

# ON THE CHANGES WHICH OCCUR IN CERTAIN CHARACTERS OF ANOPHELES LARVAE IN THE COURSE OF THEIR GROWTH.

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## Introductory.

It is generally admitted that the ability to determine the species of *Anopheles* by an examination of their larvae would place a valuable weapon in the hands of the practical sanitarian in tropical countries. In the investigation of an area for the determination of the *Anopheles* present, it frequently happens that, on account of their habit of concealment by day, adult mosquitos are difficult to find, whereas their breeding places may be located readily. If the larvae are transported to a distance they commonly do not develop further, and so, failing the specific identification of the larvae themselves, valuable information is lost. It is therefore very desirable to know whether, and to what extent, any of the characteristics of such larvae may safely be employed in determining their species.

Grassi<sup>1</sup> was the first to direct attention to certain characters of *Anopheles* larvae, notably the form of the clypeal hairs, which he considered to be of value in their specific differentiation. The valuable observations of James<sup>2</sup> and Christophers<sup>3</sup> added greatly to the knowledge of the subject, but later studies in India and elsewhere appeared to show that these characters were not constant in the same species. James and Liston<sup>4</sup>, in the second edition of their monograph on "The Anopheline Mosquitoes of India," give expression to the prevalent belief that "in the larvae of common species some of the characters vary considerably and therefore for purposes of identification we are not now inclined to attach very great importance to them."

In the course of a study of the *Anopheles* mosquitos of the Malay Peninsula, it was possible by breeding out larvae from the eggs of known species to follow the changes in them at successive ecdyses up to maturity. The results of these observations are set forth in the present paper, and it is believed that they account for the anomalous results obtained by previous workers in this field of research, by showing that the supposed variations of any specific larva are really changes of a constant kind associated with successive phases of development. The difficulty of breeding out larvae from the eggs laid by mosquitos in captivity was not found to be insuperable, and it is considered that the study of such larvae offers certain advantages over the study of the skins cast on their transformation to pupae or of groups of larvae from which a single species subsequently hatches out.

The larvae of the following species were studied :—*A. albirostris*, *A. sinensis*, *A. fuliginosus*, *A. nigrans* (= *A. karwari*), *A. umbrosus*, *A. rossi*, and *A. ludlowi*. As the results were constant and parallel in the case of each species, it will suffice for the present purpose to give an account of only one of these, and I have selected *Anopheles albirostris*, Theobald, one of the malaria-carrying species of the Malay Peninsula.

The form and arrangement of the anterior clypeal hairs and of the posterior clypeal hairs situated on the front of the head (fig. 1 A), and of the palmate hairs situated on the thorax in certain species and on a varying number of the abdominal segments (fig. 1B), are the characters in which the most striking changes occur, and these will now be described in detail.

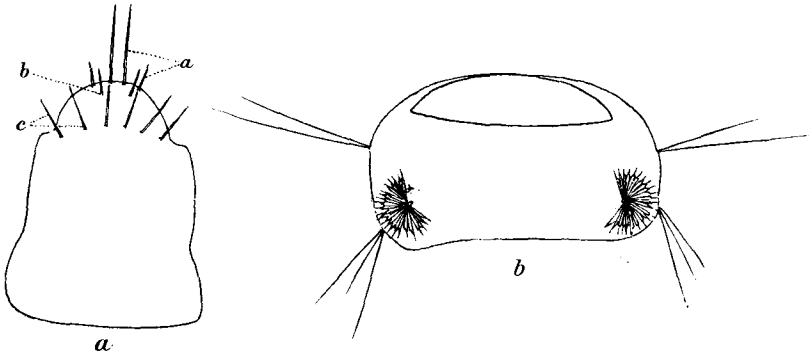


Fig. 1.—A.—Head of larva of an *Anopheles*, dorsal view, showing (a) anterior and (b) posterior clypeal hairs, and (c) frontal hairs. B.—Abdominal segment of full-grown larva of *Anopheles albirostris*, dorsal view, showing "palmate hairs" fully developed.

