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THE SEGMENTATION OF THE ABDOMEN OF LIPEURUS HETEROGRAPHUS NITZSCH (MALLOPHAGA)¹

F. H. WILSON

Department of Zoology, Tulane University of Louisiana

FIVE FIGURES

AUTHOR'S ABSTRACT

Eleven segments are recognized in a comparative study of the abdomens in immature and adult instars of *Lipeurus heterographus* Nitzsch.

The abdomen of the first instar appears ten segmented but with the apparent first segment twice as long as any one of the others and with two transverse rows of hairs on the tergum while the other abdominal segments have but one. This indicates that the apparent first segment is the true first and second abdominal segments which have fused. The apparent tenth segment of the abdomen is the true eleventh segment. A fusion of the true ninth and tenth segments occurring in the third molt further reduces the number of segments to nine which is the apparent number of segments found in the adult.

Morphologists are in general agreement that the abdomen of insects is composed typically of eleven segments. The occurrence of less than eleven segments is considered to be due to the suppression of one or more segments, to the fusion of segments with each other, or the incorporation of anterior segments with the thorax. The explanation of the apparent fusions or loss of segments is not the same for all groups of insects but varies with the orders, suborders and possibly even within groups of lower rank.

In adult Mallophaga there are usually only nine visible abdominal segments, and the loss or fusion of the others has received but little study. The interpretations of the loss or fusion have been based entirely on observations of adult forms except in the work of Harrison ('15, p. 122) who states that "certain post-embryonic stages in both *Ishnocera* and

¹ Contribution from the Department of Entomology, New York State College of Agriculture, Cornell University, Ithaca, New York and the Department of Zoology, Tulane University of Louisiana, New Orleans, Louisiana.

Amblycera show ten apparent abdominal segments which become reduced to an apparent nine in the adult." He cites as definite examples *Esthiopterum diversus* (Kellogg) and *Esthiopterum testaceus* (Tasch.). Harrison further states that, "the last ecdysis changes the three terminal segments of the abdomen to an apparent two," but does not state which segments have fused.

The proximal end of the abdomen is likewise indefinitely interpreted. From his studies of the respiratory system of the Mallophaga, Harrison ('15, p. 109) cites several reasons for suggesting that both in the adults and in the postembryonic stages of *Ishnocera*, the first true abdominal segment has been suppressed or incorporated with the thorax.

The abdomen of the adult *Ishnocera*, with few exceptions, shows nine apparent segments. Harrison would account for this as follows; the first apparent segment of the adult abdomen is the true second segment; the apparent second, third, fourth, fifth, sixth and seventh segments are the true third, fourth, fifth, sixth, seventh and eighth segments respectively. A fusion among the true ninth, tenth and eleventh segments changes them to two segments, the apparent eighth and ninth.

Mjöberg ('10, p. 214) accounts for the nine-segmented appearance of the abdomen of adult Mallophaga by assuming a reduction or suppression of the true first and eleventh segments.

As a result of the life history work on *Lipeurus heterographus* Nitzsch reported by the writer ('34) all post-embryonic stages became available for a study of the abdomen of this species.

Evidence from this study indicates that the nine-segmented appearance of the abdomen of the adult comes about as a result of the fusion of the true first and second segments and a fusion of the true ninth and tenth abdominal segments. The four instars of *Lipeurus heterographus* Nitzsch are here described as evidence that such fusions have occurred.

In the following descriptions of the instars, the segments are numbered in their apparent order.

First instar. (Fig. 1.) The nymph emerges from the egg with an abdomen of ten segments. The first segment is longer than any of the succeeding segments, in fact very nearly twice as long. It bears two rows of hairs on its dorsal surface. Each row is composed of two hairs, one on each side of the mid-line. There are no spiracles and no hairs on the postero-lateral angles. The second segment bears a spiracle in each lateral portion of the segment and mesad and slightly behind each spiracle there is a single hair (post-spiracular hair). In the median region, there is a single row of two hairs placed one on each side of the mid-line.

