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

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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.

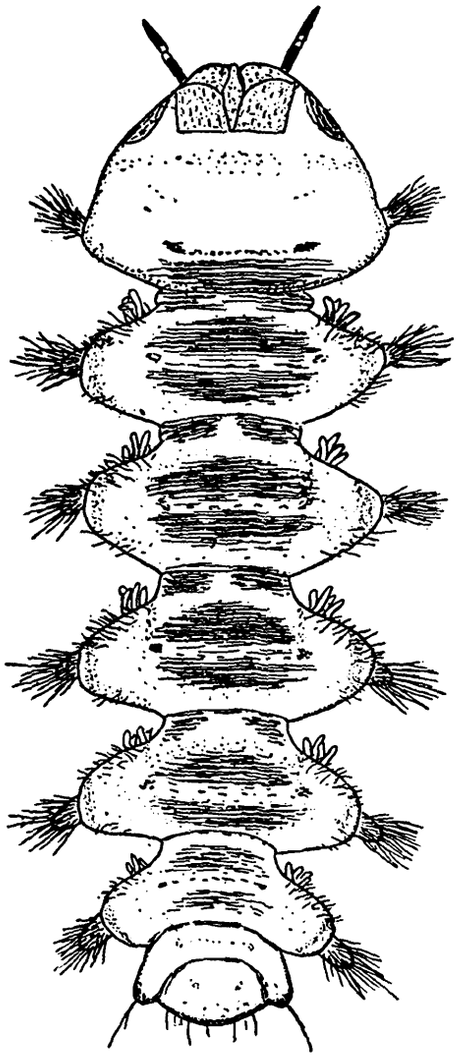
The collection of larvae which I had for study was, with one exception, not accompanied by specimens of the adult flies, and no definite identifications of the larvae could, therefore, be made. Under the circumstances, and as Agharkar has already described three larval forms under the letters " A ", " 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.

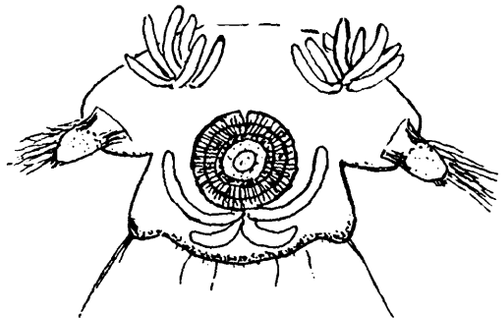


Text-fig. 1.—Larva A, dorsal view of last instar.

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.

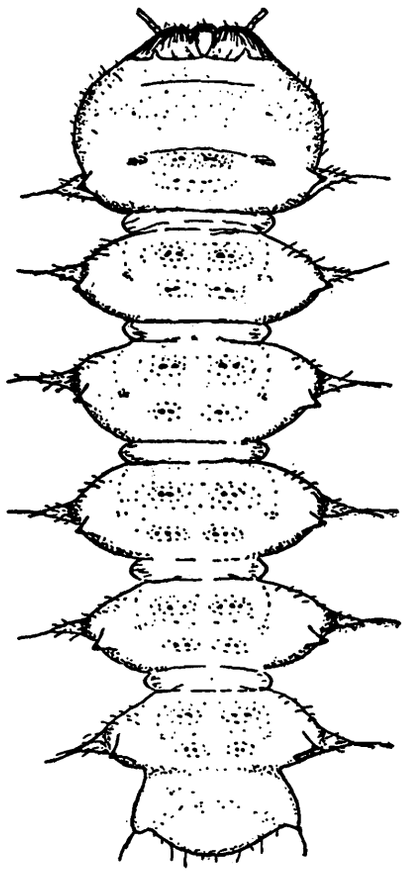


Text-fig. 2.—Larva A, ventral view of last segments of last instar.

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.

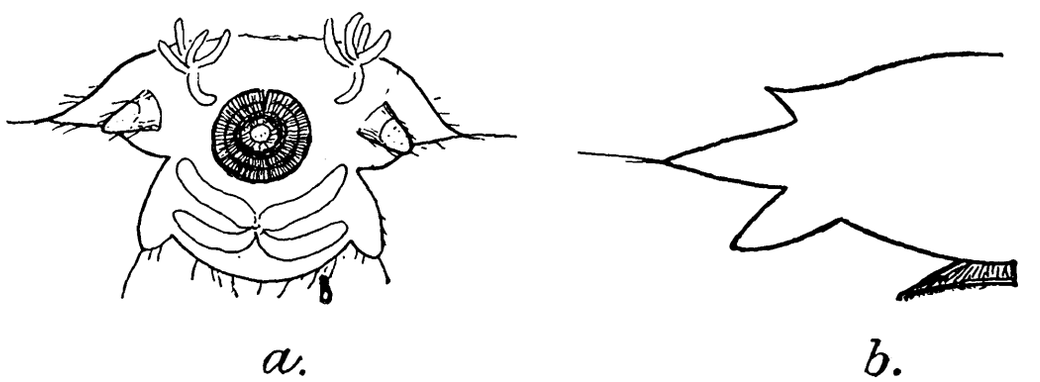
Larva B.

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.

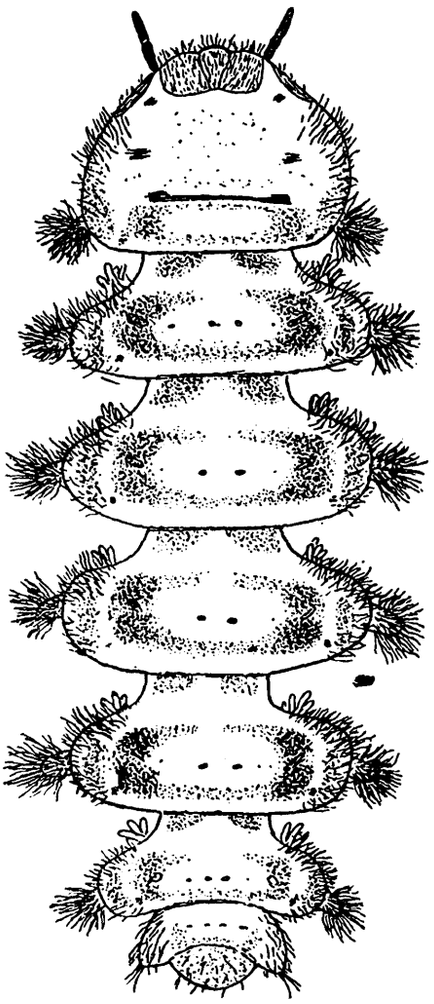
This larva, the unique specimen of which I have not seen, seems to differ specifically from the preceding one, though it evidently belongs to the same genus. Judging from Agharkar's description and drawings, it differs from larva B in the presence of two superposed lateral spines, just above the lateral 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.

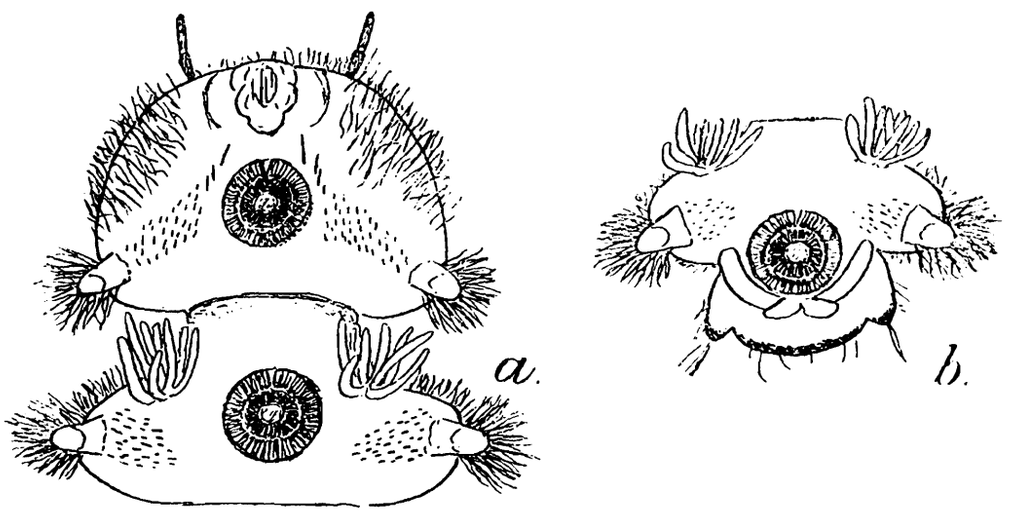
Length of the full-grown larva 6·5 mm. (fig. 5).

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.

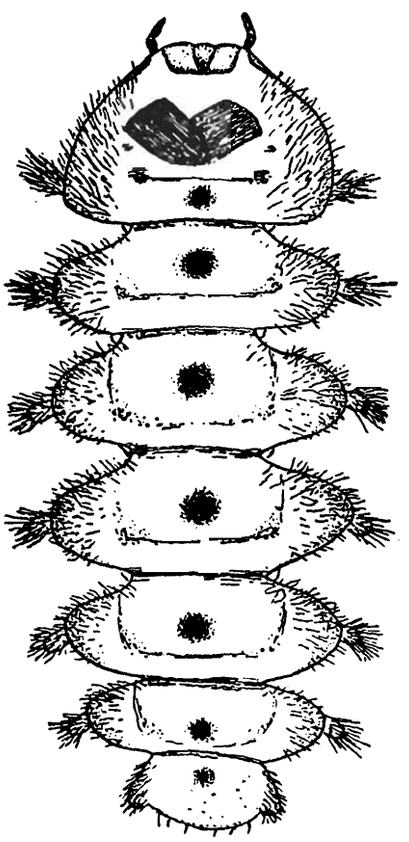
b. Ventral view of the last body division of a full-grown specimen.

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.

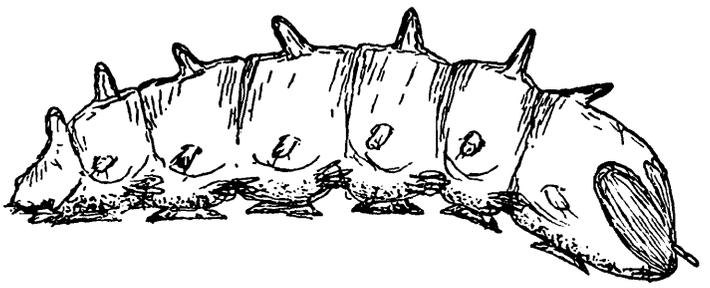


Text-fig. 7.—Larva E, dorsal view of a full-grown specimen.

