

A REVISION OF THE CULICINE MOSQUITOES
OF INDIA

2nd Copy

Part XVII

FURTHER DESCRIPTIONS OF THE LARVAE OF INDIAN
SPECIES OF *CULEX*

SOUTH EAST ASIA MOSQUITO PROJECT
DEPARTMENT OF ENTOMOLOGY
SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D. C. 20560

BY

P. J. BARRAUD, F.E.S., F.Z.S.

*(In Charge Enquiry upon Indian Culicidae, under the Indian Research Fund
Association)*

FROM

THE INDIAN JOURNAL OF MEDICAL RESEARCH, VOL. XII, No. 2, OCTOBER, 1924

ROOT

LIBRARY

CALCUTTA

THACKER, SPINK & CO

1924

427

A REVISION OF THE CULICINE MOSQUITOES OF INDIA.

Part XVII.

FURTHER DESCRIPTIONS OF THE LARVAE OF INDIAN SPECIES OF *CULEX*.

BY

P. J. BARRAUD, F.E.S., F.Z.S.

(In Charge Enquiry upon Indian Culicidae, under the Indian Research Fund
Association.)

[Received for publication, June 21, 1924.]

IN Part II of this Revision (Ind. Jour. Med. Res., Vol. X, No. 4, April 1923, pp. 934—942) descriptions were given of the larvae of eight of the "banded proboscis" species of *Culex*; the larvae of two more species of this group, viz., *C. sitiens* and *C. gelidus*, are described in this paper, together with those of seven others in which the proboscis is not marked with a conspicuous pale band in the adult. Two of these last mentioned species, viz., *C. brevipalpis* and *C. tenuipalpis*, fall into a group comprising those in which the male palpi are shorter than the proboscis.

***Culex sitiens* Wied.**

Larva: fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXIV). I am indebted to Captain B. S. Chalam, I.M.S., for the material from which this description is made; a small number of larvae were isolated by him in December 1923, at Bombay, and the larval and pupal skins, together with the adults which resulted, are now in my possession.

The larva is distinct from those of other banded proboscis species, as far as they are known, chiefly in the possession of a short and broad siphon and small anal papillae. The larva is usually found in brackish water and the modifications referred to are probably the result of this habitat.

Head pale, with faintly darker patches in some specimens; antenna (fig. 8) very similar to that of allied species, the larger part of the shaft pale, darker at

the extreme base and along the apical part between the tuft and the tip, the tuft arises at a point nine-sixteenths to five-eighths of the length from the base; mentum (fig. 11): 8 moderately large teeth on either side of the central one. *Comb of the 8th abdominal segment* formed of about 30 small teeth in a triangular patch (differing in this respect from the larvae of *C. bitaeniorhynchus*, *C. cornutus*, and *C. vishnui*), the teeth are of the form common to many species of *Culex*, with lateral fringes of minute spines or hairs (fig. 9). *Siphon* (fig. 7) short, widest at base, pale brown, darker along the basal edge and at the apex; index 2 to 2.5; five pairs of tufted hairs along the posterior border and one pair of lateral tufts; pecten normally of 9 to 11 moderately large teeth (one specimen has extra teeth alongside the main rank, the total number being 14), each tooth has a number of small lateral denticles from the base to the apex (fig. 12); acus moderately developed. *Anal segment* (fig. 10): chitinous ring thin and rather narrow especially ventrally, some minute spines along the posterior margin towards the dorsum; outer subdorsal hairs each divided into 2 or 3 branches, inner pair single and long as usual; lateral hair single, occasionally double, and as long as the segment; anal papillae small; anal fan formed of about twelve hairs each split into 10 or 12 branches.

***Culex gelidus* Theo.**

Larva: fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXIV). This larva is remarkably distinct from that of *Culex whitmorei* (Giles), although in the adult stage the two species closely resemble one another. The larva of *C. whitmorei* has been described and figured in Part II of this Revision.

Head pale in colour, faintly marked with dark spots or patches, hairs forming the tufts on the dorsal surface of the head distinctly subplumose; antenna (fig. 2) of moderate length and thickness, shaft pale except at the extreme base, some spinelets on the basal two-thirds, tuft of subplumose hairs arising at a point two-thirds of the length from the base, subapical bristles only slightly below the tip; mentum (fig. 5): 9 or 10 rather small teeth on either side of the central one. *Comb of the 8th abdominal segment* formed of about 35 small teeth arranged in a triangular patch (fig. 3 shows one of the teeth highly magnified). *Siphon* (fig. 1) fusiform, a little wider towards the middle than at the base and gently tapering from the widest part to the apex, index 3 to 3.5, four pairs of tufted hairs along the posterior border, each tuft of 4 or 5 branches, no lateral or anterior tufts; pecten of 9 to 11 moderately large teeth, each tooth with from 3 to 5 pointed lateral denticles (fig. 6); anterior apical bristles of moderate length; acus well developed. *Anal segment* (fig. 4): chitinous ring smooth; outer subdorsal hairs each divided into 2 branches, one less than half the length of the other, lateral hair single; dorsal pair of anal papillae about the length of the longest fan hairs, ventral pair shorter; anal fan rather small and formed of about 12 hairs each divided into 8 to 10 branches.

The larvae have been found in natural collections of water such as weedy pools and 'tanks,' and in marshes. The species has a wide distribution in India.

Culex theileri Theo.

Larva : fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXV). As stated in a previous part of this Revision this species is distinct from *Culex tipuliformis* Theo. (*virgatipes* Edw.); there are constant and fairly easily recognisable differences in both the adult and larval stages. The larva has been described and figured as that of *C. tipuliformis* in Edwards' Revision of the Mosquitos of the Palearctic Region, Bull. Ent. Res., Vol. XII, Part 3, November 1921, pp. 340, 341, from material supplied by me from Mesopotamia. Larvae found in the Western Himalayas agree in most details with that description and figure, but in nearly all the specimens there are 5 pairs of hair tufts along the posterior border of the siphon, instead of 4, in addition to the pair of lateral tufts, and the hairs forming the tufts are shorter, the average number of pecten teeth is larger, normally 10, the siphon is on the average shorter, and the lateral hair of the anal segment is always branched (this is also the case in some Mesopotamian examples still in my possession).

