# DESCRIPTIONS OF REMARKABLE INDIAN PSYCHODIDAE AND THEIR EARLY STAGES, WITH A THEORY OF THE EVOLUTION OF THE VENTRAL SUCKERS OF DIPTEROUS LARVAE.

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(Plate II.)

While making ecological observations in February and March in the Teesta valley on the inhabitants of waterfalls, Dr. S. L. Hora " observed that rocks on the sides of waterfalls which are kept moist by the spray harboured a very peculiar fauna. Small stones and pebbles were covered with young stages of Blepharocerid larvae and when collecting them I noticed[1] some very peculiar larvae and pupae of a Psychodid fly. I did not examine the material very carefully so as to differentiate the various types represented in it, but I was, however, aware of the importance of the find as I had seen similar larvae and pupae figured by Müller from Brazil. In no case were the larvae and pupae found submerged under water and the flies were found hopping about on wet rocks near the lips of the falls or in their immediate vicinity "

Dr. Hora intended to make a study of this material and took it with him to Europe, where he showed it to Dr. Edwards at the British Museum. It so happened that Dr. Edwards had a few days before seen some similar larvae in a collection of Simulium larvae made by Thienemann and Feuerborn in Java and knew that the latter was preparing a paper on this interesting animal Hora then relinquished his intention of dealing himself with the subject and sent his tubes to me. In the meanwhile I had found some of these larvae in the tubes containing numerous Blepharocerid larvae from the same localities which had been submitted to me for study by Hora some time before. I sent one of these to Feuerborn asking him to let me know whether it was similar to the form he was then studying. He replied that not only was his Javanese larva similar but also conspecific with Hora's and he, therefore, intended to record in his paper the presence of this species in India and to name it *M. indica* on account of its geographical distribution. However, a careful comparison of both larvae has convinced me that they belong to different species although they are undoubtedly congeneric.

In the meanwhile the material sent to me by Hora from England reached me, and was found to contain—

(1) A number of larvae, two damaged pupae and a few imagines in spirit of the species here described as *Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.

(2) Three larvae (gone dry after being kept in spirit) and numerous pupae of *Horaiella prodigiosa*, sp. nov.

[1] I quote here a passage from one of Dr. Hora's letters.

(3) A lesser number of pupae of another species of the same genus, *H. consimilis*, sp. nov., some of the pupae were preserved dry *in situ* on a piece of rock.

In order to complete this fragmentary material Dr. Hora in March, 1932, sent Mr. D. D. Mukerji to the Teesta valley and secured an abundant collection consisting of numerous specimens of all the stages of *T horai*, including a large series of pinned flies of this species, with which were associated a few larvae of a second species of *Telmatoscopus* and numerous pupae of *H. consimilis* and *H. prodigiosa*, all from the original locality or its vicinity.

This enumeration shows that some of the missing stages have not yet been found. As, however, no further opportunity was likely to occur of completing this material before the end of the year, Dr. Hora pressed me to publish an account of what was on hand.

I am doing this rather reluctantly because my account is not as complete as one could wish, especially so far as *Horaiella* is concerned; however, by extracting the nearly mature fly from the pupae of the two species of this genus I have been able to gain a fairly good knowledge of the adult stage and to establish, therefore, a sufficient definition of the genus.

I am most grateful to Dr. Hora for giving me the opportunity of making known these most interesting animals and tender him here my most sincere thanks. In order to perpetuate his wonderful discovery I am dedicating the new genus *Horaiella* and one of the new species of *Telmatoscopus* to him.

All the types have been returned to the Indian Museum.

## **Horaiella,** gen. nov.

Body and wings almost bare; antennae elongate, filiform, with cylindrical segments, apparently 17 segmented; eyes round without bridge. Wing with only 8 longitudinal veins, some of which form three contiguous forks on the disc. Larva aquatic, broadly oval and provided with a single large ventral sucker. Pupa oval, very flat with incomplete segmentation of the abdomen.

*Genotype :—H. prodigiosa*, sp. nov.

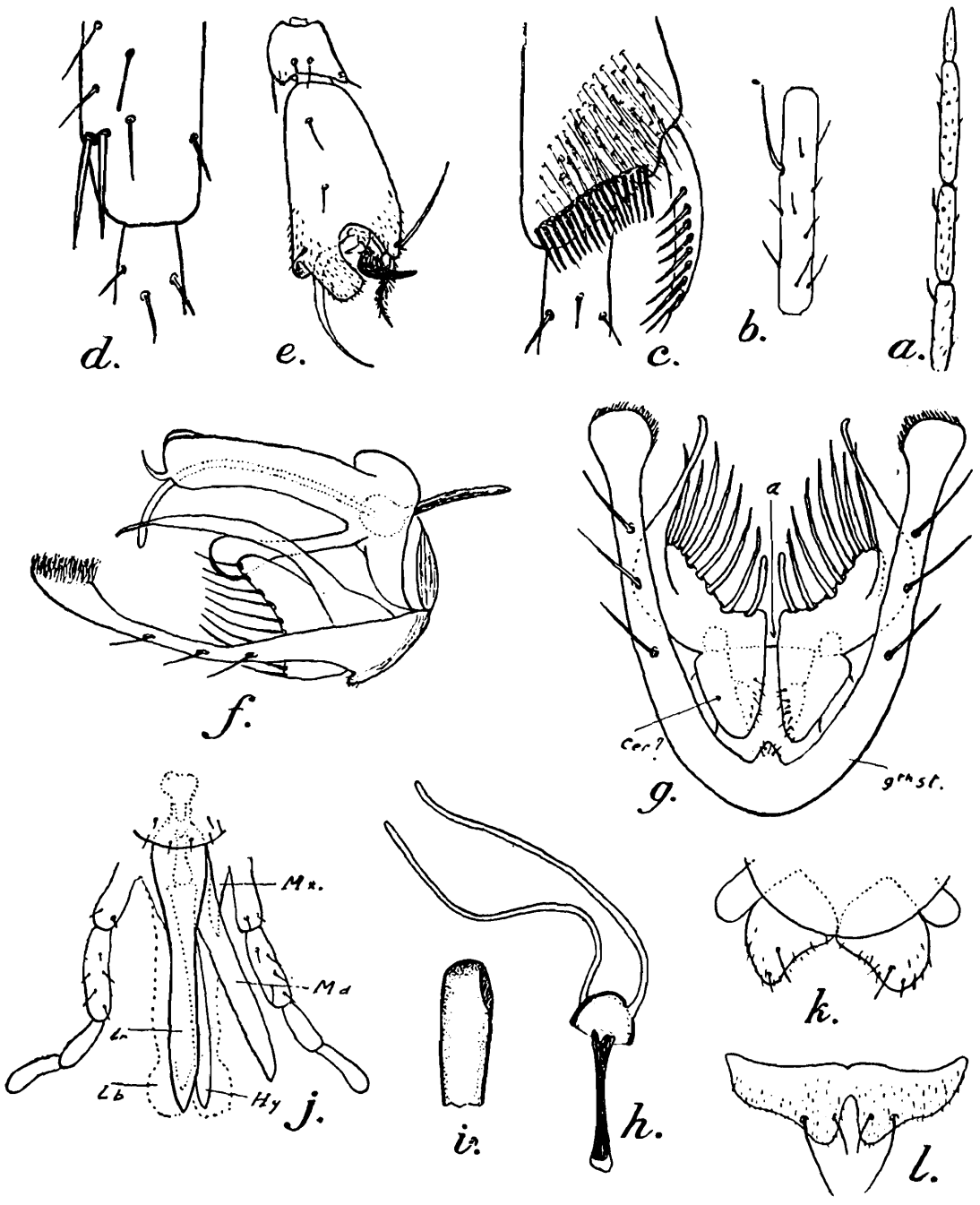
The two species which I include in this new genus can easily be distinguished in the adult stage by the venation, the two anterior forks being at widely different levels in *H. prodigiosa* and at the same level in *H. consimilis*; in addition the conformation of the genitalia is quite characteristic in both sexes of the two species. For the males compare figs. 1*f* and 2*b* and for the females figs. 1*l* and 2*d*. The pupae differ in the shape of the breathing horn, as shown in plate ii, figs. 3 and 5. The larva of only one of the two species is known.

## **Horaiella prodigiosa,** sp. nov.

*Male.*—Colouration not available. Eyes rounded without a trace of bridge on the vertex. Antennae (fig. 1*d*) in appearance 17 segmented and when fully extended[1] about as long as, if not longer than the

[1] It must be remembered that the description is drawn up from an immature fly extracted from the pupa and, therefore, not fully extended.

wings. First segment small ring-shaped; second globulous; those of the flagellum perfectly cylindrical, the basal ones very long, the others gradually diminishing in length; but the penultimate segment is longer again than the preceding one and the last segment is only half as long and half as thick, and is not distinctly articulated with the preceding one. This last segment is analogous to the apiculus of the last segment of the Bruchomyiinae for instance, but in the species of that subfamily there is not even a distinct suture between the apiculus and the segment, yet Alexander (1929) considers it to be the 17th. The bristles of the flagellum are not numerous and not longer than the diameter of the segment. A single rather long elbowed ascoid (fig. 1*b*) is present on all




TEXT-FIG. 1.—*Horaiella prodigiosa*, sp. nov.

