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The Morphology of Immature Stages of *Megaloceroea recticornis* (Geoffroy, 1785) (*Heteroptera, Miridae*)

Morfologia stadiów rozwojowych *Megaloceroea recticornis* (Geoffroy, 1785) (*Heteroptera, Miridae*)

Megaloceroea recticornis (Geoffr.) is in Palearctic the only representative of the genus from among several species known in the world. Genus *Megaloceroea* Fieb. belongs to the tribe *Stenodemini* China. All the species included in this tribe are phytophagous biologically associated with grasses. *M. recticornis* is a widely distributed species but the one rarely demonstrated and it belongs to the least known *Heteroptera* of grass communities. The morphology and biology of immature stages of the species were hardly known, which motivated the author of the present work to undertake investigations in this field. Rare information on these problems (2, 11, 13) were only fragmentary, containing a number of inaccuracies. The materials collected between 1979 and 1982 were the basis for a description of detailed morphology of all the immature stages of *M. recticornis*.

I would like to express my sincere thanks to Prof. Zdzisław Cmoluch for his care and consultations which he gave me in the course of my work on the subject. I also wish to thank Dr Alicja Cmoluch for her valuable advice and remarks, Zofia Stączek, M.A. Małgorzata Balana, M.A., and Elżbieta Budzyńska, M.A. for their help with the technical aspects of the work.

The material used in the studies came from synantropous gramineous communities of Lublin and its area as well as from the laboratory cultures. The eggs' morphology was worked out by means of observation and the measurements of the eggs freshly skeletonized from grass spikelets, and also as a comparison from the abdomen of adult females. The eggs were kept in 70% ethyl alcohol with a little addition of glycerol. In order to analyze the structure of chorion, microscopic preparations were made from 50 eggs (after a few hours' leaching in 3% solution of KOH, they were kept in glycerine). The morphometric analysis of the eggs and the larvae was made on the basis of the criteria from Puczkow's work (10). About 300 egg-masses were studied analyzing their structure and numbers. The measurements of all immature stages were made under a microscope on 20 specimens. In order to examine the structures of cuticle larvae and *imago*, microscopic preparations were made (after 24 hours' leaching in 5% solution of KOH, the specimens were closed in glycerine).

THE EGG

The morphology of the egg of *M. recticornis* has not been described so far. Neither have any pictures of the eggs of this species been given. The eggs of the representatives of *Stenodemini* tribe including *M. recticornis*, have the shape and construction which are typical of *Miridae*. They are characterized by a longitudal form or the one less bent to the ventral surface as well as by clear distinguishment of the construction of both poles of the egg. The apical part equipped with operculum has a complex structure.

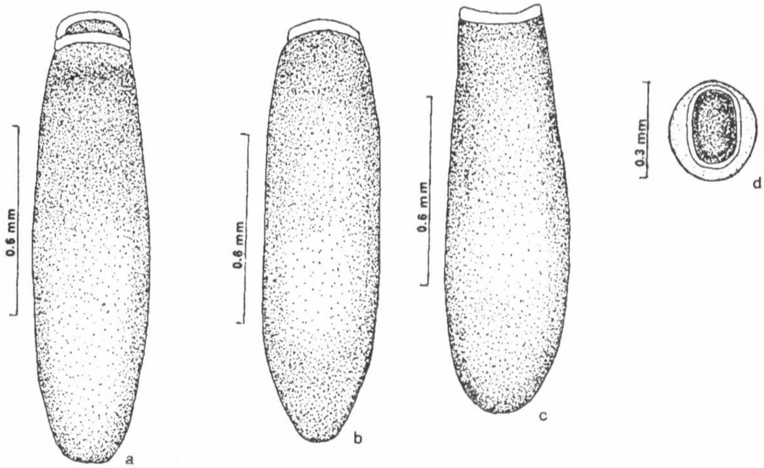

Fig. 1. The egg of *M. recticornis* (Geoffr.): a — view from the ventral side, b — dorsal side, c — from aside, d — from upwards