Head yellowish brown, some darker areas basally, the more heavily chitinised mouth parts brownish black; antenna (fig. 14) dark brown on the apical half and at the base, the remainder pale, spinelets scattered over more than the basal half, the base of the hair tuft is at a point seven-tenths to four-fifths of the length of the shaft from the base; there appears to be a good deal of minor variation in the actual length of the antenna and position of the tuft; the subapical bristles are very close to the tip; normally there are 7 teeth on either side of the central one in the mentum (fig. 17), in some specimens 6. The *comb of the 8th abdominal segment* is in the form of a triangular patch of about 30 teeth, the teeth are larger than in the larvae of most of the allied species in which the comb is of this form, each tooth has a long point and delicate lateral fringe hairs or minute spines (fig. 16). The *siphon* (fig. 13) is widest at the base, tapering slightly to the tip, yellowish in colour, brownish black at the base, in one specimen the basal half is dark brown, the apical half pale; index in most of the specimens about 4.5, but occasionally 5 or rather more; normally 5 pairs of hair tufts along the posterior border and one small pair of lateral tufts, the pair of tufts nearest the base sometimes placed between the pectens, the tufts are not always arranged in pairs and then have an irregular distribution, the pair of lateral tufts are much nearer the posterior border in some specimens than in others; pecten of from 7 to 10 teeth, more often the larger number, teeth large, curved, and those furthest from the base widely spaced, only a few lateral denticles at the base of each tooth (fig. 15); anterior apical bristles small. The *anal segment* (fig. 18) is enclosed in a complete chitinous ring as usual, pale brown or yellow in colour; outer pair of subdorsal hairs each divided into 4 branches; lateral hair normally of 3 branches (occasional variation 2 to 4); anal papillae pointed and of moderate length; anal fan of about 14 hairs each split into 8 or 10 fine branches.

The larvae have been found in large stream pools in the Western Himalayas, and large open pools in the Punjab, individuals may frequently be seen swimming

about singly, they do not usually form dense masses near the surface of the water as is the case with many domestic species.

Culex tipuliformis Theo. (*virgatipes* Edw.)

Larva: fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXV). This larva has not been described previously, as far as I am aware. The larva described and figured in Edwards' Revision of the Mosquitos of the Palearctic Region under *C. tipuliformis* is that of *C. theileri* Theo. (*vide* notes under that species). As will be seen from the description and figures the larva of *C. tipuliformis* is distinct from that of *C. theileri*, but very closely resembles that of *C. fatigans*; it also appears to be indistinguishable from that of *C. pipiens* L., a species which has not at present been found in India. The isolated larval skins of *C. tipuliformis* and of *C. fatigans* show differences in the number of teeth in the mentum, in the length of the siphon, in the number of pecten teeth, and in the form of the lateral hair of the anal segment. Apart from these small points of difference, which may be subject to a good deal of variation, the larva of *C. tipuliformis* is far less common than that of *C. fatigans*, and, in India, appears to be confined to the mountains and foothills of the North-West, it has however been found in China and Japan.

Head, siphon, and anal segment usually dark brown, but lighter in some specimens; antenna (fig. 20) unicolourous and dark for the whole length, numerous dark spinelets over the part between the base and the tuft, the latter arises at a point between seven-tenths and three-quarters of the length of the shaft from the base, the subapical bristles are inserted close to the tip; mentum (fig. 23): 9 or 10 teeth on either side of the central one. *Comb of the 8th abdominal segment*: a triangular patch of about 45 teeth of the usual form (fig. 22). *Siphon* (fig. 19) brown to almost black, widest at the base, index usually about 5 or a little more, 4 pairs of hair tufts along the posterior border, the third pair of tufts from the base usually more lateral in position than the others, usual number of pecten teeth 12 or 13, occasionally 14 or 15, the larger teeth with 5 lateral denticles (fig. 21). *Anal segment* (fig. 24): lateral hair of 2 branches; outer subdorsal hairs of 2 branches; anal fan of 12 hairs, each divided into 5, 6, or 7 branches; anal papillae rather long.

The larvae have been found in small weedy rock pools at Kasauli, Western Himalayas, at about 5,000 ft., in November 1921, and May 1922.

Culex fatigans Wied.

Larva: fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXVI). The larva closely resembles that of *C. tipuliformis* (*virgatipes*) (*vide* remarks under that species).

Head dark at the base; antenna (fig. 32) usually dark and unicolourous but lighter in some specimens, the hair tuft springs from a point three-quarters of the length of the shaft from the base, spinelets scattered over more than the basal half of the shaft, the subapical bristles are placed quite close to the tip; mentum

(fig. 35) : 11, 12, and occasionally 13 teeth on either side of the central one. *Comb of the 8th abdominal segment* : 35 to 40 small teeth in a triangular patch (fig. 33 shows one of the teeth highly magnified). *Siphon* (fig. 31) of moderate length, index usually about 4 or rather less ; 4 pairs of tufted hairs, in some specimens ~~which~~ are all along the posterior margin, but the positions are subject to variation and the third pair from the base is frequently much more lateral in position than the others, as shown in the figure, the pair nearest the base sometimes placed between the pectens, each tuft of this pair and of the next formed of 6 or 7 hairs ; pecten normally of 10 or 11 teeth, variation 8 to 12, teeth rather small, the larger usually with 4 lateral denticles (fig. 36). *Anal segment* (fig. 34) normal ; outer subdorsal hairs each of 2 branches, very occasionally of 3 ; lateral hair single ; anal fan of 12 hairs each split into 6 to 8 fine branches ; anal papillae of moderate length, the dorsal pair longer than the ventral.

The larvae are found in abundance in all parts of India and up to 6,000 ft., or more, in the hills. The species is mainly a domestic one, and the larvae live chiefly in domestic collections of water, and in any natural collections of water, such as ditches or pools, near human habitations ; they have not been found in tree-holes or bamboo stumps.

Culex perexiguus Theo.

Larva : fourth stage or final instar, identified by the isolation method, and described from four skins cast at the time of pupation (Plate XXVI).

This larva is very similar to those of *C. tritaeniorhynchus*, *C. barraudi*, and *C. fuscocephalus*. The first two were described in Part II of this Revision, and the figures given there should be compared with those on the accompanying Plates. The larva of *C. fuscocephalus* is described in this paper.