*a*. Extremity of antenna of male; *b*. A median segment of antenna of male; *c*. Apex of anterior tibia; *d*. Apex of posterior tibia; *e*. Last tarsal segment; *f*. Hypopygium with gonopods removed, lateral view; *g*. Part of hypopygium seen from behind; *h*. Pumpetta of penis; *i*. Apex of filament of penis; *j*. Mouth-parts of female; *k*. Ovipositor; *l*. Subgenital plate.

the flagellar segments except the last two; rather numerous sensory pits, surrounded by setulae, are found on the last few segments.

Palpi four segmented; their actual relative lengths are not ascertainable as the segments are not fully extended; the second is apparently the longest; the small basal segment present in *Nemopalpus* and *Phlebotomus* is here not distinguishable; the first two segments carry very few bristles. The mouth parts are not more developed than in the Psychodinae, there are no mandibles as in the female; the pharynx is large, as in *Phlebotomus*, but without sculpture or bristles on its posterior part.

Thorax bare but for the following chaetotaxy: 4 anterior, 8 lateral plus 1 small behind, 4 scutellar and 2 mesonotal.

Legs moderately elongate; tibiae and basitarsi with regular longitudinal rows of microscopic setulae, the rest of the tarsi practically bare. The anterior tibiae are provided with an apical comb (fig. 1*c*) and a conspicuous strigil, whereas the posterior tibiae have a pair of strong apical spines which may be homologized with tibial spurs (fig. 1*d*). These spurs are absent in the rest of the family. Basitarsi about as long as the tibiae and about twice as long as the four other tarsal segments together, the last one about twice as long and thick as the preceding one; it is provided with an apical dorsal flap; the claws are unequal, one being long, thin and gently curved and the other short, broad and abruptly elbowed near its base; the long claw is provided with a long bristle-like basal projection (fig. 1*e*); empodium well developed, plumose.

Wing elongate and very similar in shape to that of *Phlebotomus*; the base is narrow without a distinct anal lobe and the alula is small; the apex appears to be rounded and is located between the tips of $R_5$ and $M_1$. Sc ends in $R_1$, there is no trace of $Sc_1$, but h is present. The first branch of Rs is single but the second branch is forked so that the radial sector is composed of only three branches, as in the Trichomyiinae; $M_3$ and $M_4$ branch rather far from the base, much further than is usually the case in the family except in the Bruchomyiinae. The venation of this species is similar to that shown in fig. 2*a*, but the three forks are at different levels; that of $M_1$ $M_2$ being located midway between the two others.

The vestiture of the wing is exceedingly scanty; there are only a few macrotrichia along the veins (all of them are represented in fig. 2*a*). The fringe is meagre and short but somewhat longer on the posterior border near the base; a conspicuous tuft of 8-10 long bristles is present on the small alula. The wing fringe is characterized especially on the anterior border by the presence of small bristly hairs or spinules disposed at regular intervals, they are larger and coarser than the ordinary small hairs of the fringe and can easily be distinguished among them.

The abdomen is very flattened dorso-ventrally, but it may, of course, assume a more cylindrical shape in the mature fly; the chaetotaxy of the abdomen consists of one row of 6 long bristles on the first segment and two rows of six on the second, the following segments have only a few very small hairs.

The hypopygium of the immature fly enclosed in the pupa is of course in its normal position and it is impossible to say if it will be inverted

later in the mature imago, as is the case in all the Psychodidae except *Sycorax*. The general aspect of the hypopygium resembles that of *H. consimilis* shown in fig. 2*b*, but it differs in the structure of the internal parts, which are shown in fig. 1 *f* and *g*. The large coxites are fused together and with the 9th sternite, and thus form a large capsule; the style is subcylindrical, very elongate, rounded at the apex and gently curved inwards; its inner side is provided with about 8 strong spines between which are some smaller spinules. The aedeagus is as shown in fig. 1*f*, which represents in profile the hypopygium from which the coxites and styles have been removed; it carries on each side an elongate, spathulate projection, which may be the parameres. The penis is of the bifid forked type (fig. 1 *h* and *i*); the filaments are moderately elongate and have their origin in an ampulla to which is attached a posterior rod, both forming thus a pumpetta similar to but not so evolved as that of *Phlebotomus*; the 9th sternite has two lateral lobes, which are homologous with what Feuerborn calls cercopods in the Psychodinae but they are not articulated to the sternite; their apex is spathulate and carries a large number of fine tenacular hairs; on the internal side, interior to the base of these lateral lobes is a pair of complex structures the lower distal part of which seems to be the cerci but the pectinated part is not easy to homologize; the anus appears to be at the point marked " a " in fig. 1*g*.

Length of wing: approx. 2·5 mm.

*Female.*—Similar to the male in most respects; the antennae are identical, including the ascoids, but the sensory pits of the last segments are less numerous.

The mouth parts (fig. 1*j*) are relatively more elongate, longer than the head; the mandibles are as long as the labrum; the hypopharynx is finely toothed on its inner margins; the maxillae are not more developed than in the Psychodinae; the lack of development of the maxillae casts some doubt on the possibility of this species being a blood sucker,[1] for fully-developed mandibles associated with reduced maxillae are found in females of some Blepharoceridae and Ceratopogonidae which are not haematophagous. Palpi as in male. The anterior tibiae have strigils as shown in fig. 1*c*. The cerci (fig. 1*k*) are not developed into a long ovipositor; the sub-genital plate is as shown in fig. 1*l*.

*Holotype.*—On slide, from " stream three miles from Teesta," 7th February 1931, S. L. Hora. *Allotype* on slide from Luch-chu Jhora, Teesta Bridge, 25th March, 1932, D. D. Mukerji.

*Pupa.*—(Plate ii, figs. 1 and 2) testaceous orange on the dorsal face, which is smooth but hard, the underside soft and whitish; its outline is elongate oval as shown in plate ii, and the contour of the body is not broken by the segmentation, even the intersegmental sutures of the first few abdominal segments do not reach the sides of the body whereas those of the last segments reach the sides: the median suture of the thorax through which the emergence of the fly occurs is not distinct except in the cleared pupal exuvium.

The prothoracic breathing horn (plate ii, fig. 5) is quite different from that of the other pupae of the Psychodidae, in which the distal

[1] In a recent letter Dr. Hora says that while collecting in the localities where this species is abundant he has never been bitten by it.

part of the horn carries a number of small round craters closed by a membrane ; *Maruina* may be an exception to this as the figures given by Müller show an apical slit on the pupal horn. In *Horaiella* the stigma opens at the bottom of a deep fold of the horn, the sides and borders of this fold being covered by a fine striation (plate ii, fig. 4). This organ functions differently from the usual prothoracic horn of most aquatic dipterous pupae ; it is more akin to that of the Blepharoceridae in which the fully open prothoracic spiracles are surrounded by lamellae, whose function is to retain a bubble or a layer of air on their corrugated or velvety surface; the gaseous interchange necessary for breathing takes place between this small volume of air and the oxygen in solution in the water. The fine striations of the horns of *Horaiella* pupae must act in the same way. The adhesion of the pupa to the substratum is very strong. Judging from some pupae *in situ* on a small piece of rock which was submitted to me, the animal when ready for pupation selects a little hollow or fold in the rock so that the edge of the flat pupal body is in perfect contact with the rock. The adhesion seems to take place all round the edge of the body but the sticking fluid must also act on other parts of the under side, because sometimes, in detached pupae some tiny pieces of the rock, which is of a friable nature, still adhere to the ventral surface of the pupa, either on the wings or on the leg-sheaths but not at definite places.

Length of pupa : 2mm. width 1·2 mm. The female pupa is usually somewhat larger.

*Larva*[1].—The specimens here studied were on the verge of pupation ; when cleared in caustic potash, the typical pupal horns, as shown in plate ii, fig. 5, were found inside the body, so that there is no doubt as to their identity.

The figs. 6, 7 and 8 on plate ii give a good idea of the general aspect of this extraordinary larva, which is broadly oval as depicted for *Maruina* by Fritz Müller, but it is not particularly flat. The length of the body is about 2 mm. ; its colouration brownish above, which is due to the numerous dark tiny granulations of the integument ; the head is orange, the anterior dorsal plates of each segment are blackish and the posterior ones orange with an infuscated part in the middle.