### Growth-changes observed in the larva of *Anopheles albirostris*.

When newly hatched from the egg, the tiny larva of *Anopheles albirostris* is characterised as follows:—The anterior clypeal hairs, the inner being long and the outer short, are simple bristles; the posterior clypeal hair is also simple and is situated behind and slightly internal to the outer anterior clypeal (fig. 2); the

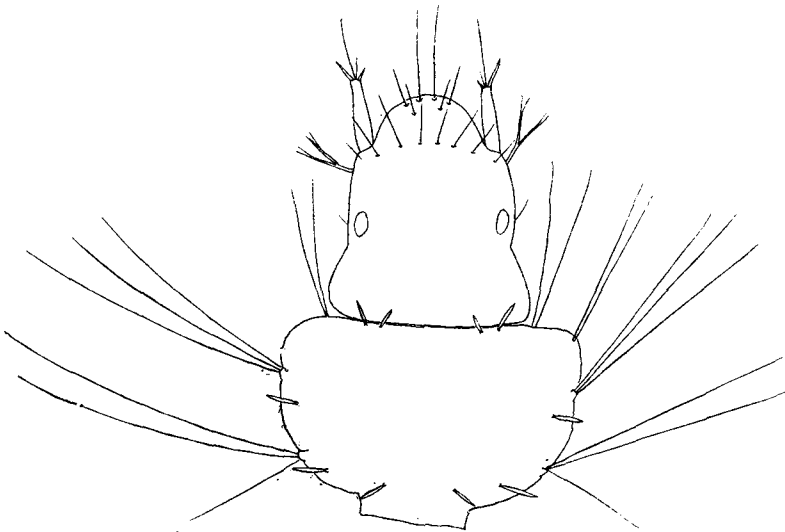


Fig. 2.—Head and thorax of newly hatched larva of *Anopheles albirostris*, showing the hairs all simple.

dorsal structures, some of which in full-grown larvae become what are known as "palmate hairs," are represented by simple lanceolate leaflets (fig. 3*a*); these are situated five on each side of the thorax and one on each side of the abdominal segments from the second to the seventh, and are longer on the posterior segments than on those nearer the thorax.

The *Anopheles* larva at this stage approximates in several of its characters to mature *Culex* larvae and appears to indicate the mode of origin of *Anopheles* as a differentiation from pre-existing *Culex* forms. The lateral thoracic and abdominal hairs are simple, as in most mature forms of *Culex* larvae. The papilla, at the base of which the tracheae open, is more prominent than at later stages and is semi-tubular (fig. 3*b*), recalling the form of the breathing tube of *Culex*. It

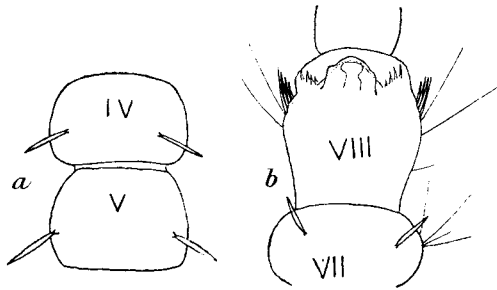


Fig. 3.—Newly hatched larva of *Anopheles albirostris*; *a*, 4th and 5th abdominal segments, showing simple lanceolate leaflets; *b*, 8th abdominal segment, showing prominent semi-tubular papilla.

should be noted that when they leave the egg all species of *Anopheles* larvae are very much alike at a casual inspection and that in several particulars they bear a close resemblance to *Culex* larvae.

After three or four days growth the characters of the larva of *A. albirostris* begin to approximate those of the mature form and are as follows (fig. 4):—The

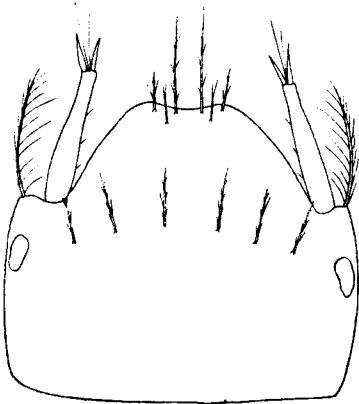


Fig. 4.—Head of larva of *Anopheles albirostris* after first moult, showing that the simple clypeal and frontal hairs have become subplumose.