The following small differences have been observed between the larvae of *C. perexiguus* and *C. barraudi* :—pecten teeth in the former less than 12 in number instead of 12 to 14 ; 5 pairs of tufted hairs on the siphon, 2 of which are more or less lateral, instead of 4 tufts of which one is lateral ; teeth of the mentum all about the same size and regular, in *C. barraudi* some of the teeth are much larger than others.

From *C. tritaeniorhynchus* larva that of *C. perexiguus* differs as follows :—base of the antennal tuft placed at about three-quarters of the length of the shaft from the base instead of at two-thirds ; 5 pairs of tufted hairs on the siphon of which 2 are more or less lateral, instead of 6 pairs of which one is lateral ; lateral hair of the anal segment with shorter branches.

The larva of *C. perexiguus* differs from that of *C. fuscocephalus* in the number and arrangement of the hair tufts on the siphon (compare figs. 25 and 37 on Plates XXVI and XXVII), in the length of the siphon, the index in *fuscocephalus* being 4.7 to 5 and in *perexiguus* about 7, and in the form of the lateral hair of the anal segment.

Short description. *Head* pale ; base of antennal tuft placed at about three-quarters of the length of the shaft from the base (fig. 26) ; mentum (fig. 29) : 7 teeth on either side of the central one (one specimen with 8). *Comb of the 8th*

abdominal segment : a triangular patch of about 35 to 40 small teeth (fig. 27 shows one of the teeth highly magnified). *Siphon* (fig. 25) widest at the base, slightly tapering to the tip, index about 7 ; 5 pairs of tufted hairs 2 of which are more or less lateral ; usually 10 teeth in the pecten, each tooth with 3 or 4 pointed lateral denticles (fig. 30). *Anal segment* (fig. 28) : lateral hair usually of 3 branches, occasionally 4 ; outer subdorsal hairs each of 2 branches.

The larvae were found in small marshy pools at Amritsar, Punjab, in April and May 1921.

***Culex fuscocephalus* Theo.**

Larva : fourth stage of final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXVII).

This larva does not exhibit any remarkable modifications and resembles those of *C. tritaeniorhynchus*, *C. barraudi*, and *C. perexiguus*, in general appearance. The larva of *C. perexiguus* is described above, those of the other two species were described in Part II of this Revision.

The larva of *C. fuscocephalus* closely resembles that of *C. barraudi*, differing in the shape of the mentum, the position of the antennal tuft, and in the average number and comparative size of the pecten teeth ; the larvae of the two species are very much alike in the length and index of the siphon, in the number and arrangement of the hair tufts on the siphon, and in the form of the anal segment. From the larvae of *C. tritaeniorhynchus* and *C. perexiguus* that of *C. fuscocephalus* differs chiefly in the number and arrangement of the siphonal tufts, in the size of the pecten teeth, and in the form of the lateral hair of the anal segment ; the index of the siphon is also less in *C. fuscocephalus* than in *C. perexiguus* (about 5 instead of about 7), and the antennal tuft springs from a point about two-thirds from the base of the shaft, whereas in *C. perexiguus* the tuft arises at about three-quarters.

Short description. The whole larval skin is pale in colour, in some specimens the part of the antenna between the tuft and the apex is a little darker, the antennal tuft springs from a point two-thirds of the length of the shaft from the base, there are small spinelets along the shaft from the base nearly to the tip ; mentum (fig. 41) : 7 or 8 teeth on either side of the central one. *Comb of the 8th abdominal segment* : a triangular patch of about 30 small teeth of the usual form (fig. 40). *Siphon* (fig. 37) : index 4.7 to 5 ; pecten normally of 10 or 11 comparatively large teeth, variation 9 to 12 (fig. 39 shows two forms of pecten teeth) ; 4 pairs of very small hair tufts on the siphon usually arranged in a row in line with the pecten. The *anal segment* is very similar to that of *C. perexiguus* (fig. 28) but the lateral hair is usually of only 2 short and fine branches.

The larvae have been found in large pools and ponds, from the Punjab to Assam, in Bengal, and in the Deccan south of Bombay.

***Culex brevipalpis* (Giles).**

Larva : fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXVII).

This larva, which has been found frequently in water in tree-holes in most parts of India, is remarkable for the unusually long and thin siphon. The cast skin is very delicate and great care is necessary, in transferring it from one fluid to another, to avoid losing the antennae and other parts which are apt to become detached.

Head: the maxillae and maxillary palpi are large and project in front of the head when the skin is mounted flat; antenna (fig. 43): the tuft appears to be towards the outside of the shaft, it arises at a point about three-quarters, or a little more, of the length of the shaft from the base; mentum (fig. 47): 8 to 10 teeth on either side of the central one, the middle tooth is unusually large and the teeth nearest to it are blunt. *Comb of the 8th abdominal segment*: a triangular patch of about 50 small teeth which are rather long when compared with those present in the larvae of other species of *Culex* in which the comb is of this form. *Siphon* (fig. 42) very long and thin, about 14 times as long as the diameter at the base, the hair tufts are reduced to minute hairs which are difficult to see except under a high power, usually 5 hairs on each side of the siphon not arranged in pairs; pecten normally of 15 or 16 teeth, variation 14 to 18, each tooth with lateral denticles from the base to the apex (fig. 44). *Anal segment* (fig. 46): both pairs of subdorsal hairs single and long; lateral hair divided into several very fine branches towards the tip.

As mentioned above the larvae are usually found in tree-holes, but have also been taken from bamboo stumps, and a large number were once found in an iron tank containing water and many dead leaves.

***Culex tenuipalpis* Barraud.**

Larva: fourth stage or final instar, identified by the isolation method, and described from skins cast at the time of pupation (Plate XXVIII).

The larva of this recently discovered species is quite distinct from that of any other species of *Culex* known from India. It bears some resemblance to the larva of *Culex whitmorei* (Giles), described in Part II of this Revision, but there are a number of differences in structure by which the two species may be easily separated.

