

Labial sensillae and the internal structure  
of the mouthparts of *Xenophyes cascus* (Bergroth 1924)  
(*Peloriidiidae*: *Coleorrhyncha*: *Hemiptera*) and their  
significance in evolutionary studies on the *Hemiptera*

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## Introduction

*Coleorrhyncha*, are the relict heteropterons the body of which are flattened and cryptically coloured. They occur in peatbogs and other humid habitats. Only one family of *Peloriidiidae* belongs to the *Coleorrhyncha*. It embraces 13 genera and 30 species. Nowadays, this group has a classic Gondwanan distribution. It is restricted to the southern hemisphere (BURCKHARDT & AGOSTI, 1991). The presence of a few species was recorded in South America, New Zealand and Australia as well as in Iceland and New Caledonia (EVANS, 1981). They constitute an important group in evolutionary studies on the *Hemiptera* because they have features that bring them close to the *Hemiptera* as well as many other features that signify their relativity to the *Auchenorrhyncha* (EVANS, 1981). Many researchers (BREDDIN, 1897; BEKKER-MIGDISOVA, 1952; CHINA, 1962; EVANS, 1963; SCHLEE, 1969; COBBEN, 1978; BOURGOIN, 1997; OUVARD *et al.*, 2000) have discussed the systematic position of *Peloriidiidae* and their relation to other heteropterons but they have not come to a uniform conclusion. So far the research on *Peloriidiidae* have showed their connection to *Homoptera* and *Heteroptera*. Probably the suborder *Coleorrhyncha* within the *Hemiptera* is the best systematic position for this group (EVANS, 1981; WHEELER *et al.*, 1993) without stating a closer belonging to one of the *Auchenorrhyncha* or *Heteroptera* groups. The systematic position of *Coleorrhyncha* within *Hemiptera* is still unclear and deba-

table. Therefore, one has to search for further features in *Peloriidiidae* which perhaps will contribute to a closer determination of relativity and their systematic position within *Hemiptera*.

The studies on the mouthparts in *Peloriidiidae* were carried out by EVANS (1936; 1937; 1939) and referred to its inner morphology and function. The internal structure of the mouthparts without the analysis of morphological features was shown in *Peloridium hammoniorum* Breddin 1897 by COBBEN (1978). Research on the internal structure of the mouthparts of other *Hemiptera* groups were carried out to a greater extent (COBBEN, 1978; BROŻEK & HERCZEK, 2001; 2004; BROŻEK *et al.*, 2006; BROŻEK, 2006). The results of this research have revealed evolutionary significance of these structures in *Hemiptera*.

Sensilla and internal structure of the mouthparts in *Peloriidiidae* were not analysed therefore the aim of this paper is to find out the position and shape of sensilla of the apical of labium as well as the linkages system of maxillae and mandibles.

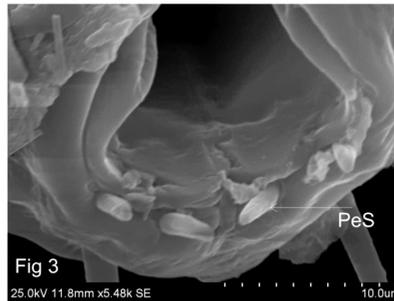
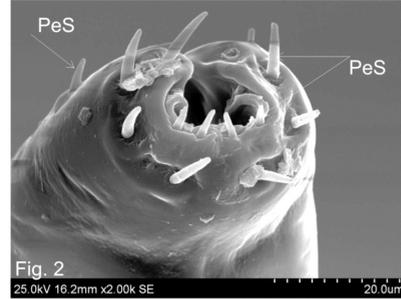
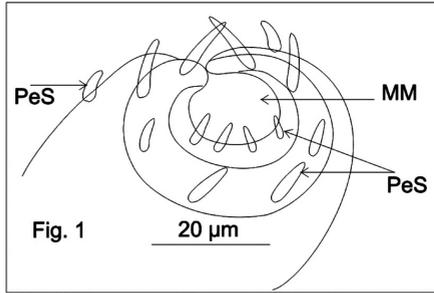
## Material and methods

*Xenophyes cascus* specimens came from New Zealand. The material was cleansed in ultrasonic washer and then dried on air. The whole specimen was attached to the table and covered with dust of gold. After having taken the pictures of the sensillae, the labium was cut manually by means of a scalpel on the height of the second segment. The material was dusted for the second time in order to cover the cut place with gold. The pictures were taken by a scanning microscope Hitachi S-3400N.

## Results

### Labial sensillae

The end of the labium is flattened in the front and forms a shield. On the apical shield there are sensilla of conical shape (Fig. 1.). Their surface is divided by shallow grooves and tiny pores. Eight bigger conical sensillae (PeS) are evenly distributed in one row around the ridge of the apical shield (Figs. 1, 2.). In the middle of the shield around the maxillae-mandible hole there are 4 shorter sensillae (Fig. 3). On the dorsal part, near the apical end there is a pair of conical sensillae placed symmetrically towards the lowering in the labium (Fig. 2.).