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

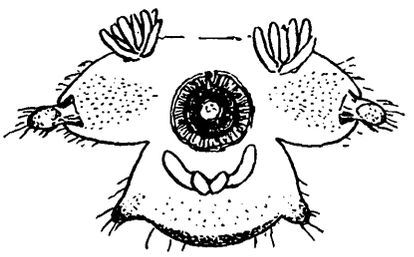
Antennae two-segmented, the segments sub-equal, tip of the first and base of the second white in the form of a white median ring. This larva resembles larva D in general, but the marks on the dorsum are different. The small spinules on the ventral surface are much more numerous, and the hairs on the 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.

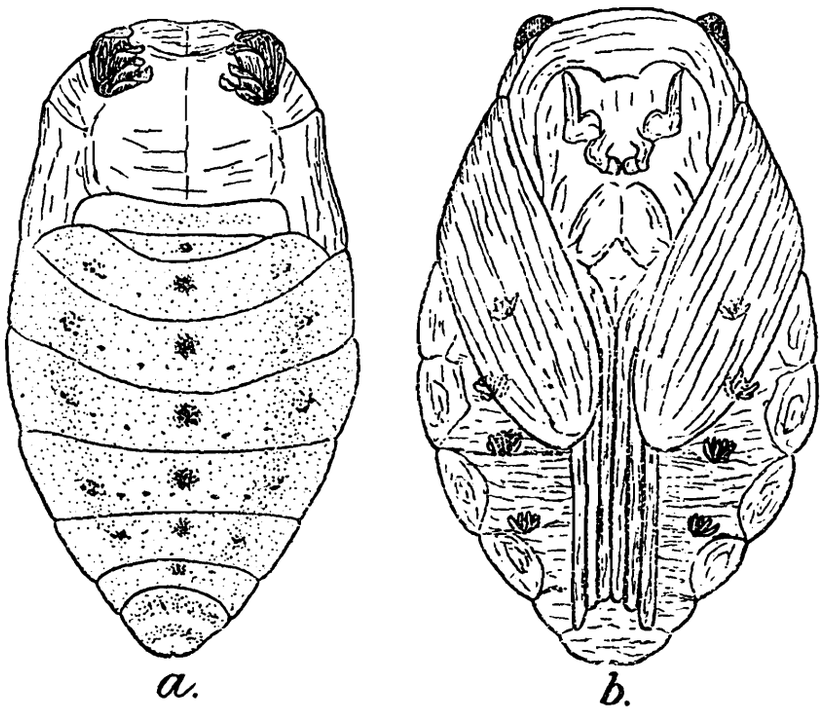
This larva belongs to a species which I believe to be different from larva D, although it was found in the same place as the latter, and in spite of the fact that, as has been pointed out by Bischoff (5), there are great variations in the morphological characters of the larvae of some species of this 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.



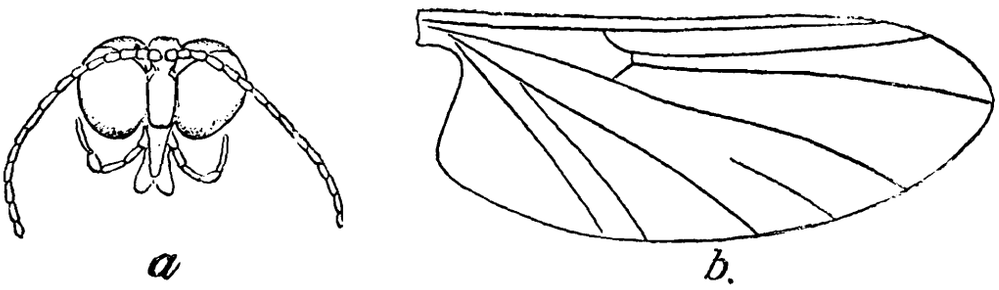
TEXT-FIG. 10.—Pupa E.
a. Dorsal view.
b. Ventral view.

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.

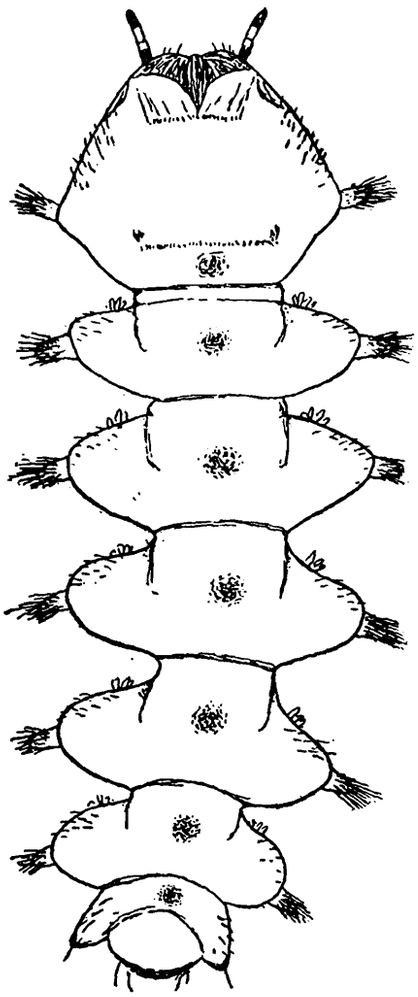
Both kinds of pupae may belong to the same species, the larger being the females and the smaller the males, and there would then be a sexual dimorphism in the mouth parts, or the larger pupae belong to larva E, and the smaller to larva D. Both of them, however, belong definitely to the same genus, and 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.



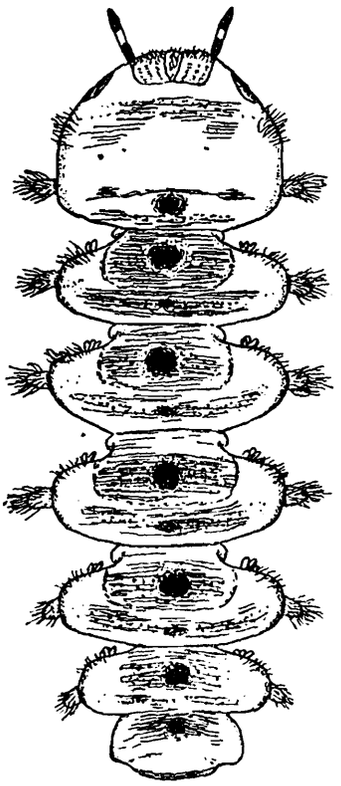
Text-fig. 13.—Larva F, dorsal view of a nearly full-grown specimen.

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.

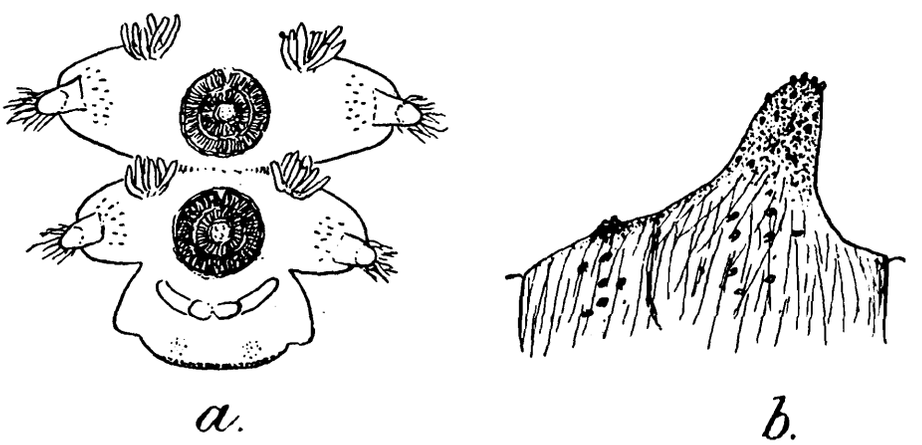
LARVA G.

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



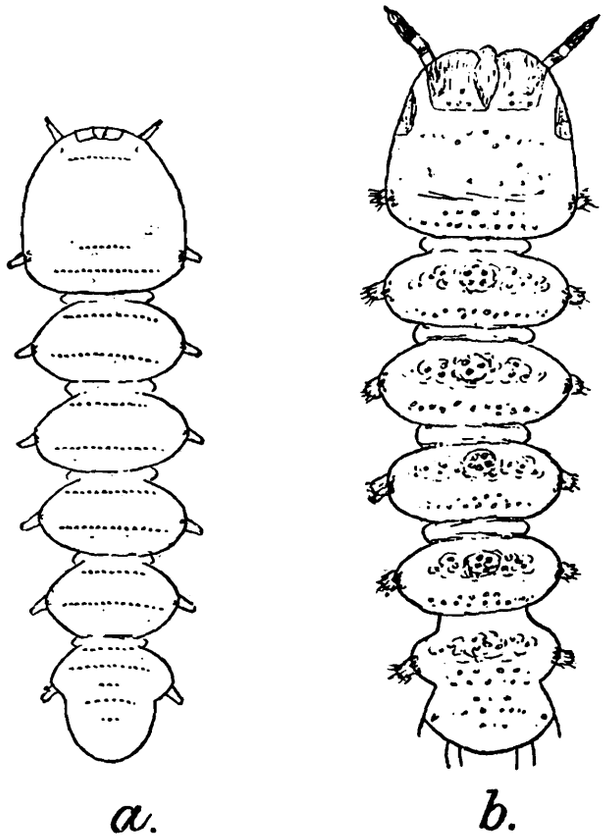
TEXT-FIG. 15.—Larva G.
a. Dorsal view of last segments of a full-grown specimen.
b. Lateral view of dorsal process of a full-grown specimen.

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.