Head pale brown; antenna (fig. 52) comparatively very long, dark at the base and on the apical half, the tuft arises at a point five-eighths to eleven-sixteenths of the length of the shaft from the base, some minute spinelets along more than the basal half of the shaft, both the apical bristles shorter than the sub-apical, the latter placed practically at the tip. *Comb of the 8th abdominal segment*: a triangular patch of 40 to 45 teeth (fig. 50 shows one of the teeth highly magnified). *Siphon* (fig. 48) pale yellow in colour except the rim at the base of the tube, widest at the base, tapering to the tip and slightly curved, index about 6; pecten of 9, occasionally 10, large teeth, each tooth with a number of denticles from the base to the apex, those near the apex very small so that the apical half resembles a small toothed comb (fig. 49); 5 pairs of tufted hairs along the posterior border of the siphon, those nearest the base long, no lateral tufts; tracheae enclosed within

the siphon very narrow. *Anal segment* (fig. 48) pale brown or yellow; outer subdorsal hairs divided into 2 branches, one fine and short the other much longer, the plate from which the subdorsal hairs arise bears a tooth-like projection on each side of the segment; lateral hair of 4, occasionally 3, fine branches; anal fan of 14 hairs arising from fan plate, each hair of from 6 to 9 branches; anal papillae very long and thin.

The larvae were found in a roadside pool at Sureil, Darjeeling Hills, at about 5,000 ft., in October 1922.

EXPLANATION OF PLATE XXIV.

Drawings illustrating the larval structure (fourth instar) of *Culex gelidus* Theo. and *Culex sitiens* Wied.

Figs. 1, 4, 7 and 10, drawn to the scale shown under fig. 1.

„ 2 and 8, drawn to the scale shown under fig. 2.

„ 3, 6, 9 and 12, drawn to the scale shown under fig. 6.

„ 5 and 11, drawn to the scale shown under fig. 5.

- Fig. 1. *Culex gelidus* : siphon, showing hair tufts of one side.
„ 2. „ „ antenna.
„ 3. „ „ comb tooth.
„ 4. „ „ anal segment.
„ 5. „ „ mentum.
„ 6. „ „ pecten tooth.
„ 7. *Culex sitiens* : siphon, showing hair tufts of one side.
„ 8. „ „ antenna.
„ 9. „ „ comb tooth.
„ 10. „ „ anal segment.
„ 11. „ „ mentum.
„ 12. „ „ pecten tooth.

EXPLANATION OF PLATE XXV.

Drawings illustrating the larval structure (fourth instar) of *Culex theileri* Theo., and *Culex tipuliformis* Theo. (*virgatipes* Edw.)

Figs. 13, 18, 19 and 24, drawn to the scale shown under fig. 13.

„ 14 and 20, drawn to the scale shown under fig. 14.

„ 15, 16, 21 and 22, drawn to the scale shown under fig. 15.

„ 17 and 23, drawn to the scale shown under fig. 17.

Fig. 13. *Culex theileri* : siphon, showing hair tufts of one side.

„ 14. „ „ antenna.

„ 15. „ „ two pecten teeth.

„ 16. „ „ comb tooth.

„ 17. „ „ mentum.

„ 18. „ „ anal segment, base of anal fan indicated.

„ 19. *Culex tipuliformis (virgatipes)* : siphon, showing hair tufts of one side.

„ 20. „ „ antenna.

„ 21. „ „ pecten tooth.

„ 22. „ „ comb tooth

„ 23. „ „ mentum.

„ 24. „ „ anal segment, base of anal fan indicated.

EXPLANATION OF PLATE XXVI.

Drawings illustrating the larval structure (fourth instar) of *Culex perexiguus* Theo., and *Culex fatigans* Wied.

Figs. 25, 28, 31 and 34, drawn to the scale shown under fig. 25.

„ 26 and 32, drawn to the scale shown under fig. 26.

„ 27, 30, 33 and 36, drawn to the scale shown under fig. 30.

„ 29 and 35, drawn to the scale shown under fig. 29.

Fig. 25. *Culex perexiguus* : siphon, showing hair tufts of one side.

„ 26. „ „ antenna.

„ 27. „ „ comb tooth.

„ 28. „ „ anal segment.

„ 29. „ „ mentum.

„ 30. „ „ pecten tooth.

„ 31. *Culex fatigans* : siphon, showing hair tufts of one side.

„ 32. „ „ antenna.

„ 33. „ „ comb tooth.

„ 34. „ „ anal segment.

„ 35. „ „ mentum.

„ 36. „ „ two pecten teeth from separate individuals.

EXPLANATION OF PLATE XXVII.

Drawings illustrating the larval structure (fourth instar) of *Culex fuscocephalus* Theo., and *Culex brevipalpis* (Giles).

- Figs. 37, 42 and 46, drawn to the scale shown under fig. 37.
,, 38 and 43, drawn to the scale shown under fig. 38.
,, 39, 40, 44 and 45, drawn to the scale shown under fig. 39.
,, 41 and 47, drawn to the scale shown under fig. 41.
Fig. 37. *Culex fuscocephalus* : siphon, showing the hair tufts of one side.
,, 38. ,, ,, antenna.
,, 39. ,, ,, two pecten teeth.
,, 40. ,, ,, comb tooth.
,, 41. ,, ,, mentum.
,, 42. *Culex brevipalpis* : siphon, showing the hairs of one side.
,, 43. ,, ,, antenna.
,, 44. ,, ,, pecten tooth.
,, 45. ,, ,, comb tooth.
,, 46. ,, ,, anal segment.
,, 47. ,, ,, mentum.

EXPLANATION OF PLATE XXVIII.

Drawings illustrating the larval structure (fourth instar) of *Culex tenuipalpis* Barraud.

- Fig. 48. Extremity of abdomen, showing part of the 8th segment, siphon, and anal segment ; hair tufts of one side of the siphon shown.
,, 49. Pecten tooth.
,, 50. Comb tooth (to the same scale as fig. 49).
,, 51. Mentum.
,, 52. Antenna.

PLATE XXIV.

