structure of the terminal division is identical. The larva (fig. 24), however, differs in its dorsal armature. It has two pairs of spines on each of the divisions except the first, the front pair of which is stout, though not so well developed when compared with those of the last instar larva; the divisions are about as long as broad. The gill-tufts are composed of four filaments, two directed forwards and two backwards.



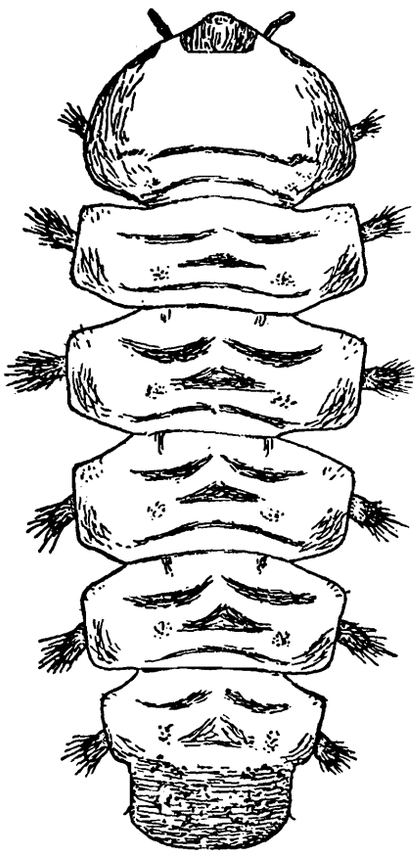
Text-fig. 24.—Larva J in the middle of the third instar.

It is difficult to determine the generic position of this larva. Neither the head capsule nor the antennae are specially characteristic. The dorsal spines are merely specific characters for similar ones are found in genera so far apart as *Liponeura* and *Curupira*. The terminal segment resembles that of a *Blepharocera*, as is clear from a comparison of fig. 22 with fig. 17. The number of filaments in the gill-tufts agrees with what is found in *Blepharocera*, but they are not all directed forwards as is the case in that genus. The integument is tougher than what is normally the case in *Blepharocera*, while the shape of the lateral appendages with hairs on the dorsum and at the tip only and their mode of insertion are quite peculiar. For these reasons I refer this form, with great uncertainty, to the genus *Blepharocera*. As the Nilgiri Hills in Southern India belong to the same zoological province as Ceylon, whence only the genus *Hammatorrhina* is known, one would be tempted to connect this unusual larva with that genus; but I do not think that this *Blepharocera*-like larva could be that of such a specialised genus as *Hammatorrhina*. Further, from the scanty description of the larva of the latter genus,—from the specimen exhibited at the meeting of the Entomological Society of London in 1890 (Gahan 11),—it is clear that this larval form had only five filaments in the gill-tufts; no mention was made of the very striking dorsal spines.

Larva K.

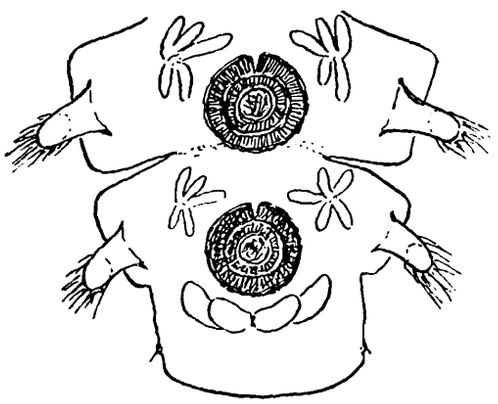
Locality: Dalhousie, Punjab. Punj Pul Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1929. One specimen apparently full-grown but not showing pupal horns through the skin.

Length of the body fully extended after boiling 5·55 mm. (fig. 25). This larva is of a type similar to that of *Paltostoma* and *Curupira*, and is characterised by the unusual shape of its last division. The antennae are two-segmented, with the completely black segments sub-equal. The head capsule is completely dark and normal with split lateralia. The dorsum does not carry any conspicuous spines or



TEXT-FIG. 25.—Larva K, nearly full-grown specimen.

hairs, but the anterior and posterior corners of the divisions are provided with very small spinules. The dorsum of each division has an anterior and a posterior transverse dark mark which does not extend to the sides; the anterior one is formed by two crescents, placed end to end, whereas the posterior one is in the form of a thin arc; between the two is a dark, triangular area. These markings are formed by a heavier chitinisation of the dorsal integument which is somewhat shining; elsewhere on the dorsum the integument is finely striated, the striae being arranged in a more or less regular longitudinal direction, except in between the central dark triangle and the anterior and posterior markings, where they are transverse. The whole dorsum is rather dark brown. The last two segments of the anal division form a dark straight-sided and round-ended prolongation, on the sides of which one can hardly see from above just the traces of lateral appendages of the penultimate segment (fig. 26). The lateral ambulatory appendages are dark, subcylindrical when seen from above, but have a broad base when seen from below; their dorsal surface is covered with numerous fine hairs. The gill-tufts are composed of five filaments, three directed forwards and two backwards, as shown in fig. 26.



TEXT-FIG. 26.—Larva K, last division from below.

The generic position of this larva is very doubtful. The almost entire absence of the seventh pair of lateral appendages or side lobes is reminiscent of what is found in *Paltostoma schineri*, *Curupira torrentium*, most species of *Dimorphotarsa* and in *Neocurupira nicholsoni*, but this character alone would not be sufficient to justify referring larva J to the *Curupira* group. Other important characters, which also seem to point in that direction, are the two-segmented antennae, the complete absence of neck anterior to the body divisions (fig. 25 represents the fully extended larva after boiling), the small number of gill-filaments and their orientation as also the absence of a demarcation between the last two segments of the anal division.

This larva shows probably more evident characters of relationship with that of *Apistomyia* in the two-segmented antennae, the number and disposition of the gill-filaments, the lack of a definite demarcation between the last two segments and the reduction of the last pair of appendages; this is, however, not quite so reduced in the larvae of *Apistomyia* so far known. On the other hand, the conformation of the main body divisions of larva J are quite different from that of *Apistomyia*, for it has two complete transverse posterior and anterior ridges separating the disc of the divisions from their tapering anterior and posterior parts. The fine striations of the integument are also found in *Apistomyia*. Larva J may, therefore, be considered as a more specialised type than *Apistomyia* larva, which has almost completely lost the last pair of appendages and in which the two transverse complete ridges are only represented by the anterior and posterior dark linear markings formed by stronger chitinisation of the integument at these places.

Genus **Apistomyia.**

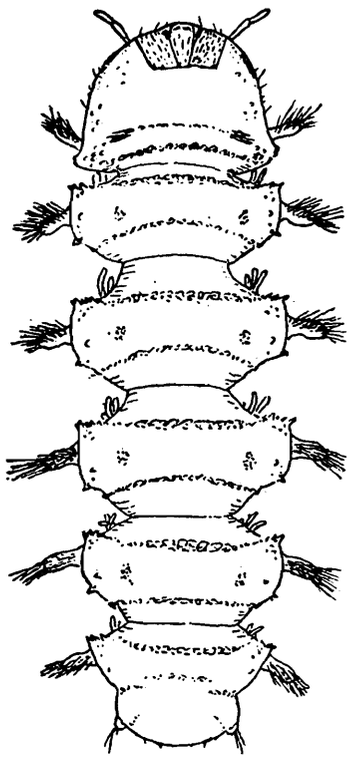
The collection from the Indian Museum contains numerous larvae which doubtless belong to the genus *Apistomyia*, for they correspond very well to the two known larvae of this genus; that of *A. elegans* Big. described by Edwards (8) and that of *A. tonnoiri* Till. which I described from Australia (17). The main features of the larvae of this genus are the presence on the dorsum of each division of an anterior and a posterior transverse ridge formed by strong sculpture, usually spinulous granulations or rather strong spines; these two ridges sharply divide the dorsum of each body division in three sections, a feature which is not found in other Blepharocerid larvae. Two of these ridges are also found on the posterior part of the cephalic division, but the last two segments of the anal division do not show traces of them. The penultimate segment of the anal division carries a pair of lateral appendages, apparently analogous with the ambulatory appendages but much more reduced. They are usually as long as wide, and are not visible from above in some species such as the Australian one; in all the forms described here they are either partly or completely visible from above. In the latter case they are somewhat similar to the small lobes found at the end of the body of *Blepharocera* larvae, though they are distinctly separated from the rest of the body either by a constriction or else by their more horny texture.

All the known *Apistomyia* larvae have two-segmented antennae, their gill-tufts are composed of only five filaments, the integument of the dorsum is strongly chitinous and exhibits either striations or some other net-like texture, or more or less numerous strong granulations usually carrying a sensory apical spinule. The five forms here described and figured seem to me to belong to different species. Only in one locality Dr. Hora succeeded in obtaining some adults together with the larvae of *Apistomyia* here described as larva O. These two specimens, females, agree rather well with the description of *Apistomyia trilineata* Brunn.; they have, however, a black ocellar triangle instead of brown, a distal flattened second scapal segment which is not specially

mentioned in *A. trilineata*, grey pleurae instead of black, complete basal grey transverse bands on most abdominal segments instead of only the anterior basal corners of that colour. In view of Brunetti's description being rather deficient (his type is in reality a female and not a male, as noted already), it is impossible without comparing them with the type to decide whether these specimens belong to a different species. The locality of *A. trilineata*, however, is Eastern Himalayas, which is widely separated from Dalhousie in the Western Himalayas where larvae O were collected. The *Apistomyia* larva here described as larva M from the same district as *A. trilineata* seems to differ specifically from larva O.

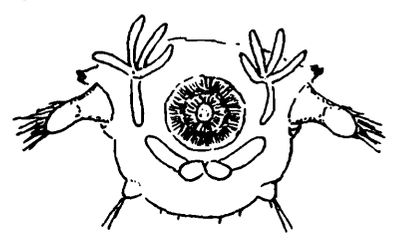
LARVA L.

Locality : Chamba, Stream below Power House, 2,600 ft. Coll. S. L. Hora, May, 1927. Nine specimens.



TEXT-FIG. 27.—Larva L, a full-grown specimen.

Length of the full-grown larva 5·25 mm. (fig. 27). The antennae are black, moderately long and two-segmented, the first segment is somewhat longer than the second and a little incrassate at the tip. The head has split lateralia, the capsule is not very distinct from the rest of the integument, which is rather dark and strongly chitinised. The main divisions only have lateral ambulatory appendages which are somewhat club-shaped, and are provided with long hairs on their upper surface and their tips only ; some rather inconspicuous spines are also intermixed with the hairs ; these appendages are ochreous yellow, much paler than the body. The general colouration is dark brown without distinct pattern. The cephalic division has two posterior ridges of granules, while each median division has a posterior and an anterior ridge of similar granulations which take on the form of more or less acute teeth or spines on the sides. The anal division has only the anterior ridge. The penultimate segment of the last division has a pair of very small and sub-conical appendages of the same nature as the lateral ambulatory appendages ; these are visible from above (fig. 28). The gill-tufts usually have five filaments, four of which are directed forwards and a longer one backwards ; sometimes, however, only four are found in larvae in the last instar.



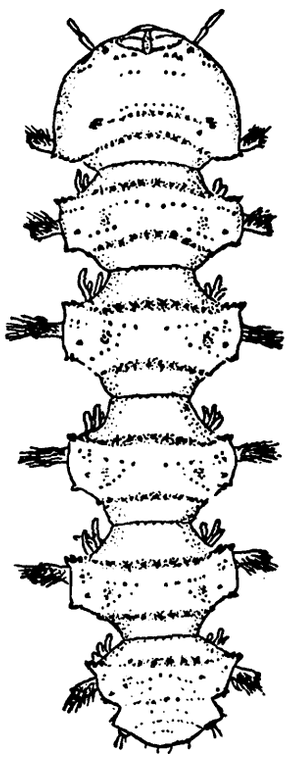
TEXT-FIG. 28.—Larva L, last division from below.

The same tube contained four larvae of an earlier instar, apparently the third. They are 3 mm. long, and differ very little from the full-grown larvae. The two ridges are present on each division, but

the teeth or spines on the sides of the body are less prominent. There are only three filaments in the gill-tufts, two directed forwards and one backwards. The appendages of the penultimate segment are proportionately just as well developed.

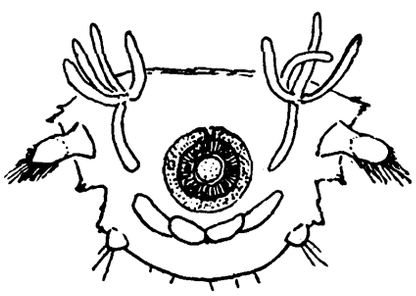
LARVA M.

Locality: Darjiling district, North Bengal. Pashok. Coll. F. H. Gravely, 26th May, 1914. Nineteen larvae, fourteen of which were in the last instar, none showing the pupal horns through the skin.



TEXT-FIG. 29.—Larva M, a full-grown specimen.