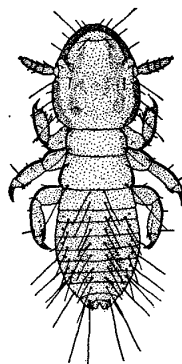


Fig. 1 First instar. $\times 50$.

The arrangement of hairs and spiracles on the terga of the third, fourth, fifth, sixth and seventh segments is identical with that of the second with the exception that the fourth, fifth, sixth and seventh segments bear one or more hairs in the postero-lateral angles of these segments. In the seventh segment the post-spiracular hair has shifted to a position lateral to the spiracle.

Segment eight bears no spiracles. It bears a single row of hairs, one on each side of the mid-line of the tergum and hairs similarly placed occur on the terga of the ninth and

tenth segments. The hair in the lateral margin of the eighth segment is not on the postero-lateral angle and may be the post-spiracular hair which in the absence of the spiracle appears close to the margin. The single hair in the postero-lateral angle of the ninth segment may correspond to the similarly placed hairs in the postero-lateral angles of the more anterior segments but may be the post-spiracular hair.

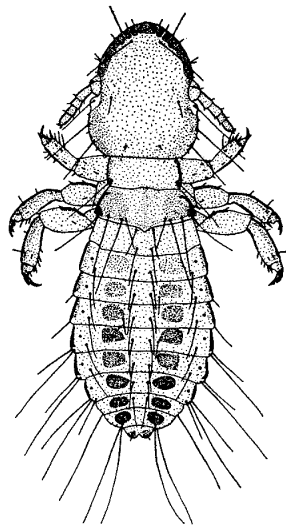


Fig. 2 Second instar. $\times 50$.

The tenth segment bears only the two hairs, one on each side of the mid-line of the dorsum.

In the above description it will be noticed that each of the ten segments bears a single row of hairs in the median region of the tergum, with the exception of the first segment which bears two such rows. Each row consists of a single pair of hairs, one on each side of the mid-line.

Second instar. (Fig. 2.) The chaetotaxy of the abdomen of this instar is identical with that of the first instar except

that there are additional hairs in the postero-lateral angles of some of the segments and there is now a third hair added to the left of the usual row of two hairs of the mid-dorsal region of the fourth segment. In the ninth segment, the two hairs of the single row are more lateral in position, and in the tenth they are located at the posterior margin.

A pair of brownish pigment spots occurs on segment two and on each of the following segments.

Third instar. (Fig. 3.) In this instar there has been an irregular number of hairs added lateral to the usual two

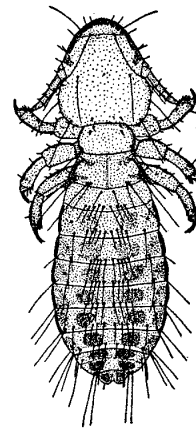


Fig. 3 Third instar. $\times 34$.

of the median dorsal region of each segment with the exception of the anterior row of two hairs in segment one and the rows of two hairs on segments eight and ten. In these the chaetotaxy is unchanged from that of the second instar. The effect has been, in the other segments, that the original rows of two hairs of the first and second instars have been extended laterally and now consist of numerous hairs, the numbers of which are not constant for any segment or even the right and left sides of the same segment.

The pigment spots indicative of segments posterior to the first are conspicuous.

The suture between segments eight and nine is not clearly visible although the line of its expected position may be clearly recognized. This appearance is indicative of the beginning of a fusion of these two segments.

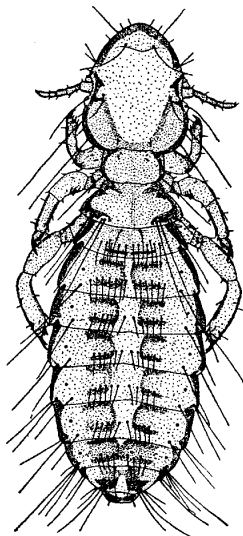


Fig. 4 Fourth instar, adult female. $\times 34$.