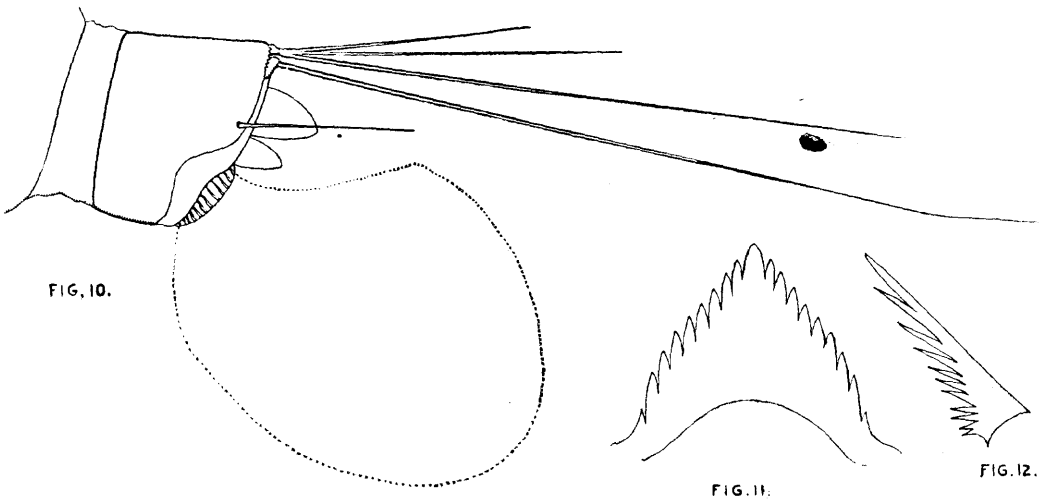
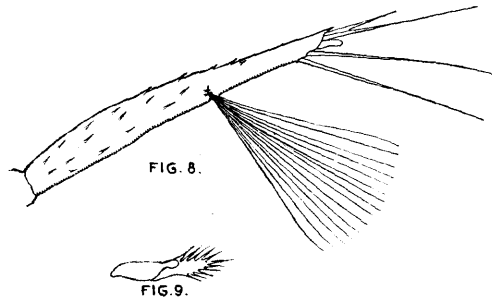
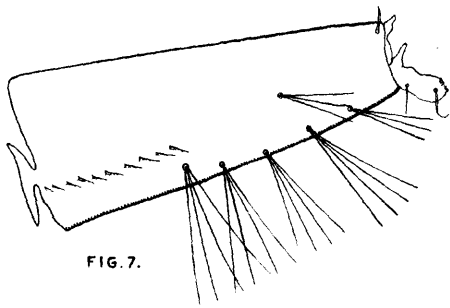
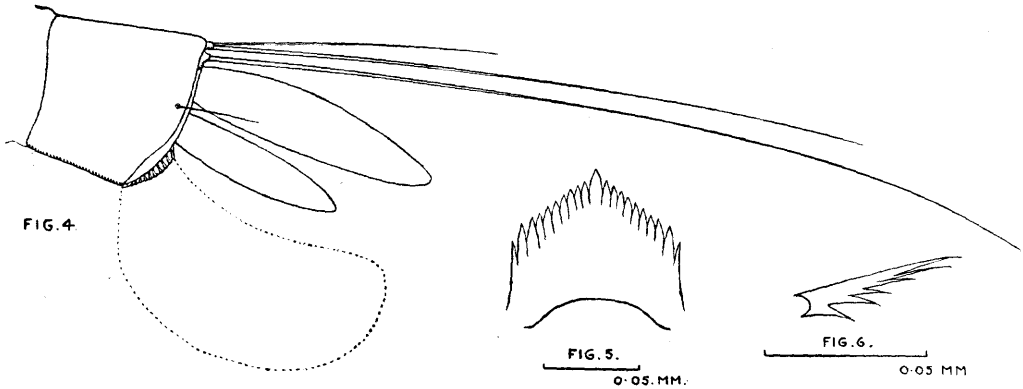
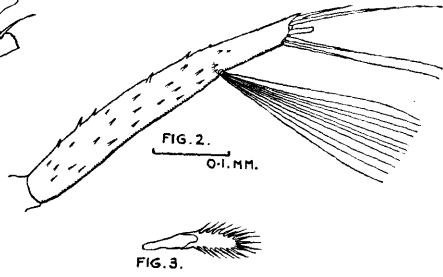
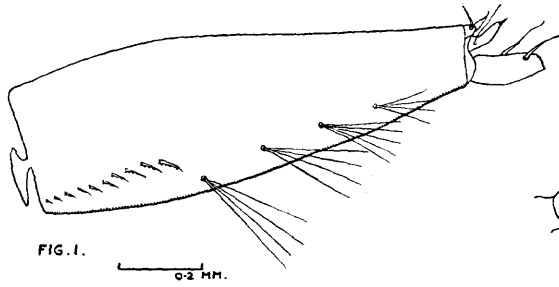


PLATE XXV.

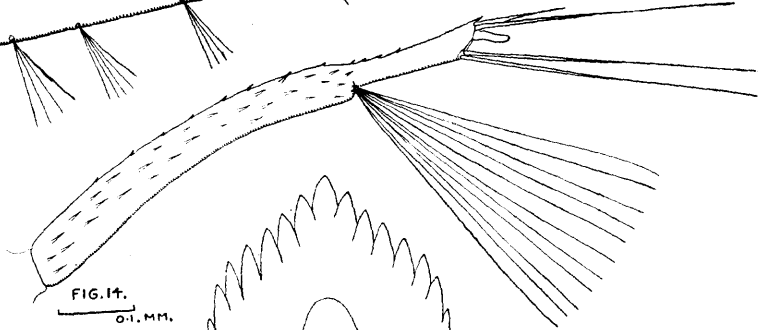
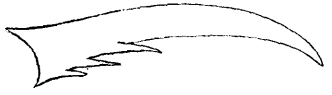
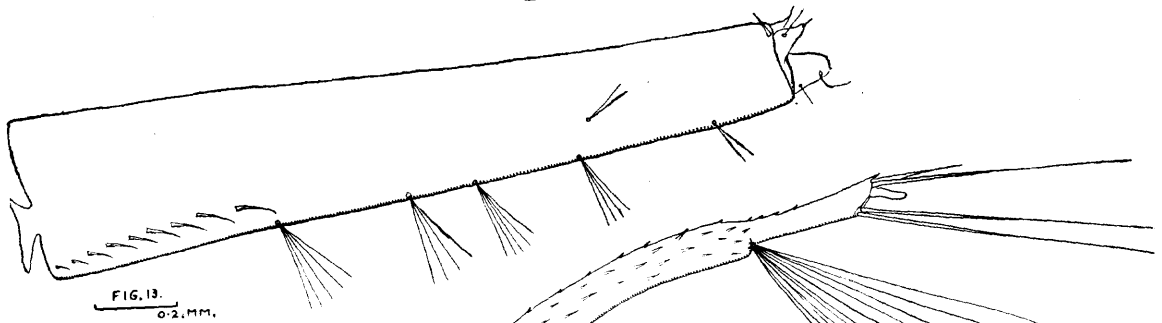


FIG. 16.