The egg of *M. recticornis* has a cylindric shape, it is moderately prolate (its length being about four times bigger than its width) and it is slightly bent towards the ventral part (Figs. 1a, b, c). The egg's length ranges between 1.26–1.53 mm, the greatest diameter (0.32–0.36 mm) is reached in 1/3 of the caudal pole. The posterior pole of the egg is round, the anterior one is slightly flattened sidewards and it is almost straightly truncate (Figs. 1a, c). The neck (*collum ovi*) of the width is little smaller than the longer diameter of the apical ring (Table 1). In the area of a weakly marked neck the egg is minimally flattish sidewards, and the body (*corpus ovi*) has an almost round section (Fig. 1d). The measurements of the egg are given in Table 1.

The rim of the chorion (*limbus chorioni*) surrounding the egg cap (*operculum*) is low, its upper edge being slightly bent and the basic edge almost straight (Fig. 1c). The egg cap is linked with the rim of chorion by means of cylindrically rounded rim (*limbus operculi*). A flat base of the cap (*basis operculi*) is slightly

Table 1. Measurements of the egg *Megaloceroea recticornis* (Geoffr.). The data constitute the means from measurements of 20 eggs

Measured parameters	Measurements (mm)
Height (measured parallel to the length axis of the egg) — h	1.35 ±0.085
Height (measured at an angle α to the length axis of the egg) — h_1	1.31 ±0.087
Length of the big diameter of the apical ring — d	0.27 ±0.011
Length of the small diameter of the apical ring — d_1	0.17 ±0.001
Height of the apical ring — k	0.08 ±0.010
Maximum width of the body in ventral — dorsal surface — a	0.34 ±0.003
Maximum width of the body in lateral surface — a_1	0.32 ±0.009
Width of the egg's neck in ventral — dorsal surface — w	0.25 ±0.010
A degree of bend of the egg's body — ratio $h:h_1$	1.03 (1 : 1.03)
A degree of elongation of the egg — ratio a : h	3.9 (1 : 4)
A degree of elongation of the apical ring — ratio h : d	3.3 (1 : 3.3)
The shape of the apical ring — ratio $d:d_1$	1.58 (1 : 1.6)
The shape of cross-section of the egg's body — ratio $a:a_1$	1.06 (1 : 1.06)

lowered inside the rim of chorion. The cap as seen from above is rectangular in shape with round angles. Its longer diameter is 1.5 times bigger than the diameter in the lateral plane (Table 1). The surface of the cap is not smooth but the micro-sculpture of operculum with pentagons and hexagons is indistinct (Fig. 2).

Fig. 2. The surface sculpture of the egg cap (a fragment of the operculum), magn. 400 ×

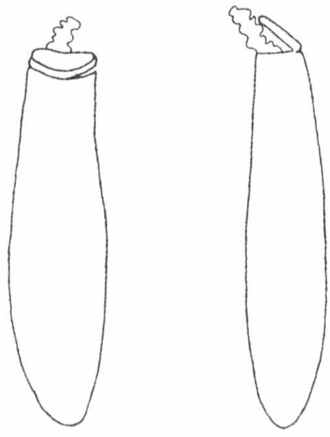

Fig. 3. An empty shell of the egg

The chorion of the egg is transparent with smooth and shiny surface and without any design. Straight after being laid, the egg is cream coloured, next it becomes yellow and then strongly orange. Change of the colour is connected with the growth of the embryo. The cap is of porcelain-white colour. The empty shell of the egg (Fig. 3) is opaque white.

The cleared microscopic preparations of the egg showed the structure of the apical part of chorion. About 40 oblong air canals seen in the rim of chorion communicate with the exterior environment by means of aeropyles at the base of the rim (Fig. 4). In the operculum, the air canals in mutual anastomosis form a regular network (Fig. 5).

