A NOTE ON GRAPPLING TAIL-HOOKS IN ANOPHELINE LARVÆ.

BY

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In a paper read before the Indian Science Congress, January 1920, I made a reference to the occurrence and utility of grappling tail-hooks in anopheline larvæ including those of *A. stephensi*, *hyrcanus* (*sinensis*) and *fuliginosus*.* Prior to this there has been no reference made to the presence of hooks in the setæ on the ninth segment of the abdomen. In the figures drawn by various authors, the supra-anal setæ are represented as straight and pointed at the tips. The object of the present note is to describe, in detail, my observations on the occurrence and utility of these hooks, in a large number of Indian species.

The posterior dorsal region of the anal segment has a set of four tufts of setæ, a median pair and an outer pair (Plate LXI, fig. 1). They start from plates of chitin arranged as in Plate LXI, fig. 2, on the posterior dorsal tip of the anal segment. The median pair starts from either end of a transversely placed strip of chitin, and is anterior and dorsal to the outer pair. The outer tufts start from two curved beak-like plates of chitin on either side of the median line, and which in some cases (*A. hyrcanus*) may be fused at the base (Plate LXI, fig. 3). These plates could only be seen well when the setæ had been pulled out. If the setæ are intact, we cannot get a superficial view of these plates.

The median tufts are of the feathered type and when the larva is at rest, they are projected backwards and upwards from the tip of the anal segment. The branches are in one plane and the tuft is vertically

* Preliminary Report of a Malaria Survey of Calcutta, *Indian Journal of Medical Research*, Special Indian Science Congress Number, 1920, pp. 15-16.

Explanation of Plate LXI.

Fig. 1. Dorsal views of the ninth segment of the abdomen of anopheline larvæ showing M—median tufts, E—external tufts and A. G.—anal gills.

Figs. 2 & 3. Dorsal tip of the anal segment showing chitin plates supporting the dorsal tufts of *A. jamesi* and *hyrcanus*. (The tufts have been pulled out.) M—the socket of the median tuft, E—the socket of the external tuft. Drawn with the Camera-lucida. Zeiss ocular 2, objective AA, tube length 160 mm.

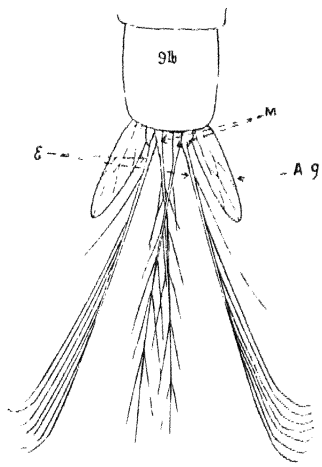
Fig. 4. Lateral view of the posterior region of the abdomen of *A. hyrcanus* larva. Camera-lucida drawing. Zeiss oc. 2 obj. AA, T. L. 160 mm.

M. median supra-anal tuft.

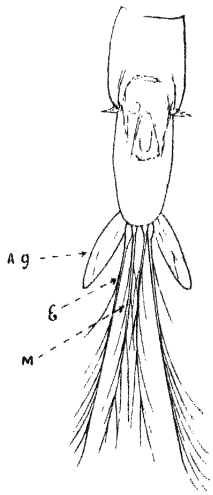
E. external supra-anal tuft showing hooks.

A. G. anal gills.

PLATE LXI.



A



B

Fig 1

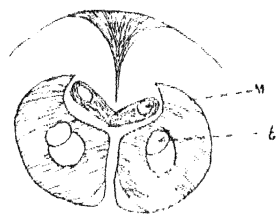


Fig 2

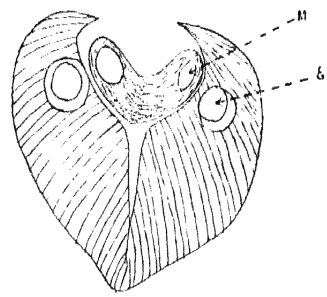


Fig. 3.