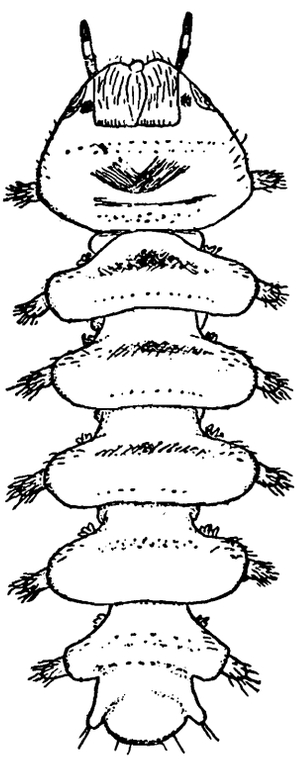
The same larvae were also found in Stations 1 and 3, Punj Pul Nullah, where they were more numerous. In the collection from both the localities there were few pupae which did not differ from the one shown in fig. 10, *a*, as belonging to larva E. They vary in length from 4 to 6 mm. There does not seem 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.*

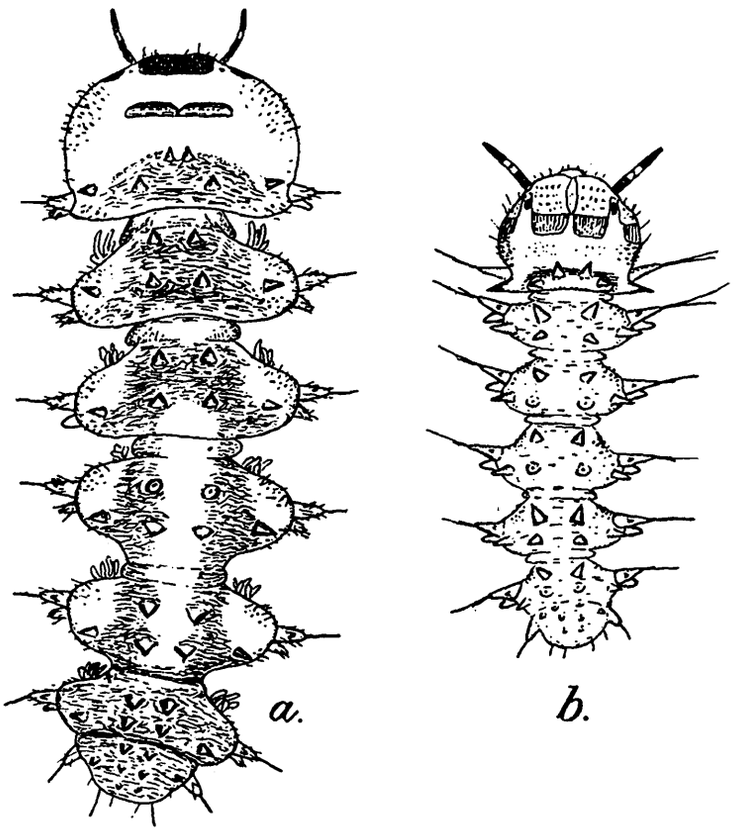
LARVA I.

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.

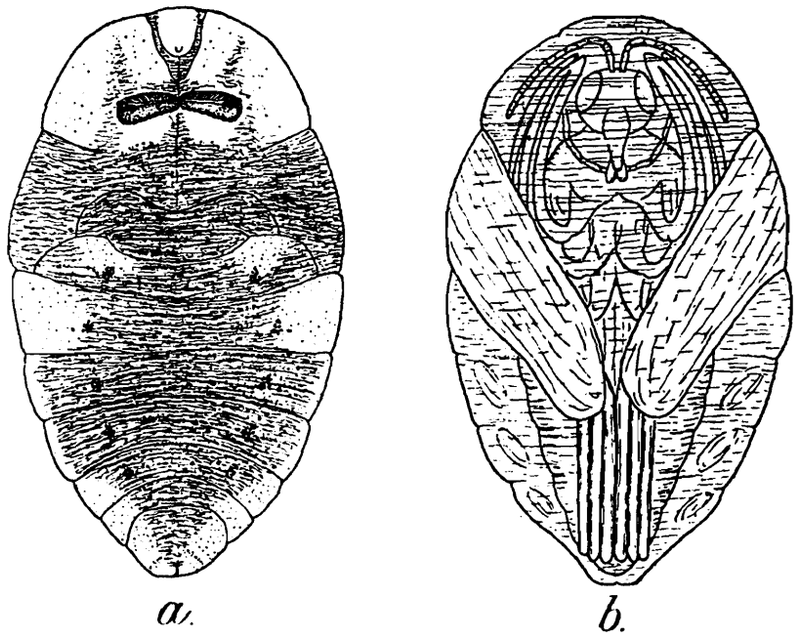
The second instar larva differs from the full-grown one in the antennae being two-segmented, the first segment being less than half as long as the second, which is white at the base and the tip ; the distal half of the second segment is evidently conical. The two kinds of lateral appendages and the dorsal, 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



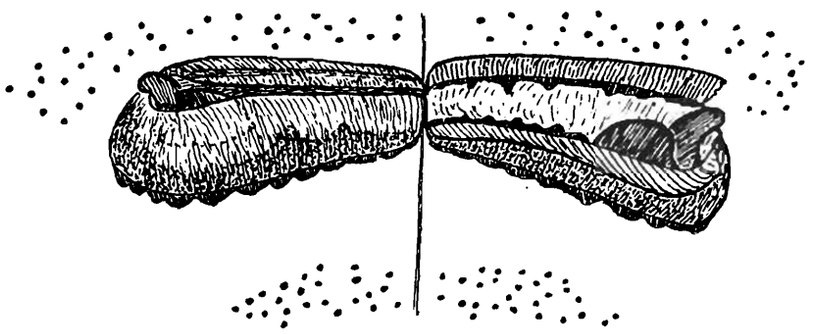
TEXT-FIG. 19.—Pupa I.

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

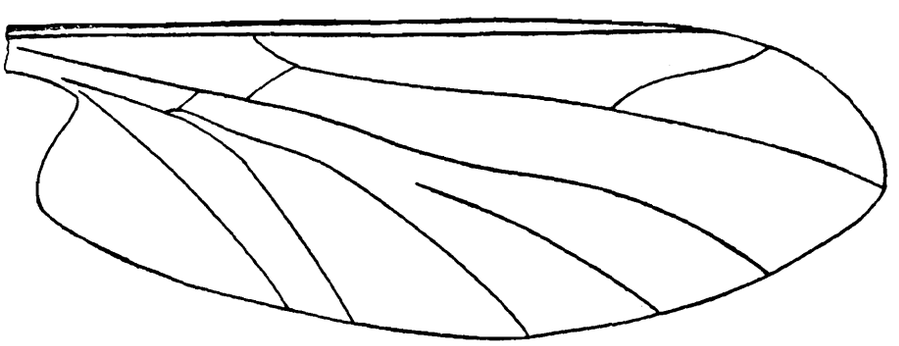


TEXT-FIG. 20.—Pupa I, breathing organs.

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.

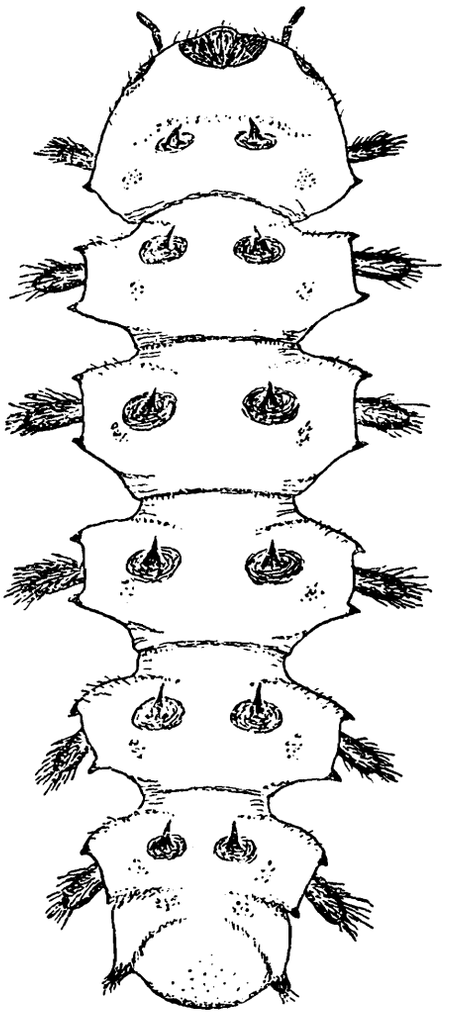
LARVA J.

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.

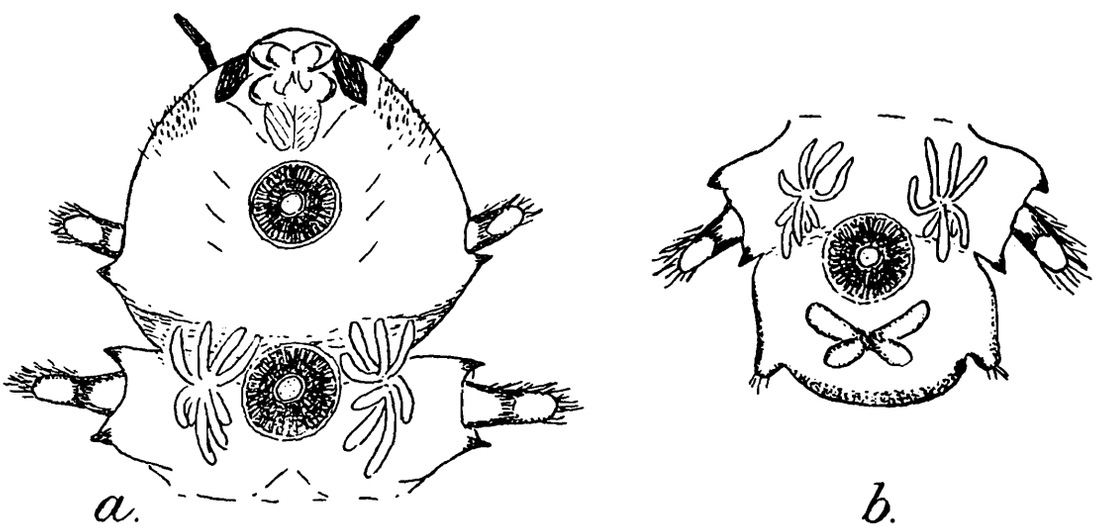
Length 6½ mm. The general colouration is ochreous brown without definite markings; the posterior margin and sides of divisions are darker, the edge of the last segment and the lobes are blackish. The integument is more strongly chitinised than in *Blepharocera* larvae in

[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.



