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Studies on morphology of nymphs of selected Amblycera and Ischnocera (Mallophaga)

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Abstract. A comparative analysis of three nymphal instars of Amphisira perditis megalotoma, Uchida phasian, Goniocotes chrysoscepalus, Zlotorzyckya colchici. Lipeurus maculosus maculosus, Reticulipener mesopotae colchicus, and Laopoeus colchicus is given. The diagnostic criteria to Mallophaga of subfamilies Somaphantinae, Menoponinae, Menacanthinae, and families Gonioidae, Lipeuridae, and Degeeriellidae have also been estimated.

Introduction

The systematic and faunistic studies on mallophagans are generally based on the knowledge of adult forms. Developmental stages, i.e. nymphs called larvae by several authors, however, are difficult to differentiate, particularly within one or between related genera. Also, it is not easy to determine properly one of three developmental stages within a given mallophagan species. The respective data are inadequate and not comparable in general. The present work is supposed to determine the diagnostic characters in nymphs. Mallophagans from pheasant (Phasianus colchicus L.) were chosen as a pattern because material collected from this host was very rich and varied. We have examined nymphs of 7 species representing the following families: Somaphantinae, Menoponinae, Menacanthinae, Gonioidae, Lipeuridae, and Degeeriellidae and we studied a comparative section (Coll. Zlotorzycka) and literature dealing with nymphs of mallophagans from cock (Wilson, 1939; Conci, 1956; Arora and Opra, 1959). After this we tried to determine criteria useful in
separating species, developmental stages, and also in determining a comparative degree. The works of the authors mentioned above lack only descriptions of nymphs of representatives of the family Lepidoptera (Wilson and Arora & Chopra) and Goniodidae (Conci). At this time, there is no description of Somaphantinae and Menoponinae, and the data on morphology of Degeeriellidae nymphs (Clay, 1938) is based only on one genus Kellerinrus which is relatively divergent from malthaphagans of the genus Lagopoeus we are studying. After this, our personal investigations correspond only with the literature on the subject.

MATERIAL AND METHODS

Nymphs and adults of the following species were the subject of studies:
- Amyrsidea perdicis megalosoma (Overgaard, 1943) - 125 Np, Nm, 354 adults
- Uchida phasiani Modrzejewska and Złotorzycka, 25 Np, 56 Nm, 55 Nm, 149 adults
- Gonioctes chryscephalus Giebel, 1874 - 7 Np, 60 Nm, 85 adults
- Złotorzyckella colchica (Denny, 1842) - 137 Np, 340 Nm, 532 adults
- Lippeurus maculosus maculosus Clay, 1938 - 32 Np, 49 m, 167 adults
- Reticulipeurus mesopelios colchicus (Clay, 1938) - 69 Np, 137 Nm, 191 adults
- Lagopoeus colchicus Emerson, 1949 - 18 Np, 48 Nm, 146 adults.

The material was fixed in 70% ethanol. Next, the slides of specimens have been made after maceration in 5-10% NaOH. Reduction in alcoholic sequence, overexposure in xylene, and mounting in canadial balsam.

Schematic draftings were made basing on microscopic view magnification and also on photos of selected specimens.

RESULTS

The following diagnostic characters were determined for the
Somaphantinae, Menoponinae, Menacanthinae (Amblyceria): 8

1. Amyrsidea perdicis megalosoma - Np, Nm, Nm

*Np, Nm, Nm - nymphs of the first, second and third instars.
that in N₃ only in presence of an additional seta at antenncal fossa. On sides of gular plate there appear two pairs of setae. Lateral pronotum angles with single setae. Number of short setae on abdominal III-V grows to 5-7. Terminal segment chaetotaxy as in N₄.

N₅: Body length: 1.41-1.89 mm. Dorsal head chaetotaxy unchanged. Three pairs of setae on sides of gular plate. Number and arrangement of setae on prothorax and on dorsal side of mesothorax the same as in N₄. Each fascicle on abdominal III-V numbers 9-13 setae. It is also possible to differentiate sex basing on chaetotaxy. Female nymphs have a wreath of short setae (25-30) at the end of abdomen; it is absent in males. Females. Apart from that, female nymphs have only 4 sternocentral setae, whereas male nymphs have 8-9 of them (fig. 8).

Setae on dorsal side of head in adults are like in N₄. However, number of setae at margins of antennal fossa on ventral side of head in adults arises to 20-22, and number of setae on gular plate sides to 4 pairs.