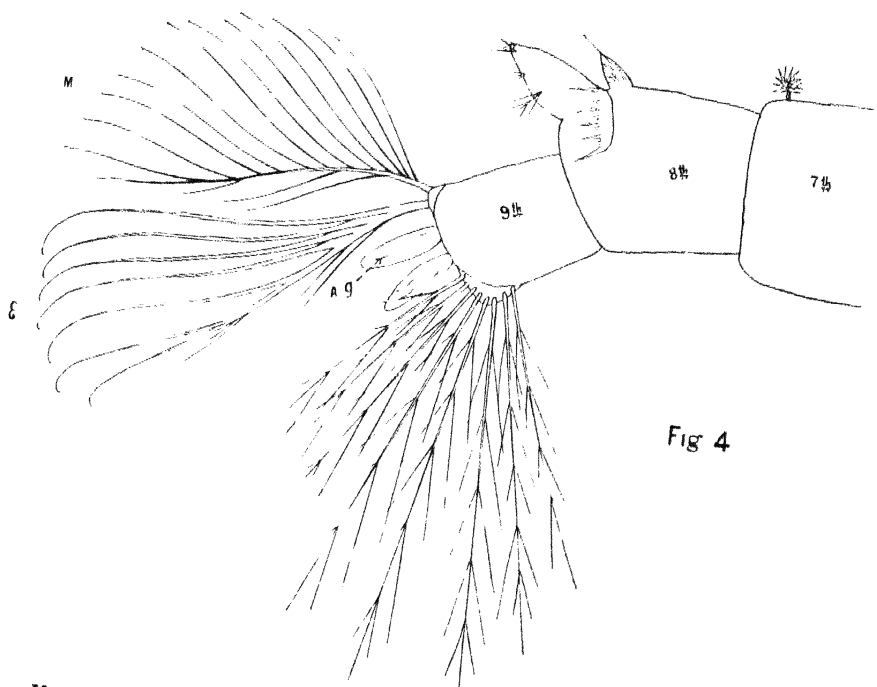


Fig 4

M. O. TIRUNARAYANA IYENGAR.—A Note on Grappling Tail-hooks in Anopheline Larvæ.

Plate LXII.

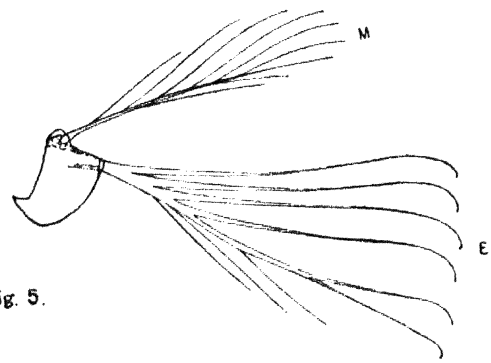


Fig. 5.

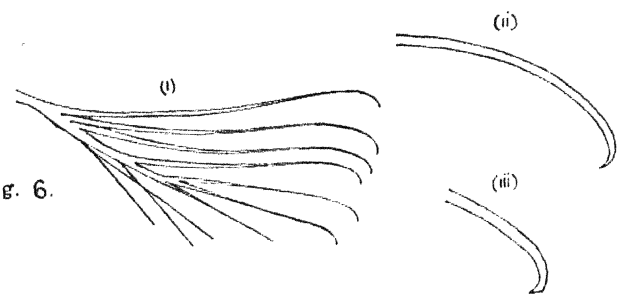


Fig. 6.

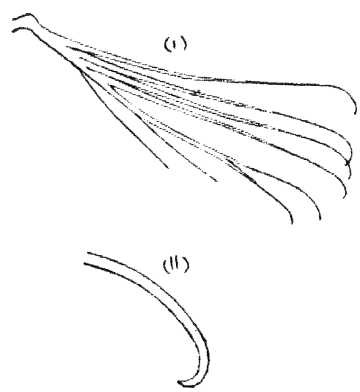


Fig. 7

M. O. Tirunarayana Iyengar.—A Note on Grappling Tail-hooks in Anopheline Larvæ.

Explanation of Plate LXII.