Length of the body 4·5 mm. in the full-grown larva (fig. 29). The antennae are two-segmented, the first being slightly swollen at the whitish tip; the base of the second segment also is narrowly white and gives to the antennae a ringed appearance. The head has split lateralia and in the slit the eye spots are clearly visible. The general colouration is rather pale ferruginous, but is not by any means as dark as in the other known larvae of the genus *Apistomyia*. The first division carries a row of blunt spinules just behind the head capsule. This row is composed of two median groups of two to three stronger spinules, which are followed on the side by a number of smaller ones. The posterior part of the cephalic division has two rows of blunt spinules or granulations, the posterior one being on the edge of the division; these ridges formed by the spinules are darker brown than the rest of the dorsum of the body, the integument of which exhibits a quite peculiar fine, ferruginous reticulation, especially in the neighbourhood of the granulations and spinules from which they radiate. Each of the median divisions has an anterior and a posterior ridge of granules in between which there is another line of granulations placed near the anterior ridge. On the sides the granulations of the ridges are replaced by more or less strong spinules, rather strongly developed on the anterior and posterior corners of the divisions. There are besides a number of smaller spinules or granulations forming on each side a small oblique line posteriorly. The lateral appendages are more or less club-shaped with a fine, moderately long whitish pubescence on the dorsal surface only. The last body division (fig. 30) shows, especially on the sides, a well marked constriction between the first two of the three segments of which it is composed; the penultimate segment at its posterior end is angular on the sides, and carries a pair of rather



TEXT-FIG. 30.—Larva M, last division from below.

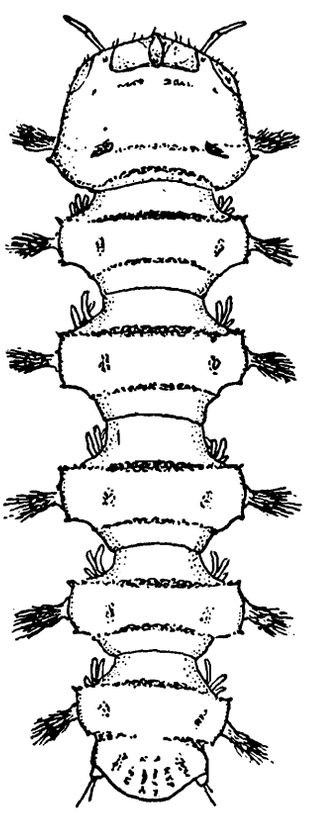
small reduced lateral appendages visible from above ; the last segment is rounded. The ventral gill-tufts are composed of rather long filaments, four directed forwards and one backwards. The anal gills, which are normal, are moderately long.

A few larvae were in the third instar ; these vary in length between 1·75 mm. and 2·75 mm. They are similar to the last instar larvae, but for the three branched gill-tufts and the lesser development of the sculpture on the dorsum ; the spinules or granulations are less numerous on the anterior and posterior ridges. The spines on the sides of the divisions are also less numerous. The small appendages of the penultimate segment are placed nearer the edge and hence are more visible from above.

This larva of *Apistomyia* differs from the preceding one in the sculpture and ornamentation of the dorsum of the body divisions and is possibly the larva of *A. trilineata* Brunn., which was collected in the adult stage in the Darjiling district.

Larva N.

Locality : Dumpep, Khasi Hills, Assam. Pun-wa-Sherra stream. Coll. S. L. Hora, 21st November, 1926. Numerous larvae in second, third and fourth instars.

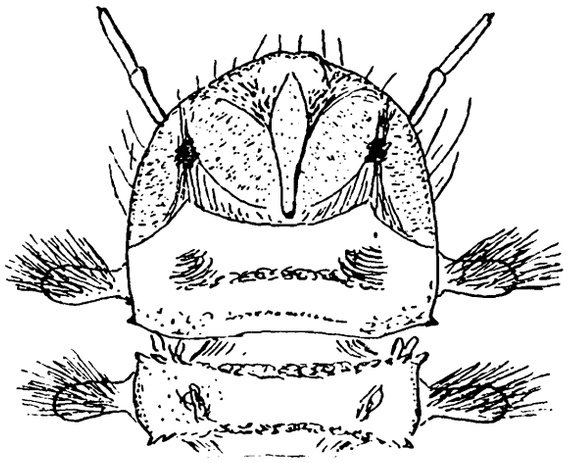


Text-fig. 31.—Larva N, a full-grown specimen.

Length of body of the full-grown larva 5 mm. (fig. 31). The antennae are two-segmented, with the segments sub-equal, completely black, the first one is somewhat enlarged at its distal end, but is without any white ring. The integument of the dorsum is dark brown, but paler than in larva L, and the reticulation of the skin can, therefore, be distinctly seen in a good light. The main divisions do not show any blunt spinules in between the two main ridges of granulations, as is the case in larva M. The last division exhibits a number of foveoles arranged as shown in fig. 31. The ventral gills are composed of five filaments, four directed forwards and one backwards. The lateral appendages carry long, fine hairs which are usually thickly covered with a fungus of the genus *Empusa*.

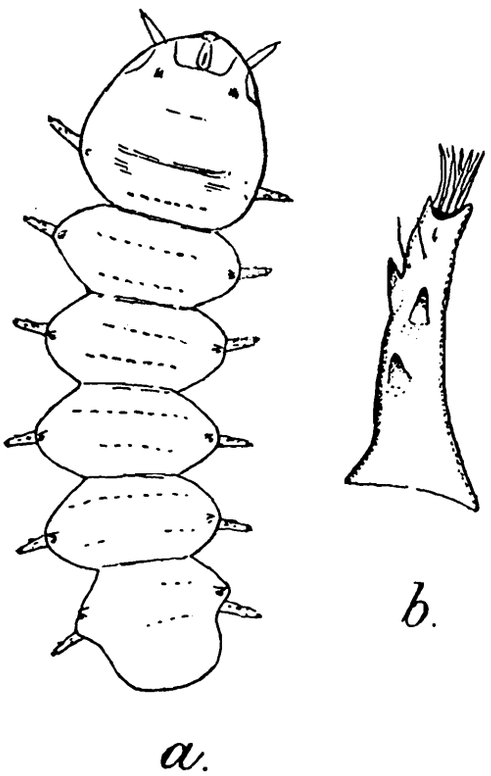
The second instar larvae measure from 1 mm. to 2 mm. Towards the middle of this instar the anterior part of the cephalic division in front of the anterior ridge is usually much paler than the rest of the body. The transverse ridges are not as well marked as in the full-grown larva, but there is a rather distinct blunt spinule or tubercle on the middle of each side of the division at the level of the lateral appendages. The first antennal segment is shorter by at least half than the second conical segment. The gills are formed of only one filament pointing forwards ; the anal gills are comparatively large.

The third instar larvae vary in length from 2·5 mm. to 3 mm. The lengths of the antennal segments are not equal, but in this instar the difference is not as great as in the preceding one; the first segment being just a little shorter than the distinctly conical second segment. Just after passing into that instar the head capsule and the antennae are of a creamy white colour, the capsule being larger than half of the division (fig. 32). In this stage the lateralia evidently are not split, and the eyes, therefore, lie well under the head capsule. The sculpture is very similar to that of the last instar, except that the space of the dorsum in between the two ridges of granulations shows a row of very weak granulations in the specimens which are not fully extended.



TEXT-FIG. 32.—Larva N, the first two divisions of a specimen just moulted into the fourth instar.

In the same tube was a larva of the first instar measuring 1 mm. (fig. 33,*a*). The antennae in this larva are one-segmented, and completely black. The fronto-clypeus is provided with a distinct egg-burster. The lateral appendages are conical (fig. 33,*b*) with a few lateral or dorsal spinules and ending in a bundle of four to five apical setae. There is no trace whatever of the retractile organs which are found in many Blepharocerid larvulae. Above the base of the lateral appendages there is on the side of each division a pair of spines; these are absent on the cephalic division. Each body division exhibits a double row of microscopic triangular teeth. There is no distinct colour pattern but the integument of the dorsum is finely striated. There are no ventral gills present except the anal ones.

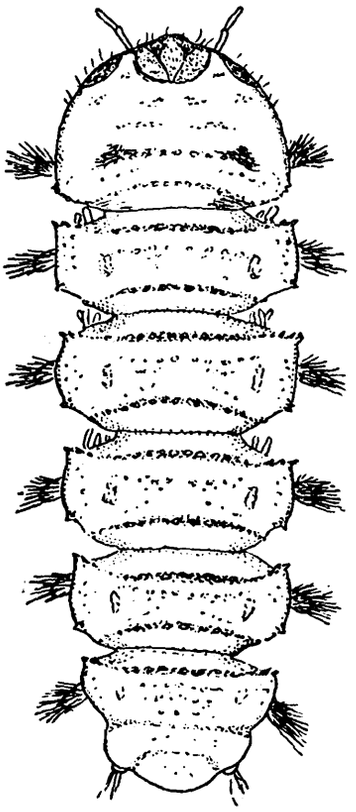


TEXT-FIG. 33.—Larva N.
a. A specimen in first instar.
b. Lateral process of first instar.

This larva is very similar to larva L, but it is doubtful if it belongs to the same species. The fine texture of the dorsal integument differs from that of the former in a few points, which, however, are difficult to illustrate, while the sculpture of the last division is markedly different.

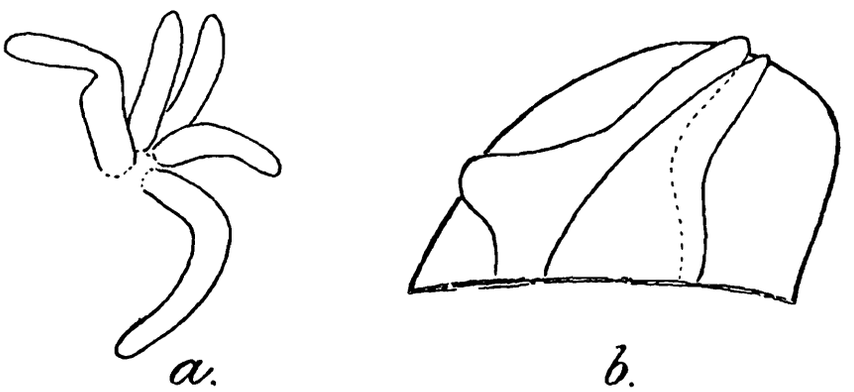
LARVA O.

Locality : Dalhousie, Punjab. Krelnu Giri Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1927, and Punj Pul Nullah. Twenty-eight full-grown larvae from the first locality, some of which exhibit the pupal horns below the skin. The larvae from the second locality are very numerous, and most of them are in the last instar.



TEXT-FIG. 34.—Larva O, a full-grown specimen.

Length of full-grown larva 6 mm. (fig. 34). All the morphological characters of this larva are very similar to those of larvae L and M. The antennae are completely dark and not ringed with white as in larva M. The larva differs from the two forms described above in the granulations on the dorsum of the divisions between the two transverse ridges of granulations. The number of these discal granulations seems variable. They are as a rule less numerous on the anterior divisions and in some specimens there seems to be only a single row of them, except on the last division. The anterior internal filament of the gill-tufts has a more apparent two-segmented structure than in the other two species (fig. 35,*a*). The colouration is almost dark brown, the fine structure of the integument of the dorsum of the divisions is markedly different from that of larvae L and M, and I believe this form to be specifically distinct from both of them. The pupae in the course of formation below the skin were quite distinct in some specimens, and one was dissected. The shape of the internal lamellae of its breathing organ is shown in fig. 35,*b*.

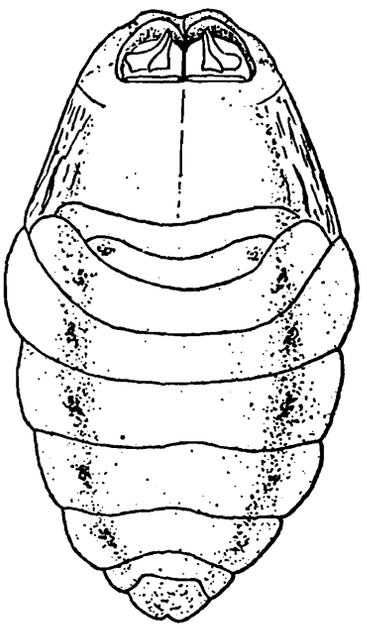


TEXT-FIG. 35.—Larva O.

a. Gill-tufts of fourth instar.
b. Breathing organ of pupa extracted from larva.

The specimens from the second locality vary in length between 2·5 mm. and 6 mm. They correspond in every point to the specimen described above ; the median granulations on the disc of the division are also very variable, and sometimes there seems to be only a single row of them, especially on the anterior divisions.

