

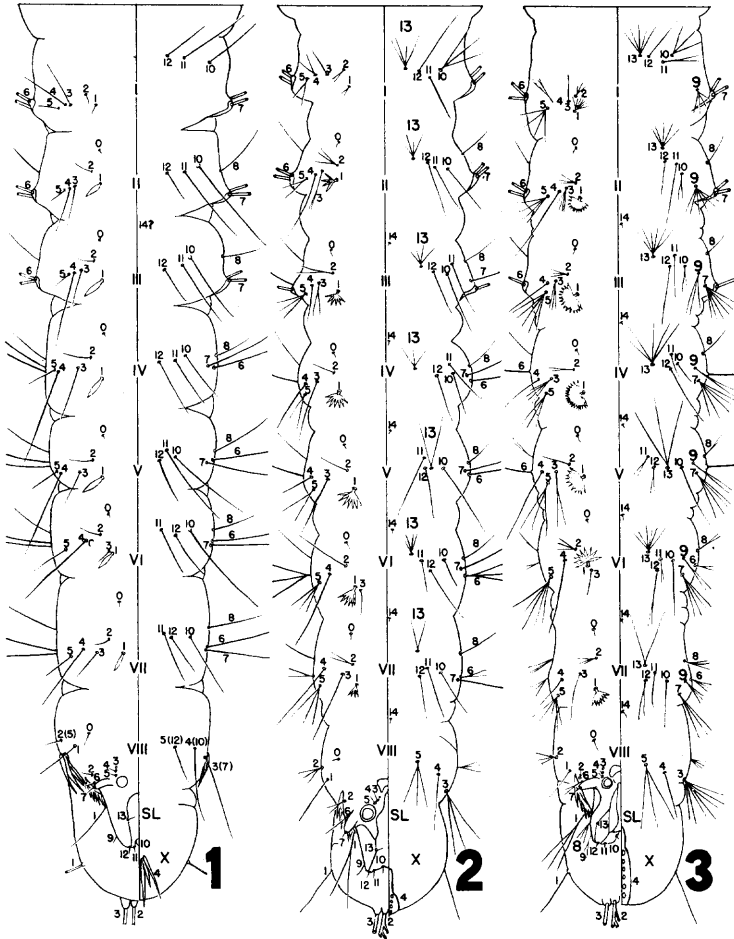
**CORRECTED INTERPRETATIONS OF SOME ELEMENTS OF
THE ABDOMINAL CHAETOTAXY OF THE MOSQUITO LARVA
AND PUPA**

(DIPTERA, CULICIDAE)

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Since the publication of the revised homologous terminology of the chaetotaxy of the mosquito larva and pupa (Belkin, 1952), considerable additional evidence, particularly in the form of anomalies, has come to hand. Some of this evidence requires a reinterpretation of certain elements of the abdominal chaetotaxy, some strengthens the original interpretations and finally other evidence indicates homologies not apparent before. Moreover, some of the errors which have crept into earlier interpretations need to be corrected. While the changes proposed here and before may seem to add further confusion to that already existing in the nomenclature of the chaetotaxy of the mosquito larva and pupa, my contention is that a useful stable terminology can be arrived at only if it is a homologous one, for then it can be used not only for diagnostic purposes but also to show the relationship of the different groups of mosquitoes. In all probability, few additional changes will have to be made and these must await the completion of a comparative study of all the subgenera now in progress. Anomalies have been particularly useful in establishing homologies but unfortunately their occurrence is limited and unpredictable, and it is hoped that other workers will report them as they come to light. Opportunity is here taken to present a series of labelled diagrams of the abdominal chaetotaxy of the four larval instars and the pupa of *Anopheles freeborni* Aitken, 1939 to illustrate more clearly the homologies and the system of nomenclature.