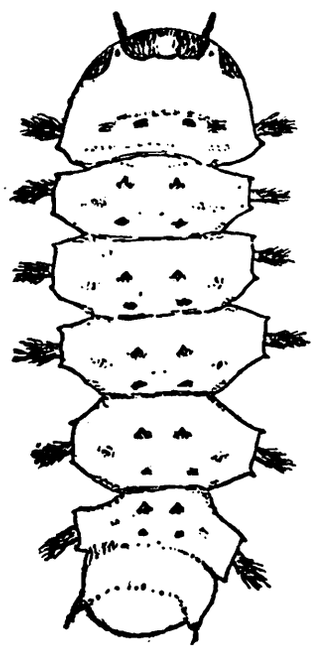
TEXT-FIG. 23.—Larva J.

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.



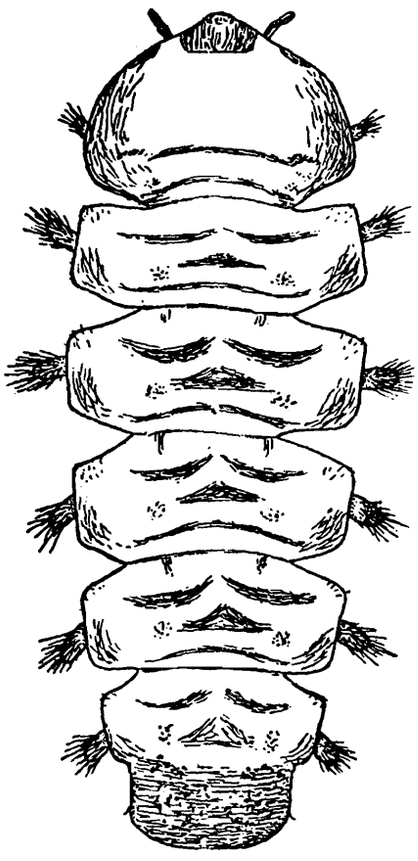
Text-fig. 24.—Larva J in the middle of the third instar.

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.

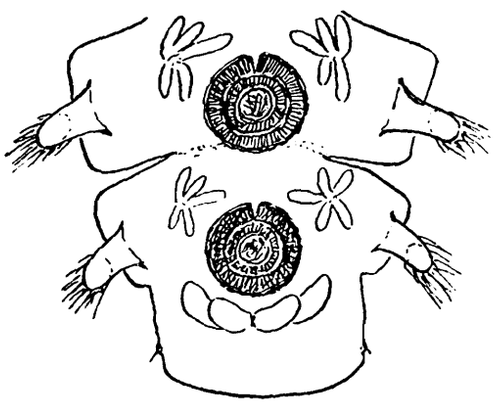
Locality: Dalhousie, Punjab. Punj Pul Nullah, 6,500 ft. Coll. S. L. Hora, May-June, 1929. One specimen apparently full-grown but not showing pupal horns through the skin.

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.**

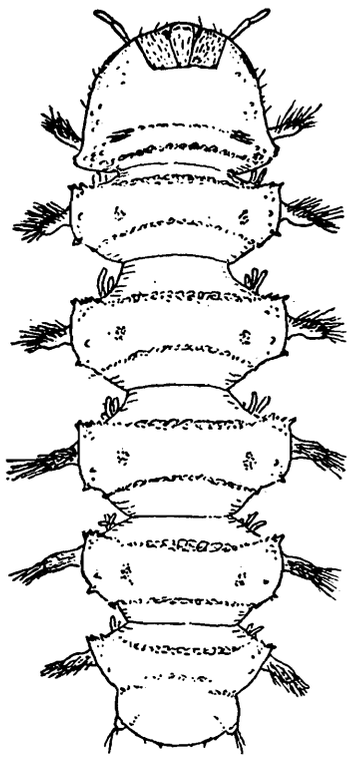
The collection from the Indian Museum contains numerous larvae which doubtless belong to the genus *Apistomyia*, for they correspond very well to the two known larvae of this genus; that of *A. elegans* Big. described by Edwards (8) and that of *A. tonnoiri* Till. which I described from Australia (17). 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.

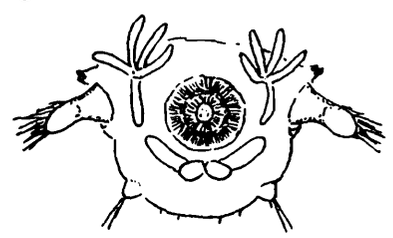
LARVA L.

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.



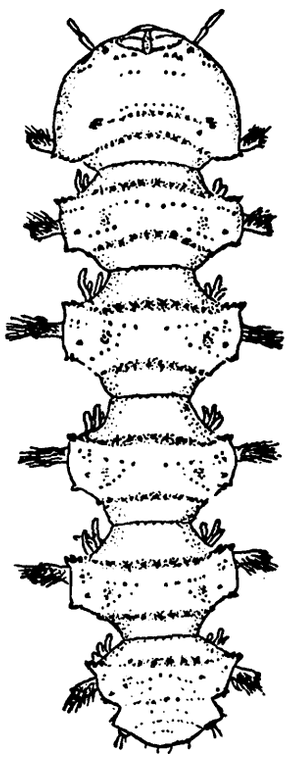
TEXT-FIG. 28.—Larva L, last division from below.

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.

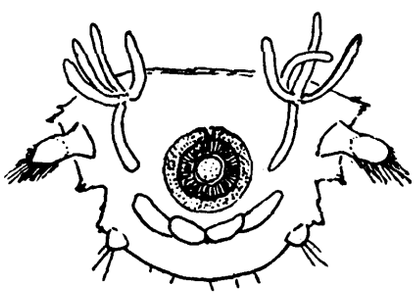
LARVA M.

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.

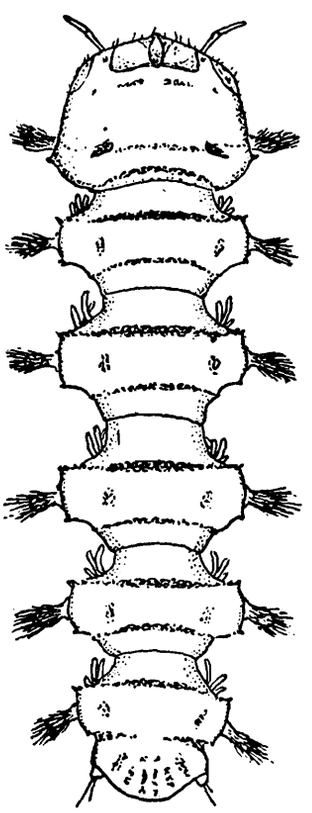
small reduced lateral appendages visible from above ; the last segment is rounded. The ventral gill-tufts are composed of rather long filaments, four directed forwards and one backwards. The anal gills, which are normal, are moderately long.

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.

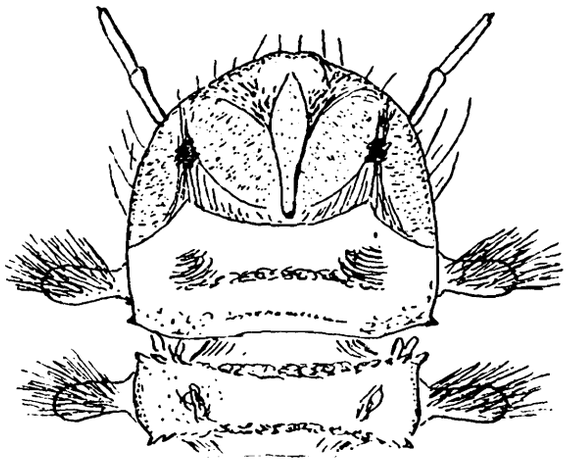


Text-fig. 31.—Larva N, a full-grown specimen.

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*.

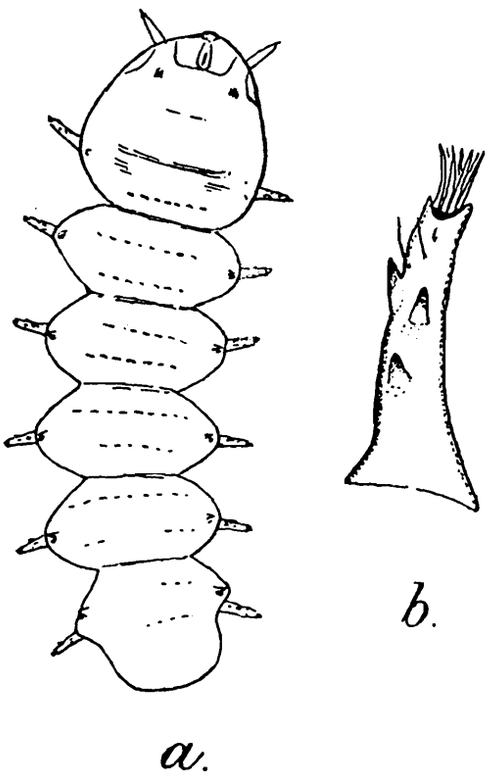
The second instar larvae measure from 1 mm. to 2 mm. Towards the middle of this instar the anterior part of the cephalic division in front of the anterior ridge is usually much paler than the rest of the body. The transverse ridges are not as well marked as in the full-grown larva, but there is a rather 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.

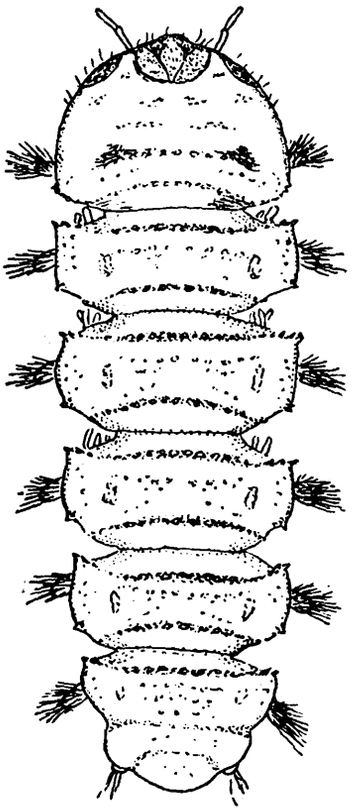


TEXT-FIG. 33.—Larva N.
a. A specimen in first instar.
b. Lateral process of first instar.

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.