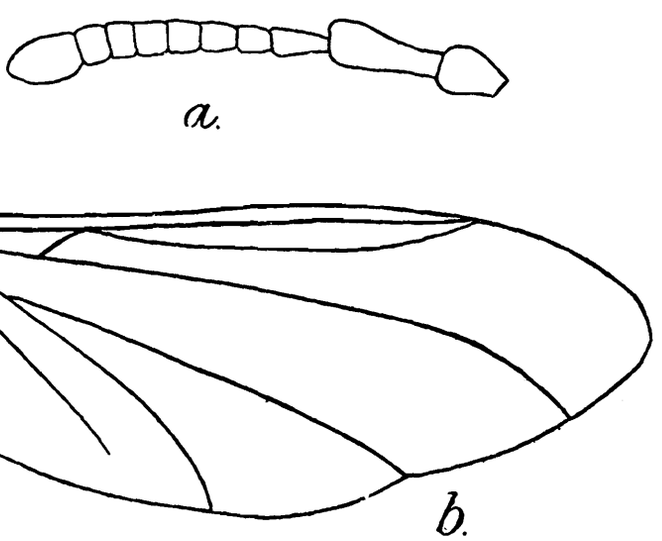
The larvae in the second instar do not show as many granulations on the dorsum of the divisions. Usually there is only one single row in between the ridges but they may be absent altogether from some of the divisions, particularly the penultimate. The colouration of this instar, just before passing into the next one and showing the latter below the skin, is quite peculiar; the body is then much darker than the anterior two-thirds of the cephalic division. The first antennal segment is distinctly shorter than the second. In that instar the length of the body varies between 1·75 mm. and 3 mm.



TEXT-FIG. 36.—Pupa O.

A number of pupae were present in the tubes containing the larva O from the two localities referred to above. Their form is shown in fig. 36. These pupae are characterised by the structure of their breathing organs, which are very similar to those of *A. tonnoiri* Till. described by me (17, p. 55), except that the shape of the internal lamellae is somewhat different and the anterior lamella has a much more developed side lobe.

In two of the pupae the imagines were sufficiently mature to be extracted. In both cases the imagines were males. The antennae are quite different from those of *Apistomyia trilineata* Brunn., but this is apparently a sexua ldifference, as some less advanced female imagines, dissected out of similar pupae, exhibited the characteristic flat second scapal segment. As the male of *A. trilineata* is not known, it cannot be stated definitely whether the males extracted from pupa O belong to that species. On



TEXT-FIG. 37.—Pupa O.

a. Antenna of male fly extracted from the pupa.

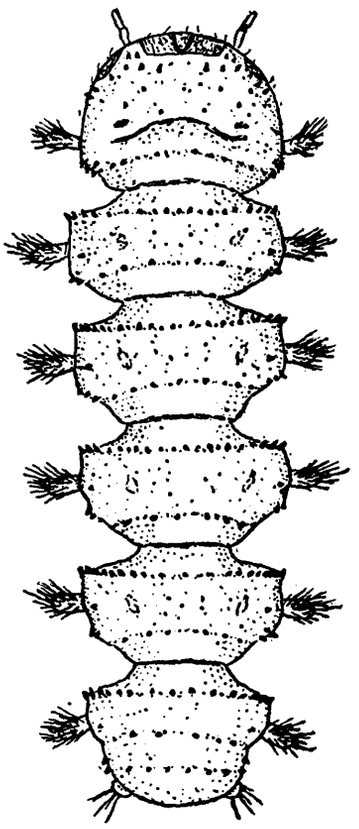
b. Wing venation of male extracted from the pupa.

the other hand, they are not sufficiently mature to allow of a complete description. The structure of their antennae and wing venation is shown in fig. 37,*a* and *b*.

LARVA P.

Locality: Dalhousie, Punjab. Punj Pul Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1927. Four larvae in the third instar.

Length of body 3 mm. (fig. 38). The colouration is very dark brown, nearly black in some specimens. This larva is to be distinguished from the other *Apistomyia* larvae described in this paper by its rather spiny appearance and the smaller bristles of the lateral appendages, which, however, are more strongly developed than in the other species; in the latter they become indistinct among the tufts of longer hairs; the hairs are also somewhat coarser in this larva. The antennae are two-segmented, completely black, with the segments sub-equal. The lateral appendages are comparatively large and have the same colouration as the body. On the cephalic division there is on each side an anterior curved row of black spines with the outer ones much larger. They are preceded by a few smaller spines between the slits of the lateralia. A group of spines is also found at the posterior edge. Each body division carries similar spines on the anterior ridge, whereas the posterior ridge carries only half a dozen; the strongest are found on the sides. An isolated spine is also found on each of these divisions above the base of the lateral appendages. All the spines are black. On the disc of these divisions there are about four or five very small black spinules, visible only under a high magnification. The last division of the body is shown in fig. 38; in this view the last pair of small appendages is visible from above. The ventral gill-tufts are composed of three filaments, two directed forwards and one backwards.



TEXT-FIG. 38.—Larva P, a full-grown specimen.

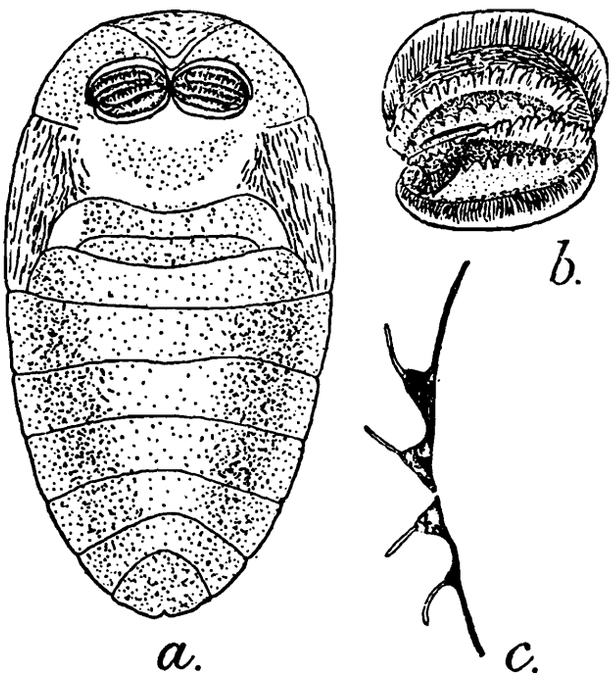
On account of its striking spiny appearance and its dark colouration this larva, from the same locality as larva O, could be separated quite easily from the numerous specimens of the latter species. The larvae of this species also differ by the absence of definite rows of granulations on the discs of the divisions, and may, therefore, belong to a different species. They have been carefully compared with all the specimens of the third instar of larva O, which even in the beginning of that instar never show such a spiny ornamentation.

PUPA Q.

Locality: Dalhousie. Punj Pul Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1927.

Length of body 7·5 mm.; width 4·5 mm. This large pupa is rather flatter than is normally the case (fig. 39,*a*). The sutures of the head and prothorax are distinctly visible from above. The colour is also

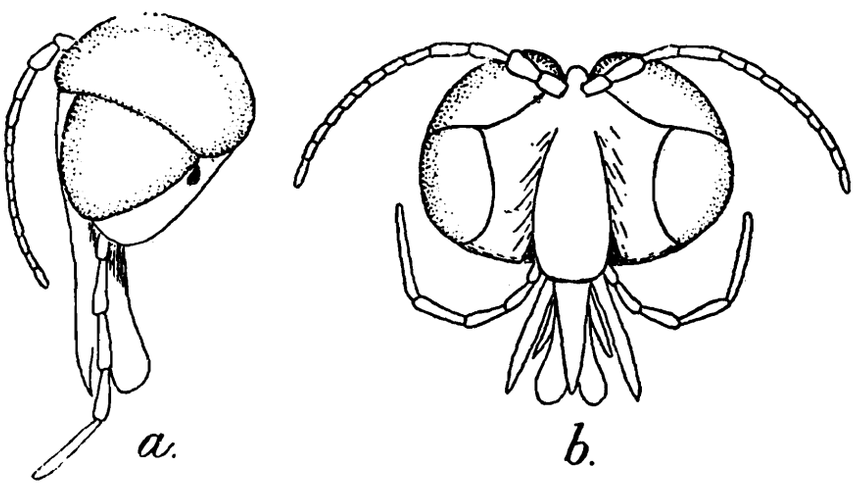
somewhat paler than is normally the case in Blepharocerid pupae. The head sclerite projects backwards and lies almost against the breathing organs, while the suture between the pro- and meso-thorax reaches nearly to their base. The breathing organs are very peculiar and so far without equal among those of the known pupae of the family. They are formed of four arched ridges, the outer ones enclosing an ovate area in which are found the two transverse internal ridges. The external ridges carry a narrow transparent membrane directed outwards and the internal ridges, which are somewhat corrugated and dark-coloured, carry also a colourless fringing membrane with numerous and irregular indentations which give them the appearance of being torn to pieces ; the spiracle is found in between the two internal ridges in the normal situation. An attempt at depicting this unusual organ is reproduced in fig. 39,*b* and a diagrammatic longitudinal section of it in fig. 39,*c*.



Text-fig. 39.—Pupa Q.

a. The entire animal.
b. Left breathing organ.
c. Diagrammatic section of breathing organ.

The imago enclosed inside this pupa is rather far advanced ; its sex could be determined from the shape of the end lamellae and the presence of the ovaries. The principal morphological features are as follows : The eyes are hairy, bisected, the upper portion of large facets being larger than the lower portion, as can be seen from



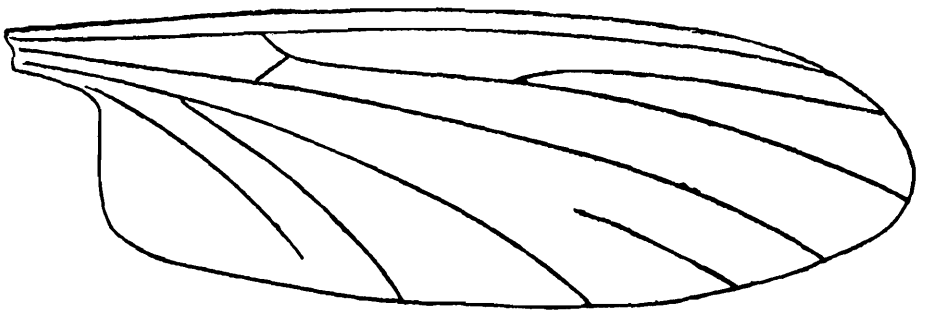
Text-fig. 40.—Pupa Q.

a. Head in profile of female extracted from the pupa.
b. Front view of head of female extracted from the pupa.

figs. 40, *a* and *b*. The frons is very narrow and keeled, the proboscis is short, the mandibles are present ; the palpi are five-segmented and are

longer than the proboscis. The antennae are longer by half than the height of the head, and are thirteen-segmented. The tibial spur formula is 0·0·2. The wing venation is depicted in fig. 41, which is a diagrammatic drawing of the rather crumpled unfolded wing. On account of its immature state it was neither possible to make out clearly the base of M and Cu, nor to decide whether the posterior basal cell is present. The wing venation, however, is characteristic owing to the long stem of the fork of Cu, which is similar to that found in *Philorus yosemite* O.-S.

The generic position of this pupa, in spite of the imaginal characters which were made out by dissection of the immature female fly enclosed in it, is doubtful. On account of the general flatness of the body, the



TEXT-FIG. 41.—Diagrammatic venation of wing extracted from Pupa Q.

continuity of the breathing organs, and of the corrugated ridges on which some of the lamellae are inserted this pupa is allied to that of *Euliponeura*, but the head structure of the female fly with a narrow frons and bisected eyes is different. On the whole the head is more like that of *Blepharocera* or *Bibiocephala*, it resembles that of *B. doanei* Kell., but for the thirteen-segmented antennae. It is unfortunate that the presence or absence of the posterior basal cell could not be ascertained in the immature crumpled wing, for that would have definitely established its affinities with *Euliponeura* or *Blepharocera*. On account of the bisected and approximated eyes this fly, if the posterior basal cell were present, would be closely allied to *Philorus*.

I do not think that this pupa has any connection with larva K found in the same locality as that larva is of a much more specialised type than the imago found in pupa Q would suggest.