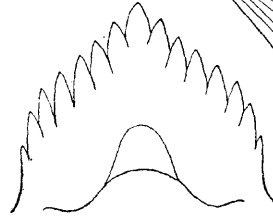


FIG. 18.

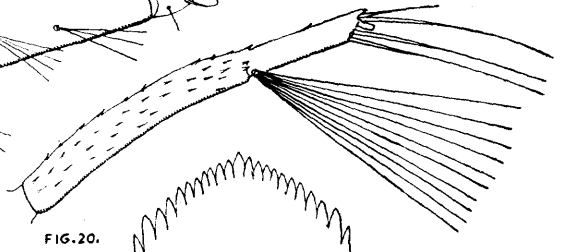
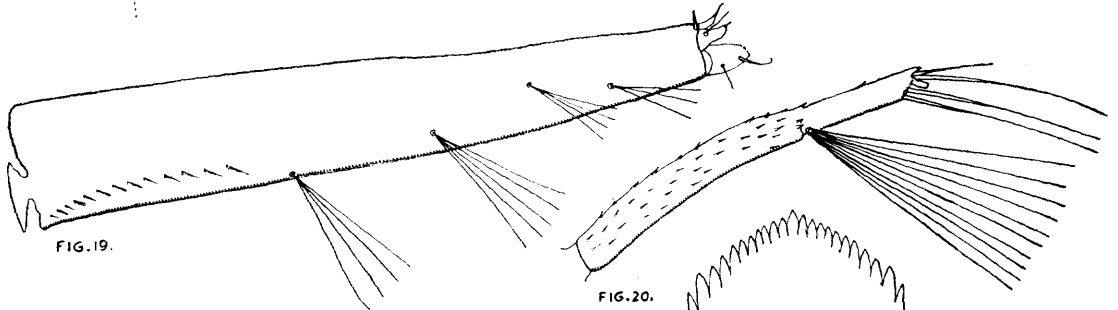


FIG. 21.



FIG. 22.

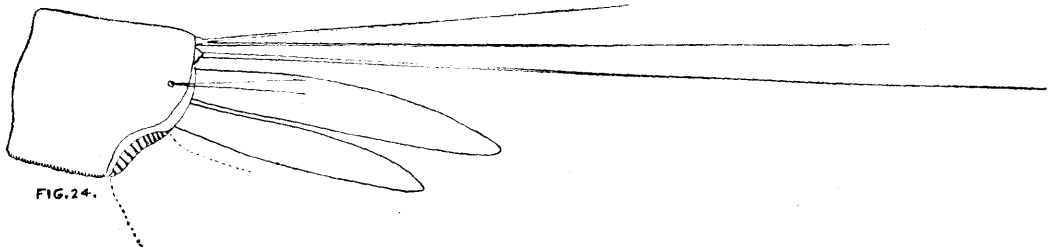
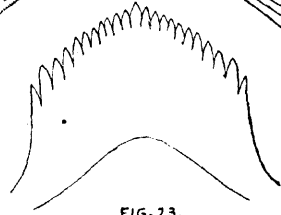


FIG. 24.

PLATE XXVI.

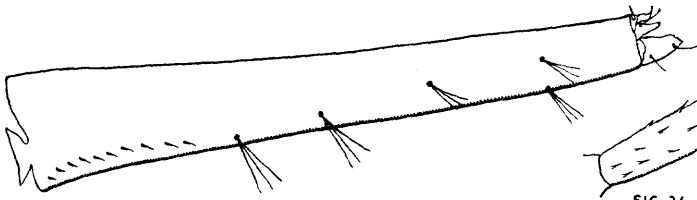


FIG. 25. 0.2. MM.

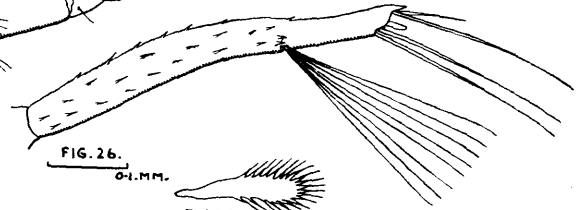


FIG. 26. 0.1. MM.

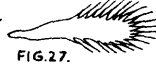


FIG. 27.

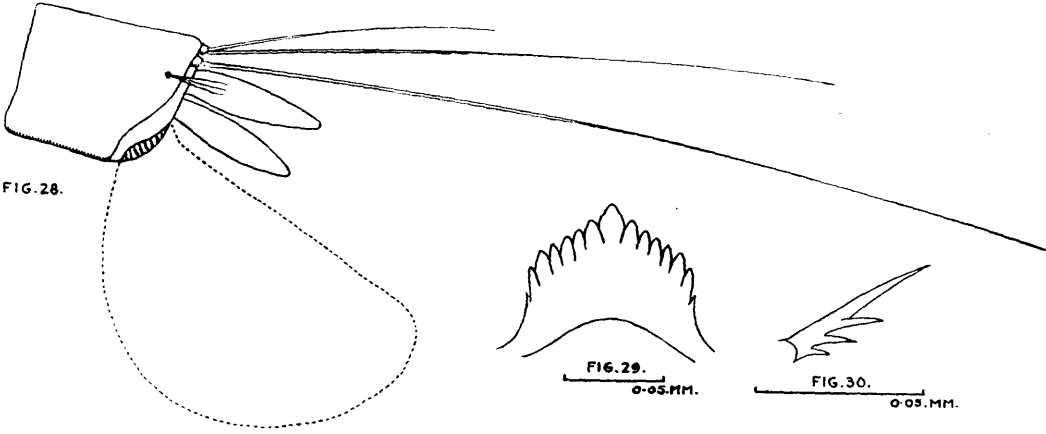


FIG. 28.