As pointed out earlier (Belkin, 1952) one of the most vexing problems in the homology of the abdominal chaetotaxy of the larva and pupa is that presented by the transitory abdominal hairs which appear in the



Figs. 1-3, abdomen of first, second and third instar larva respectively of *Anopheles freeborni*; left, dorsal; right, ventral; SL, siphon lobe; large 13, transitory hairs first appearing in second instar; large 9 and large SL-8, transitory hairs first appearing in third instar.

second and third instar larva and normally disappear in the pupa. Originally, I interpreted these as hairs 9 and 11. Recently, in studying the pupae of the anophelines of California, I have encountered a large number of anomalies in *A. freeborni*, western race of *A. punctipennis* (Say), 1823, and several races of *A. occidentalis* Dyar and Knab, 1906, which indicate beyond any doubt that the more mesal of the two transitory hairs is actually hair 13 and not 11. It will be noted that in the pupa (fig. 5) this hair, labelled 13 in larger figures, occupies the same position in relation to hairs 11 and 12 on segments II-VII that it does in the second, third and fourth instar larvae (fig. 2-4). Particularly significant is the location of hair 13 on segment V, for it will be noted that in the pupa as well as in the older larval instars it is found caudad and laterad of hair 11. While it is located mesad of hair 12 on this segment in the pupa, this does not necessarily disturb the homology, for similar lateral migrations of hairs are not uncommon elsewhere on the pupal abdomen. On segment VII, pupal hair 13 also occupies a position strikingly similar to that found on the corresponding segment of the larval instars 2 to 4. A further support for this interpretation of hair 13 will be found by comparing the first and second instar larvae (fig. 1 and 2, respectively). Although there is a slight shift of the hairs interpreted as 10, 11 and 12 between the two instars it will be noted that the most likely interpretation is that the new hair appearing in the second instar is the one labelled with the large figure 13, and that on segment II it is the most mesal of all the ventral hairs. I have checked this interpretation in several culicines and find that it also fits the facts. F. E. Baisas (1951) in a personal communication also interpreted this same transitory hair as hair 13 in *Tripteroides microcala* Dyar, 1929 from the Philippines. These two lines of evidence taken together indicate without any doubt that this must be the correct interpretation. It will also be noted that hair 13 is absent on segment VIII of the larva and is not represented by an anomaly in the pupa. The latter of course is not a proof in itself for it may merely mean that no favorable material was encountered; nevertheless, the absence of the anomaly on this segment and its presence on all the others, except the second which has the venter reduced, is also in line with the present interpretation.

The evidence for the interpretation that the second, more lateral, of the transitory hairs is hair 9 is not nearly as strong but it appears very likely that it is correct. First of all, inspection of figs. 2-4 reveals that it is hair 9 which appears for the first time in the third instar larva. By analogy with hair 13, this hair (9) should then be the second transitory hair which is normally absent in the pupa. In the pupa, anomalous retention of hair 9 is not as common as in the case of hair 13 in the material that I have examined. I have already reported (Belkin, 1952: 128) its presence in *Uranotaenia quadrimaculata* Edwards in Paine & Edwards, 1929. In the material of the anophelines of California, I have encountered it to date on segments V and VI only (fig. 5). Although it