The head is almost hexagonal and is inserted well under the first tergite, it leans obliquely downwards ; its chaetotaxy is not much developed, as can be seen from plate ii, fig. 9. The antennae are much longer than is usual in the family except in *Sycorax* ; they are composed of a small annular basal segment and of a long distal one which carries sensory cones at the end. The labrum is provided anteriorly with two comparatively large sensory rods similar to those found in some Chironomid larvae ; the premandibles are present, as in all the larvae of the family except perhaps in *Phlebotomus* ; the mandibles are inserted obliquely and do not meet, they are provided with a longitudinal comb on the outside (plate ii, figs. 10 and 11) which is intended to work in conunction with the posterior portion of the maxilla, which is modified

[1] The description of the larva is drawn up from three specimens, two of which are very defective, owing to the drying up of the tube during transit. The description on account of the paucity of material is, therefore, not absolutely complete.

into a similar comb; this part of the maxilla is articulated to the head capsule along its length, so that mandibles and maxillae can both work together as a carding machine. This is a highly peculiar arrangement which, to my knowledge, has never been recorded in a dipterous larva, and is widely different from what is found in other Psychodid larvae. The mentum is but little developed, it is not toothed but is provided with a flat brush of fine hairs.

The segmentation of the body may at first sight appear to be different from that of other Psychodid larvae on account of the broad and short shape of the body, but actually it is not so. There are seven fully developed abdominal segments, the 8th, 9th and perhaps the 10th being modified to form the breathing armature. All the unmodified segments carry two sclerotized dorsal plates, but in the first thoracic segment the plates are broader and somewhat diffused in the integument; the two sections of this first segment are much more developed than the others, the anterior stigma are placed on the second division of the first segment and well on the dorsum of it; they are more or less olive shaped as shown in plate ii, fig. 12. The sides of this segment are provided with a few coarse lateral bristles. The thoracic segments 2 and 3 have on both sides a peculiar organ which is shown more highly magnified in plate ii, fig. 13. It is not clear whether these are spiracles or the scars of such organs nor whether the dark piece provided with bristles is an operculum which can be brought down to close the circular opening, which does not appear to be closed by a membrane. It has not been possible to detect if this organ is connected with the breathing system; it does not appear to be so but more material is needed to ascertain this point. The only abdominal spiracles are those of the eighth segment, this larva is, therefore, amphipneustic like all the rest of the family except *Neotelmatoscopus,* in which the anterior spiracles are not functional. Each of the thoracic segments 2 and 3 carries two very narrow dorsal plates in every way similar to those of the abdomen. The anterior one is narrower and darker, the posterior is infuscated in the middle only. The plates bear a number of bristles, as in other larvae of the family, but in this case they are exceedingly small. The caudal breathing armature is of a type quite unusual in the Psychodidae; it could be more fittingly compared to that of an aquatic Tipulid larva, in which a spiracular chamber is formed between the bases of several fleshy, more or less elongated lobes, the spiracles being lodged at the bottom of such a cavity. Here the cavity is formed by two latero-dorsal plates, a median extensible membrane, which is usually folded, and, lastly, by a semicircular plate carrying two rather thick processes and two thin ones. The spiracles are not placed at the bottom of this chamber but near the apex of the latero-dorsal plates on their ventral face; they are surrounded by a fan of rather long bristles, which are scarcely visible from above. The median dorsal lobe is formed by a thick membrane, folded like a fan and with its distal half doubled under the basal half; it appears that this membrane can be unfolded and extended distally when the latero-dorsal plates are pulled apart; its function may be to clean the spiracles when it comes to be extended; in fig. 6 on plate ii it is represented with its distal half doubled under, but in fig. 14 on the

same plate it is shown extended though not unfolded towards the sides. The two thick finger-like terminal processes are each provided with a double row of hairs ; I do not think that they are to be homologized with the cerci, as they are not placed on the tenth but on the ninth segment ; they are the homologues of the larger processes of the flabellum of the Psychodinae larvae, which Martini (1928) considers as belonging to the ninth segment whereas Feuerborn considers them as the cerci. The two small styles of the last visible segment are more in the nature of sensillae and have apparently no homologues in other Psychodid larvae. The anus is placed below the dark three-branched sclerite which is seen under the body at the base of the two terminal processes.

The ventral side of the body exhibits a most peculiar structure in the shape of a very large sucker, the edge of which is formed by a rather thin membrane composed of very fine and numerous agglutinated hairs. On account of the paucity of material for sectioning and dissecting, it has not been possible to ascertain on to which segments this sucker extends, especially anteriorly, but it seems that only the first thoracic sternite is not included in it ; at the posterior end, as it extends right to the anus, it is clear that the ninth abdominal segment is included within the sucker. The ventral surface within the fringe is concave, its colouration is pale as the skin is there rather thin and soft ; there is a slight indication of segmentation in the shape of darker transverse lines, along which there are in certain parts, especially in the middle, very weak and small fringes of hairs similar to those of the edge of the disc ; similar hairs are also present on the middle of the sternites. These hairs have not been represented in plate ii, fig. 7, so as not to complicate the drawing and destroy the effect of concavity of the ventral surface which I have not too well succeeded in bringing out in the drawing.

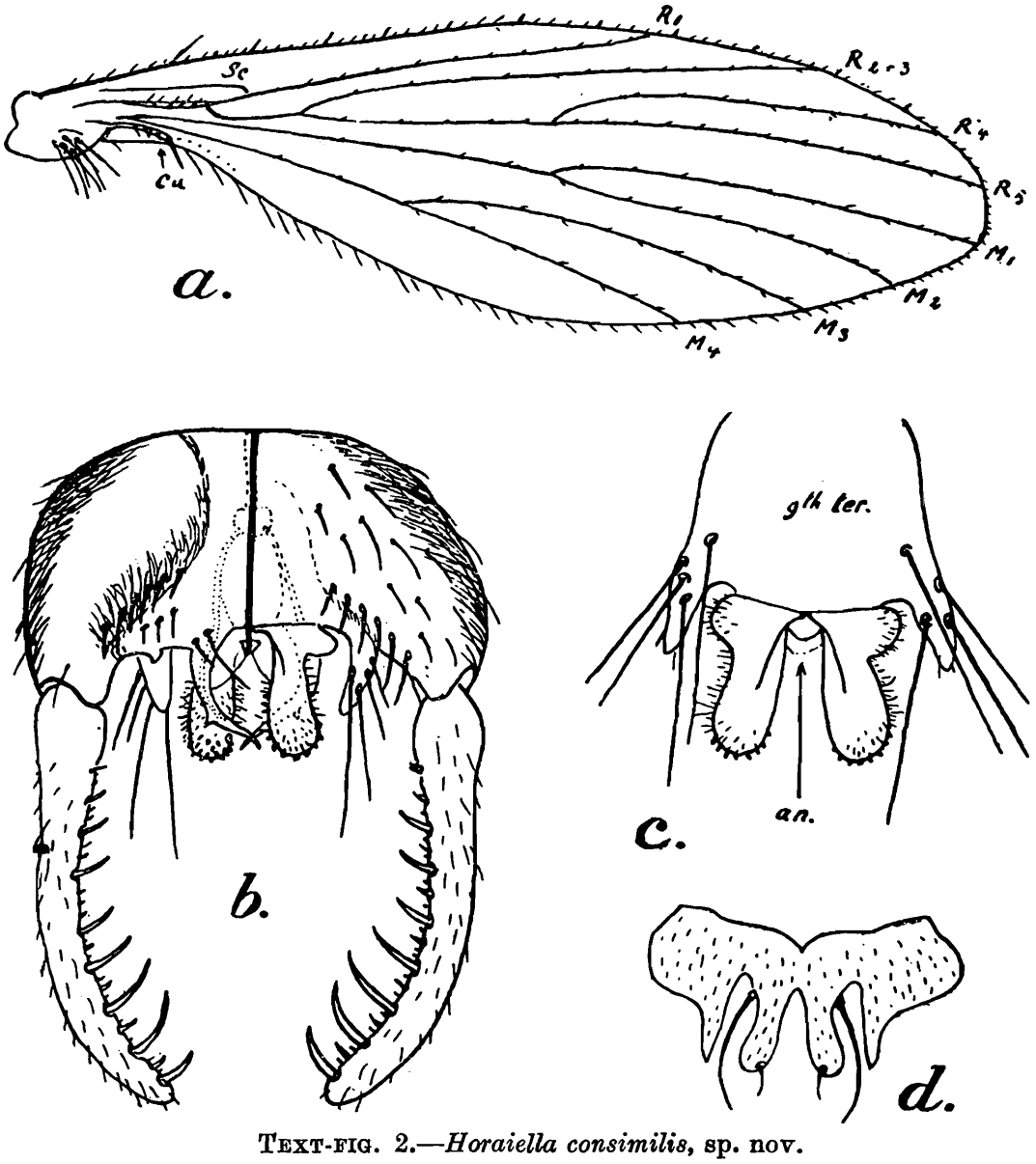
As this larva is provided with only one sucker it is clear that it is unable to move on the substratum by reptation movements which would tend to destroy the vacuum within the sucker. It has, therefore, evolved other means of locomotion in the shape of a modification of the edge of the eighth or ninth segment which is produced in a ridge or curtain provided with a double row of conspicuous hooks ; the movement of this curtain backwards and forwards allows the animal to glide on the stones. This proleg is composed of two symetrical parts, as indicated by the small but quite distinct median indentation ; this double organ appears, therefore, to be the homologue of the posterior proleg of the Chironomid larvae, in which case it would be part of the ninth sternite.