Figs. 1, 2, 3. Distribution and forms of sensillae on the apical shield; PeS-conical sensillae; MM – hole of maxillae – mandible

### Internal structure of the mouthparts

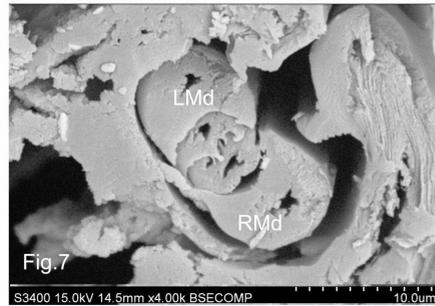
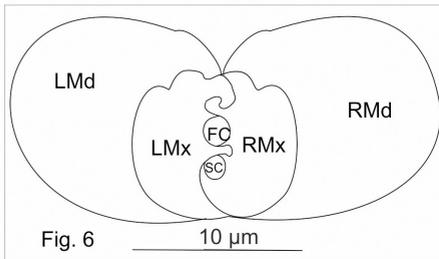
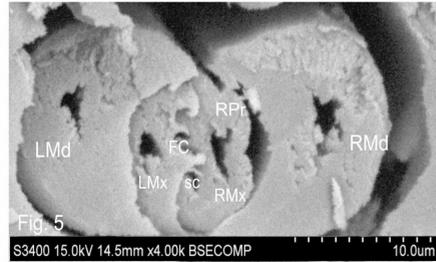
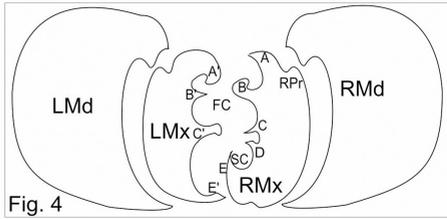
A system of linkages between maxillae and mandibles is visible in *X. cascus* on the cross-section through the subapical segment of the labium. Both the right (RMx) and the left (LMx) maxillae have internally formed appendages, which by joining one another make the so-called locks. In the system of linkages there are three such locks: dorsal, middle and ventral. Dorsal lock is formed by four appendages i.e. the straight appendages A and the unciform B on the right maxilla, and two appendages (unciform A' and straight B') on the left maxilla. The unciform appendages indent making a strong linkage (Fig. 4, 5, 6.). The middle lock consists of three straight appendages with slightly widened ends. On the right maxillae there are two appendages (C, D) and on the left maxillae only one unciform appendage (C').

The ventral lock has two appendages marked as unciform E on the right maxilla and unciform E' on the left maxilla. The E' appendage lapses over the E appendage (Fig. 4. and 5.).

Digestive tract (FC) is small and consists of two maxillae. Salivary tract (SC) is located in the middle and closed by appendages C' and E (Fig. 5.).

Digestive and salivary tracts are of an almost equal size. The salivary tract is placed below the digestive one.

Mandibles (LMd, RMd) are oval, placed lateral towards the maxilla and surround it (Fig. 7.). Maxillae in the dorsal part have an exterior right and left appendage (RPr and LPr) which link maxillae with mandibles.



Figs. 4, 5, 6, 7. Cross-section of subapical segment of labium *Xenophyes cascus*

RMx right maxilla; LMx left maxilla; RMd right mandible; LMd left mandible;

FC digestive track; SC salivary track; A straight upper right appendage of dorsal lock;

A' unciform lower left appendage of dorsal lock; B unciform lower right appendage of dorsal lock;

B' straight lower left appendage of dorsal lock; C straight lower right appendage of middle lock;

C' unciform lower left appendage of middle lock; D straight lower right appendage of middle lock;

E unciform lower right appendage of ventral lock; E' unciform lower left appendage of ventral lock

## Discussion

The distribution of sensilla in *X. cascus* (*Peloriidiidae*, *Coleorrhyncha*) is different than in the other *Hemiptera*. Two semi-circular rows consisting of innumerable conical sensillae were observed in this species. Comparing the data that can be read from the picture of *Peloridium hammoniorum* published by

COBBEN (1978) one can see clear likeness in the distribution and shape of labial sensillae in both species, though they represent different genera and distribution. *P. hammoniorum* is present in Chile and Argentina, while *X. cascus* only in New Zealand (BERGROTH, 1924). The distribution of sensillae in *Peloriidiidae* is specific for this family and thus this feature can be treated as an apomorphies.