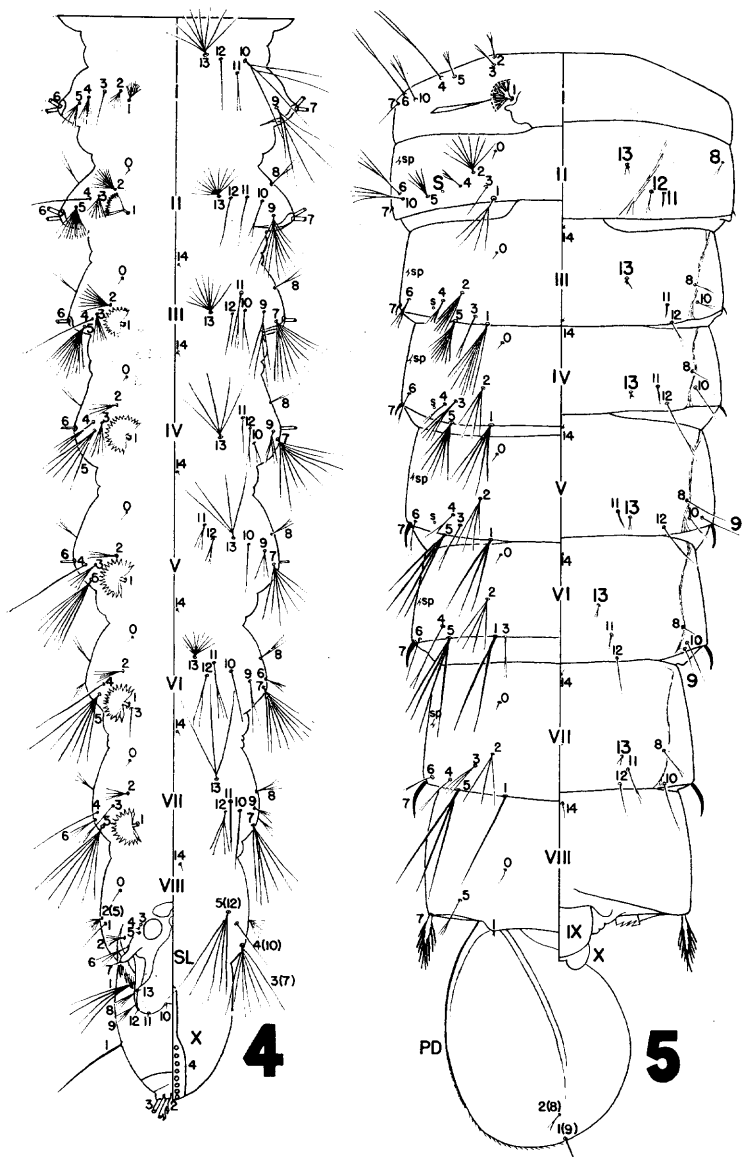


Fig. 4, abdomen of fourth instar larva of *Anopheles freeborni*; left, dorsal; right, ventral; SL, siphon lobe; fig. 5, abdomen of female pupa of same; left, dorsal; right, ventral; transitory hairs 9 and 13 in large figures; anomalous hairs of segment II (8, 11, 12) in large figures; PD, paddle; s, dorsal sensillum; S, anomalous dorsal sensillum on segment II; sp, spiracle (some transitory and anomalous structures added from *A. punctipennis* and *A. occidentalis*).

would be possible to interpret these latter anomalies as duplications of hair 10, the position of the hairs, as illustrated, strongly suggests that they are really hair 9 (see figs. 4 and 5).

On the basis of the above mentioned evidence, I am changing the nomenclature of the two mesal ventral hairs of the pupa to hairs 11 and 12. Usually hair 11 is considerably more cephalic in position than hair 12; in the nomenclature of Knight and Chamberlain (1948) it was known as hair 12 and in that of Belkin (1952) as hair 13. Hair 12 of my present interpretation was so interpreted by me in 1952 and was known as 11 by Knight and Chamberlain. The reason for calling the more caudal hair 12 is that in all the larval instars it occupies a more mesal position on the proximal segments and particularly so on segment II, which is the basic segment for general and serial homologies. Furthermore hair 11 has a tendency to move laterad on some segments; in the sabethine larvae this movement is very pronounced on segments III and IV. Unfortunately in the pupa hair 11 is often mesad of 12, but there is considerable variation in this respect in the various groups and on different segments. It appears that in the pupa, hair 11 may assume the position shown by the corresponding hair on the first, second, third or fourth instar larvae. In figures 11 and 12 (Belkin 1952-125) of *Trichoprosopon digitatum* (Rondani), 1848, pupal hair 14 should be relabelled 13, since, as I pointed out (1952:128), it represents the retention of the more mesal of the two transitory larval hairs. The other corrections to be made in the nomenclature of the ventral abdominal hairs on the figures in that paper (Belkin, 1952) are as follows: fig. 5, pupal 12 to 11, pupal 13 to 12, pupal 7 (the spine) is not labelled; fig. 7 and 8 are of abdominal segment IV and not II, pupal 13 to 11; fig. 11, 12, 13 and 14, pupal 13 to 11. In the figures of Knight and Chamberlain (1949) hair 12 and 11 should be reversed in all genera; hair 13 on the figure of *Trichoprosopon* should remain as 13, since it is not homologous with their hair 13 (14 in the terminology of Belkin) in the other genera.

The other anomalous retentions of hairs on the abdomen of the pupa are to be found on the venter of segment II and clearly involve hairs 8, 11 and 12, labelled in larger figures (fig. 5). It will be noted that hair 12 on this segment is drawn as being slightly cephalad of 11. Such is not always the case for it may be at the same level or slightly caudad. It is significant that the same relationship is to be found in the larval instars on this segment (fig. 3 and 4). The anomalous hairs 8, 11 and 12 of segment II are not in the same class as hairs 9 and 13 and they are regularly present as fully developed hairs in many species of mosquitoes.