Setae on ventral side of mesothorax and abdomen become enriched. In adults, chaetotaxy of terminal abdominal segment is different than in nymphs. Terminal abdominal sternum in females has an anal wreath of setae. Numerous setae in males are situated in the middle of terminal segment.

Uchida phasiani Modrz. and Zlot.

N₆: Body length: 0.71-0.89 mm. Head rather wide, rounded from sides. Facial wedges comma-shaped, sharply ended. Numerous setae of ventral lengths on the head. Gular plate with one seta on each side. Characterizing thorax are the same as in Amyrsidea p. megalosoma. Abdomen—oval, almost as wide as the head, with distinctly marked intersegmental incisions on the sides. On segments III-V there is always observed a lateral margin of temples. Prothorax considerably narrower than mesothorax. Abdomen dumpy, a little wider than head, gradually contracting posterad. It has 9 pairs of medium long tergocentals, 8 pairs of sternalocentals, and on terminal abdominal segments short or rarely pleural setae. Nymphs I of Goniocotes chrysocephalus share the following characters with nymphs of other species of Ischnocera described above: prothorax distinctly separated from mesothorax; suture between prothorax and abdomen being effaced; not marked intersegmental rings on abdomen; lack of pigmented plates which appear in N₅; single pair of setae present at lateral angles of hind margin of prothorax and abdomen; number and arrangement of prothoracic and head setae in the same as in other nymphal instars and adult forms (only some of them are being elongated during the succeeding molts); a shallow furrow at the end of abdomen in N₆, N₇, and N₈.

Goniocotes chrysocephalus Giebel.

N₇: Body length: 0.59 mm. Head rather big, much wider and longer in thorax. All the head setae very short, except one pair arising from lateral margin of temples. Prothorax considerably narrower than mesothorax. Abdomen dumpy, a little wider than head, gradually contracting posterad. It has 9 pairs of medium long tergocentals, 8 pairs of sternalocentals, and on terminal abdominal segments short or rarely pleural setae. Nymphs I of Goniocotes chrysocephalus share the following characters with nymphs of other species of Ischnocera described above: prothorax distinctly separated from mesothorax; suture between prothorax and abdomen being effaced; not marked intersegmental rings on abdomen; lack of pigmented plates which appear in N₅; single pair of setae present at lateral angles of hind margin of prothorax and abdomen; number and arrangement of prothoracic and head setae in the same as in other nymphal instars and adult forms (only some of them are being elongated during the succeeding molts); a shallow furrow at the end of abdomen in N₆, N₇, and N₈.
3. Goniocotes chrysocephalus - N_s, N_m, N_n

N_s: Body length: 0.66-0.77 mm. Paired setae, one of them long, the other short appear at hind margin of ptero thorax on both sides of pleural setae.

N_m: Body length: 0.72-0.99 mm. Number of setae at hind margin of ptero thorax increases to 4 on each side. On abdomen only some pleural setae are elongated.

In adults, thoracic and head chaetotaxy is like in N_s, however, is different. In females, there are 3 pairs of tergal setae: 2 pairs on abdomen, like in N_m (however being elongate) whereas in males number increases to 6 pairs. Tergocentral setae in females appear in six segments, in males only on the first five. First visible tergocentral segment in nymphs has two pairs of tergo centrals and three pairs of abdominal III.

Zlotorzyskella colchica (Denny)

N_s: Body length: 0.87-1.08 mm. Head rather big, considerably longer than thorax. From all the setae on head the longest are arising from lateral margins of temples, like in G. chrysocephalus. At lateral margins of ptero thorax there are two short setae apart from 2 long ones. Thorax dumpy, a little wider than head, contracting downward. Abdomen with 5 pairs of tergolaterals, 8 pairs of tergo centrals, 8 pairs of sternocentrals, and pleural setae occurring individually or in pairs.

N_m: Body length: 1.08-1.50 mm. Two long setae appear between some existing previously at hind margin of ptero thorax on both sides. Abdomen more dumpy, with next pair of tergolaterals and two pairs of sternocentrals. Pleural plates, mostly rectangular in shape, gradually diminish posterad. They are stronger sclerotized than the inner and oval tergal setae.

4. Zlotorzyskella colchica - N_s, N_m, N_n

N_s: Body length: 1.19-2.14 mm. One more long seta appears at hind margin of ptero thorax. Abdominal chaetotaxy is considerably altered.