On each pleura of the abdominal segments 1–7 there is, just against the fringe of the sucker, a small brush of hairs inserted on a little stalk and also some sensory setae on the fringe itself (not figured) ; these apparently have only a tactile function.

### **Horaiella consimilis,** sp. nov.

*Male.*—Very similar to that of the preceding species, from which it differs only in the wing venation and the structure of the hypopygium. The anterior and the middle fork on the disc of the wing are approximately at the same level. The general aspect of the hypopygium is the same as in the genotype, the gonocoxites and styles being identical and

equally developed. Fig. 2*b* shows this organ from above on the right and from below on the left; the dorsal part has a simpler structure than




TEXT-FIG. 2.—*Horaiella consimilis*, sp. nov.

*a*. Wing with all hairs represented in position; *b*. Hypopygium, right-half ventral view and left-half dorsal view; *c*. Hypopygium, 9th tergite and cerci; *d*. Subgenital plate.

in *H. prodigiosa*, the side lobes of the ninth tergite are small (fig. 2*c*) and carry only a few rather long bristles; the cerci are short, more or less club-shaped and provided distally with a large number of short blunt spines.

The female differs only in the shape of the subgenital plate, as shown in fig. 2*d*, the two pairs of lobes are not found in any other Psychodid.

*Pupa* (plate ii, figs. 1 and 2).—It is somewhat smaller than that of *H. prodigiosa* and the breathing horns are provided with a very thin, elongate stalk which enables one to identify the species at first sight.

*Larva*.—Unknown.

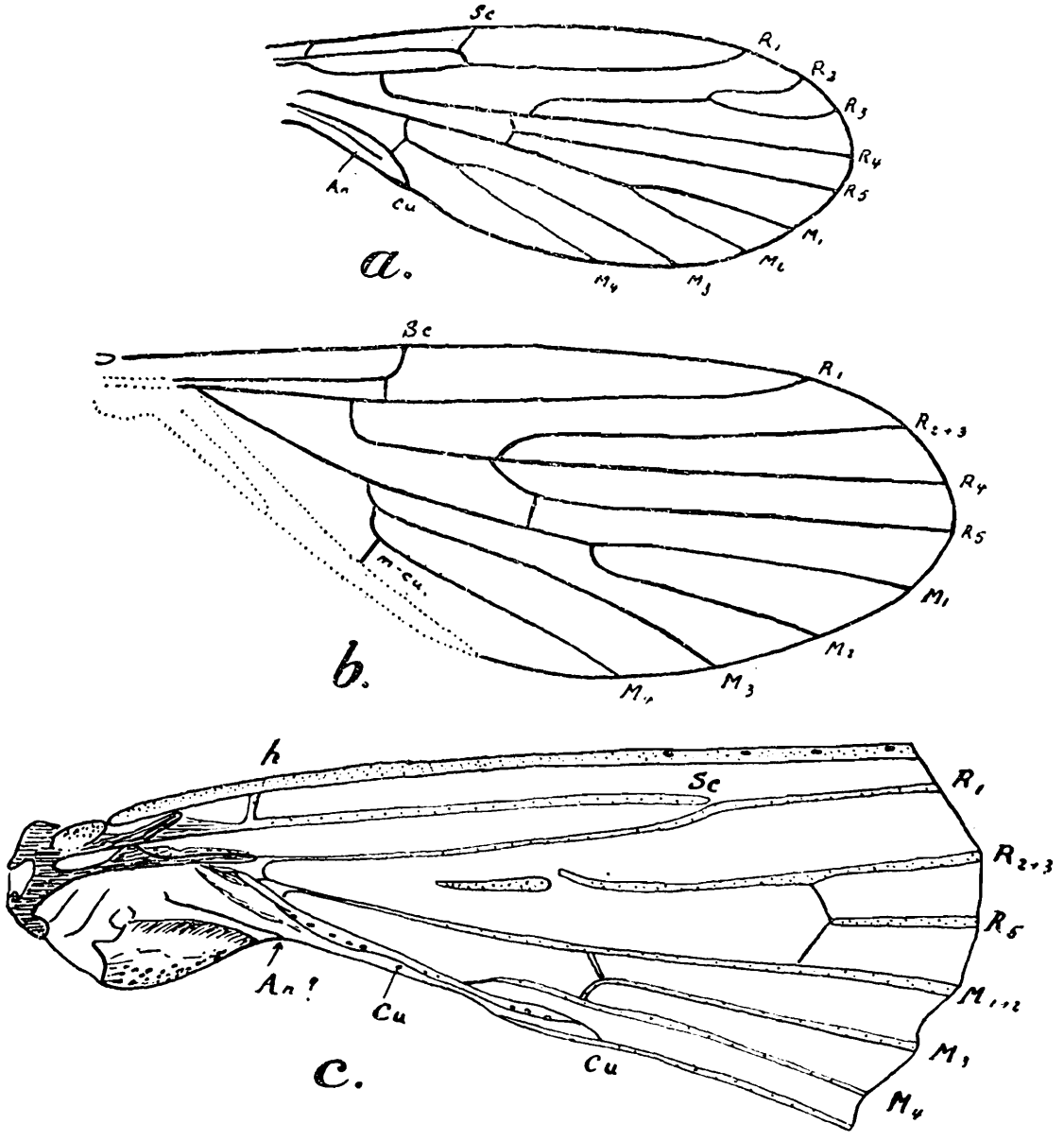
*Holotype*.—Teesta Bridge (stream three miles from) 7th February 1931. S. L. Hora.

*Allotype* with Holotype.

*Paratypes* with types and at Luch-Chu Jhora. D. D. Mukerji, March 1932.

It now remains to discuss the affinities of this strange insect.

The antennae of the fly are of a primitive type, similar to those of *Phlebotomus* and with the same kind of ascoids but there is one more segment. The terminal segment may, of course, be a specialisation due to the modification of the extremity of the 16th segment, because, as mentioned above, this apical section is not truly articulated on the 16th segment. The round eyes are found in all genera of the family except those of the Psychodinae; the palpi are four segmented, as in all genera except *Phlebotomus*, *Nemopalpus* and *Bruchomyia*. The well developed toothed mandibles have their equal only in *Phlebotomus*. The lack of long hairs or scales on the body, legs and wing is unparalleled in the family although *Sycorax* is comparatively less hairy than the other genera. The conformation of the tarsi is more akin to that of the Psychodinae; the strong development of the last segment is an adaptation allowing the insect to cling to rocks in strongly ventilated places; the dorsal flap of this segment is also present, but much less developed than in the Psychodinae.




TEXT-FIG. 3.—Wings of *Eophlebotomus*, *Eatonisca* and *Phlebotomus*.

*a. Eophlebotomus* after Edwards; *b. Eatonisca* from Eaton's manuscript; *c.* Wing base of *Phlebotomus* sp.