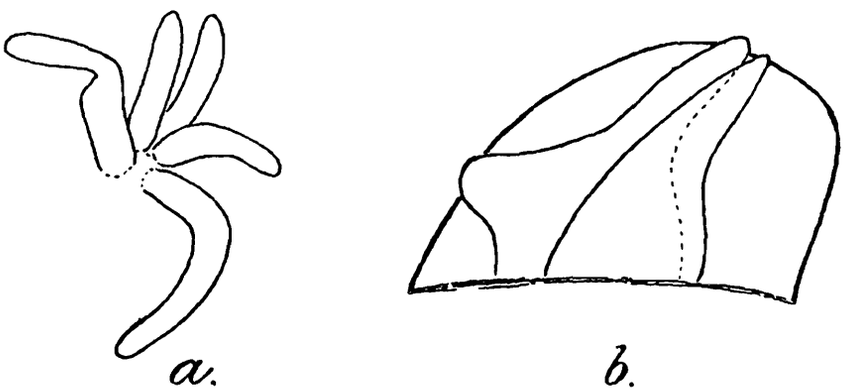
LARVA O.

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*.

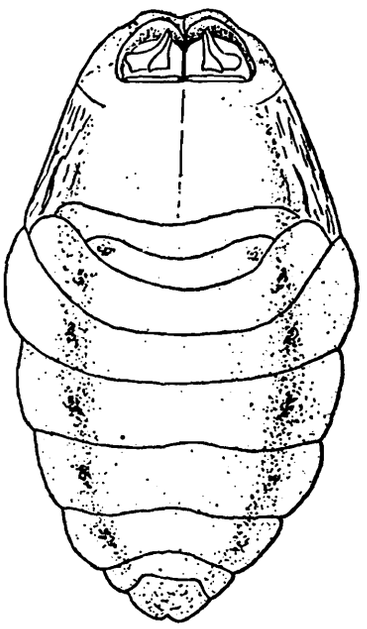


TEXT-FIG. 35.—Larva O.

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.

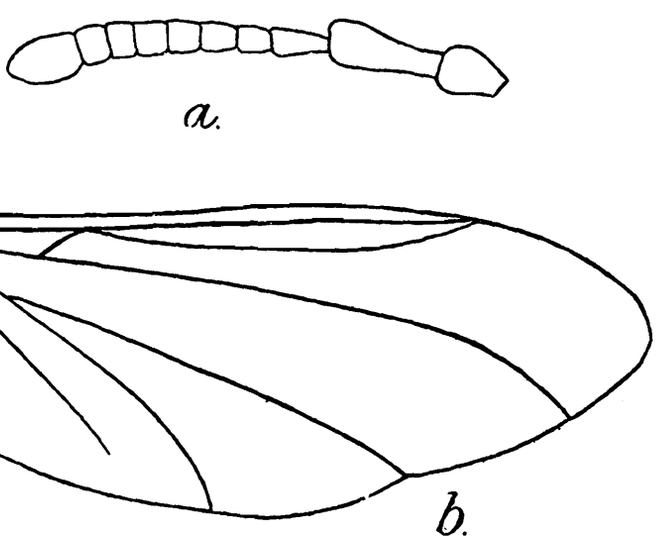
The larvae in the second instar do not show as many granulations on the dorsum of the divisions. Usually there is only one single row in between the ridges but they may be absent altogether from some of the divisions, particularly the penultimate. The colouration of this instar, just before passing into 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.

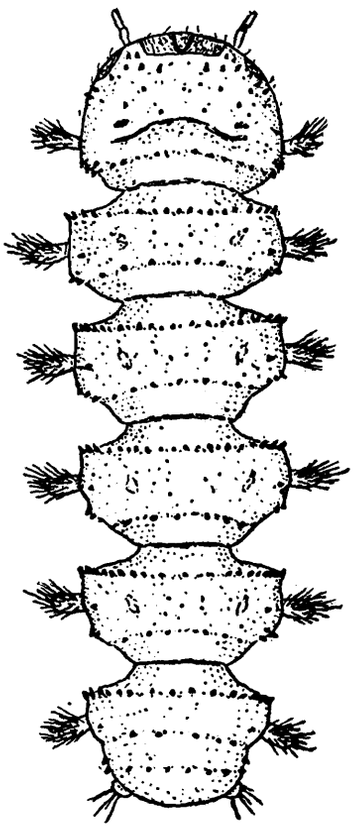
b. Wing venation of male extracted from the pupa.

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.

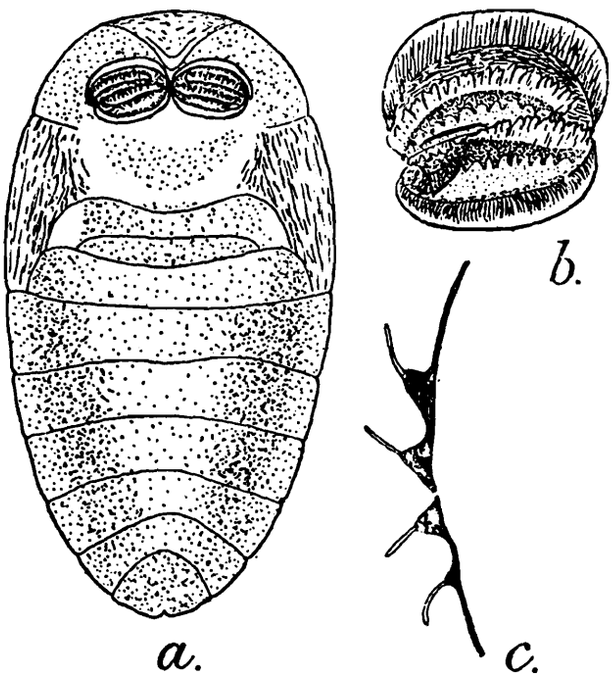
On account of its striking spiny appearance and its dark colouration this larva, from the same locality as larva O, could be separated quite easily from the numerous specimens of the latter species. The larvae of this species also differ by the absence of definite rows of granulations on the discs of 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

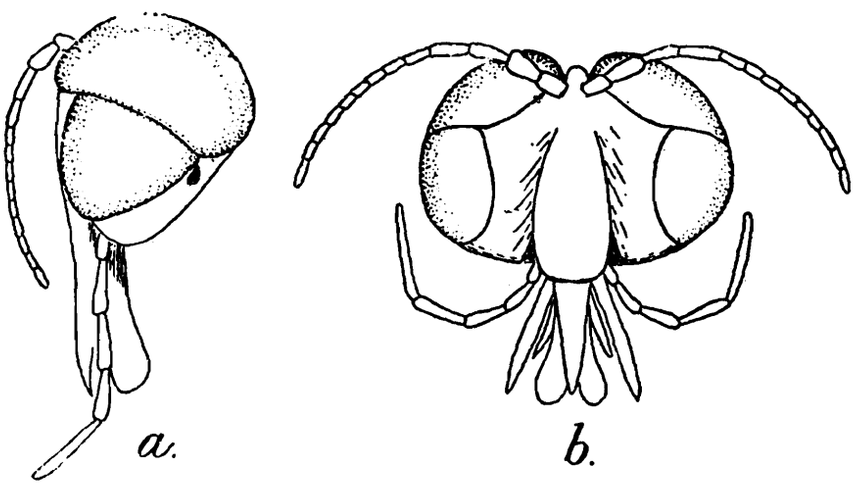
somewhat paler than is normally the case in Blepharocerid pupae. The head sclerite projects backwards and lies almost against the breathing organs, while the suture between the pro- and meso-thorax reaches nearly to their base. The breathing organs are very peculiar and so far without equal among those 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



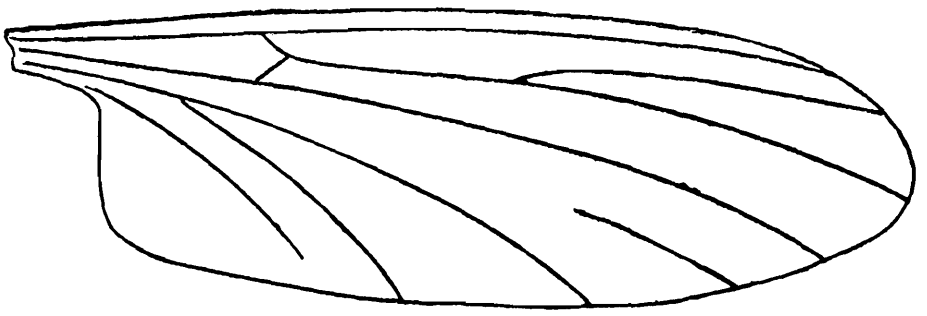
Text-fig. 40.—Pupa Q.

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.

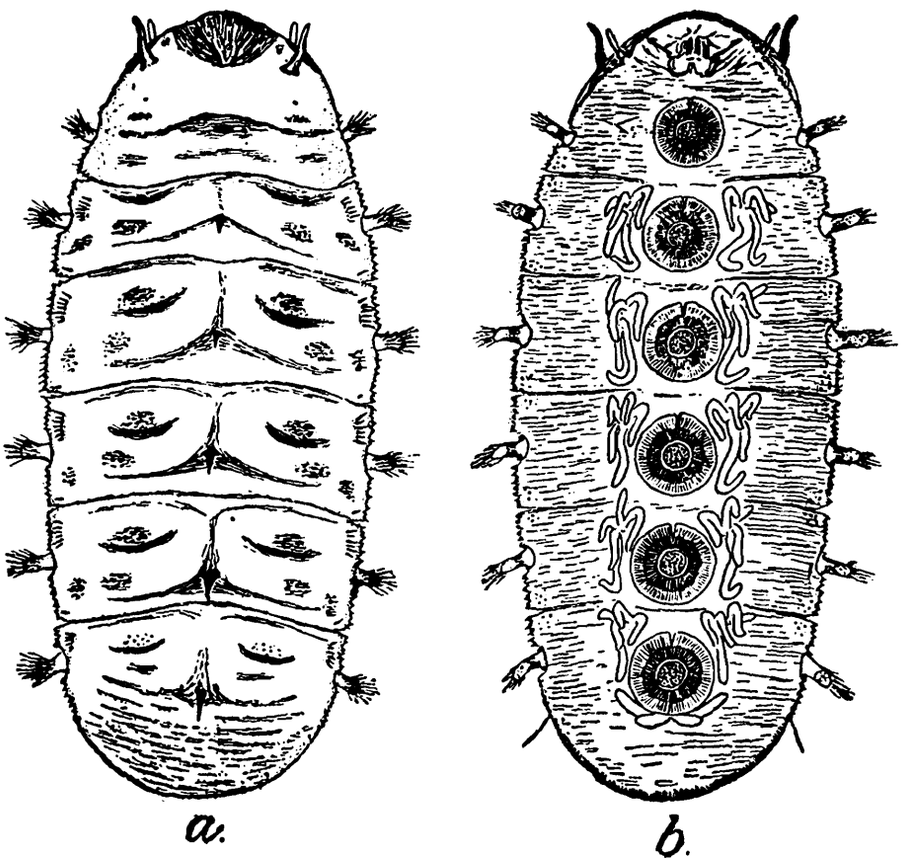
LARVA R_1.