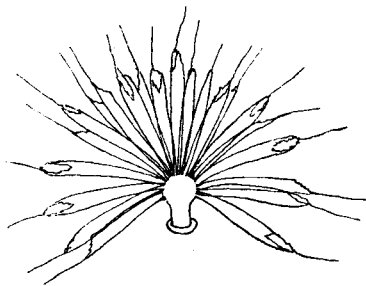


Fig. 5.—Cockade, or "palmate hair," from the 5th abdominal segment of full-grown larva of *Anopheles albirostris*, showing the great change from the condition illustrated in fig. 3*a*. Greatly magnified.

anterior clypeal hairs now show traces of feathering; the posterior clypeal hair is forked and is placed nearer the mid line; instead of a single leaflet, the palmate hair now becomes a whorl of lanceolate leaflets. Four of the five simple leaflets on each side of the thorax in the first stage are transformed, not into rosette-like palmate hairs, but into stout feathered hairs, and one of the simple bristles on the lateral aspect of the first abdominal segment is transformed into a whorl of leaflets.

A curious feature of the larva of *Anopheles umbrosus* in regard to the palmate hairs should here be noted. Neither in the newly hatched larva of this species nor in its more mature form have any leaf-like palmate hairs been observed, their place being taken by simple bristles and feathered hairs. The larva nevertheless assumes in the water the horizontal position common to all *Anopheles* larvae.

With the further growth of the larva and at successive ecdyses, the branching of the clypeal hairs becomes more marked, and the form of the palmate hairs alters until the characteristic form and arrangement of these hairs in the mature larva are attained (fig. 5).

At maturity (fig. 6), the anterior clypeal hairs are much feathered; the posterior clypeal hair, now situated behind and near the inner exterior clypeal, consists of a very short stem from which four or six branches arise; on the thorax and first abdominal segment, the leaflets of the palmate hairs are lanceolate, and on the second to seventh abdominal segments they are jagged at the base of the terminal filament, which is long and sharply pointed (fig. 5).

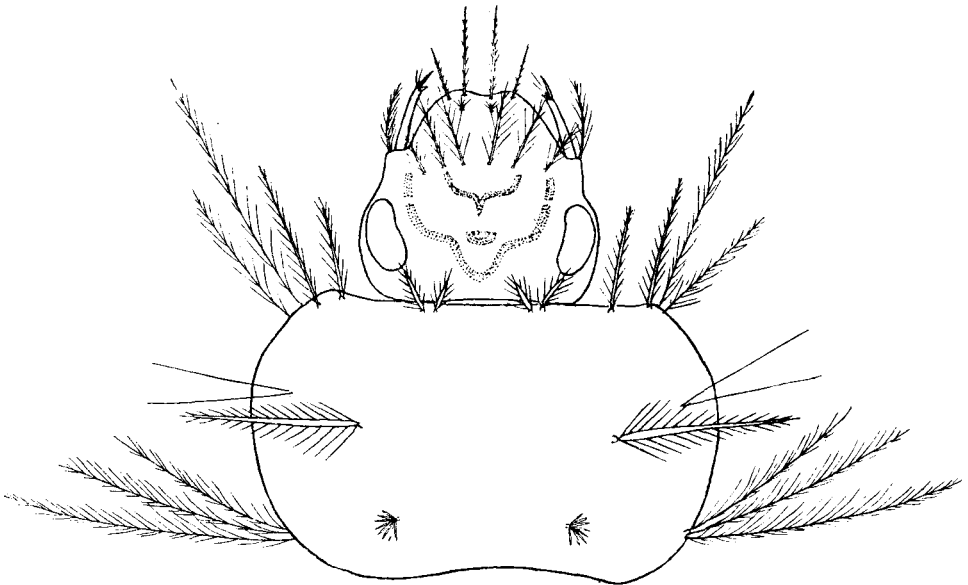


Fig. 6.—Head and thorax of full-grown larva of *Anopheles albirostris*, showing that all the hairs, etc., have become either plumose or subplumose.

Save in the case of a few closely-related species, of which *rossi* and *ludlowi*, *sinensis* and *barbirostris* are examples, the mature forms of larvae of Malayan *Anopheles* have been found to possess characteristic features which permit of

their specific differentiation. So far, only the anterior and posterior clypeal and the palmate hairs have been studied in detail, and it is hoped that further study will reveal points of difference which will enable one to recognise the mature forms of *all* valid species. It may well be that the distinctive characters which may be observed in these developmental stages will form the basis for a more satisfactory grouping of adult *Anopheles* than that which has been founded upon scale characters alone.

The drawings accompanying this paper were executed by Col. A. Alcock, C.I.E., F.R.S., to whom I am under obligation for this and other valued advice and assistance in the preparation of these notes.

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