The wing shape and the venation find their strongest affinities with those of *Phlebotomus*. The wedge-shaped narrow base without any trace of anal lobe and the reduced alula is almost exactly as in the latter. As the venation of *Phlebotomus* has seldom, if ever, been correctly interpreted or even figured, I am giving here (fig. 3*c*) an exact drawing of the base of the wing of an Australian species of the *minutus* group, in which it will be seen that Cu is a very short strong vein and An is very doubtfully to be traced at the base. In both genera Sc runs straight into $R_1$, and $M_4$ is four branched ; but the main difference lies in the conformation of the radial sector, which is four branched and of the pectinated type in *Phlebotomus* and only three branched in *Horaiella ;* however, in this latter genus, although it seems that the first branch of Rs is simple and represents $R_{2+3}$ and the second branch is forked and represents $R_4$ and $R_5$, it is not certain that this is really the case, the anterior vein of the latter fork may be $R_3$ whose base has switched over to $R_4$ ; instances of such a switching over of the base of $R_3$ can be found in other species of the family (*Psychoda aberrans* Tonn. and an, as yet, unnamed species of *Telmatoscopus*). What seems to give some weight to this interpretation is the lack of any macrotrichia on the base of that vein which is marked $R_4$ in fig. 2*a* but on the other hand, if the venation of *Horaiella* is compared with that of two fossil genera of the family, *Eatonisca* and *Eophlebotomus*, it seems as if the first branch of Rs might be a simple vein on account of the loss of $R_2$. *Eatonisca tertiaria* has been described by Meunier (1905) from the baltic amber, the complete insect being figured ; the venation as given by Meunier is somewhat puzzling on account of the presence of an unusual cross vein and the bifurcation of the veins at the base of the wing. Fortunately the type of this species had been loaned by Meunier to Eaton who made a new drawing of the venation of the only good wing. This drawing and a few comments on it were included in the uncompleted manuscript which Eaton was preparing on his extensive collection. Thanks to Dr. F. W Edwards' kindness his collection and manuscript have been loaned to me for revision by the authorities of the British Museum. This revision will appear shortly in some other publication. I am giving here (fig. 3*b*) a reproduction of Eaton's drawing of the wing of *Eatonisca tertiaria* ; from this it will be seen that, firstly, there is no basal cross vein and that, therefore, the anterior basal cell is large and shaped as in *Sycorax* or *Trichomyia* and secondly, that the base and a part of the posterior margin was so broken that the shape and the length of Cu and An are purely hypothetical in Meunier's as well as in Eaton's drawing. What is specially to be noted, however, is the three-branched condition of Rs. If one now refers to the wing venation of *Eophlebotomus connectens* Cog. as given in the amended drawing of Edwards (1929) made from the type (fig. 3*a*), one sees how closely *Eatonisca* and *Eophlebotomus* agree in spite of the four branched condition of the radial sector in the latter genus ; a study of this part of the wing allows one to conclude, without much doubt, that it is one vein of the anterior branch of the sector which has disappeared in *Eatonisca*. It should be remarked that in *Eophlebotomus* Cu is a decidedly shorter vein and, therefore, approaches the condition found in *Horaiella*.

If we now compare the venation of *Horaiella* with that of these two genera, and with that of *Phlebotomus*, we note that the unbranched Sc running straight into $R_1$, the short basal cell, the extremely short Cu and the apparent absence of An, as well as the presence of some regularly spaced spinules on the costa are characters which are also shared with *Phlebotomus*. The three-branched condition of the radial sector, brought about by the loss of one vein of the anterior branch, is found in *Eatonisca* in which the conformation of Rs would be the same as in *Horaiella* if the base of the vein marked $R_{2+3}$ in fig. 2*a* were shifted towards the base of the wing along the stem of Rs. On the other hand it is not improbable to conceive that the venation of *Horaiella* may have been evolved from a type similar to that of *Sycorax*, in which the posterior vein of the anterior fork has switched over to the simple second branch of Rs.

The male genitalia of *Horaiella* are on the whole more like those of *Phlebotomus* on account of the presence of the cerci, as well as the lateral lobe of the ninth tergite, the gonostyles with long spines, and the bifid penis with its pumpetta. A species of *Sycorax* is also known which has a bifid penis (*S. chilensis* Tonn.) but it is apparently an exception in the genus, of which I know all the described species and a few more still undescribed.

If we now examine the larva of *Horaiella* we see at once that it has nothing in common with that of *Phlebotomus*. This latter is not aquatic, its head is not flattened but rounded, the antennae are short and bulbous, the mouth parts are of a generalised type without premandibles and with simple mandibles and maxillae ; the body segments are subdivided into two but they do not carry sclerotized dorsal plates and the last segments are not modified into a breathing organ; the spiracles are simple, small buttons on the sides of the eight segment.

The larva of *Horaiella* with its dorsal plates and its modified last few segments would seem at first sight to be more closely related to those of the Psychodinae ; its general shape is not unlike that figured for *Maruina ursula* by Fritz Müller but a comparison with the larva of *Sycorax* deserves closer attention although *prima facie* it would seem that the simple undivided tergite of the latter genus would preclude any sort of affinity.

I know the larva of *Sycorax* only from the figures of C. W Müller (1927) and those of Baugerter (1928) and Feuerborn (1932) ; I have, therefore, been unable to ascertain if there is no trace of the anterior dorsal plates left. As far as the head is concerned the only point of resemblance is found in the elongate antennae ; but the continuous fringe which surrounds the body is evidently the homologue of the fringe of the sucker of *Horaiella* in which it has been shifted more ventrally. Feuerborn remarks (*l. c.* p. 96) that this fringe in *Sycorax* aids in the adhesion of the larva to the substratum, so that this animal can be considered as a " wandelnde saugscheibe " ; the same applies also to *Horaiella*. One of the strongest points of resemblance between the two larvae is the division of the 8th tergite into two lateral lobes which carry the hind spiracles near their extremity, in *Horaiella* the spiracles have shifted to the ventral side of the lobes, so as to be included in the chamber or

cavity formed by these lobes and the ninth tergite, but the latter does not carry any appendages in *Sycorax.*

The pupa of *Horaiella* shows no affinity either with that of *Phlebotomus* or with that of *Sycorax*; it is more closely related to that of *Maruina.*

From this analysis it results that *Horaiella* should find its place between *Phlebotomus* and *Sycorax,* the affinity being greater with the former genus in the adult stage; I cannot, however, see my way to placing it in the same subfamily : on the other hand I am not yet prepared to erect a new subfamily for it and prefer to reserve my decision on this point until the study of more abundant material, especially of mature flies, allows me to throw more light on the subject. We are already threatened with too many monogeneric subfamilies in the Psychodidae, besides the Phlebotominae, there are the Trichomyiinae which would also remain with a single genus if Edwards' suggestion, to remove *Sycorax* from it and place it in a subfamily of its own, be accepted. Theodor has even proposed that *Phlebotomus* should be separated from the rest of the Psychodidae and be placed in a new family. The discovery of *Horaiella,* which is a link between *Phlebotomus* and the rest of the Psychodidae, completely invalidates this suggestion.

In his recent paper, already referred to, Feuerborn has described from Java a species of Psychodid whose larva is provided with ventral suckers and for that reason he has placed it in the genus *Maruina.* Before discussing the generic status of this species and of the closely related one discovered in India by Hora, I think it more expedient to give first a detailed description of all the stages of the latter species, which I place in a new subgenus of *Telmatoscopus* characterised by the larvae provided with six ventral suckers, the subgenotype being the following species.

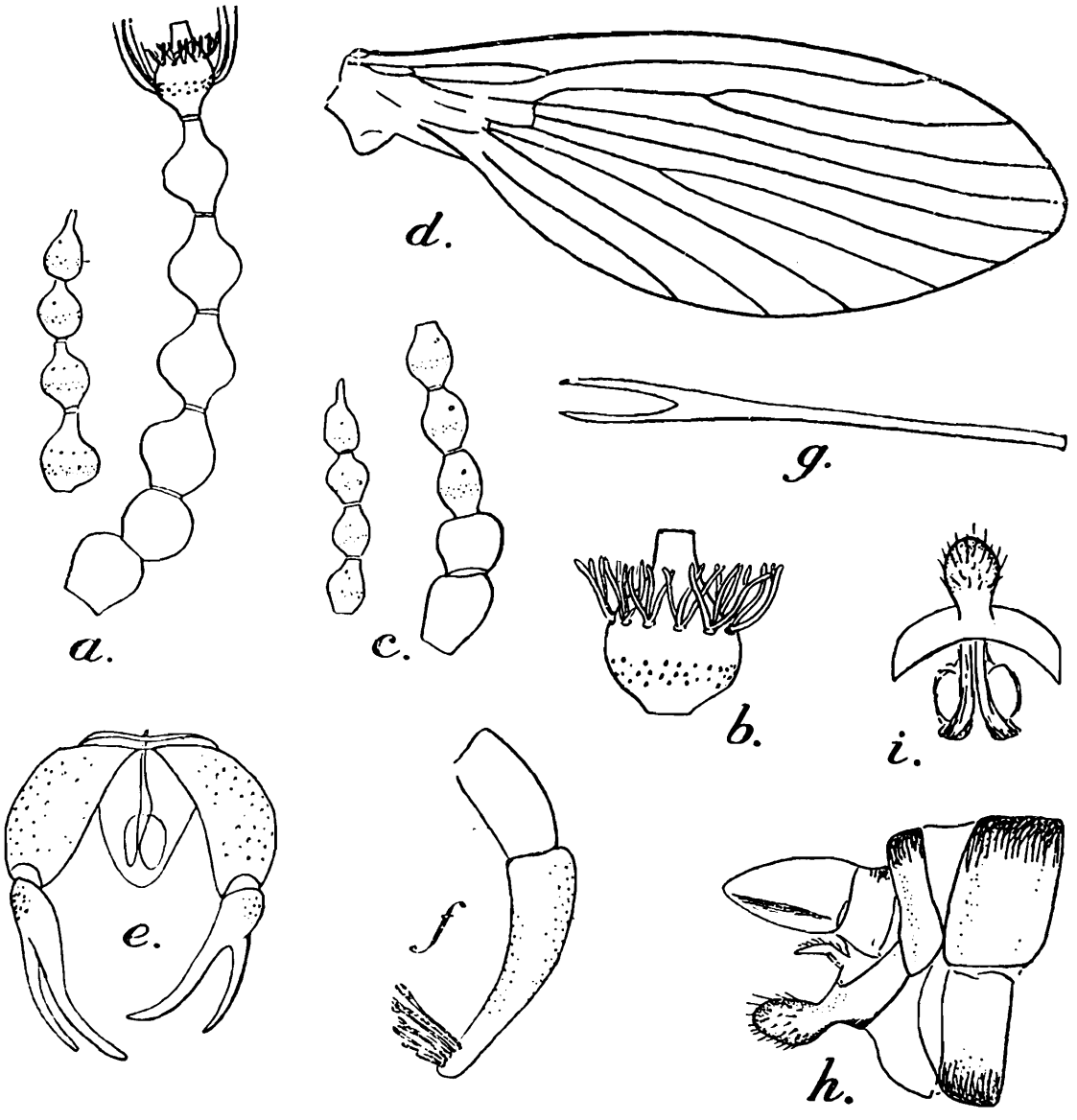
### **Telmatoscopus (Neotelmatoscopus) horai,** sp. nov.