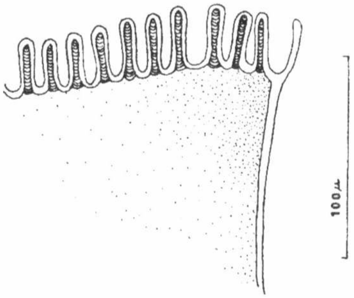

Fig. 4. A fragment of the apical part of the egg chorion. The arrangement of air canals and aeropyles in the rim of chorion

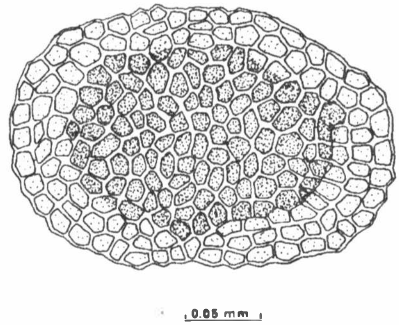

Fig. 5. The operculum — the arrangement of air canals

Some authors (1, 6–8) who describe the eggs of *Miridae*, referred to the canals in the rim of chorion as "micropylar canals" or "pseudomicropylar canals" of unknown function. The problem of the reduction of proper micropyles in *Cimicomorpha* (usually 2) is referred to by Puczkowa (9) and Cobben (3). As the examinations of the ultrastructure of the eggs of *Heteroptera* by Hinton (5) showed, numerous oblong canals in the rim of chorion are a part of the respiratory system of the shell of the eggs. Therefore, the present paper while describing the structure of the chorion of the egg of *M. recticornis*, introduces the name of "air canals" adequate to the function they perform.

The eggs of *M. recticornis* which are characterized by a slight bend, a weakly marked neck and a little flattening sidewards in the apical part and in a broadly oval *operculum*, resemble the eggs of *Stenodema leavigatum* L. as described in Buczek's work (1). Kullenberg (7) drew attention to the adaptive aspect of the shape and outside structure of the eggs of *Miridae*. While analyzing descriptions of the eggs of a number of the species of bugs from the *Stenodemini* tribe which are included in References (1, 10), the author of the present paper observed a clear relationship existing between the eggs' shape and the type of the substrate to which those eggs were laid. Henceforth, one can think that the described shape of the eggs *M. recticornis* is characteristic of the species laying eggs on the spikelets of grasses.

The structure of the egg-masses

In the laboratory the females of *M. recticornis* laid eggs in the spikelets of the following grass species: *Festuca pratensis, F. rubra, Lolium perenne, Brachypodium pinnatum* and *Bromus inermis* (Figs. 6 and 7). The eggs were placed between the lemma and the ovary; having the apical pole turned upwards and being glued to each other in two, they came off the substrate easily. Outside, they were completely invisible. In the laboratory and in field conditions the females usually laid eggs in the spikelets of grasses in the phase of seed formation and sporadically in the spikelets before the flowering or with a formed grain (Fig. 6). No eggs were found in other grass organs.

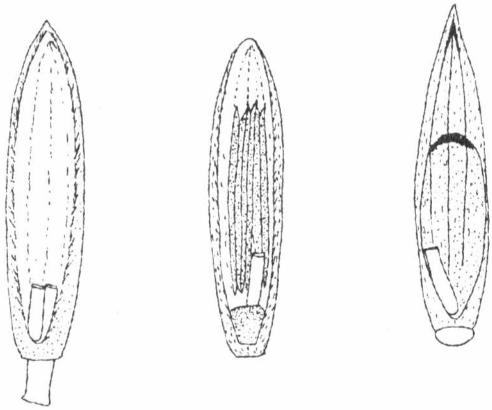

Fig. 6. Egg-masses of *M. recticornis* (Geoffr.) in the spikelets of *Lolium perenne*

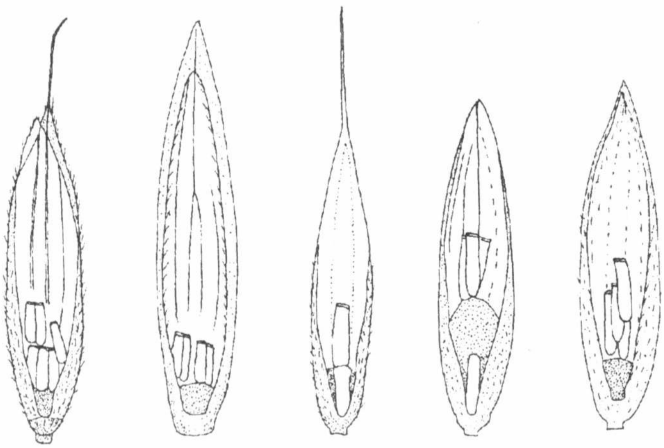

Fig. 7. Egg-masses in the spikelets of *Brachypodium pinnatum, Bromus inermis, Festuca pratensis, F. rubra*