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



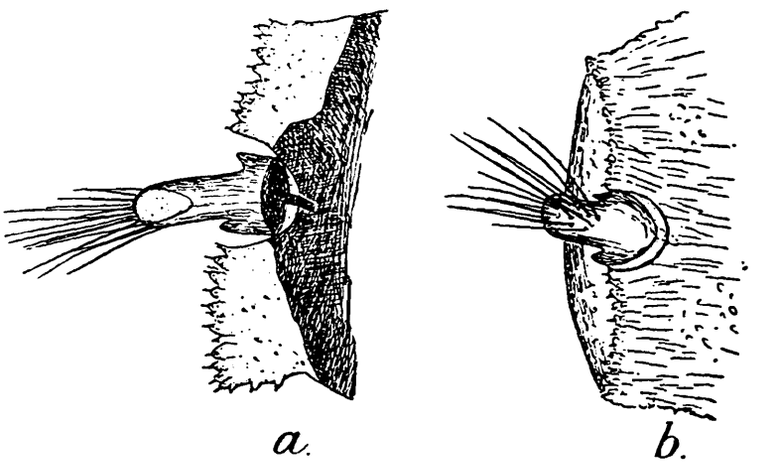
TEXT-FIG. 42.—Larva R_1.

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.

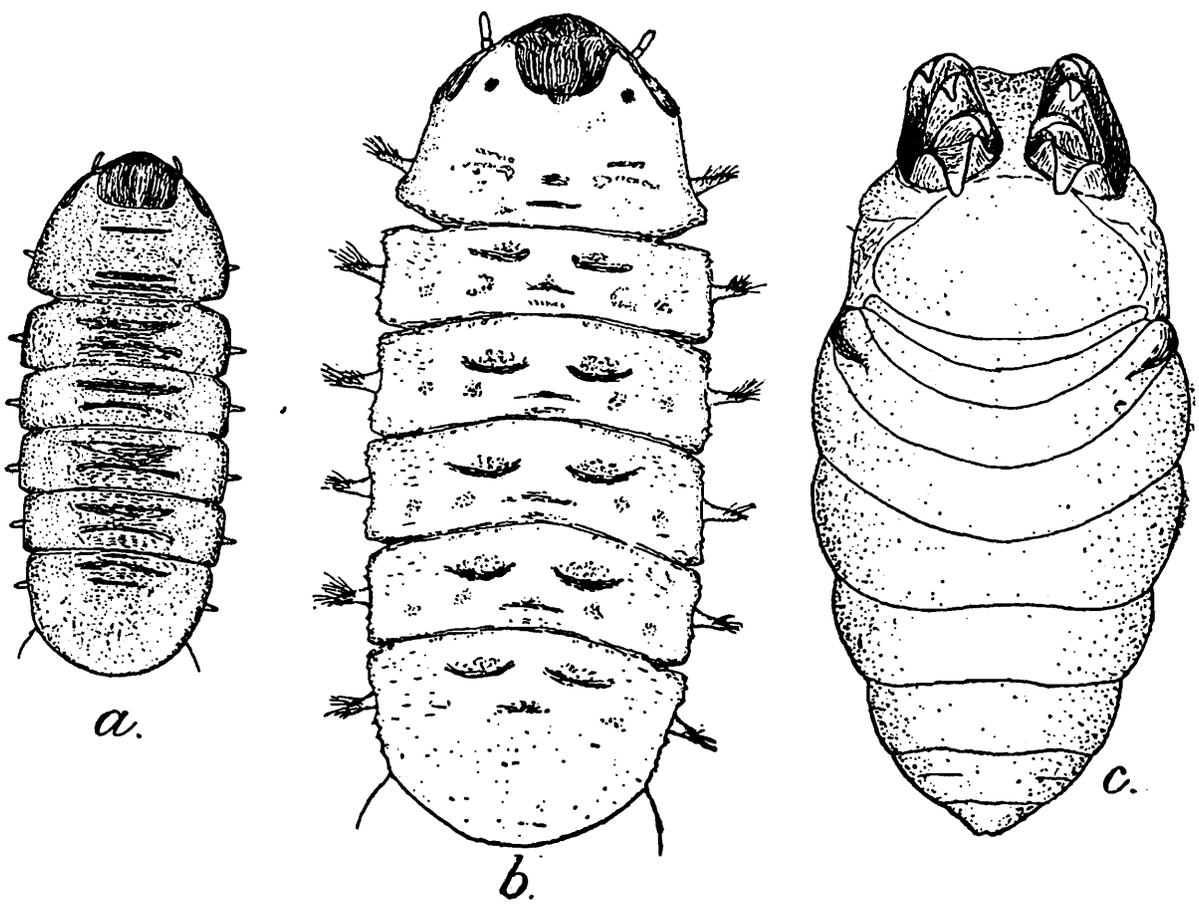
a. Ventral view of insertion of lateral appendage.

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.

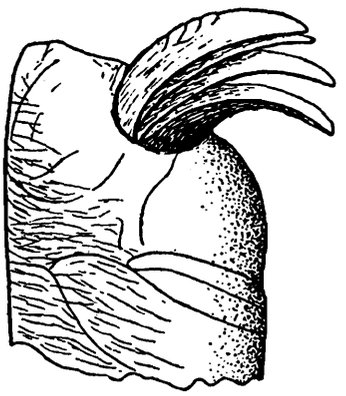
appearance from the full-grown larvae; its length is 1·1 mm.; the body ornamentation, as is the case in all the known Blepharocerid larvulae, is composed of a double transverse ridge. The lateral appendages are small and conical with a few terminal bristles, but no retractile hooked organs of fixation. 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.

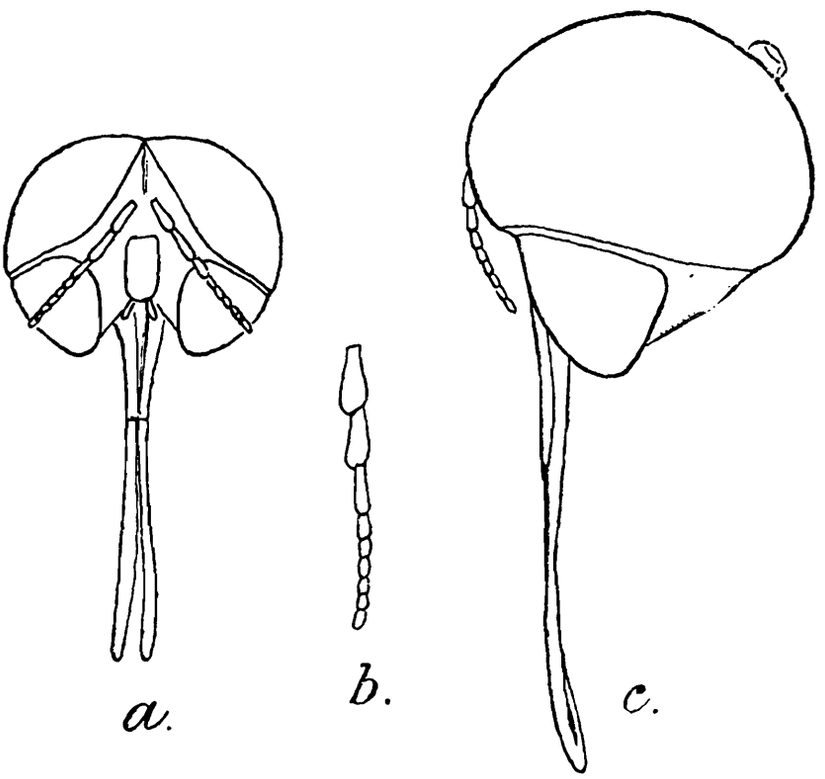
The imago was fairly developed inside one of these pupae, but its sex could not be ascertained definitely.[1] The genitalia were much damaged, but as I could not make out any eggs or spermathecae in the abdomen, the probability is that the extracted fly was a male. Its wing venation is represented in 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.

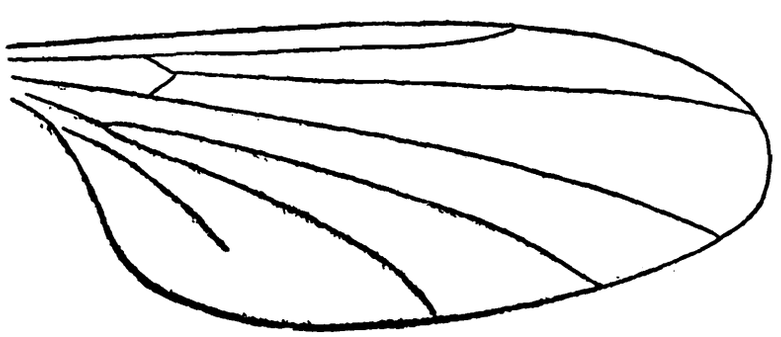
small, nine-segmented[1]; proboscis thin and somewhat longer than the height of the head; labella very elongate, palpi much reduced, mandibles apparently absent. Venation as in *Paltostoma* or *Peritheates*, the tip of Rs. reaching the wing margin a little above the wing apex.



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.