A small species with uniformly blackish vestiture on the body, wings and legs, and with the habitus of a *Psychoda.*

*Male.*—Eye bridges contiguous on their whole width, no noticeable tuft of hairs on face or vertex; antennae 16 segmented, distinctly longer than the width of wing when fully extended [1], first segment rounded, not longer than broad, second spherical, the following one bulbous with a short distal neck (fig. 4*a*); the basal segments of the flagellum are somewhat asymetrical, as is often the case in species of *Telmatoscopus,* they gradually diminish in size but the last ones are not diminutive as in *Psychoda*; the neck of the basal segments is short but it gradually

[1] In most, if not all, the pinned specimens submitted to me, the segments of the flagellum are telescoped; this gives to the antennae of the male a very thick appearance, the verticils thus fitting into one another. This is often the case in recently emerged *Psychoda* because when still enclosed in the antennal sheath of the pupa the segments of the flagellum are telescoped in this manner and when specimens are kept in a dark and moist place after emergence the antennae do not extend for some time, if at all; but when a telescooped antenna is treated in caustic potash it soon extends to its normal size and shape. As the examples of the above species were collected on the rocks of a waterfall it is possible that they had recently emerged and had not had time to dry and harden properly; they all have a rather immature appearance.

increases up to the 12th segment where it is about half as long as the bulb ; the last segment is pear-shaped and ends in a thin cylindrical apiculus placed on one side. The numerous ascoids are arranged in a circle on the distal half of the bulb (fig. 4*b*) ; on the basal segments there




TEXT-FIG. 4.—*Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.

*a*. Antenna of male ; *b*. A median segment of antenna of male ; *c*. Antenna of female ; *d*. Wing ; *e*. Gonopods ; *f*. Inferior appendages ; *g*. A retinaculum ; *h*. Side view of female genitalia ; *i*. Subgenital plate.

are about 12 pores in which are inserted two-or three-branched ascoids which do not reach over the level of the end of the neck ; on the 10th segment the number of pores is only ten and on the last three there are only two pores each with a multibranched fan-shaped ascoid. The verticils of ordinary bristles are not specially developed or distinctly campanuliform, as in many species of the genus they are inserted only on a part of the basal half of the bulb.

Palpi formula : 12 ; 16 ; 17 ; 27 The last segment thinner but not conspicuously so ; vestiture moderately dense.

Thorax without organs for erotic display. Legs uniformly dark, the last segment of the tarsi somewhat more developed than in other species of the genus, its dorsal flap extends well in between the claws which are strong and sharply elbowed.

Wing ovate lanceolate (fig. 4*d*), not sharply pointed at apex which is placed a little below the tip of $R_4$ ; Sc ending straight in $R_1$, the posterior fork somewhat before the anterior one, which is placed a very little before the level of the tip of Cu ; origin of the stem of the anterior fork on the apex of the anterior basal cell, the second basal cell much shorter than the first.

Wing vestiture uniformly dark brown without any tuft or any marking, the rows of erect hairs moderately dense and, therefore, only slightly conspicuous, they are absent on the usual veins : $R_1$, $R_5$ and $M_4$ ; on the branches of Rs they do not extend as far as the level of the tip of $R_1$ and on the branches of M a little beyond the tip of $M_4$ on Cu they reach the tip of that vein.

*Hypopygium.*—Gonocoxites (fig. 4*e*) several times as long as broad and arched on the outside, gonostyles with a scarcely swollen base, its distal two thirds divided into two equally long and almost equally strong beaks which are only moderately curved ; aedeagus of a simple symetrical pattern almost similar to that of *Pericoma exquisita* and allied species. Inferior appendages (fig. 4*f*) about twice as long as the ninth tergite, their distal third becoming suddenly thinner than the basal part but not very much more so, apex with 7-8 retinacula which are forked at the tip (fig. 4*g*).

Length of wing 2 mm.

*Female.*—Similar to male. Antennae relatively shorter (fig. 4*c*). the necks of the flagellar segments being much shorter so that the last segments appear to be almost spherical, but not diminutive. The ascoids on all the segments are similar to that of the last three segments in the male, they are multibranched and inserted on a pair of pores only. The verticils are much less developed than in the male. The genitalia (fig. 4, *h* and *i*) are very peculiar on account of the relatively large oval knob-like hairy process on the middle of the subgenital plate ; ovipositor short, subtriangular.

*Holotype.*—Teesta bridge, 7th February 1931. S. L. Hora.

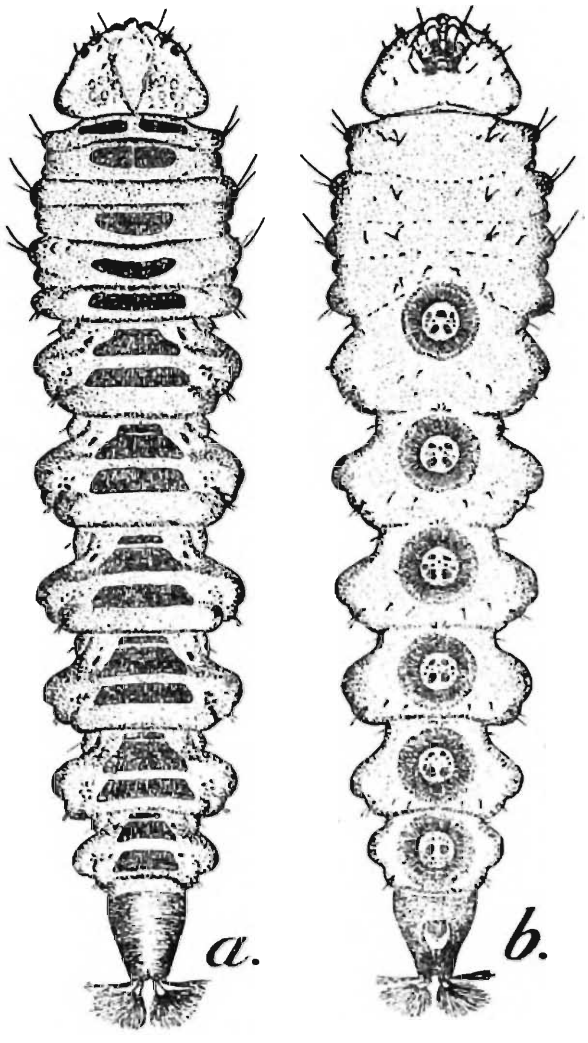
*Allotype* with the holotype.

*Paratype* same locality and Luch-chu Jhora, Peshoke Jhora, etc., all in the vicinity of Teesta Bridge in March 1931. D. D. Mukerji.

*Larva* (fig. 5, *a* and *b*).—As a similar larva has been described in detail by Feuerborn (1932) I shall only give here a description of its main features. The most remarkable of these, besides the presence of the ventral suckers, is the reduction of the basal segments of the abdomen. This occurs to a much lesser extent in many, if not all, the larvae of the Psychodinae, the first abdominal segment having only two subdivisions instead of three (and, therefore, two instead of three dorsal plates, when these plates are present at all). In the larva of *T horai* the first abdominal segment has only one plate, the second two and the third three so that at first sight the larva may be taken to have an abdomen with only six unmodified segments, the more so as the third thoracic tergite is apparently undivided and carries only one dorsal plate.

The ventral suckers evidently belong to segments 2 to 7 ; as the most anterior sucker is placed almost below the first abdominal segment, which, as mentioned above, is very reduced, there may be some doubt

as to the segment to which it belongs, the first or the second. A study of the musculature of the suckers shows, however, that the first sucker does




TEXT-FIG. 5.—Larva of *Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.
*a*. Dorsal view; *b*. Ventral view.