The analysis of egg-masses considering the numbers showed that on *F. pratensis*, *F. rubra* and *L. perenne* the females most often laid eggs singularly and a little more rarely in the form of masses consisting of 5 and 6 eggs. In the case of *B. pinnatum* and *B. inermis* which are characterized by big measurements of the glumes, the number of eggs in a mass ranged between one and seven, but the masses of four and five eggs prevailed (Fig. 7). The numbers of egg-masses of *M. recticornis* is probably connected with the structure of grass spikelets in which the females lay eggs.

LARVAE

The information concerning the morphology of larvae of *M. recticornis* can be found in the works of Slater (11) and Smardzewska (12). In Slater (11), this information is limited only to very general descriptions of latter's instars larvae. Smardzewska (12) publish descriptions of the morphology of all instars larvae and a key for their designation. In the present paper, the author continues the subject and describes the features of the morphology of larvae which have not been analyzed so far as well as the changes in the morphology of larvae taking place during the development.

The larvae of *M. recticornis* have the structure and the shape of the body typical of representatives of the *Stenodemini* tribe. As follows from the analysis of the data published earlier (12), the larval forms differ from each other first of all in size, degree of wing formation, length of the segments of *antennae* and *tarsus* and in chetotaxy — in diagnostics, the differences in *antenna* and *tibia* pubescence were used. The development of larvae is parallel with changes in the relations between the linear measurements of particular parts of their bodies. An important taxonomic feature of larva morphology is the relation between the length of particular antennal segments departing from a typical scheme of the other species of the *Stenodemini* tribe.

The rostrum is composed of four segments of almost equal length and in time of rest it adheres the thoracal sternite. The rostrum top in two early instar larvae reaches the base of posterior hips, and in older larvae it reaches the edge of the first abdominal sternite. The ending of the labium has sensory processes (Fig. 8).

The structure of the foot and its appendages changes together with larva development. In the larvae of subsequent instars, the relation between the length of both segments of the feet gets smaller (12). Pretarsus claws are weakly curved and equipped with membraneous, foliaceous arolia and weakly formed pseudo-arolia, set on the inner surface of the claws (Fig. 9). Only in the first instar larvae, the arolia are as long as the claws, in the others these are clearly shorter but the pseudoarolia are more distinct.

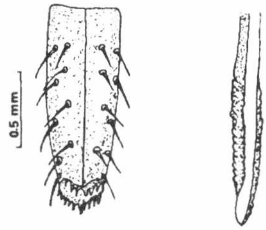

Fig. 8. The structure of the rostrum of larva L_4: the ending of the final segment of labium and the final segment of the mandibular and maxillary stylets

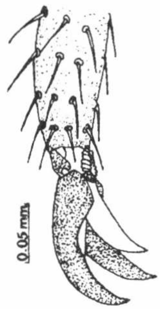

Fig. 9. The final segment of tarsus L_2 (claws with the appendages)

The microscope analysis of the cuticle structures of larvae showed that their bodies' chaetotaxy, according to the denomination used by Wagner (15), is formed by bristles (*setae*) of a round section which protruded from a porous pit and had articular joints with the cuticle (Fig. 10). The bristle-like hairs and bristles differ from each other only in the manner of connection with the cuticle, which is visible only in big magnification on a microscope and that is the reason why they are so difficult to distinguish (15). The cuticle structures described earlier (12) as hairs are in fact bristles according to the criteria applied by Wagner (15).