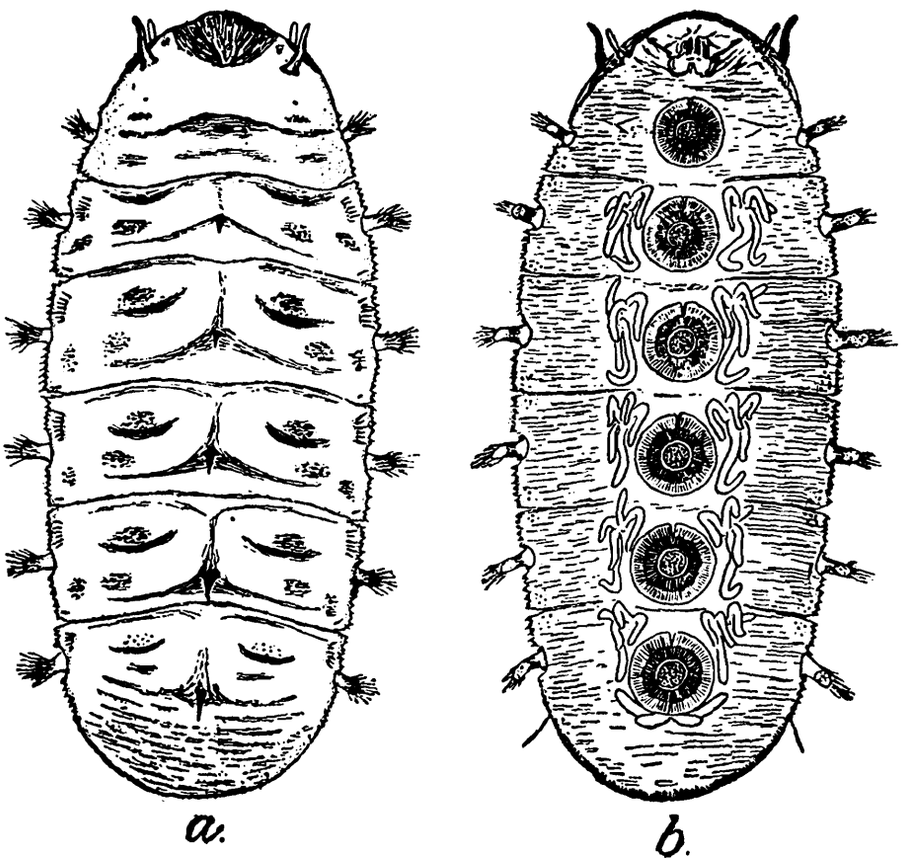
LARVA R_1.

Genus **Horaia**, nov.

Locality: Chamba, Punjab, *alt.* 2,600 ft. Stream below Power House. Coll. S. L. Hora, May, 1927. Fourteen full-grown specimens with discal spines and one in the third instar also with discal spines; one in the third instar, seven in the second instar and three in the first instar; all without discal spines.

Length of body 6·75 mm. to 7 mm. when full-grown (figs. 42, *a*, *b*). The body is oval without any marked constrictions between the divisions, as in other larvae of the family; the divisions are indicated by small indentations on the sides. The underside is very flat, while the dorsum is arched like a coccidiform shield; the sides of the body have a sharp edge which is finely serrated and ciliated. The colouration is sometimes

yellowish with brown markings as depicted in fig. 42, *a*, but the colour pattern is variable in the last instar. It can range down to uniform



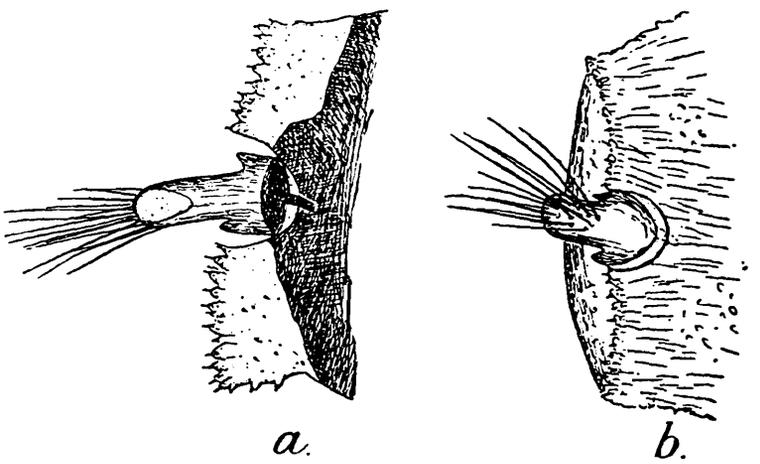
TEXT-FIG. 42.—Larva R_1.

a. A full-grown specimen.

b. Ventral view of a full-grown specimen.

brown, but sometimes only the sides are brown leaving a more or less continuous central pale vitta ; in the latter case the granulations of the skin over the dorsum are very coarse, but this kind of granulation may also be found in pale specimens. The head is of the usual type with split lateralia ; the eyes are distinct, the mouth parts are normal, there being no distinct mentum. The antennae are black, short, two-segmented ; the first segment about half the length of the second, which is somewhat fusiform ; the first segment is not visible from above. The cephalic division carries on each side a long, erect, black, horn-like spine placed just behind the external portion of the lateralia. Similar dark, long and rather thin spines are present on the middle of the disc of each of the other divisions ; on the second division the spine is placed just midway between the anterior and posterior borders ; on the following divisions the spine shifts gradually to the posterior border, but it is on the middle of the anal division. The divisions have on each side three depressions ; the anterior ones, rather elongated transversely, are bordered posteriorly by a dark brown crescent-shaped streak ; on the second division the depressions lie right against the anterior margin but on the following divisions they are placed gradually further backwards ; the others are formed by a number of small pits and are of a brown colour. The lateral appendages are rather small, club-shaped, black, strongly chitinous except on their under surface. They are inserted directly on

the lateral edge of the body in a small emargination on the side of each division, and on the dorsal surface have a number of stiff hairs; those of the cephalic division are somewhat smaller than the others. The anal division has only one pair of these appendages which are placed well forward. There is a trace of reduced appendages on the penultimate segment in the form of lateral serrations which are not more prominent than the lateral serrations, but can be distinguished owing to the presence of a large bristle at their apex. This type of compact larva is not capable of progression by the undulations of the body, but the much more mobile lateral appendages enable it to move about with sufficient ease and speed. The skeleton of this larva is much harder on the sides and especially below the body in this region than is normally found in larvae of other genera; the lateral edge is also reinforced by its hard spinulous structure, and the base of the appendages is, therefore, inserted in a sort of rather rigid socket. The appendages, however, move easily owing to the special musculature attached to a long apodeme which



TEXT-FIG. 43.—Larva R_1.

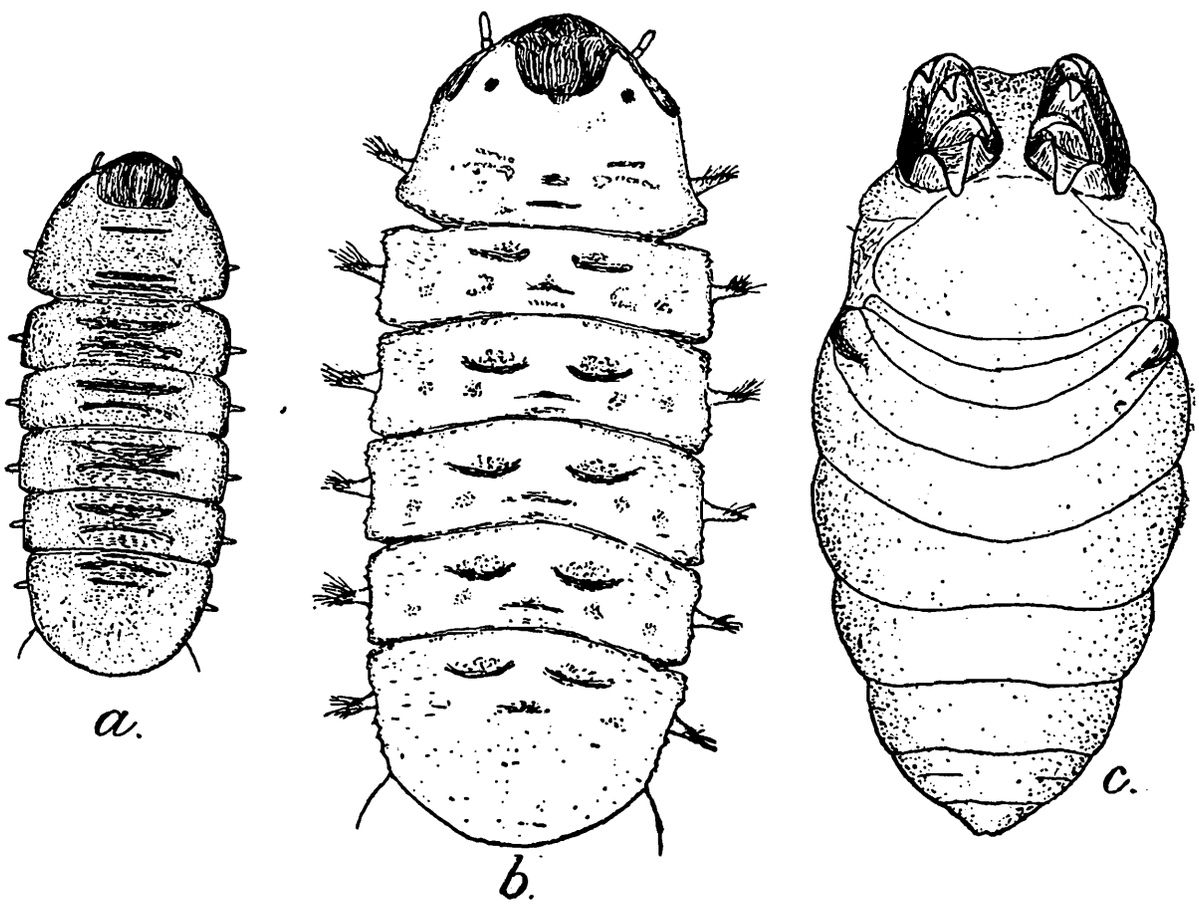
a. Ventral view of insertion of lateral appendage.

b. Dorsal view of insertion of lateral appendage.

so far as I am aware, is not found in the other known types of Blepharocerid larvae or at least is not so well developed (fig. 43, *a*, and *b*). The rudiments of such apodemes exist in the same place in *Apistomyia* and in *Neocurupira*, but in these forms the appendages are not inserted in a socket and are not mobile to such an extent independently of the side of the division. Each of the divisions, except the cephalic, carries on the sides somewhat above and in front of the appendages a small comb of spinules, and on the same line right against the posterior border a similar solitary spinule. The anal division does not show any trace of segmentation and is perfectly rounded posteriorly; its edge is devoid of any denticulation. The under side of the body is as strongly chitinised as the dorsum except in the region of the gills, which are lodged in a depression on both sides of the suckers. The anterior and posterior corners of the division carry a few blackish spinules. The suckers are large and their disc is more strongly chitinised than is normally the case. The gill-tufts are formed of five filaments, all curved backwards in a peculiar manner as shown in fig. 42, *b*.

In the material from this locality there were with the spiny larvae described above a number of similar larvae without the dorsal spines; some, however, showed what may be termed the scars of such spines at the same places. As will be seen from the description of further material of this type below, it is not at all likely that these mutic larvae belong to a different species. In some cases the lateral comb of small spines is replaced by a row of long bristles in these specimens. Out of one of the four full-grown mutic larvae which was in the pre-pupal stage, the pupal skin was extracted and compared with another extracted from a spiny larvae. There was no appreciable difference between the two; the breathing organs of the pupa being exactly the same and presenting the peculiar corrugations as described below. A number of smaller larvae in the material from this locality, in my opinion, belong to the same species.

The first instar larvae, as depicted in fig. 44, *a*, has quite a different



TEXT-FIG. 44.—Larva and Pupa R_1.

a. First instar specimen.
b. Second instar specimen.
c. Pupa.

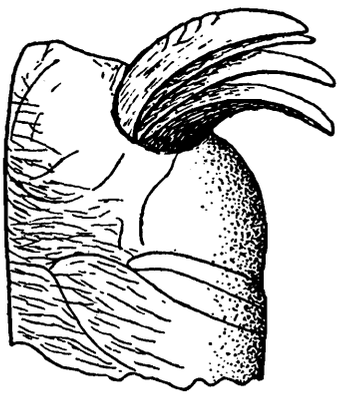
appearance from the full-grown larvae; its length is 1·1 mm.; the body ornamentation, as is the case in all the known Blepharocerid larvulae, is composed of a double transverse ridge. The lateral appendages are small and conical with a few terminal bristles, but no retractile hooked organs of fixation. The antennae are one-segmented. There are no ventral gills on the median segments.

Second instar larva (fig. 44, *b*): Length of body 2 mm. The ventral gills, composed of a single filament, are curved backwards. The sculp-

ture of the dorsum resembles strongly that of the full-grown type. The two front depressions and the small triangular median ridge, which carries the dorsal spine in the fourth instar larvae, are present. The antennae are two-segmented.

Third instar larvae: Length of body 3·25 mm. The gill-tufts, formed of three filaments, are curved backwards. The dorsum is without spines. The general form is shown in fig. 48, *a*, which depicts a larvae of the third instar from another collection.

The pupae from the same locality belong most certainly to this larva, as the corrugation of the anterior lamellae, which is so characteristic of this pupa, was found also on the pupal skins extracted from the larvae either of the spiny or the mutic type. Length of body 5·5 mm. (fig. 45). The colouration is very dark brown, the dorsum being completely covered with a rather coarse granulation, except on the base of wing sheaths. The strongly developed breathing organs are curved upwards and are inserted nearly perpendicularly on the body; the outer lamellae are particularly strongly chitinised, the anterior one having a few slight corrugations on its middle (fig. 46, *a*).



TEXT-FIG. 45.—Pupa R_1, side view of breathing organ.