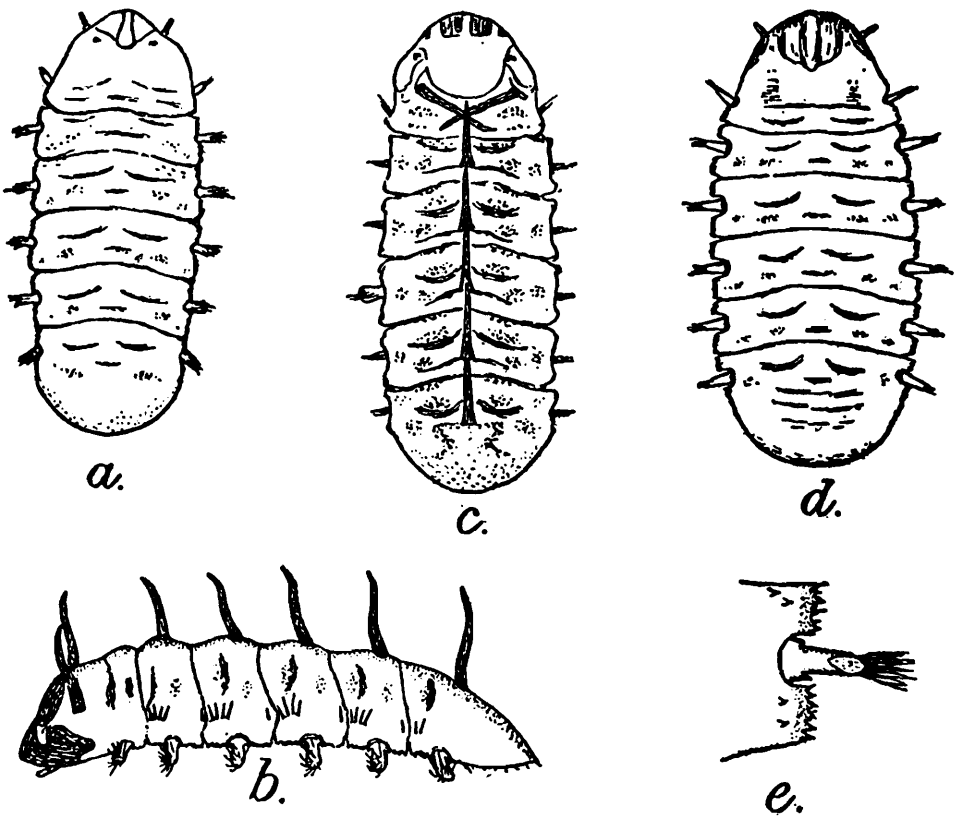
Larva R_1.

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.

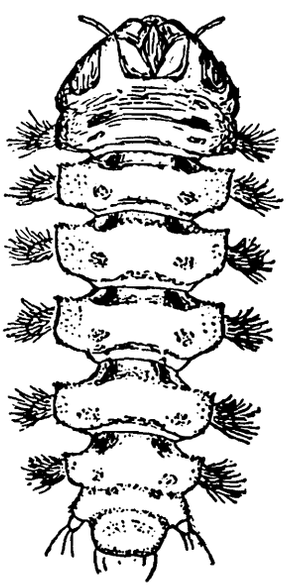
Under the microscope I have observed at some length the working of the mouth-parts while the larvae were feeding. The chief role in this connection is played by the two large pads which form the proximal part of the maxillae, and which are thickly covered with setae. They are first spread flat on the 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.

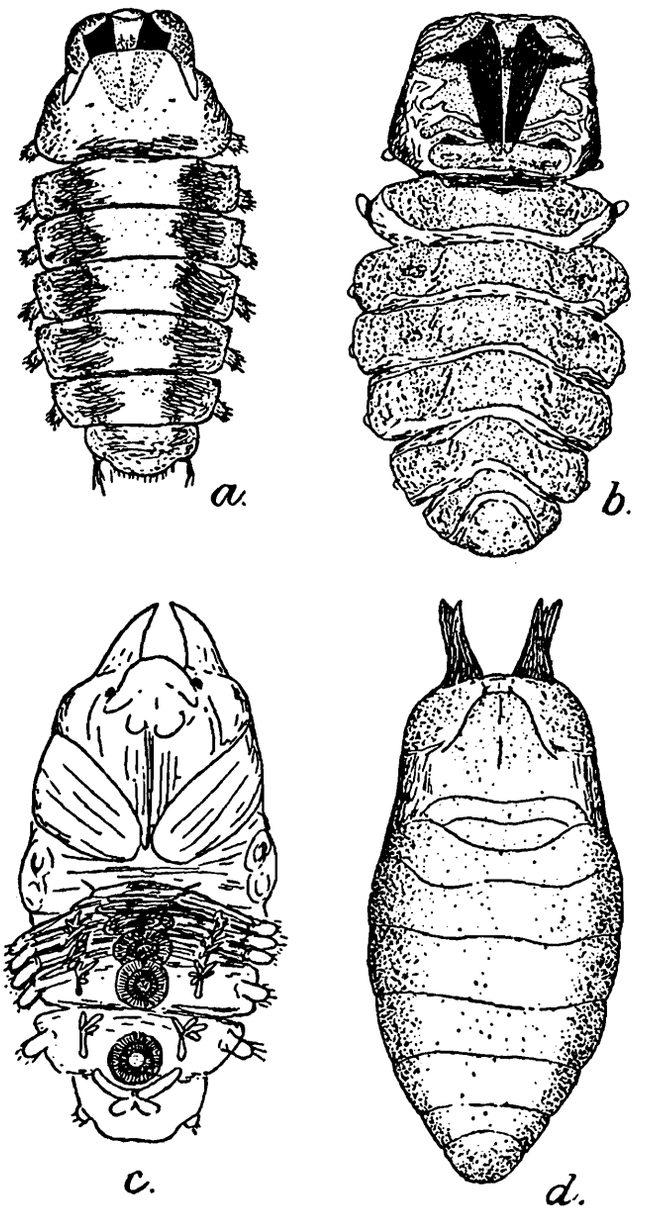
When a larva is nearing pupation,[1] it fixes itself as far as possible with the head turned against the current, and the whole body contracts itself, the divisions being brought close together (compare figs. 49, 50, *a*). If a larva at this stage is dissected one finds under its skin a prepupa shaped 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*.

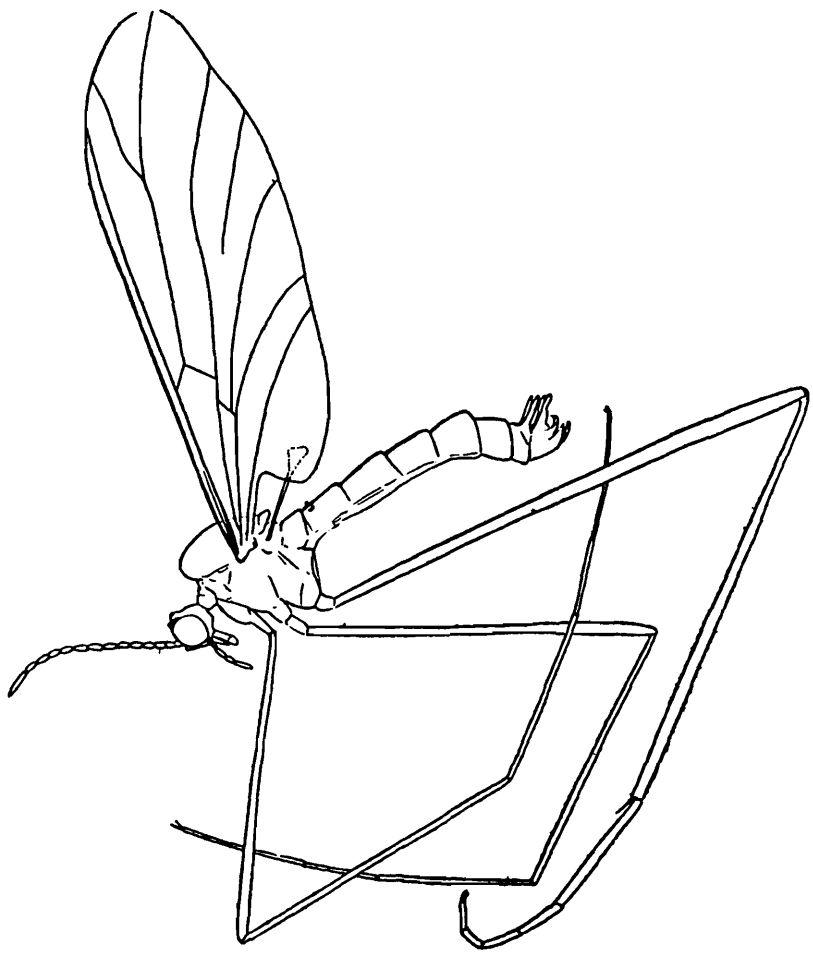
This species may be described as follows:—

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. ♂.

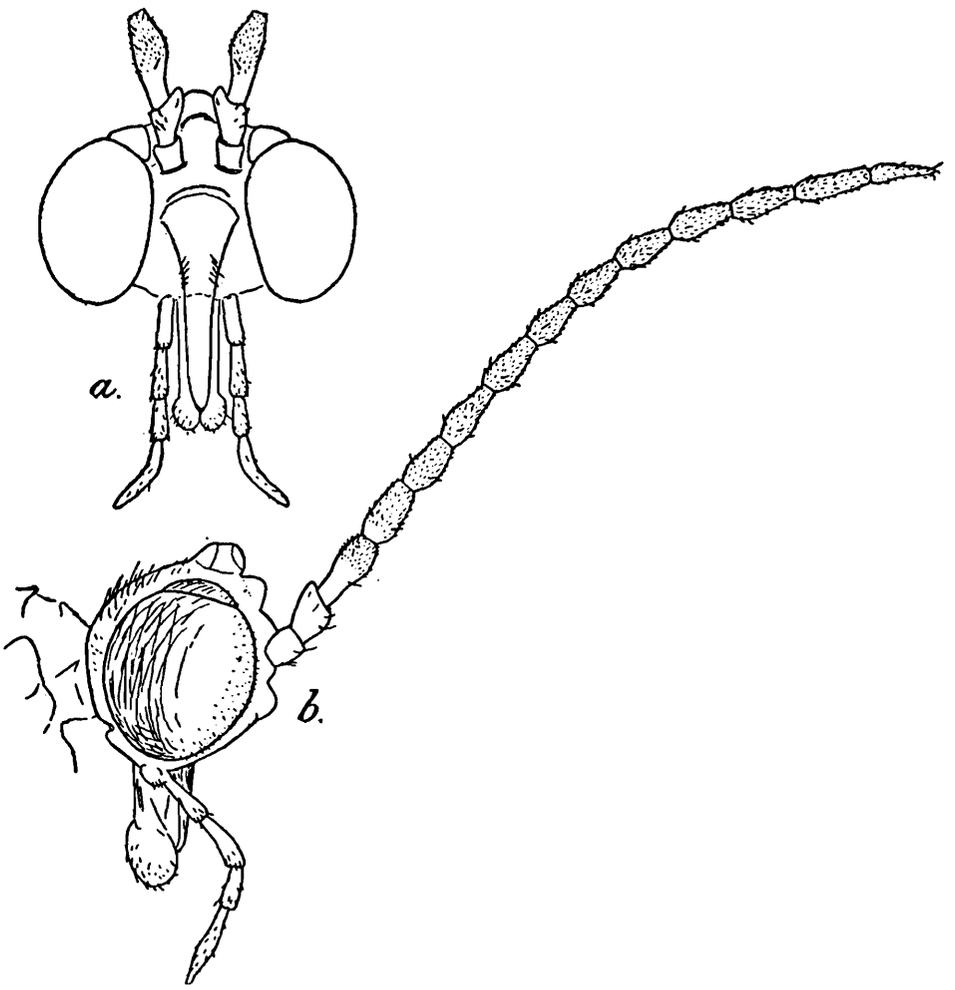
The venation is practically identical with that of *E. horai* but for a somewhat different shape of the fork of Rs. The head (fig. 52, *a* and *b*) is characterized by the wide frons on which there is a tubercule just below the ocellar turret ; the face is also somewhat raised just below the antennae. 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.