What deserves attention are the cuticle structures forming the brushes on the top of front tibias of larval forms which have not been described so far in *Stenodemini*. They are on paracentral surfaces of the tops of front tibias and they have a form of compact row of bristles of which the marginal ones are clearly

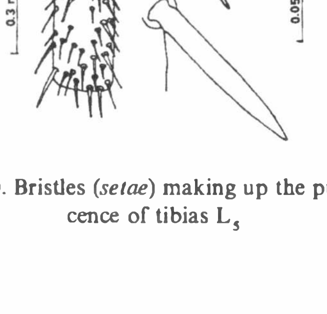

Fig. 10. Bristles (*setae*) making up the pubescence of tibias L_5

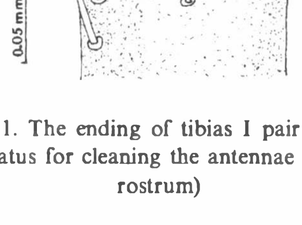

Fig. 11. The ending of tibias I pair L_2 (an apparatus for cleaning the antennae and the rostrum)

longer and thicker (Fig. 11). The arrangement and number of bristles are the same in larvae of all instars. The brushes are used to clean the antennae and the rostrum.

THE ADULT (IMAGO)

Body length: 7.38–8.16 ♂, 8.22–9.35 ♀; width of: head 0.88–0.95 ♂, 0.88–1.02 ♀;vertex 0.51–0.58 ♂, 0.51–0.61 ♀. Pronotum: mean length 1.12–1.20 ♂, 1.12–1.36 ♀; width of the anterior margin 0.78–0.88 ♂, 0.88–0.98 ♀; width of the posterior margin 1.36–1.43 ♂, 1.43–1.53 ♀. Antennae length: segment I 1.53–1.73 ♂, 1.71–1.87 ♀; segment II 3.09–3.74 ♂, 3.40–3.74 ♀; segment III 3.16–3.33 ♂, 3.23–3.40 ♀; segment IV 1.05–1.26 ♂, 0.88–1.19 ♀ (measurements given in mm).

On the basis of observation of the colouring of the insects in different periods from imaginal moulting one can say that this property in the discussed species changes with an insect's age. Direct after moulting off all the bug's body except the milk-white wings of both pairs is water-green. A few days later young specimens were light-green with different shades: the head, the pronotal calli, the scutellum base and the underside of the body were green, hemelytrons were yellow-green with a white-grey membrane, antennae, legs (except the darkened feet), the rostrum and the top of the scutellum were yellowish, the antennae and legs pubescence was brown. At the same time observations were made on the specimens of both the sexes, which had grey-green pronotum, scutellum, hemelytrons, legs and antennae. In the period of sexual activity the colouring of the insects' bodies changed into dark green which suited the colouring of the host plants. The whole body of fully mature and coloured specimens was almost evenly green, the legs, antennae and the rostrum (segments 2–4) having a brown shade. Two wide, longitudal brown-green stripes (darker in males) are on the pronotum. The sulcus on vertex, labium top, feet and claws are almost black. The female membrane is light grey, the male one clearly darker. After death, the insect's colouring is olive-green.

The body of *M. recticornis* is prolate and narrow with strong build-up. The head is straight, with its length bigger than the width, with a longitudal sulcus on vertex and a transverse depression near the posterior margin (Fig. 12). The anterior margin of the frons is arched, round on top; the clypeus is well visible from the top (its length equals the distance between the antennae base and the frons end). An especially long rostrum reaches the end of the first abdominal sternite. The antennae are longer than the body; the length of the first segment is 0.8 of the sum of lengths of the head and the pronotum (in both sexes), the second and third segments are almost of the same length. The pronotum's width is bigger than its length. The anterior and posterior margins of the pronotum are slightly concave. The scutellum is not punctate, with a delicate transverse stration. The pronotum, the scutellum, the hemelytrons and the abdominal sternite are with short and pale pubescence. The legs are long, the thighs almost cylindrical. Their pubescence is dark, short and rough on the tibia except the short black and protruding bristles; there are also longer spiniform bristles. The first and second antennae segments are with short protruding and black bristles, the third and forth segments are more thickly haired but the bristles are lighter and longer (Fig. 12).