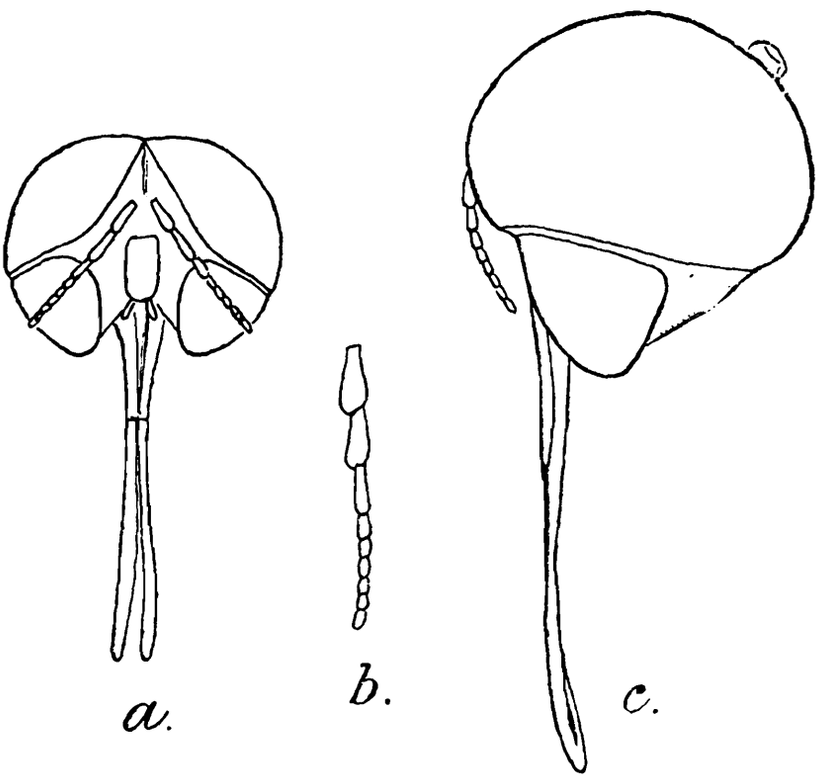
The imago was fairly developed inside one of these pupae, but its sex could not be ascertained definitely.[1] The genitalia were much damaged, but as I could not make out any eggs or spermathecae in the abdomen, the probability is that the extracted fly was a male. Its wing venation is represented in fig. 47. It comes very near that of *Paltostoma* or *Peritheates*, as Rs. is not curved upwards as in *Apistomyia*; but the detail of the venation near the base could not be made out fully owing to the crumpled condition of the wing; the venation as depicted must, therefore, be considered as diagrammatic. The head of the fly is shown in fig. 46, *a* and *c*; the antennae are nine-segmented, the proboscis is thin and elongated; the palpi are very reduced and apparently one-segmented; the eyes are bisected, a bare space existing between the two portions, the upper ones touching on the frons. The imago in the other pupa, which was 6·5 mm. long, was still more damaged, but the development of the legs was sufficiently advanced to make out that the claws were simple and the spur formula was 0·0·2.

I consider this form as belonging to a new genus for which I propose the name of *Horaia* in honour of Dr. S. L. Hora who has brought to light so many new larval forms of Blepharoceridae.

It is characterised in the imaginal stage (in the male ?) by the contiguous bisected eyes, the sections being separated by a narrow bare line, the upper one being considerably larger than the lower one; antennae

[1] Since this was written a further lot of pupae of this genus came to hand, from which nearly mature imagines have been extracted; this species is described further in the addendum as the genotype.

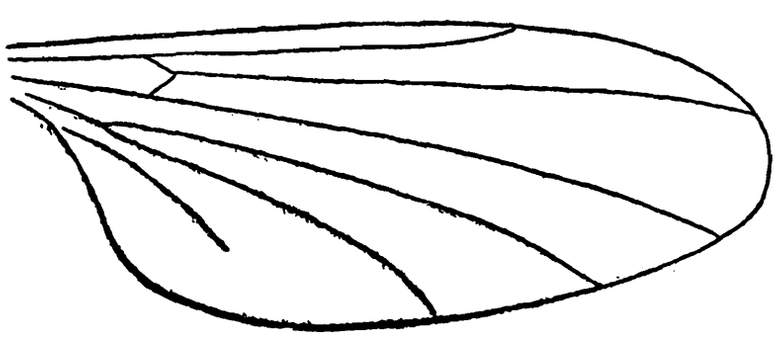
small, nine-segmented[1]; proboscis thin and somewhat longer than the height of the head; labella very elongate, palpi much reduced, mandibles apparently absent. Venation as in *Paltostoma* or *Peritheates*, the tip of Rs. reaching the wing margin a little above the wing apex.



TEXT-FIG. 46.—Pupa R_1.

a. Front view of head of a female specimen extracted from the pupa.
b. Antenna of same.
c. Head of same in profile.

This genus differs from *Peritheates* by the eight or nine instead of eleven-segmented antennae, the much shorter proboscis, the eye structure, the upper sections of larger facets being much smaller than the lower ones, and not separated from them by a bare space as in the latter genus; in *Peritheates* they do not touch on the frons in the male. It differs from *Apistomyia* in the number of antennal segments, the shorter proboscis and the straight Rs.; the eye structure, at least in the male, is very similar.



TEXT-FIG. 47.—Diagrammatic venation of wing extracted from Pupa R_1.

[1] In the genotype described in the addendum the antennae are eight-segmented; the specimen here described may therefore either belong to a different species or else be abnormal in that respect.

In its early stages this genus is quite different from either *Peritheates* or *Apistomyia*. The larva, as shown by the compact structure of the body, its armature, etc., is much more specialised. The pupa, on the other hand, is less specialised ; its breathing organs are like most of the other genera and not contiguous with reduced internal lamellae as in *Apistomyia*.

This type of larvae is represented in the collection from other localities as follows :—

Larvae R_1 and R_2. Dalhousie, Punjab, Punj Pul Nullah.

Spiny Larvae. A series of six spiny larvae nearly full-grown with median pale vittae and strong granulations (type R_2) ; the side combs formed of bristles, mostly broken. In some specimens the dorsal spines are broken at the base, except one or two of the posterior ones. They can scarcely be distinguished from the non-spiny form.

Non-spiny Larvae. More than one hundred specimens without, or with very slender, dorsal spines, sometimes partly broken. They can be divided into two types, one mostly yellowish with brown spots and side combs formed of spinules (type R_1), the other brown with a median pale vitta and strong granulations on the dorsum. The side combs formed of bristles (type R_2).

Dalhousie, Punjab. Krelnu Giri Nullah.

Spiny Larvae. One specimen in the fourth instar with distinct, though small, dorsal discal spines. One specimen in the third instar similar to the fourth instar larvae with small dorsal spines.

Non-spiny Larvae. Thirty-seven specimens, mostly near pupation, all with distinct scars of spines, strong granulations and median yellow vitta. One specimen at the beginning of the fourth instar exhibits no trace of spines ; this shows that the non-spiny larvae are not necessarily specimens which have lost their spines in the course of an instar.

Larva R_3. Pashok, Darjiling District. Coll. Dr. F. H. Gravely. First tube.

Spiny Larvae. Nine specimens in the fourth instar, with very large black dorsal spines. Colouration of the head with the posterior part of the plates reddish-brown and not black as in the smaller larvae ; side combs with rather short bristles ; antennae and appendages mostly pale.

Non-spiny Larvae. A collection of small specimens in the third instar, maximum length 2·5 mm.; all similar to the young larvae described under Type R_1. One specimen in the second instar, appendages pale.

Same locality. Second tube.

Spiny Larvae. One specimen, in the last instar, seems to be distinct from R_1 and R_2 by its relatively smaller size, lighter colouration and relatively longer spines, the red-brown colour of the side plates of fronto-clypeus, the pale colour of the antennae and lateral appendages, and the side combs formed of only four spines. Fig. 48*b* represents one such specimen in the middle of the last instar, its length is 3·5 mm. Fig. 48c shows a fourth instar larva removed from a third instar larva from which it was about to emerge by moulting. The spines are not formed within those of the previous instar but are addressed, as shown, against the dorsum of the new instar ; they have, therefore, their full length from the start. The lateral appendages are also not formed within the old ones, and only the bristles of the new ones are enclosed in the cavity of the old ones. The appendages are telescoped within themselves and can be forced out by pulling the bristles with a pair of forceps. One of these extracted appendages is shown on the left hand side of fig. 48c.

Pashok, Darjiling District. Jhora Stream.

Spiny Larvae. Three larvae in the last instar. In two of them the spines, although longer, are weak and thin. They apparently belong to exactly the same type as above.

Larva R_4.

Darjiling, Reo Jhora Stream.

Non-spiny Larvae. Three specimens in the fourth instar. Length 5 mm. Distinctly broader than the other forms (figs. 48*d* and *e*). The head capsule is pale posteriorly as in type R_3. There is not the slightest trace of the dorsal spines ; the notches in which the lateral appendages are inserted are distinctly deeper than is normally the case. The appendages are mostly pale and relatively longer. Two specimens in the third instar, The posterior part of the head not distinctly pale.

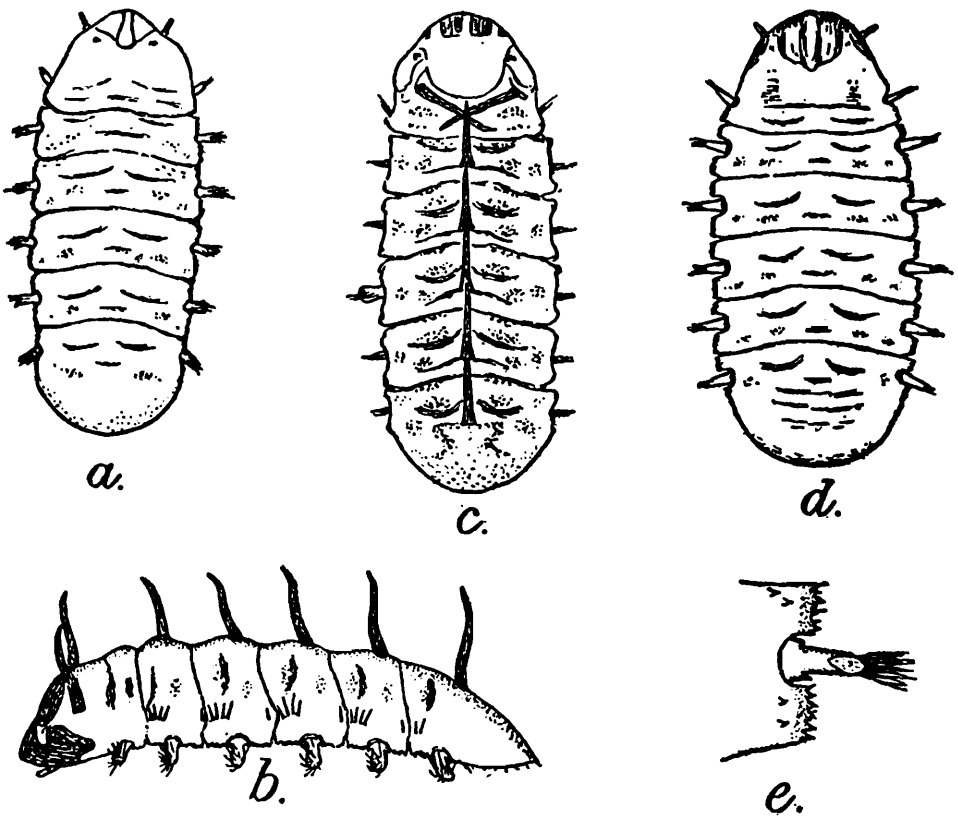
Larva R_1.

Assam. Dumpep.

Spiny Larvae. About sixty-five specimens, half a dozen of them full-grown and a number at the beginning of the last instar. Their lengths vary from 3·5 mm. to 6 mm. Numerous specimens in the third instar, their lengths varying between 2 mm. to 3·5 mm. Colour pattern as described above for type R_1.

Non-spiny Larvae. Eighteen specimens in the third instar not differing in any way from the spiny ones. Two of these larvae at the beginning of the instar and others at the end of the same instar have weakly developed, pale, thin and flexible dorsal spines; in these mutic specimens the lateral appendages are paler. Three specimens in the second instar have no trace of spines. Their lengths vary from 1·5 mm. to 2 mm.

It is doubtful whether the forms referred to above as types R_1, R_2, R_3, and R_4 really belong to different species, but it will be seen from the above analysis of the contents of the specimens in the collection that both types of larvae, the spiny and the non-spiny ones were, except in



TEXT-FIG. 48.—Larvae R_3 and Larvae R_4.

a. Larva R_3, third instar.
b. Larva R_3, lateral view of a specimen at the beginning of the last instar.
c. Larva R_3, fourth instar specimen extracted from a third instar specimen; only one of the lateral appendages has been pulled out.
d. Larva R_4, last instar.
e. Larva R_4, ventral view of lateral appendage.

two instances, found in the same localities and that the spiny type was mostly found in the fourth instar and only seldom in an earlier instar; no larvae of this type in the first and second instar were found. From my examination of hundreds of specimens, I think it is safe, therefore, to conclude that the presence or absence of dorsal spines is not a specific character, as some intermediate specimens with weakly developed spines are to be found in some of the lots. However, more extensive research on these interesting larvae in the field and an extensive collec-

tion of imagines from these different localities is necessary for solving the problem.