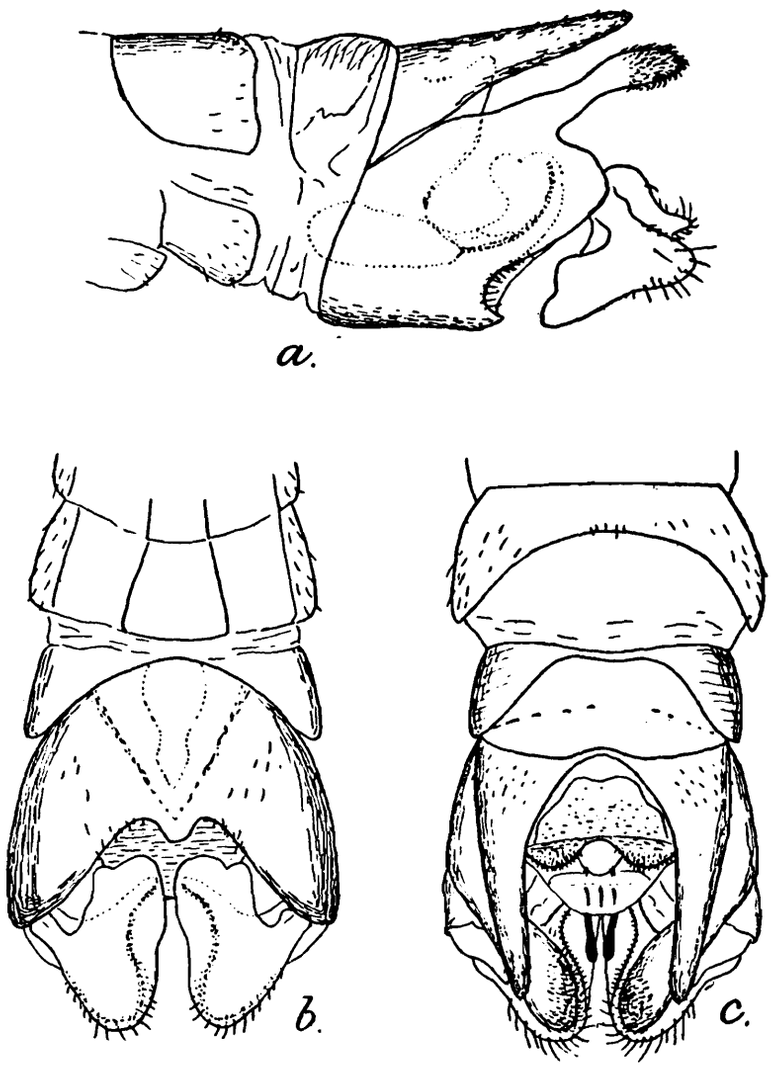
Length of body 5 mm. ; wing 6·5 mm. *Type,* one male in spirit from Dumpep, Khasi Hills, Coll. S. I. Hora, x. 29, in the Indian Museum.

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.



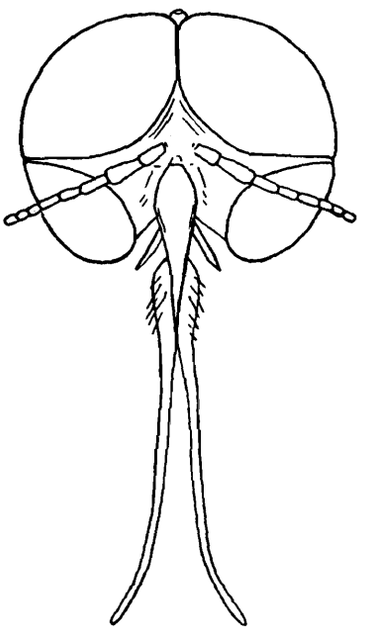
TEXT-FIG. 53.—Hypopygium of *Euliponeura assamensis*, n. sp. ♂.
a. Lateral view ; *b*. ventral view ; *c*. dorsal view.

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.

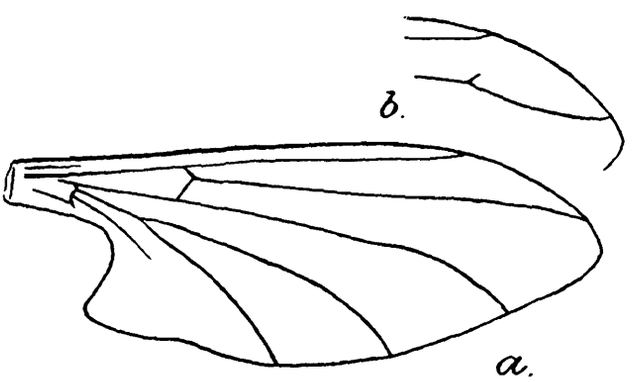
Head as shown in fig. 54, the eyes being completely divided by a bare narrow space between the two parts, but the difference in size between the large facets of the upper part and the small ones of the lower part is probably not so marked as in *Apistomyia*. The labrum is relatively short and the whole 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*).



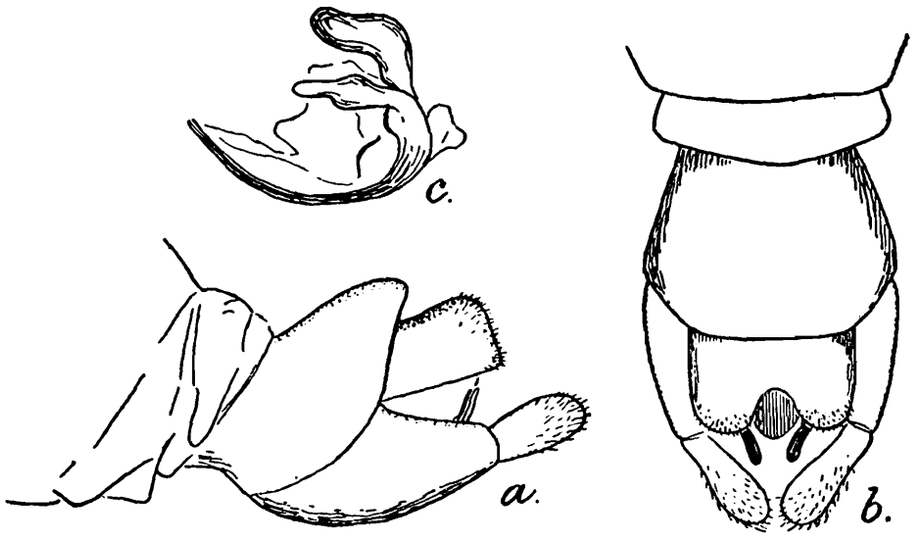
TEXT-FIG. 55.—*Horaia montana*, n. sp. ♂.
a. Venation ; *b*. tip of wing.

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*).

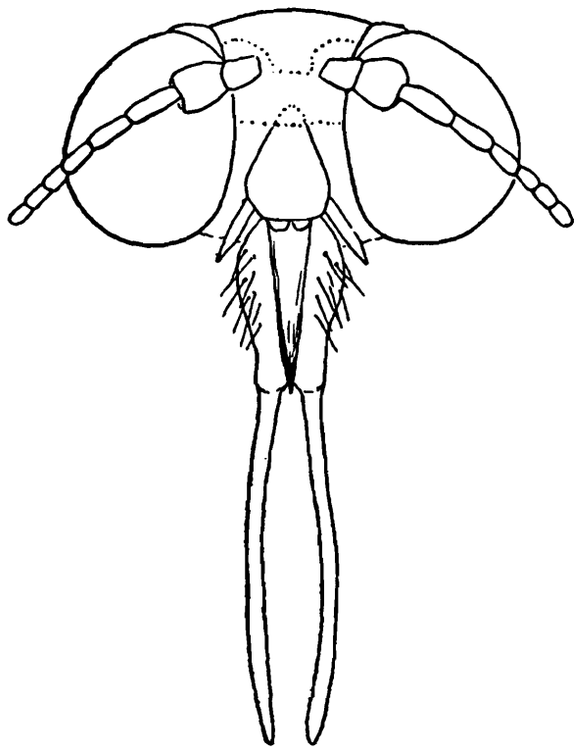
Female.—Similar to male in venation ; head as depicted in fig. 57 ; the frons broad but not as wide as the width of an eye ; ocellar tubercule very little evident, not visible from the front.

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.

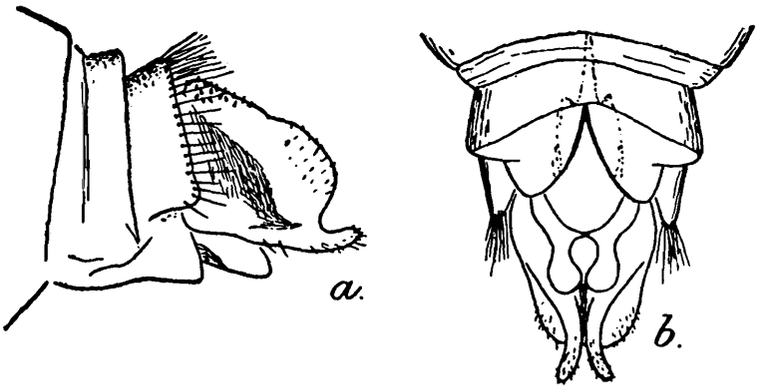
Mandibles absent ; eyes divided, no space between the two divisions, the upper one very small, its facets not distinctly larger than those of the lower one.



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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