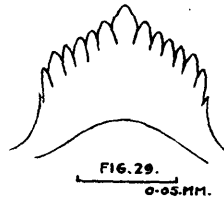


FIG. 29. 0.05. MM.

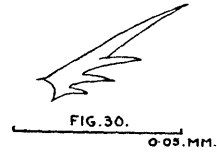


FIG. 30. 0.05. MM.

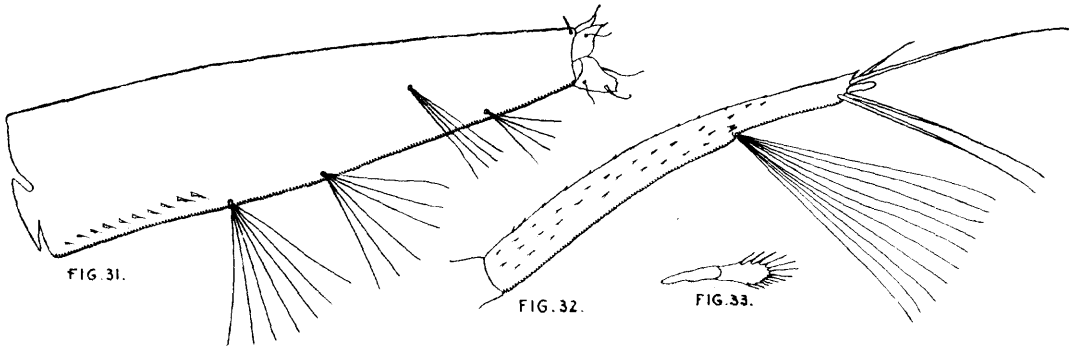


FIG. 31.

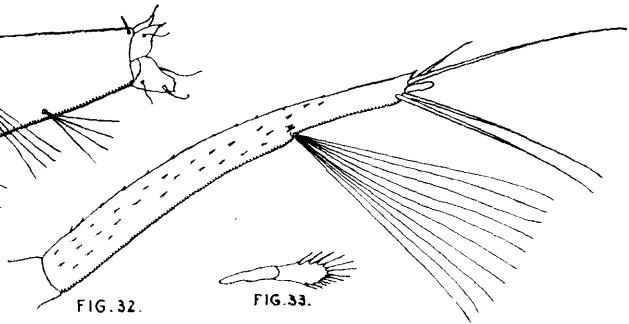


FIG. 32.



FIG. 33.

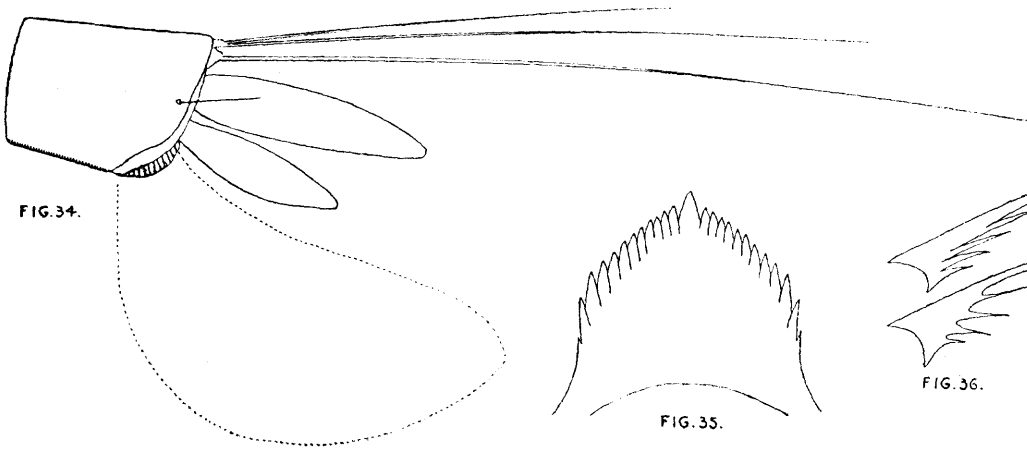


FIG. 34.

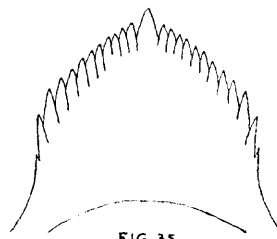


FIG. 35.



FIG. 36.

PLATE XXVI.

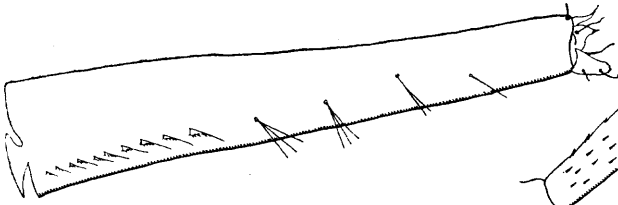


FIG. 37.
0.2. MM.

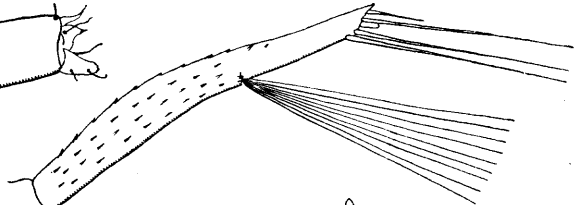


FIG. 38.
0.1. MM.



FIG. 39.
0.05. MM.



FIG. 40.

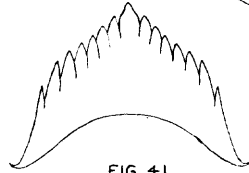


FIG. 41.
0.05. MM.

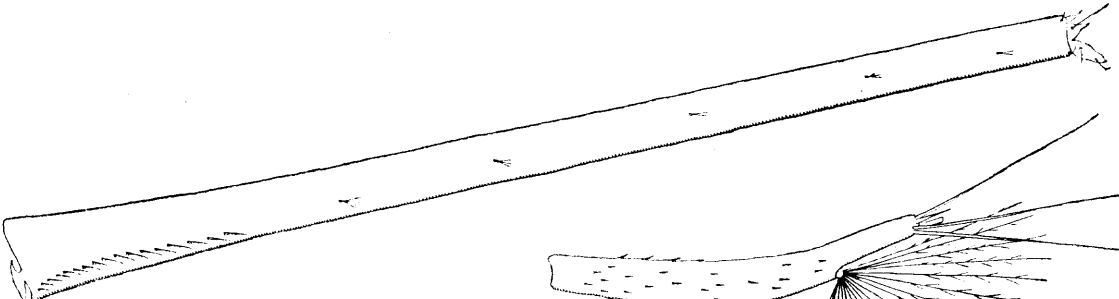


FIG. 42.