To sum up the result of my study of the material submitted to me from India I give below a list of the genera into which the larval and pupal forms can be classified.

Euliponeoura, gen. nov. Larvae and pupa I, Larvae C, Larva B ?.
Blepharocera, Larvae A, Larvae D, Larvae and pupa E, Larvae F, Larvae G, Larvae H (*B. indica* Brunn. ?).
Genus ? (near *Blepharocera*), Larvae J.
Genus ? (near *Blepharocera* and *Philorus*), Pupa Q.
Apistomyia, Larvae L, M, N, Larvae and Pupa O, Larvae P.
Genus ? (near *Apistomyia*), Larvae K.
Horaia, gen. nov. Larvae and Pupa R_1, Larvae R_2, R_3, R_4.

As scarcely any of the adult forms corresponding to these larvae and pupae are known, it would be premature to try to draw conclusions concerning the Blepharocerid fauna of India. It is certainly the richest of the world in the number of genera, and I hope that this paper will stimulate the collectors in the Indian region to pay more attention to these interesting flies.

NOTES ON THE MORPHOLOGY OF THE LARVAE AND PUPAE OF BLEPHAROCERIDAE IN GENERAL AND ON THEIR METAMORPHOSIS.

Having now examined a very large number of Blapharocerid larvae, I am convinced that in all species there are only four larval instars, during each of which the larvae can increase to approximately twice their original length.

The *first instar* is characterized by the presence of an egg-burster on the fronto-clypeus, the one segmented antennae, the double transverse rows of very small more or less triangular teeth on the dorsum of each division, the presence of one or sometimes two spines on the sides of these divisions and the total absence of ventral gills except for the anal ones. The lateral appendages are very peculiar in that they possess an exsertile distal portion provided with a group of hooks.[1]

This exsertile organ is not present in all the genera of Blepharoceridae. I have found it in *Paracurupira*, *Peritheates*, *Blepharocera*, *Hapalothrix* and *Liponeura*, but it is absent in *Edwardsina*, *Apistomyia* and *Horaia*.

The *second instar* is usually characterized by the presence of ventral gills having one filament only, antennae two-segmented in species with divided antennae, but the relative length of the segments is not the same as in the last instar, and the basal one is usually smaller; the lateral processes normal, without exsertile organs.

In the *third instar* the gill-tufts are composed of three filaments in species with five filaments in the previous instar, and of four to five in species with seven to nine in the last instar.

[1] This peculiar structure was discovered by me in *Paracurupira* and was figured and described on p. 23 of my paper on Tasmanian Blepharoceridae (19); Bischoff (6, p. 254) apparently by mistake gives credit to Lamb (1922) for this discovery in a South African species of *Paracurupira*. So far as I know this genus does not occur outside New Zealand, and Lamb did not publish any paper on Blepharoceridae in 1922.

The breathing organs of the Blepharocerid pupae are, owing to their varied structures, extremely interesting. In many genera they are of a simple type and consist of four more or less elongate, rounded or pointed lamellae, the two outer ones being thicker than the two inner. It has been my good fortune to describe for the first time all the unusual types, such as those found in *Edwardsina*, *Apistomyia*, *Euliponeura*, and Pupa Q. Quite recently Edwards (10) has described a few other types belonging to the genus *Edwardsina*.

In the present state of our knowledge it is rather difficult to make out the evolution of this organ. The link between the *Edwardsina* type and the *Blepharocera* type is not evident, although the organ of *Edwardsina gracilis* Ed., with its four lamellae, reminds one somewhat of what is found in the pupae of the *Blepharocera* group, especially on account of the stigmatic slit being placed in between the two internal lamellae. In the *Apistomyia* type, which is evidently derived from the *Blepharocera* type, the two organs are contiguous, the lamellae are much shorter and the two outer ones divergent. The breathing organ of Pupa Q is somewhat akin to that of *Apistomyia*, but that of *Euliponeura* is without any evident connection with the others. In view of the phylogenetic position of this latter genus in the family this type of breathing organ cannot have been evolved from that of *Apistomyia*, and the fusion of the two outer lamellae to form an elongate transverse case may be only a specialization of the Blepharocerid type. Miss Pulikovsky in her valuable work (15) on the breathing organs of *Simulium* doubted that the function of the lamellae of this breathing organ, as I had pointed out from a study of the pupal breathing organs of *Edwardsina* (19, p. 27), was purely mechanical. She did not think that a functional spiracle could be present at the base of and in between the internal lamellae, and considered the latter as cuticular gills similar to those of *Simulium*, and Bischoff is also inclined to share her views on this point (5, p. 221). There can, however, be no doubt whatever that there is an open spiracle at the base of the internal lamellae, and a section across this organ is absolutely convincing on this point. Besides, I have had the opportunity of verifying my hypothesis on the real function of the lamellae in my breeding aquarium, in which some larvae which had pupated on the front pane enabled me to observe them under a binocular microscope. The air bubble between the base of the internal lamellae varies greatly in size and is not always evident; sometimes there is only a silvery layer of air on these lamellae as well as on the external pair, with small air bubbles scattered here and there. It is, therefore, clear that the lamellae of the Blepharocerid pupae do not function like the cuticular gills which Miss Pulikovsky found in *Deuterophlebia* and in some species of *Simulium*.

The initial supply of air needed to form the bubble in between the lamellae or the layer of air covering them, if not pre-existent in the tracheal system of the newly formed pupa, is probably obtained by means of the ventral gill-tufts which, as I have shown above, are retained in the pupae (fig. 10, *b*) of *Blepharocera* and other genera. These gill-tufts are probably functional for some time at the beginning of the pupal stage.

Blepharocerid larvae have not been bred in the laboratory so far, probably because it was considered impossible to be able to provide in aquaria highly oxygenated and cool water, and the special algal food needed by these animals. Actually, however, it is not difficult to keep them alive in an aquarium for a sufficiently long period for observing the main phases of their metamorphosis.

I have used with success the cage aquarium with rapid-running water, which I described some time back (18). It is perfectly adapted for a close observation of Blepharocerid larvae, as they gather together on the front plate glass at the spot where the water leaves the inlet in the form of a fan and strikes the pane at great speed. Here they can be observed by means of a binocular microscope fitted with a dermatoscopic attachment placed right against the glass.

The chief difficulty in the aquarium is the scarcity of food which does not allow of the breeding of larvae from an early instar to the adult stage. However, it should not be impossible to carry out this breeding in a series of aquaria, in which the larvae sould be transferred from one to the other as the food is exhausted.

The Blepharocerid larvae feed on microscopic vegetation covering the stones or rocks on which they live. Before placing the larvae in an aquarium, it is necessary, therefore, to keep it going for a time to allow sufficient amount of algal growth to develop on the plate glass ; several weeks are sometimes necessary, but this depends on the nature of the water used. The Nelson town supply which I have used, being unfiltered and obtained from a mountain creek only a few miles from the town, is wonderfully suited for this purpose. As the larvae do not leave the spot where the speed of the water in the aquarium is at the maximum, that is near the inlet fan, it is advisable to have it so arranged as to be able to slide it along the plate glass side of the aquarium. The inlet fan can then be displaced when the food supply is exhausted round it and the larvae will follow the fan, for they congregate round the place where the conditions for their breathing are most favourable. It is a most interesting sight to watch the larvae on the glass pane as they move about slowly, grazing like cattle in a paddock, or else keeping closely huddled together. They thus convey a very different idea from what they do in the boisterous habitat in which the Blepharocerids usuaally live.

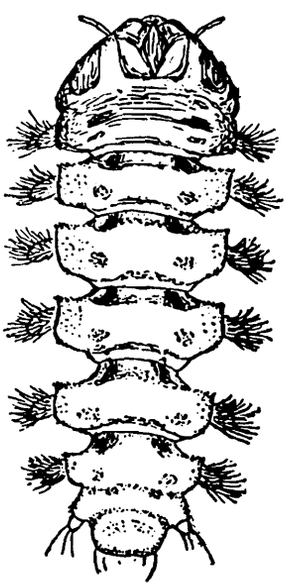
Under the microscope I have observed at some length the working of the mouth-parts while the larvae were feeding. The chief role in this connection is played by the two large pads which form the proximal part of the maxillae, and which are thickly covered with setae. They are first spread flat on the glass, and then brought up together when they gather all the food particles within their reach by a licking action. They do not function as filters, as stated by Bischoff. During this time the mandibles are simultaneously moving backwards and forwards and come in contact with the hypopharynx[1] which remains motionless. When

[1] Bischoff (6, p. 220) designates this organ as the prementum, but I doubt if it is really so. In *Ewardsina* larvae, the prementum is a distinct chitinous structure placed below the hypopharynx and hidden under the terminal brush of the mentum itself ; its shape is not unlike that of the mentum but it is smaller, and is terminated by a flat brush of microscopic hairs.

the mandibles are brought forwards, the maxillary pads are laid flat on the glass, and when the mandibles are drawn backwards the two pads are drawn together against the hypopharynx. On account of the small size of the food particles the role of the mandibles is not evident. Bischoff suggests that they are used for scraping the food from the substratum, but this is not what I have observed under the microscope in my aquarium, though it is possible that the smoothness of the glass pane in the aquarium causes them to behave differently from what they do in nature.

The larvae do not move sideways, as is described by several authors, unless they are disturbed and taken out of their element; they move straight forwards with a sort of undulating movement, so that when the suckers let go their hold they are fixed a little forwards, each in turn, but the undulation, which is in no way jerky, starts again anteriorly before the previous one has reached the extremity of the body.

When watching the larvae from their ventral face as they rest on the plate glass, one realises the double nature of the gills which I have already recorded elsewhere. The filaments of the gill-tufts on each side of the body division appear quite silvery on account of the numerous tracheoles in them. These filaments are more or less curved and their arrangement is identical in each tuft. They are absolutely rigid and do not oscillate or vibrate under the action of the current of water. On the other hand, the anal gills or papillae do not show any trace of tracheoles, and are, therefore, of quite a different nature from the others; they are similar to those found in the same situations in Chironomid and Simuliid larvae.



Text-fig. 49.—Larva of *Peritheates intermedius* nearly full-grown.

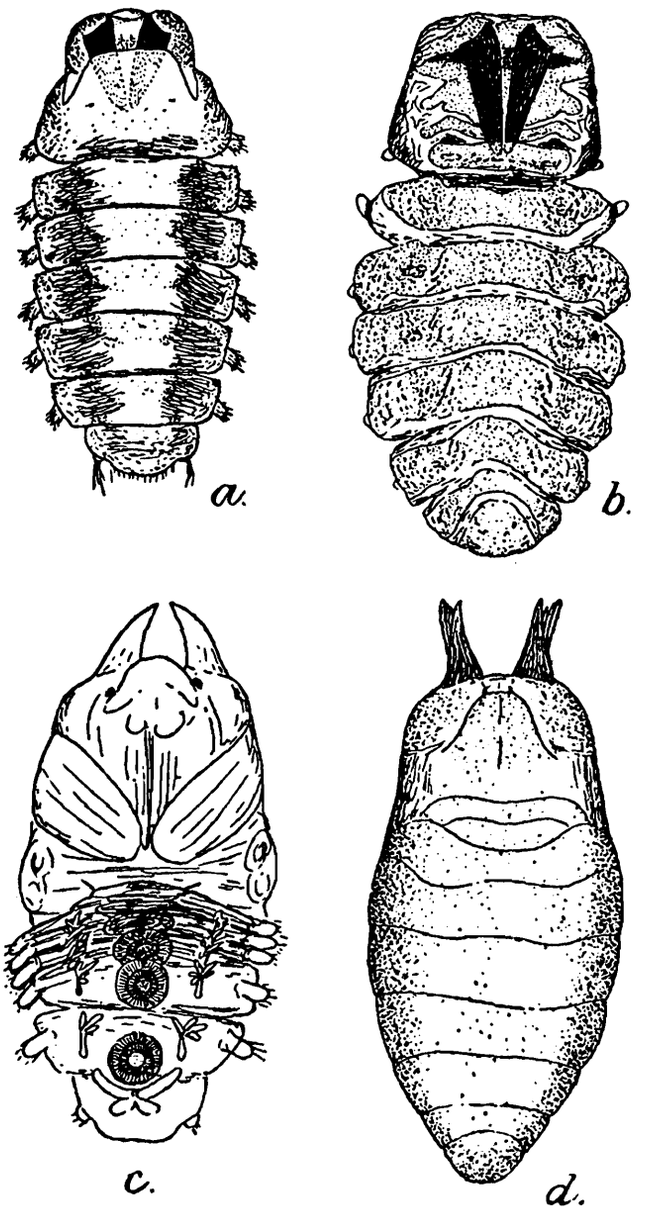
When a larva is nearing pupation,[1] it fixes itself as far as possible with the head turned against the current, and the whole body contracts itself, the divisions being brought close together (compare figs. 49, 50, *a*). If a larva at this stage is dissected one finds under its skin a prepupa shaped as shown in fig. 50, *b*. This prepupa presents some quite interesting features; among these are the appendages on the sides of the first median division and the vesicles on the sides of the four following ones. The breathing organs lie flat on the back, their apex being inserted under the first abdominal tergite.[2]

All the tergites are not yet unfolded or linked together as they are later in the fully formed pupa. On the ventral side one finds the antennae, legs and wing-sheath very little developed, and not reaching the posterior border of the cephalic division. A pair of pinkish ocular spots can also be

[1] These observations were made on *Peritheates intermedius* Till.