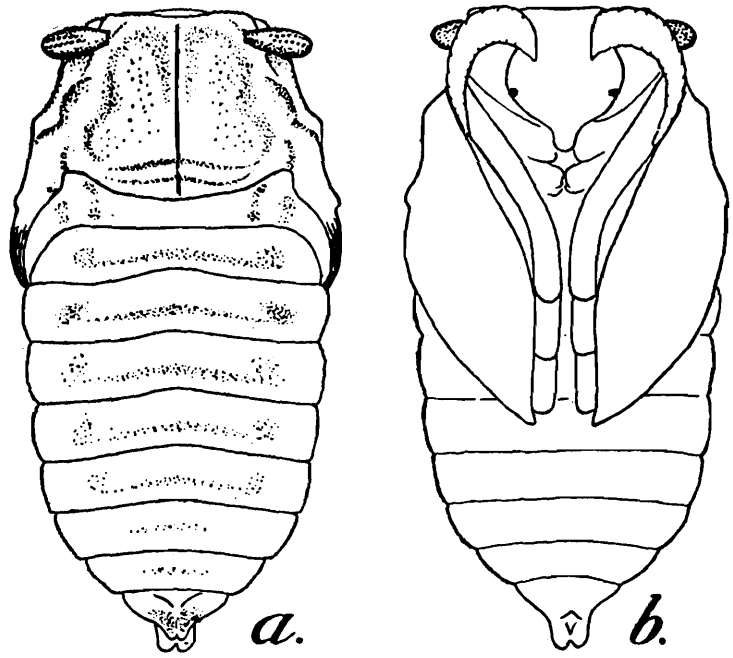
not belong to the first segment. Even without dissection or cross section this conclusion can be reached by studying the position of the dorso-lateral sclerosities of the integument, which indicate the point of attachment of the dorso-ventral muscles; these callosities are missing on the first abdominal segment, therefore the first sucker does not belong to it.

The head is wider than long; its posterior part is widened into moderately developed lobes which do not extend backwards as in *T. indica*. The mouth parts are as in most Psychodinae larvae, except that the maxillae are provided with a large brush of hairs in the form of a fan directed backwards. The terminal segments are strongly sclerotized and fused in a conico-oval flabellum with the usual four apical processes provided with small hair fans. There are four pairs of anal gills which are retracted in most specimens. The anterior spiracles are not functional; they are represented by very weak tiny scars.

The round suckers are of a simple type, the edge of the disc is formed by a simple layer of agglutinated rods which are analogous to those found in the Blepharoceridae, they are prolonged by a thinner felty tissue giving more fexibility to the edge of the sucker; the disc is not invaginable like the piston of the Blepharoceridae, the suction power is, therefore,

very much weaker, as can logically be inferred from the difference of habitat.

*Pupa* (figs. 6 *a* and *b*).—It is not unlike that of any other Psychodinae ; it is not greatly modified in shape to suit its habitat, though it is much more so than that of the Javanese species. The underside of the body is fairly flat, soft and whitish and the contour of the abdomen is fairly continuous, although the segmentation remains clearly indicated by shallow indentations between the segments. Adhesion to the substratum seems to take place by the whole of the ventral face ; there is no special




TEXT-FIG. 6.—Pupa of *Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.
*a*. Dorsal view ; *b*. Ventral view.

sealing mass at the end of the wing sheath, as mentioned by Feuerborn in his Janvanese species. The breathing horns do not present any special features ; they are provided with a double row of about ten little craters. The integument of the horn has a fine sculpture which gives it the appearnce of being covered with minute imbricated scales.

In the same locality occurs also another larva, differing from that of *T horai* by the shape of the head, which has latero-posterior lobes as much developed as those of *T indica* ; in shape the abdominal segments are wider at the posterior end and thus are also quite different. I have not seen the pupa or the fly of this species, I shall, therefore, refrain from describing it ; it is intermediate in character between *T horai* and *T indica*.

The generic status of this remarkable insect has now to be discussed. Feuerborn has placed the species that he discovered in Java in the genus *Maruina* established by Fritz Müller (1895) to receive three Brazilian species, because the larva of this Malayan moth-fly is also provided with ventral suckers. This is the only ground on which it can be done because very few reliable characters are given by Müller for the adult stage of *Maruina*. These points have already been discussed by Eaton (1895) and Feuerborn takes them up again in his recent paper but he reaches a conclusion which is totally unsound from a taxonomic point of view

He says (*l. c.*, p. 106) that as the two species of *Maruina*, more or less described in the adult stage by Müller, *viz.*, *M. spinosa* and *M. pilosella*, belong very likely to *Pericoma*, and as the third species has not been described in the imaginal stage, the generic name given by Müller, therefore, becomes untenable (hinfällig) for the American species but can be transferred to the Javanese species, the more so because the idea of larval suckers is already linked up with the name of *Maruina*; and this in spite of the fact that he recognizes that the imago of his species "ist durchaus Arten der Gattung *Telmatoscopus* ähnlich".

Through the kindness of Mr. F. D. Klyver I am now in possession of all the stages of *Maruina californiensis* (Kellog); a study of these shows that, contrary to Eaton's and Feuerborn's opinion, *Maruina* is a perfectly valid genus, quite distinct in all stages from any other known genus of the family. It is, therefore, impossible to place Feuerborn's Javanese and Hora's Indian species in it, even if only larval characters are considered. The larva of *Maruina* has eight incomplete more or less oval suckers (exactly as depicted by Müller), whereas those of the Indo-malayan species number only six and are in the form of a complete round dics.

Feuerborn has rightly remarked that the imago of his *Maruina indica* is in every respect similar to members of the genus *Telmatoscopus*. This genus was erected by Eaton (1904) to receive a number of species that he had previously classified in the genus *Pericoma;* no genotype was mentioned by him and, so far as I am aware, none has been designated since. At the end of his generic diagnosis Eaton gives the following indication: "This genus is nearly coextensive with section 3*c*, 3*d* and 4*a* of *Pericoma* in the supplement to my Synopsis" (*l. c.*, 1900, p. 206, etc.). If we now turn to section 3*c* we see that the first species mentioned there is *Pericoma morula* Eaton. I therefore propose here definitely to consider this species as the genotype of *Telmatoscopus*.

Eaton's diagnosis of this genus is based on the structure of the antennae, the male genitalia and the venation; as the last two characters are too general and may be applied to almost any species of the Psychodinae, only the structure of the antennae need be considered.

The 16 segmented antennae of *Telmatoscopus* have a flagellum composed of segments formed by a bulbous basal part and a distal more or less elongate neck, the last few segments being similar to the others and not diminutive or indistinctly articulated on each other, so that the flagellum is "furnished with 14 sets of verticillate hairs inserted upon the nodes, the verticils mostly cupuliform or bowl-shaped and imbricate; several nodes towards the base of the series oblate or napiform and gibbous or extended laterally into a rounded lobe so as to render the thread or beak of the joint excentric instead of cimate"

Among the many species possessing these antennal characters, the venation varies to a very large extent; the radial sector may or may not be pectinate, Sc may run straight into $R_1$ or not and the apex of the wing may or may not be placed at the extremity of one of the longitudinal veins. Furthermore, the structure of the male genitalia is also varies greatly from one species to another.

*T indica* Feuer. and *T. horai*, sp. nov. answer in every point of their antennal structure to the definition just given above, and there is nothing in the wing venation and the male genitalia which would preclude their admission in the genus *Telmatoscopus*.

Up-to-date, about 36 species of this genus have been described ; they are mostly found in the Palaearctic region ; there is no doubt that a certain number of species will turn up also in the Indo-Malayan region although so far only one of the species of Psychodidae described by Brunetti can be referred with certainty to the genus *Telmatoscopus*, whereas a few more of his species could but doubtfully be placed in it. In Australia about a dozen as yet undescribed species are known to me ; it is amongst these that *T indica* and *T horai* find their closest allies rather than among the Palaearctic species. About six of these Australian species have the same venation with Sc running straight into $R_1$, the origin of the stem of the anterior fork at or very near the apex of the first basal cell and the two main forks more or less at the same level ; the structure and the disposition of the ascoide are also very similar and the necks of the flagellar segments more or less elongate ; however they all differ from the Indo-Malayan species in the presence of organs for erotic display on the thorax of the males. None of the early stages of these Australian species is known so far and the habitat of the flies, except for two species, is not in the vicinity of waterfalls but along the edges of sluggish streams ; this habitat would preclude the presence of a strong fixation organ, in the larva, such as the series of suckers of *T horai*.

The larva of the genotype has not yet been found, so far as I am aware, and only those of two other species have been recorded up to the present. It is therefore, very difficult, if not impossible, to establish the general characters of the early stages of the genus on such scanty knowledge.