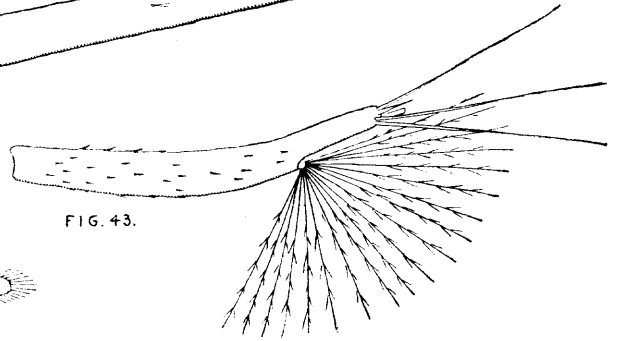


FIG. 43.



FIG. 44.

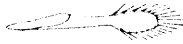


FIG. 45.

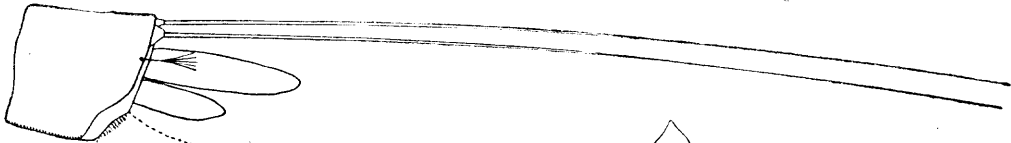


FIG. 46.

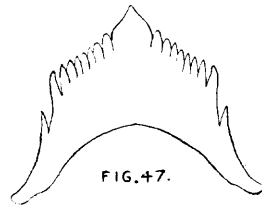
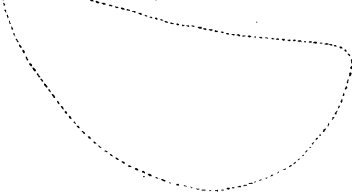


FIG. 47.

PLATE XXVIII.

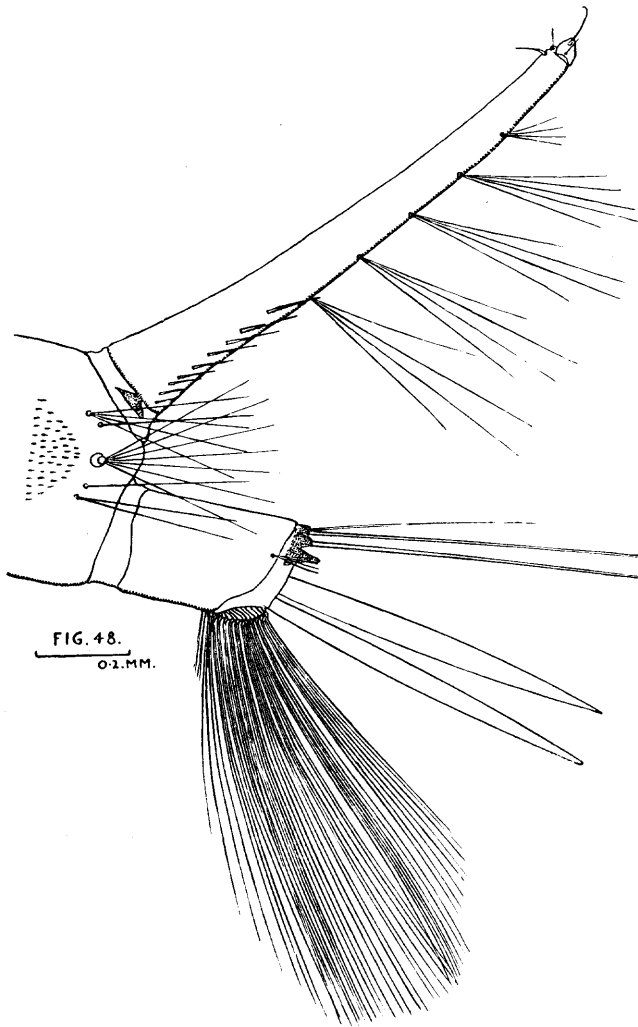


FIG. 48.
0.2 MM.

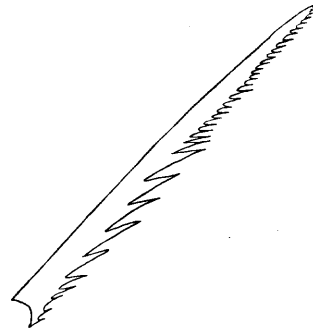


FIG. 49.
0.05 MM.

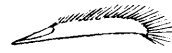


FIG. 50.

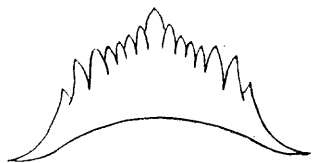


FIG. 51.
0.05 MM.

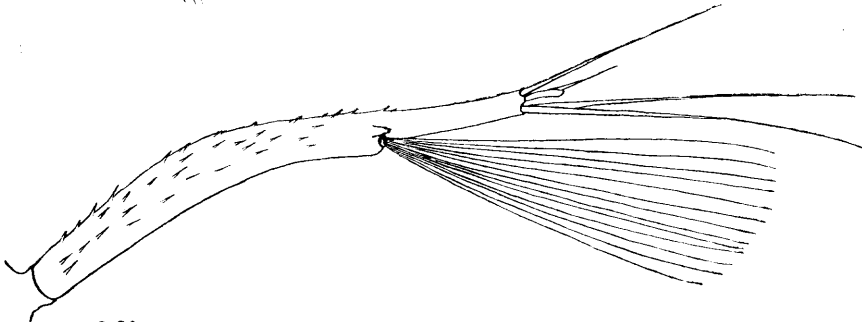


FIG. 52.
0.1 MM.