A second point of discrepancy involves the nomenclature of hairs 4 and 5 on all abdominal segments. In the revision of the pupal chaetotaxy (Belkin, 1952) I followed the pupal nomenclature of Knight and Chamberlain and reversed these two hairs as compared with the original anopheline larval terminology. After examining representatives of the

majority of the genera, including several first instar larvae, I have come to the conclusion that these hairs shift their position laterad a great deal but appear to retain a cephalocaudal relationship much more consistently. Since the nomenclature of the chaetotaxy is based on the anophelines it would appear advisable to retain the terminology originally used in this group. In anophelines the more anterior of the two hairs is hair 4; hair 5 frequently moves mesad and caudad of it, although in the first instar larva it is found laterad of 4 (fig. 1). This mesocaudal movement is most strikingly exhibited in the pupa (fig. 5). Accordingly the terminology used by me (Belkin, 1952) should be reversed for these two hairs and the following changes should be made in the figures: figs. 5 and 7, interchange hairs 4 and 5 in larva and pupa; fig. 9, interchange hairs 4 and 5 for pupa only; figs. 10 and 11, no change; figs. 12 and 13, interchange hairs 4 and 5 for larva and pupa; fig. 14, interchange hairs 4 and 5 on all segments. In the figures of Knight and Chamberlain (1948) hair 5 should remain as labelled while hair 6 should be changed to hair 4. Further study of these hairs is needed, for in some culicines it appears that hair 4 and 5 may show disruption of the normal cephalocaudal relationship on some segments.

A similar situation is found with hairs 2 and 3. It appears that hair 2 is generally anterior to hair 3, but, as in the case of hairs 4 and 5 and 11 and 12, there is a considerable lateral shifting between members of the pair. In anophelines it is quite evident that the small hair mesad of hair 1 on the abdominal segment VI is hair 3 and not 2 as usually interpreted (fig. 1-5). Knight and Chamberlain correctly interpreted this hair in the pupa of anophelines. In other mosquito pupae there is a similar hair moving mesad of hair 1 on several segments, but Knight and Chamberlain interpreted it as hair 2 and I followed this interpretation. In some forms this hair is cephalad of 3 (some sabethines) while in others it is caudad of that hair. The question as to the homology of this hair cannot be settled without further study of the larval chaetotaxy of culicines and examination of pupal hairs *in situ* in the fourth larval instar. Until this is accomplished it is suggested that the terminology of Knight and Chamberlain as homologized by me be followed. It must be remembered that, if a change is made, the terminology of the anophelines should be adopted, for otherwise the well-known and widely used anopheline hair 2 would have to be renumbered.

Additional homologies have become evident in the terminal abdominal segments of the larva and pupa and are indicated in parentheses in figures 1, 4 and 5. On segment VIII of the larva, the first pentad hair is apparently homologous to hair 1; in sabethine larvae its position and degree of development are identical with hair 1 of the preceding segments. The second pentad hair appears to be homologous to hair 5 in these forms also and the corresponding hair in the pupa has also been interpreted as hair 5. The third pentad hair is almost certainly hair 7 from its position both in the larva and the pupa. The remaining pentad hairs, absent in the pupa, are in all probability hairs 10 and 12. Cer-

tainly pentad 5 cannot be hair 13 as interpreted by some workers, since it is present in the first instar larva while hair 13 is entirely absent in this instar (fig. 1). As these homologies are tentative only, I am retaining the arbitrary designation 1-5 for the pentad hairs of segment VIII of the larva. The two hairs of the pupal paddle (fig. 5) appear to be homologous with the two lateral hairs of the ventral valve; hair 1 is probably homologous with 9, and hair 2 with 8 (figs. 4 and 5). In this connection it is interesting to note that paddle hair 2 is often absent in the pupa and that its homologue in the larva (SL-8) is a transitory hair, appearing in the third instar (fig. 3).

The "dorsal hairless setal ring" has been interpreted by some workers as an element of the pupal chaetotaxy. In a recent paper (Belkin, 1953) I have attempted to show that this structure cannot be homologous with any regular hair and I have renamed it the *dorsal sensillum*. The accompanying figure shows this sensillum on segments III-V on which it regularly occurs (fig. 5,s) as well as its anomalous development on segment II (fig. 5,S).

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