[2] I agree with Bischoff, that the cephalic division of the larva contains only the thorax and the first abdominal segment of the pupa although his figure 2 (4, p. 233) is not very convincing, as he mistook the postnotum for the metanotum. The true metanotum, which is reduced to a very narrow bridge, does not come in front of the first small dorsal division of the pupa.

observed. They may be peculiar to the pupa, but I believe that they are the remnants of the visual organs of the larva; they are later hidden



TEXT-FIG. 50.—*Peritheates intermedius.*

a. Pupa starting to emerge from the larval skin.
b. Prepupa extracted from the larva just before pupation.
c. Ventral view of pupa half way through ecdysis.
d. Fully formed pupa.

under the antennal sheath, but can still be observed behind the compound eyes of the nearly fully formed imago enclosed in the pupa. The most remarkable feature of the pupa at this stage is certainly the pair of lateral processes on the cephalic and the first main division. These are somewhat similar to the larval ambulatory appendages inside which they are developing, but have no functional analogy with them. They are perhaps being developed out of the pupal tissues contained in the lateral appendages of the larva. They are not horny but soft and whitish, and their function is not evident. The latera portions of the following abdominal segments have some rounded areas, the skin of which is

more or less exsertile, especially on the fourth segment, and is thus somewhat similar to a small pseudopod or vesicle. They are placed where the pupa will later be attached to the substratum, and it is probable that they contain the glands for producing the sticky fluid for this purpose.

In the middle of the ventral surface of the segments, where the larval suckers were placed, there is a small cavity due to the presence of the suckers, on each side of this cavity it is possible to distinguish the lumen of a gland. These two glands may be the remnants of the larval glands which secrete the viscous fluid of the suckers.

How a pupa could free itself from the larval skin without being carried away by the current appeared to me a rather difficult problem. After observing the process in the aquarium I realized that it is a very simple mechanism. In all it takes the larvae about 5 minutes to pass through this last moult. In its contracted attitude the pupating larva is securely fixed to the substratum by means of its suckers. Although the muscles of these suckers become separated from these organs with the formation of the pupa in the larval body, this does not seem to prevent the suckers from fulfilling their function. By pressing a dead larva on a smooth surface like glass I found that the suction is quite passive and that the suckers adhere automatically, and keep dead larvae in place in spite of the action of the current. It is possible, however, that before pupation an increased secretion of the glands supplying the suckers with the adhesive fluid takes place, and this helps to keep the pupating larva in its place, even though the fluid does not prevent the suckers from sliding on the substratum.

When the pupa is ready to emerge the larval skin bursts along a broken line behind the head (as shown in fig. 50, *a*). The pupa oscillates its body from right to left and thus slowly emerges from the larval skin, the base of the breathing horns coming out first. The oscillating movements cause the larval skin to slide gradually backwards ; in fact, the pupa does not change its position while moulting is taking place, and it is the larval skin which goes on sliding backwards.

As the larval skin is provided with some strong constrictions between each of the body divisions, it could not slide backwards along the pupal body if some slits were not made inside these constrictions. What actually takes place is as follows : The skin splits on either side of the constrictions from near the base of a lateral appendage to near the base of the following one. This slit is not regular and does not appear to take place along a line of lesser resistance, at least no trace of such a line is visible in the larva examined, even under a high magnification, prior to pupation, or at any time. It is possible that the animal is using the lateral appendages of the cephalic and especially those of the first main division to push the larval skin backwards. It is not easy to be sure whether this is what really takes place, for as the pupa is freeing itself from the larval skin, the sheaths of the wings are extending gradually backwards and come to hide the sides of the body (fig. 50, *c*). When the third main division of the body is free there is a stop in the lateral oscillations, and one finds that the sides of this division, which carries the vesicles mentioned above, come very narrowly in contact with the substratum where the

secretion of the glands fixes them securely. Then the fourth division is freed in its turn by means of oscillating movements of the *posterior part of the body* and its lateral extremities are glued on the substratum in the same way as those of the third division. To end the ecdysis the posterior extremity of the body is moved more violently and with the help of the current the larval skin is soon completely detached and carried away, whereas the last segments get a hold on and become fixed to the substratum.

During this time, the wing-sheaths and the legs gradually lengthen, and take their final position under the body, whereas simultaneously the tergites of the pupa get intimately connected to form a continuous dorsal surface showing an unbroken appearance. The colouration of the pupa, which is at first creamy with fine black dots of the dorsal granules, within a few hours gradually turns from brown to red.

ADDENDUM.

As this paper was in the press Dr. Hora sent me further material of larvae, pupae and imagines of Blepharoceridae collected in the Khasi Hills, Assam.

This material was composed as follows:—

A. Lashdat Stream (below mile stone 19/3 below Chirrapunji road, 10—x—29, in rapid water).
Numerous larvae R1 in all instars and pupae of *Horaia*.
Numerous larvae N in all instars and some pupae of the same species of *Apistomyia*.

B. Um-daung, Fall below Dumpep, x—29.
Several half grown larvae R1.
Numerous larvae N and some pupae.

C. Shillong (rapid running stream below power house, 6—x—29, station 16).
Nine *Blepharocera* larvae F.
Six *Apistomyia* larvae N.
Six larvae R1.

D. Dumpep, x—29.
One male fly *Euliponeura*, n. sp.
Two males *Blepharocera* sp.

Genus **Euliponeura.**

It is worth while publishing without further delay the description of the new species contained in this material as only a few features of the adult stage of this genus are known, my description of this stage having been made from immature imagines extracted from pupae. The structure of the hypopygium of this fly is quite unusual in the family and that of the other species of this genus may be similar.

This species from Assam appears to differ from the genotype, *E. horai*, from the Punjab mainly in the eye structure, those of the male of the latter species being apparently undivided, whereas those of the former are divided as shown in fig. 52, *a* and *b*.

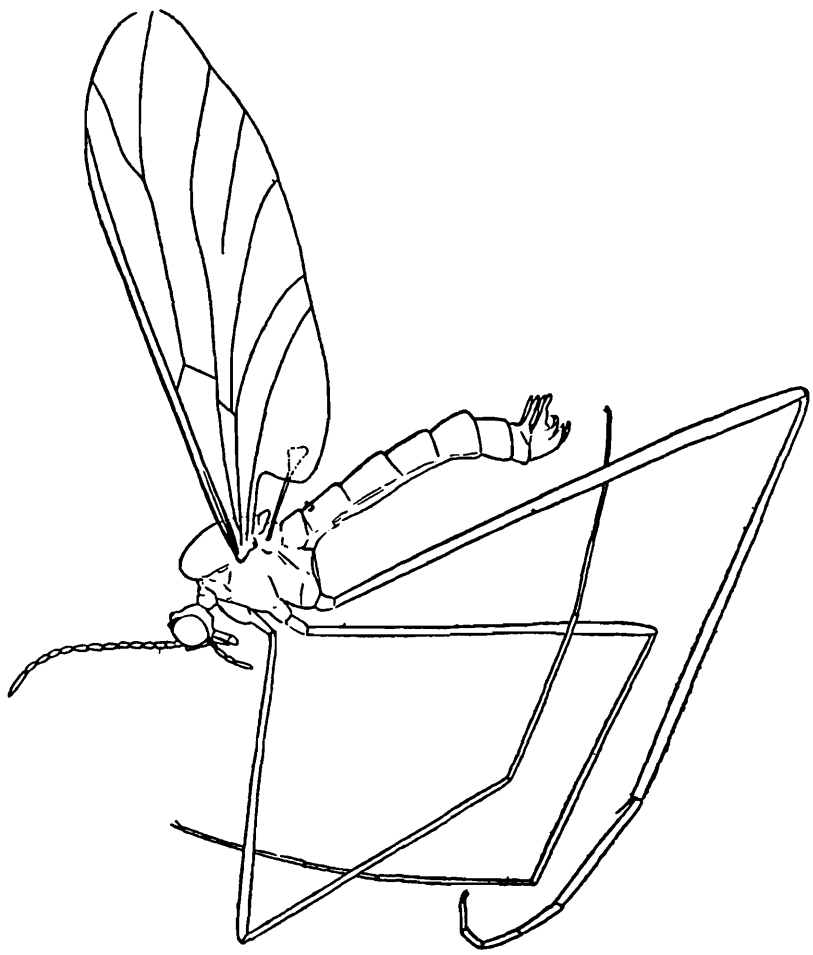
This species may be described as follows:—

Euliponeura assamensis, n. sp.

The unique specimen being preserved in spirit it is not possible to make out the colouration in detail. The body is ochraceous brown

with the ventral side paler ; there are no distinct markings on the metanotum ; the wings are also unmarked.

Fig. 51 gives a general view of the fly in profile and will replace a detailed description of the various morphological features, especially the relative length of the segments of the three pairs of legs.



Text-Fig. 51.—*Euliponeura assamensis*, n. sp. ♂.

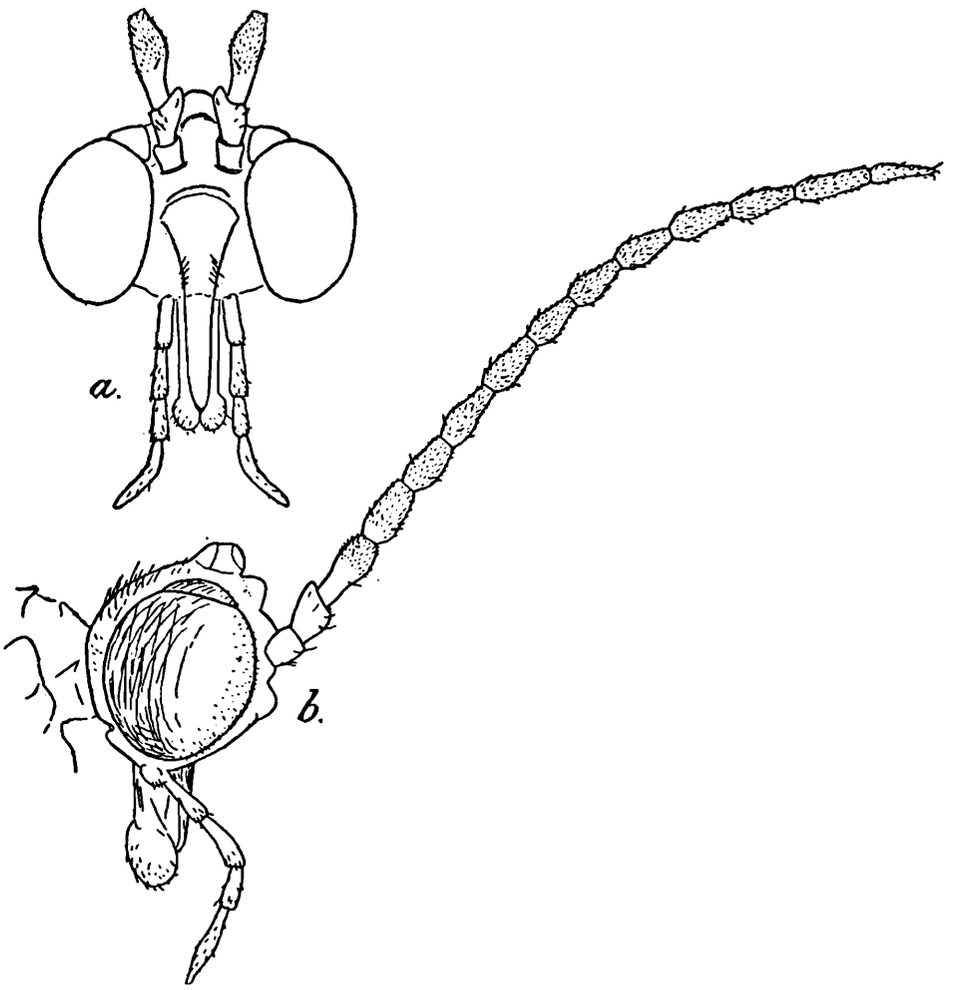
The venation is practically identical with that of *E. horai* but for a somewhat different shape of the fork of Rs. The head (fig. 52, *a* and *b*) is characterized by the wide frons on which there is a tubercule just below the ocellar turret ; the face is also somewhat raised just below the antennae. The eyes are subdivided, the upper portion being red, the lower one brown ; the facets of the former are scarcely if at all larger than those of the latter.