Fig. 5. Median and external tufts of one side of the larva of *A. jamesi* Camera-lucida, ocular 2, objective AA.

Figs. 6 & 7. External hooked tufts of *A. barbirostris* and *jamesi* and the tips of the hooked hairs magnified: drawn with the Camera-lucida, (i) oc. 2, obj. AA., (ii) and (iii) oc. 2 and obj. DD.

placed. Frequently, the two tufts may cross each other (Plate LXI, fig. 1. A). It will be seen from Plate LXI, fig. 4, that there are many more branches on the dorsal than on the ventral side. In *A. hyrcanus* there are 12 dorsal and only 4 ventral branches, and in some cases the ventral branches are still fewer.

The outer tufts consist each of about six equally long strongly chitinised setæ the tips of which are bent and sharply hooked and a few (2 to 4 or more) thin branches ventrally which possess no hooks. In some forms, the number of such hooked setæ may be as many as 7—10. The branches are somewhat flat at their bases. The hooks on the external supra-anal setæ are strong and thick. But the branches of the median supra-anal tufts have also been found in a few cases to have very minute hooks at their tips, visible only under the high power. They are very small and feeble, and may not be of any great use. I have found them in the larvæ of *A. maculipalpis, culicifacies* and *minimus.*

The following are observations of larvæ of *Anopheles stephensi* breeding in cisterns in Calcutta. When the larva rests along the surface of the water, the hooked setæ are projected backwards and the hooks point downwards (Plates, LXI and LXII, figs. 4-5). When disturbed, the larva goes to the bottom if the water is shallow. But if deeper, it has been observed to go only to the side of the cistern and sink slowly with the tail end touching the side. While thus descending, the hooks catch even the smallest prominence or roughness in the side and the larva hangs head downwards from the wall of the cistern by means of these hooks. It sticks to this position as long as the disturbance continues, and when everything is quiet again comes up to the surface. If from one such resting position the larva is disturbed by touching it gently with a long needle, it either comes up to the surface, or more frequently goes to another place on the cistern side and hangs from the new position in the same way. This led me to suspect the presence of some grappling organs in the tail, and an examination showed that these were the hooks of the external supra-anal tufts. Larvæ can stick to the sides of even a glass-jar in which they may be kept and dangle head downwards for varying lengths of time. In one instance, a larva clung to the sides of a cistern, under water for as long as 3 minutes.

All the species of *Anopheles* available for study have been examined since, including *A. subpictus,* Grassi (*grossi,* Giles); *vagus* Donitz; *culicifacies,* Giles; *fuliginosus,* Giles; *jamesi,* Theob; *maculipalpis,*

Giles ; *maculatus*, Theob ; *minimus*, Theob. ; *funestus var. listoni*, Liston ; *stephensi*, Liston ; *barbirostris*. v. d. Wulp. *hyrcanus*, Pallas and *gigas*, Giles. In all these species, the hooks are present quite characteristically.

In a pond, it may be presumed that if the larva were to be disturbed it would be compelled to go to the bottom. But this has never been observed to happen. The larvæ of Anophelines breeding in ponds with a floating vegetation of *Pistia stratiotes* for instance, get in between the roots of the *Pistia* when disturbed and hang from the rootlets by their tail-hooks. But sometimes they grip the rootlets with their mandibles. From such positions it is difficult to dislodge them. If the larvæ should go to the bottom of the pond on any disturbance, the possible dangers they would risk thereby would be (1) the exposure to enemies like fish and (2) exposure to pressure at the depths of a pond which cannot be withstood by these air-breathing organisms. This also enlightens us as to why larvæ always rest near floating aquatic plants or algal scums, or near the edge of the pond or cistern, and never at the clear centre of a pond.