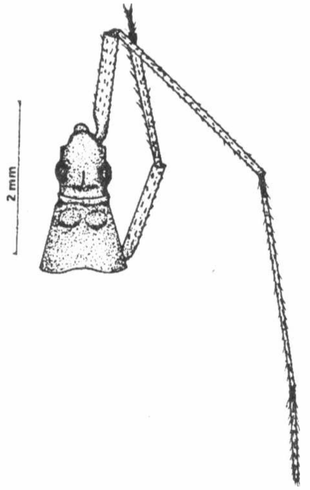

Fig. 12. The front segment of the male's body of *M. recticornis* (Geoffr.)

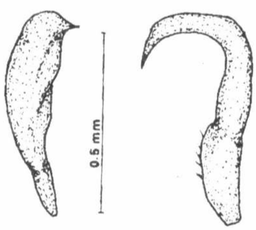

Fig. 13. A male's claspers (as seen from the dorsal side)

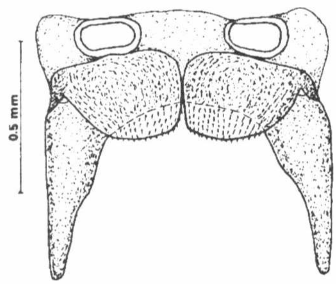

Fig. 14. The top wall of a female's *bursa copulatrix* — chitinous rings

The right clasper is of a clavate shape, with a prolate basis and a sharply closed *hypophysis* (Fig. 13). The left one is sickle-shaped, with a long and flat sensory callus with poor pubescence; the arm of *hypophysis* is strong and long, in the apical part being slightly curved and sharpened (Fig. 13).

The structure of the copulatory sack (*bursa copulatrix*) of the females collected in Lublin does not in fact depart from that which was presented by Slater (11). The difference was only observed in the morphology of the upper wall of *bursa copulatrix* in relation to the material obtained in the area of the USA — chitinous rings are almost regularly oval (Fig. 14).

The features of the morphology of imagines *M. recticornis* as presented here partly agree with the data contained in taxonomic works (4, 14, 15). The linear measurements of the specimens from New Zealand as given by Eyles (4) are slightly bigger than those of the bugs collected in Lublin, but the mutual proportions of these measurements in the specimens of both the studied populations are very similar. The divergencies existing in the present literature (4, 14, 15) and concerning the colouring can probably be accounted for by changeability of the colour connected with an insect's age.

The structure of the bodies of larvae and mature bugs is well adapted to the inhabited environment and to the activities performed by the insect. The colouring, the body shape and the structure of its stipules (rostrum, foot appendages) certainly make the life of these bugs easier on grass inflorescence.

The form and colour of the body of *M. recticornis* which go well with the shape and colour of the spikelets of host grasses produce a masking effect because a motionless insect is almost invisible against the plants on which it lives. Kullenberg (7) also draws attention to the protective aspect of the body's colour and shape in *Stenodemini*.

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STRESZCZENIE

Na podstawie kilkuletnich badań (1979–1982) opisano morfologię wszystkich stadiów rozwojowych *Megaloceroea recticornis* (Geoffr.). Nie znane dotąd jaja poddano szczegółowej analizie morfometrycznej (tab. 1). Analizowano również strukturę apikalnej części chorionu — układ kanałów aeropylarnych w kołnierzu chorionalnym i *operculum* ilustrują ryc. 4 i 5. Opisano budowę złóż jaj *M. recticornis*.

Uzupełniając wiadomości o wcześniej opisanych larwach *M. recticornis* (11) przedstawiono wyniki analizy mikroskopowej niektórych cech morfologicznych (budowę rostrum i stopy, wytwory kutikuli). Dokładny opis morfologii zewnętrznej imago uwzględnia: zmienność ubarwienia związaną z wiekiem owada, cechy biometryczne, chetotaksję, budowę przysadek płciowych. W opisach poszczególnych stadiów rozwojowych zwrócono uwagę na znaczenie przystosowawcze cech morfologicznych.