The 14-segmented antennae are longer than the head and thorax together ; the median segments of the flagellum are rather distinctly pyriform ; the colour of the scape and pedicel is paler than that of the flagellum. The five-segmented palpi are longer than the proboscis, which is distinctly shorter than the height of the head ; mandibles absent.

Tibial spur formula 0. 0. 1. (in *E. horai* it is 0. 0. 2). Claws simple.

The hypopygium is exceedingly peculiar on account of the pair of projections of the ninth tergite ; this is the only instance of modification of this sclerite in any Bepharocerid so far known ; the coxites (fused with the sternite) also carry a pair of processes parallel to the former but more rounded at the apex and more hairy ; the

forceps are formed of two superposed plates and in that respect are not very different from those of *Liponeura ;* the aedeagus is small but it has a very large vesica and only short penis filaments, not longer than the vesica ; the parameres are apparently absent. The three views



TEXT-FIG. 52.—Head of *Euliponeura assamensis,* n. sp. ♂.
a. Front view ; *b.* in profile.

of the end of the abdomen (fig. 53, *a—c*) will explain the peculiar conformation of this organ ; in the profile view the hypopygium is somewhat compressed so as to give a better view of the forceps.

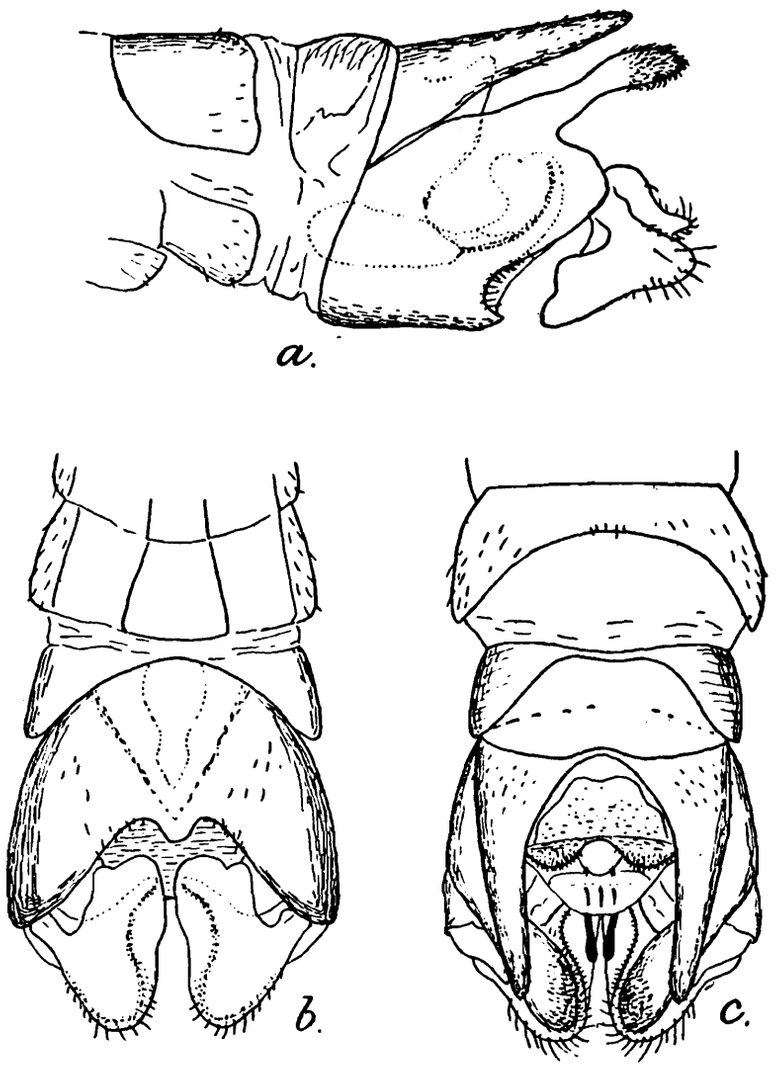
Length of body 5 mm. ; wing 6·5 mm. *Type,* one male in spirit from Dumpep, Khasi Hills, Coll. S. I. Hora, x. 29, in the Indian Museum.

Genus **Horaia.**

A large number of pupae of this genus were included in the material recently come to hand ; they differ somewhat from those described above in their smaller size and the corrugations on the anterior lamellae of the breathing horns are hardly perceptible.

The larvae correspond rather well with those I described above under type R1 but it is doubtful if they belong to the same species.

The imagines of both sexes are sufficiently developed in some of these pupae to allow of a good description of the adult stage being made ; this will give more validity to the genus *Horaia* in making the new species the genotype.



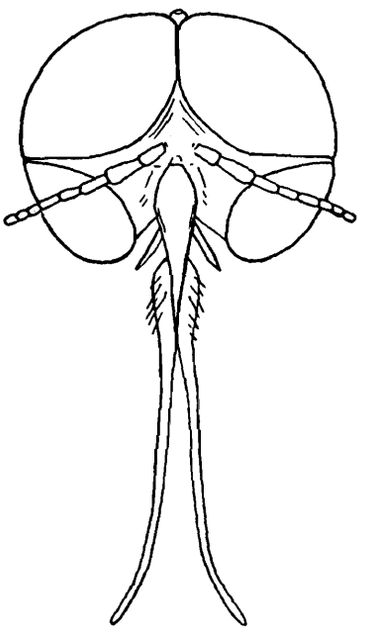
TEXT-FIG. 53.—Hypopygium of *Euliponeura assamensis*, n. sp. ♂.
a. Lateral view ; *b*. ventral view ; *c*. dorsal view.

Horaia montana, n. sp.

Male.—As the imago was extracted from a pupa preserved in spirit only few details of colouration can be given ; the fly seems to be uniformly brownish, except perhaps on the scutellum and in front of it, at any rate it does not present the conspicuous thoracic markings which are to be found even in the immature imagines of *Apistomyia* extracted from pupae.

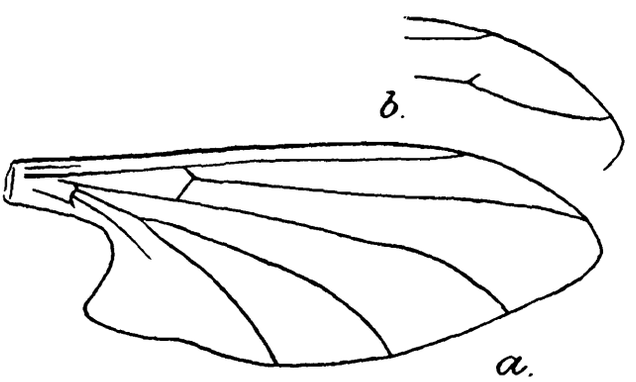
Head as shown in fig. 54, the eyes being completely divided by a bare narrow space between the two parts, but the difference in size between the large facets of the upper part and the small ones of the lower part is probably not so marked as in *Apistomyia*. The labrum is relatively short and the whole proboscis is only about one and a half times as long as the height of the head ; palpi one-segmented ; antennae eight-segmented, the second segment being the longest ; the first three

segments of the flagellum elongate, the last three barely longer than wide.



TEXT-FIG. 54.—Head of *Horaia montana*, n. sp. ♂.

Venation as in fig. 55, *a* ; in some specimens of either sexes Rs shows a small stump on its distal third and then that vein is somewhat curved at the tip (fig. 55, *b*).



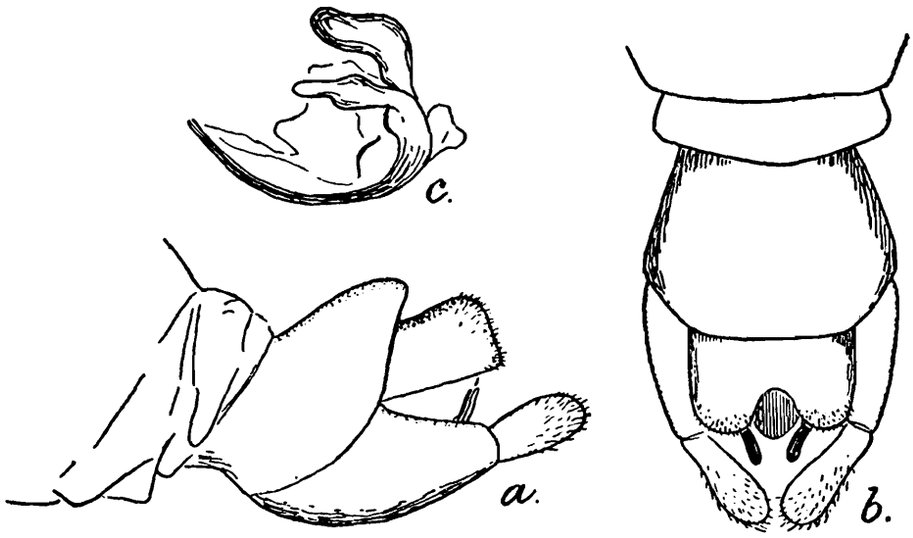
TEXT-FIG. 55.—*Horaia montana*, n. sp. ♂.
a. Venation ; *b*. tip of wing.

Tibial spur formula 0. 0. 2 ; claws simple.

Hypopygium (fig. 56, *a* and *b*) of simple structure, very similar to that of an *Apistomyia* ; the forceps are half as long as the sterno-coxites ; they are rounded at the tip and finely hairy as usual ; the anal valve is deeply emarginated in the middle ; the vesica of the aedeagus is very large (fig. 56, *c*).

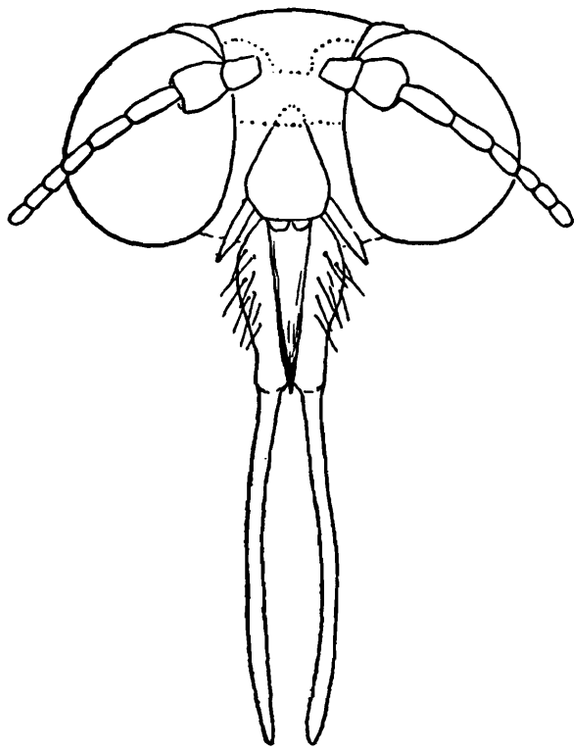
Female.—Similar to male in venation ; head as depicted in fig. 57 ; the frons broad but not as wide as the width of an eye ; ocellar tubercule very little evident, not visible from the front.

The pedicel of the antennae is much more developed than in the male, a feature which is also found in several species of *Apistomyia*.



TEXT-FIG. 56.—Hypopygium of *Horaia montana*, n. sp. ♂.
a. Lateral view ; *b*. dorsal view ; *c*. vesica of aedeagus.

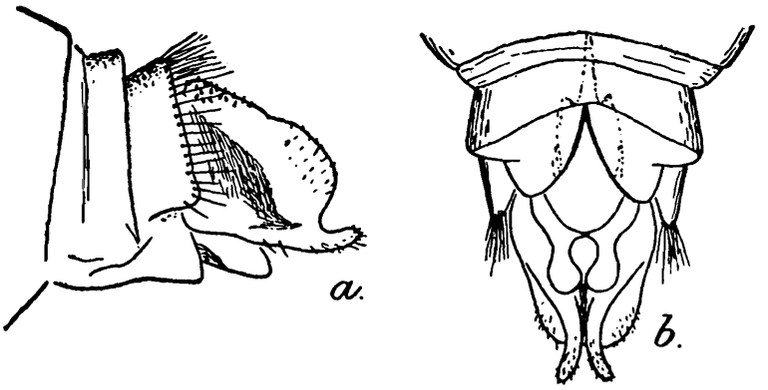
Mandibles absent ; eyes divided, no space between the two divisions, the upper one very small, its facets not distinctly larger than those of the lower one.



TEXT-FIG. 57.—Head of *Horaia montana*, n. sp. ♀.

Genitalia as shown in fig. 58, *a* and *b*, the lamellae with a peculiar turned up apex.

Type and *allotype* from Lashdat stream, Khasi Hills, Assam. 10—x—29 (*S. L. Hora*).



TEXT-FIG. 58.—Genitalia of *Horaia montana*, n. sp. ♀.
a. Lateral view ; *b.* ventral view.

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