Fourth instar. (Female, fig. 4.) In this instar several hairs have been added to the row of hairs in the mid-dorsal region of each segment, except in the anterior row of hairs of the first segment, the anterior row of hairs of the apparent eighth segment and the two hairs of the apparent ninth segment. Each segment now bears a single row of hairs except the apparent first and eighth segments which show two rows of hairs.

The first segment bears, on the extreme anterior region of the mid-dorsum, a row of two hairs and a second row just behind the middle of the segment, consisting of the original two hairs of the first instar to which succeeding instars have added hairs laterally.

The second row of hairs on the tergum of the apparent eighth segment is near the posterior margin and closer to the lateral margin than are the hairs of the anterior row. It will also be noticed that, at the lateral margin of this segment, on a line with each of the two rows of dorsal hairs, there is a group of hairs. Each lateral margin thus shows two groups of hairs whereas the anterior segments show but one group of lateral hairs and these at the postero-lateral angles.

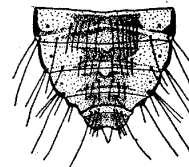


Fig. 5 Posterior end of male abdomen.

The conclusion which may be drawn from this peculiar chaetotaxy is that the apparent eighth segment, was formed by a fusion of the apparent eighth and ninth segments of the earlier instars. The anterior median two hairs of the tergum represent those of the eighth segment, as seen in the first, second and third instars. The marginal hairs opposite these are to be interpreted as the hairs of the postero-lateral angles of the eighth segment, as seen in the first, second and third instars. The posterior row of hairs is without doubt the groups of hairs described in the postero-lateral regions of the ninth segments of the first, second and third instars.

The apparent ninth segment is the apparent tenth segment of the first, second and third instars and does not differ from these except that its posterior margin is evenly rounded.

Fourth instar. (Male, fig. 5.) The chaetotaxy of the male abdomen is like that of the female with two rows of hairs on

the tergum of the first and eighth segments. On the tergum of the eighth segment, the anterior row consists of a pair of hairs, one on each side of the median line, and on each margin at the level of this row there is a group of two hairs. As in the female the above-mentioned hairs represent the hairs of the eighth segment of the first, second and third instars. The posterior row of hairs of this apparent eighth segment of the male is composed of six hairs which are placed farther from the lateral margin than those of the female. These hairs no doubt, as in the female, represent the hairs of the ninth segment of the first, second and third instars.

CONCLUSIONS

From the above study it may be concluded on the basis of the distinct segmental pigmentations of the eighth and ninth segments of the second and third instars and on the basis of the partial disappearance of the suture separating these segments in the third instar, that in the fourth instar we have the complete fusion of the eighth and ninth segments of the immature instars to form the apparent eighth segment of the adults. It has been pointed out also that, correlated with this observed fusion, the chaetotaxy of the apparent eighth segment of the adult shows a double row of hairs which are traceable to the single rows of hairs of the eighth and ninth segments which were not fused in the immature instars. It is interesting in this connection to observe that the single row of hairs on the tergum of each abdominal segment is a constant character which might serve as a criterion of segmentation for all segments of the first, second and third instars with the exception of the first segment which has two rows of hairs, and of the fourth instar with the exception of the apparent first and eighth segments which likewise have two rows of hairs each. In this eighth segment of the adult it has been shown that this condition has resulted from the fusion of two segments.

The double row of hairs on the first segment of all instars thus remains as the only real exception and may be explained as due to a fusion similar to that which took place between the apparent eighth and ninth segments except that it took place during embryonic development. The two-segment length of this apparent first segment in the first instar is a further indication that such a fusion has taken place.

The writer on the basis of the evidence presented would account for the segments of the abdomen of *Lipeurus heterographus* Nitzsch as follows: The first segment of all instars has been formed by a fusion in late embryonic development, of the true first and second abdominal segments. This would account for eleven segments in the first, second and third instars. A fusion between the true ninth and tenth segments, the apparent eighth and ninth, taking place in the second and third molts has further reduced the apparent number of segments from ten to the nine segmented condition as seen in the adults of this species.

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