Above we have seen the utility of the tail-hooks in stagnant waters.* In flowing waters, the larvæ of species breeding therein stick to boulders on the sides of the streams by means of their well-developed tail-hooks. The larvæ of *A. maculatus* and *minimus* breeding in the 'jhoras' (hill-streams at the foot of the Himalayas) have been observed to do so. But the power to stick to the sides of streams is particularly remarkable with larvæ of *A. maculatus*, and they are able to withstand very strong currents. Experiments in the Bengal Duars have shown that flushing a stream has no great effect in driving the larvæ of *A. maculatus* far down the stream. When the stream gets a good flush, the *maculatus* larvæ breeding in it at once get to the surface of the flush water, move a short distance with the current and suddenly dart out to the sides and there stick to the stones or boulders, in spite of the strong current. When the flush spends itself and the level of the water falls, the larvæ creep down the sides, and when the water is stationary again, get into the water. The larvæ of *A. culicifacies* breeding in the sluggish streams in the colliery districts also utilise their tail-hooks to stick to stones and sand,

* It has been said in the paper referred to in the postscript that the floating Anopheles larva sticks to the edge of a glass vessel and maintains itself at right angles to the side of the vessel by means of the two lateral hook tufts. I have observed larvæ in which the tufts were completely removed without injury to the larva and they behave exactly similarly so that, apparently there is no connection between these hooks and the resting position at right angles to the sides of a vessel.

but they have no capacity to withstand a flush. In one instance, a good flush was able to drive all larvæ of *culicifacies* a mile down the stream.

Specimens of larvæ of *A. maculipennis*, Meigen, *bifurcatus*, Linn, and *plumbeus*, Haliday, received through the courtesy of Prof. G. H. F. Nuttall, were also examined. The hooks were quite typical in the two former, but in *A. plumbeus*, the hooks were very few and minute.

I have (through the courtesy of the Director, Zoological Survey of India) seen type specimens of larvæ of *Anopheles annandalei*, Prashad, a tree-hole breeding species from the Himalayas. I have observed that the hooks are present quite characteristically in this species also.

Postscript.—Just prior to sending this note for publication, I have seen a paper by W. A. Lamborn on the 'Nature and function of caudal tufts in malayan anopheline larvæ,' in the latest issue of the Bulletin of Entomological Research (Vol. XII, pt. 1, July 1921).

I wish to note briefly on some points raised by Mr. Lamborn. He believes that in previous literature, no structural differentiation of the two sets of (dorsal) brushes had been noted' (p. 92). It should be pointed out that Nuttall and Shipley in their articles on the 'Structure and Biology of *Anopheles maculipennis*' (*Journal of Hygiene*, Vol. 1, pt. 1, 1901) have clearly described and figured these tufts. Their figures and descriptions are perfect, though they missed these hooks.

Mr. Lamborn says 'The presence of any hooks at all in the case of *A. subpictus var. vagus* and others which breed by choice in the still 'waters of muddy pools is doubtless to be explained by recent modifica-'tions of breeding habits; for until the advent of the white man to this 'country and the subsequent great economic development, there must 'have been comparatively few such breeding places available.' It is here assumed that these hooks are quite useless in stagnant waters; this statement is fully controverted by my note. It is too much to assume that there were few stagnant waters before the advent of the white man; and there is no evidence to show that there has been any 'recent modification of breeding habits.'

Mr. Lamborn notes that tree-hole breeding species have imperfectly developed hooks. I have not seen *A. asiatica* *A. plumbeus* larvæ from England show this reduction, but the hooks are present though few and feeble. But as stated above the larvæ of *A. annandalei* Prashad, also a tree-hole breeder, show no such reduction, the hooks being quite well developed. There is no evidence about the other tree-hole breeding species.