Adult forms show a distinct sexual dimorphism, but no differences have been observed in nymphs. Shape of head and antennae is different in males and females, but all the nymphs have the same type of head. It refers also to the thread-like antennae. Number of tergal and tergolateral setae increases to 5 on the first abdominal segments in adults. Females have 4-8 tergo centrals on separate segments, the males have only two.

Lipeurus maculosus maculosus Clay.

N_s: Body length: 0.99-1.17 mm. Head elongate with parabolically shaped clypeus and with temporal part moderately contracting downward. All the head setae short. Thorax consisting of small prothorax considerably bigger ptero thorax. Abd men slim, nearly as wide as
Antennae in male nymphs are more massive than in female, particularly first article is strongly incrassate (fig. 9). Sternal plate in male nymph is different and less regular in outline at its posterior part than that in female nymphs. Adult forms do not possess such plates.

Antennae in males are considerably different from those in females. Proportions of articles are different and males have a big, finger-like appendix (ŻLOTORZYCKA, 1980, fig. 45). Also head is shaped in different way in both sexes (ŻLOTORZYCKA, 1980, fig. 42, 43) and chaetotaxy is a little varied. Differences in chaetotaxy are also marked in pterothorax males have two setae near central body line; in females these setae are absent.

**Reticulipeurus mesopelops colchicus** (Clay)

Nf: Body length: 0.81–1.18 mm. Head elongate like in *Lipeurus m. maculosus* but temples are more rounded, with numerous short setae. Pterothorax a little narrower and shorter than pterothorax. Abdomen slim.
Lagopoeus colchicus Emerson.

N₃: Body length: 0.77–0.95 mm. Head slightly elongate, tegument not carinculated, clypeus and mouth hooks not ciliated, antennae nearly as wide as head. Not numerous setae occurring mainly posteriorly. N₄: Body length: 1.30–1.58 mm. On dorsal side of pterothorax at hind and lateral margins two next setae appear and surround that long observed previously. Pleural and tergal plates similar to those of Lipurus m. maculosus. Abdominal chaetotaxy becomes considerably enriched: pairs of tergo-centrales appear on first seven segments, and of sternocentrals on the first three. Single short tergalateral setae appear also on segments III–VI.

N₅: Body length: 1.64–2.02 mm. On dorsal side of pterothorax at hind margin, the number of setae arises to 5 on each side and remains unchanged in adults.

In N₆ sexual dimorphism may already be noticed and appear differences in structure of antenna, like in Lipurus m. maculosus. Nymphs of both sexes have ventral margin of clypeus frame arcuate, whereas in adults it is irregularly folded. Nymphs also lack transverse furrows on dorsal side of clypeus which is observed in adults. In adults also, setae on dorsal side of abdomen are strongly elongate. Number and arrangement of setae on ventral side of abdomen in males is generally the same as in N₅; additional setae appear only in genital region (Zlotorycka, 1954, fig. 72). Females have 6 sternocentrals on abdominal VI and males have only 4 as nymphs. Numerous setae appear on margins of genital lobes.

Number of tergo-centrales on abdominal I–VII in adults arises usually 6 in one row, but we can also observe 7 to 8 of them. Abdominal VIII in adults with one pair of tergo-centrales and one pair of sternocentrals less. Females, hind margin of genital lobe with a row of short setae. In males, hind margin of last abdominal segment with numerous setae, which are not observed in females.

DISCUSSION AND CONCLUSIONS.

Nymphs as well as adults of paurametabolically developing Mallocphaga are constituted in a similar way. Three nymphal instars differ in length of all in length (Kesel, 1942; Eichler, 1963) and in differences between dimensions of individual parts of the body. The last stage was described in detail by Keler (1952). He showed different progression of growth of size of head as well as dimensions of the whole body during the developmental period of Pseudomenopons rovanae Keler (Pseudomenoponidae). Eichler (1963) pointed that only the most derived groups of mallophagans do not change during their development period. Nymphs of more specialized groups however, where adults are characterized by peculiar modification of setae, have only gradual modifications or they are not observed at all. As an example of such highly specialized representatives of Amblycerida, Eichler (op. cit.)
introduced *Eudonothriion cubense* (KELL.) (Laemobothridae) successive instars of that species, number of setae transformed into linear thorns on osculum successively grows to create definitive adult. Also the representatives of *Ischnocera* - Columbicola c. columbiae (L.) (Esthiopteridae) developed two clypeal setae of linear shape about 1-1.5 mm long, not before adult. *N. ocellata* do not possess those setae while they are present in *N. u* (MARTIN, 1934). Also CLAY (1958) described gradual appearance of new setae in nymphs of the tribe Degeeriellini (Degeeriellidae) but not before adult.