Within other taxons of the *Hemiptera* the sensillae occur in apical end in the so-called sensory fields (FOSTER *et al.*, 1983). Sensory fields are areas in which sensillae are numerous and located closely to one another. Sensilla on the apical shield are grouped in three areas in *Fulgoromorpha* (BACKUS, 1985; BROZEK & BOURGOIN, unpublished data) in two areas in *Cicadomorpha* and only in one in *Heteroptera*. The apical end in the case of some heteropterans e.g. *Nepomorpha* is divided into three lobes and the sensillae are present in sensory field in lateral lobe (COBBEN, 1978; BROZEK, 2007). Conical sensillae on the labium were registered to occur in *Peloriidiidae* and in other *Hemiptera*. It is their common feature. Apart from conical labial sensillae in most *Hemiptera* (except for *Coleorrhyncha*) there are also sensillae of a different shape (PEREGRIN, 1972; GAFFAL, 1981; FOSTER *et al.*, 1983). The shape of these labial sensilla and their distribution is characteristic for the sub-orders of the *Hemiptera*.

As far as the internal structure of the mouthparts is concerned the *Coleorrhyncha* reveal likeness to *Fulgoromorpha* and *Heteroptera*. The system of linkages, three locks and the number of appendages in *Coleorrhyncha* and *Fulgoromorpha* is the same. The linkage of maxillae with mandibles by means of appendage is characteristic only for the representatives of *Heteroptera* and *Coleorrhyncha*. In the other infra-orders of the *Fulgoromorpha*, *Cicadomorpha*, *Sternorrhyncha* such linkages between the maxillae and mandibles are not present (BROZEK *et al.*, 2006). Concave internal surfaces of mandibles adhere to convex maxillae. Three-locked system of maxillae linkages that is present in *Sternorrhyncha* (POLLARD, 1968; FORBES, 1977; BROZEK, 2006), *Fulgoromorpha* (BROZEK *et al.*, 2006), *Heteroptera* (COBBEN, 1978; BROZEK & HERCZEK, 2004) and *Coleorrhyncha* should be perceived as a plesiomorphic condition in relation to the two-locked maxillae linkages in *Cicadomorpha* (BROZEK & HERCZEK, 2001). The mandibles which are widened on the side and linked with maxillae by means of an appendage in *Coleorrhyncha* represent apomorphic condition in comparison with *Sternorrhyncha*, *Cicadomorpha* and *Fulgoromorpha*. The *Coleorrhyncha* are heteropterans which are unique for a mosaic of features. They have clear features deriving from both *Homoptera* and *Heteroptera*. Looking at the shape and linkage of maxillae with mandibles in *Coleorrhyncha* one can see their shared apomorphy with the *Heteroptera*. On the basis of distinguished synapomorphy one can conclude their close relativity and treat the *Coleorrhyncha* as a sister group of the *Heteroptera*. *Peloriidiidae* were for the first time identified by BREDDIN (1897) and classified as *Heteroptera*. Throughout the many years of research the systematic position of the *Peloriidiidae* was

treated variously. They were included into the *Homoptera* (MYERS & CHINA, 1929), *Auchenorrhyncha* (CHINA, 1962), *Cicadomorpha* (EVANS, 1963), and *Fulgoromorpha* (BOURGOIN *et al.*, 1997; SORENSEN *et al.*, 1995). Most researchers, however, pointed out to an affinity of the *Coleorrhyncha* with *Heteroptera* (BEKKER-MIGDISOVA, 1952; POPOV & WOOTTON, 1977). On the basis of morphological, anatomic and molecular research results the sister-relation between the *Coleorrhyncha* and *Heteroptera* was approved by SCHLEE (1969), WHEELER *et al.* (1993), SCHUH & SLATER (1995), CAMPBELL *et al.* (1995), OUVRARD *et al.* (2000).

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**Narządy zmysłowe wargi dolnej i struktura wewnętrzna aparatu gębowego  
*Xenophyes cascus* (Bergroth 1924)) (*Peloriidiidae: Coleorrhyncha; Hemiptera*)  
i ich znaczenie w rozważaniach ewolucyjnych *Hemiptera***

**Streszczenie**

Na tarczy apikalnej wargi dolnej u *Xenophyes cascus* (*Peloriidiidae, Coleorrhyncha*) znajduje się 12 stożkowatych narządów zmysłu ułożonych w dwa szeregi półkoliste. Jedna para sensilli położona jest na stronie grzbietowej w pobliżu rynienkowatego zagłębienia końca apikalnego wargi. Obserwowano tylko jeden typ tych narządów. Rozmieszczenie narządów zmysłowych u *Peloriidiidae* jest specyficzne. Ten typ położenia sensilli stanowi apomorfie w stosunku do pozostałych *Hemiptera*. Struktury wewnętrznej aparatu gębowego *Coleorrhyncha* wykazują podobieństwo do *Heteroptera*. Połączenia szczęk przez trzy zamki jest charakterystyczne dla *Coleorrhyncha, Fulgoromorpha, Sternorrhyncha* i *Heteroptera*. Połączenie szczęk z żuwaczkami za pomocą wyrostka jest charakterystyczne tylko dla przedstawicieli *Heteroptera* i *Coleorrhyncha*. Na podstawie wyróżnionej synapomorfii można wnioskować o bliskim pokrewieństwie i traktować *Coleorrhyncha* jako grupę siostrzaną *Heteroptera*.

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