The larva and pupa of *T albipunctatus* Willist. (=*meridionalis* Eat.) have been well described by Efflatoun (1920) and later in much more detail by Zavattari (1924). The larva of *T deminuens* Feuer. has been well figured by Feuerborn (1923, p. 198, fig. 7) but not described.[1]

These two larvae are widely dissimilar, although the imagines are fairly closely related. Their difference of structure is evidently due to adaption to different habitats. The larva of *T albipunctatus* lives in bilge water or similar foul liquids ; it is elongate and possesses a long flabellum and has well developed dorsal plates, whereas the larva of *T deminuens*, which according to Feuerborn is oligomydobiontic (living among grass, plants and leaves at the edge of the water) is stumpy with a short flabellum and is almost devoid of dorsal plates.

From this it can be seen that the larvae of this group are eminently plastic in their faculty of adaptation, just like those of the rest of the family : for instance the larva of *Trichomyis* living in wood has the appearance of a wood borer (Keilin 1914), whereas that of the closest

[1] The imago of *T. deminuens* has not been described by Feuerborn ; it has been made known only by a drawing of a few segments of the male antennae (1922, fig. 7) which are so characteristic that I am convinced that this species is the same as the one described by me previously as *Pericoma longicornis* (1919).

related genus, *Sycorax*, is an aselliform larva living in damp moss. One should, therefore, not be too surprised to find in *Telmatoscopus* some species whose larvae are provided with special means of adhesion as an adaptation to their special habitat.

From an examination of all the stages of *Maruina californiensis* (Kell.)[1] I can definitely state that *Maruina* and *Telmatoscopus* are in no way closely related. In fact we have here a curious state of affairs because in *Maruina* the imago, which has a lesser number of antennal segments and a more reduced venation, is more specialized than that of *Neotelmatoscopus*, whereas the larva with a larger number of suckers is more primitive.

It seems most probable to me that the larval suckers have been evolved independently here and there, in various groups of the family with such plastic larvae, in response to the same special habitat.

From the above analysis I can only conclude that *T indica* and *T horai* cannot be placed elsewhere but in the genus *Telmatoscopus* on imaginal characters ; however as the larvae of the two known species are so peculiar I think that it is convenient to erect a new subgenus, *Neotelmatoscopus*, based on larval characters alone and defined by the presence of six ventral suckers.

After Fritz Müller and Hora, Feuerborn has treated of the relationship of the Blepharoceridae and the Psychodidae at full length in his recent paper (1932) ; however, in spite of his efforts his arguments do not seem to me to be convincing enough and I cannot see that the relationship between the two families is as close as he would make us believe. I stand by Hora when he says (1930, p. 231) " I do not believe that any genetic affinity exists between the two families ; the resemblances are the result of convergence " The resemblances Hora had in mind are those between the larvae and not between the imagines. The latter are much further apart than Feuerborn makes out as a result of his incomplete knowledge of the Blepharoceridae, which he himself acknowledges. This family has quite a number of archaic characters such as the presence of the tibial spurs, the presence of the ocelli, the long anal vein, and the non-twisted hypopygium, which are not to be found in the Psychodidae. Crampton as a result of his study of the structure of the thorax of the Psychodoid diptera (1926) also fails to find any strong affinities between the two families.

However, if the discovery of the early stages of *Horaiella* and *Neotelmatoscopus* does not shed a new light on the affinities of the Psychodidae with other families of the Nemocera besides those included by Crampton in his Psychodoid complex, it gives at least a very good indication as to how the complicated sucker of the Blepharocerid larvae may have been evolved.

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[1] Malloch has pointed out (1917, p. 266) that M. *californica* Kinc. is a synonym of *M. californiensis* Kellog because the description of the very characteristic early stages of this species appeared under the latter name before that of the imago by Kincaid. In reality the question is more complicated than Malloch thought because the fly described by Kincaid has certainly not been bred from the larva and pupa described by Kellog. The nearly mature fly which I extracted from similar pupae from a locality near that of the type does not at all correspond to Kincaid's description either in antennal structure or in the shape and venation of the wing. Some confusion must have occurred when the specimens were sent for description to Kincaid by Kellog.

To my knowledge there are two attempts at an explanation of the origin and evolution of these suckers, neither of which seems satisfactory to me.

The first one is by Komaıek (1914) who assumes that at the beginning, at the places where we now find the suckers, there were some glands producing a sticky secretion by means of which the animal adhered to the bottom of the stream ; in order to release the hold on the substratum the dorso-ventral muscles came to converge at that spot and produced an invagination of the soft skin and thus formed beginning of a sucker. The chief objection to this explanation is that it is purely theoretical since no aquatic insect larvae are known which can fix themselves on the substratum by means of a glandular secretion on the ventral surface.

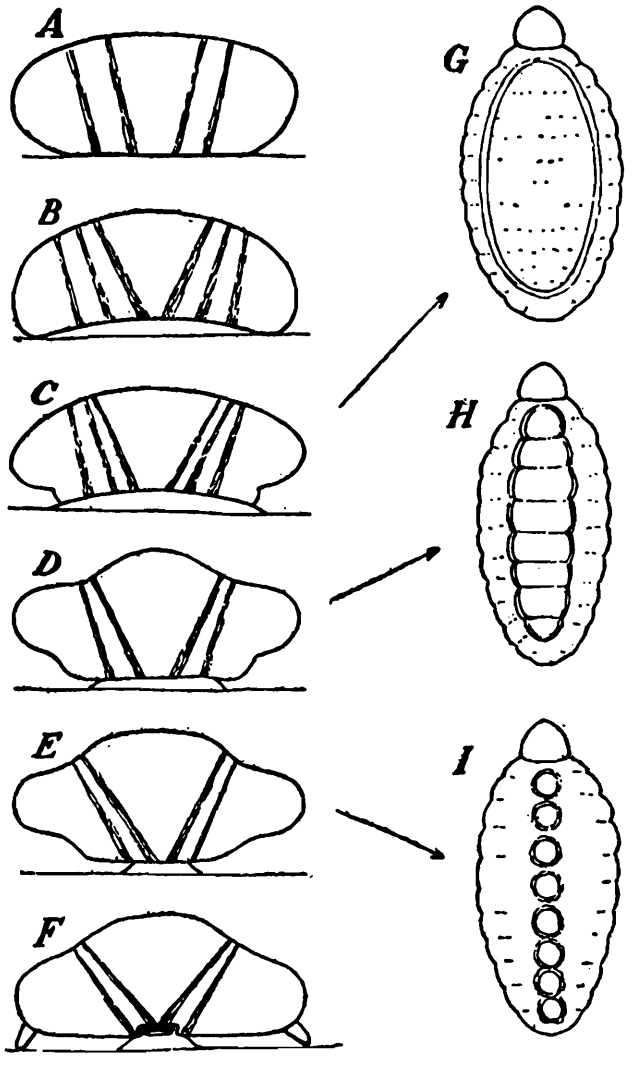
The second tentative explanation is that of Hora (1930, p. 224) who tried to find the origin of the suckers by studying the ontological development of this organ in the Blepharocerid larva. He found that : " in the young larva the sucker is comparable to the abdominal proleg of a caterpillar with a circle of crochets of equal length, all the hooks being turned towards the centre of the planta which can be engaged or disengaged by the contraction and relaxation of the muscles acting on the centre of the disc. As the larva grows it seeks more rapid waters and as life in rapid waters demands a close application of the ventral surface of the animal to the substratum, in this process the crochets have gradually flattened down and have formed the disc as we know it in the larger larvae "

Unfortunately this explanation does not rest on facts because the structure of the sucker in all the genera, including the most primitive *Edwardsina,* is the same in the first instar, just hatched, as in the fully grown fourth instar larva, except that the number of rods is not as large and that the valvular gate is not yet present. It is to be wondered if Hora would have found something of real value if he had started his ontological study with the embryo.

I am now proposing a third tentative explanation which has come to my mind while studying the Psychodid larvae which are the main subject of this paper.

The two series of diagrams here given (fig. 7) are almost self-explanatory : A is a section of an insect larva living in rapid water which, as a beginning of adaptation to this habitat (stage I of Steinmann), is flattened dorso-ventrally and has a large surface of adhesion ; in B there is a sucker action of the whole ventral surface brought about by the action of the dorso-ventral muscles ; to facilitate the retention of the suction or vacuum a pleural fringe of hairs or a pleural membrane has been evolved in C such as we find respectively in *Sycorax* and *Horaiella* ; D shows a section of a larva in which the fringe has migrated towards the axis of the body in order to allow more mobility, at that stage, this fringe may be either continuous as in *Horaiella* or interrupted and form a series of oval more or less complete discs as in *Maruina californiensis* ; the number of discs is probably not higher than eight. E is a stage similar to *Neotelmatoscopus* and as the animal takes to swifter waters a

more powerful type of sucker is evolved as shown in F such as we find in the Blepharoceridae.




Text-fig. 7.—Diagram illustrating the probable evolution of the suckers of dipterous larvae.

G, H, and I are the stages corresponding respectively to the sections C, D and E seen from below; they do not require any explanations.

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