Results of our study confirm that idea but only in males. It turned out that not always sexual dimorphism in structure of antennae in adults occurs together with initial dimorphism in antennae in nymphs. For example, antennae in nymphs of *Ziotorzycella colorella* do not differ between both sexes, however this species resembles *Goniodes pavonius* (L.) in nymphs. Also CONC (1952, 1956) states that it is not possible to determine sex of nymphs of *Cuclogaster heterographus* (HÖRZSCH) (Lipeuridae) and nymphs of *Columbicola c. columbiae* (Esthiopteridae) after the shape of antennae. We were successful in observing sexual dimorphism manifested in incassation of first article of antenna in males, but at least in third instar, of *Lipeurus m. maculosus* and *L. colicoccus*. It is also possible to differentiate males from females among nymphs of third instar in *Amblycera*. Chaetotaxy of the terminal part of abdomen is the distinctive criterion there, what has already been noticed by KÉL (1951) in reference to the genus *Amblycera*.

8. Amyrisidea perdicis megalosoma – chaetotaxy of the terminal segment of nymph male *N. ocellata*. Making a diagnosis of individual nymphal instars progression of chaetotaxy, as it was preformed by CLAY in related mallophagans of the genus *Kelerinurus*, appeared to be suitable for our investigations of nymphs of the genus *Lagopoea* (also *Daeidae*) as well as the representatives of related families *Lipeuridae*, *Gonioididae*, included by EICHLER (1963) in the separate superfamily *Gonioidoidea*.

We saw however, that changes in chaetotaxy during the dental period of mallophagans may perform a main diagnostic criterion for nymphs of *Amblycera*: Somaphantidae and Menoponidae, which are the most derived groups within the subordo. The diagnostic chaetotaxy characters based on chaetotaxy do not stand alone in derived taxa.

9. Lipeurus maculosus maculosus – antennae in male and female *N. ocellata*.
facial wedges in nymphs of *Pseudomenopon* which were absent in adults. We noticed some dark coloured plates on abdomen in *N. m. maculosus* which are not observed in adults. Size and shape of these plates depends on sex.

Variability or progression does not refer to all characters in all nymphs and adults of investigated *Ischnocera*. CONC (1952, 1956) showed that head and prothoracic chaetotaxy in nymphs of *Cucotogaster hirsutus* (Lipeuridae) and *Stenocotopus gigas* (Gonioidae) is the same in adults. Our studies confirmed those observations also in some species of those families and in *Lagopoeus colchicus* (Degeerellidae), the only constant character in studied mallophagans of *Amblyceridae* is the dorsal head chaetotaxy except one seta near antenna which may be observed not before *N. m*. This is also observed in *Pseudomenopon rowanae* (Pseudomenoponidae) which has been examined by KÉLER (1951).

The described categories of characters may be arranged as follows:

1. Constant characters, independent from developmental stage, in head and prothoracic chaetotaxy in studied *Ischnocera*.
2. Characters gradually changing (nymphal) during postembryonic period, as abdominal chaetotaxy in examined *Ischnocera*.
3. Characters referring only to preimaginal stages (large cuticular plate occurring on ventral side of abdomen in *N. m. maculosus*.
4. Characters present only in adults (imaginal), as folds on the margin of clypeus frame in *Reticulipeurus m. colchicus*.

All the above categories of characters may be useful in the designation of nymphs; differentiation of individual instars within a species is possible but only basing on nymphal and larval characters. Similarities in progression of nymphal characters in examined *Amblyceridae* basing on head and abdominal chaetotaxy, and in *Ischnocera* only chaetotaxy and development of sclerites point at two generic equivalencies: (a) *Somaphantidae* and *Menoponidae* and (b) *Gonioidae*, *Lipeuridae* and at any rate partly *Degeerellidae*. The conclusion seems particularly valuable in reference to phylogenesis of *Gonioidae* and *Lipeuridae*. The imaginal characters in both groups have reached a high level of development that it is not possible to characterize unequivocally taxa of a comparative degree.

REFERENCES