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Esakiella - the genus with the most ancestral ovipositor within the Helotrephinae

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Abstract

This study brings two alternative hypotheses on the homology of individual structures of the helotrephid ovipositor that is extremely derived from the ovipositor of the Notonectoid or Pleid type, respectively. These hypotheses are based on the morphology of this body part in *Esakiella* (*Megesakiella*) spp.. *E.* (*Megesakiella*) spp. have probably the most plesiomorpic features of the ovipositor architecture among the taxa of the subfamily Helotrephinae. This finding supports the hypothesis on the basal position of the African genus *Esakiella* in the phylogeny of Helotrephini.

Key words: Heteroptera, Helotrephidae, *Esakiella*, ovipositor, morphology, homology.

Introduction

Helotrephidae (Heteroptera Nepomorpha) are minute (<4 mm) predaceous water bugs with unique morphology (e.g., with cephalonotum and coleopteroid hemielytra) that are distributed mainly in tropics and subtropics and inhabit different types of waters. Alhough there is a consensus on the close phylogenetic relationships of water bugs of the families (1) Notonectidae, (2.1) Pleidae and (2.2) Helotrephidae (2 = Pleoidea) at present (Hebsgaard *et al*., 2004), the ovipositor of Helotrephidae strikingly differs from the same organ in the Notonectidae and Pleidae. Notonectidae and Pleidae have ovipositors of "the ornamental type" (sensu Larsén, 1938), with well distinguishable and homologizable individual parts sensu the interpretation according to Scudder (1959) and Štys (1959). The ovipositor of all the known species of Helotrephidae is hardly derived from corresponding body part in Notonectidae and Pleidae. It is difficult to distinguish and homologize its individual parts. Bauplans of the ovipositor differ one from another within the lower taxa of Helotrephidae on the generic level in some characters (Papáček, 2002). This finding was quite naturally followed by the question - What genera have an ancestral ovipositor? This is the purpose of the present study.

Materials and methods

Ovipositors of 48 species representing all the genera of Helotrephidae (Papáček and Zettel, 2004) were examined and compared (specimens were dry mounted or fixed in ethanol). Prepared ovipositors were examined in two steps: (i) as three-dimensional preparations under stereomicroscopes Leica (Wild) M3C and Leica MZ9.5 (by max. 108 - 200 x magnification), and (ii) mounted in slides and studied under Olympus BX40 or BX41 microscopes (max. 400 x magnification). Structures of ovipositors were drawn by using a camera lucida and photgraphed by the Olympus Camedia C-4040Zoom camera.

Architecture of the ovipositor in the Notonectidae and Pleidae were evaluated as plesiomorphic for the Notonectidae and Pleoidea. The polarity of characters or the judgement of transformation series from the plesiomorphic to the apomorphic state respectively, were related to this initial consideration.

Results and discussion

Helotrephidae have flattened ovipositor in comparison with Notonectidae and Pleidae. Some parts are fused together. Short and extremely thick spur-like setae of the 1st valvulae, characteristics for the notonectid and pleid ovipositor of the ornamental type, are missing. Species of the most primitive subfamily of Helotrephidae - new world Neotrephinae (*Neotrephes* and *Paratrephes*) - have two small separated gonostyloids in the set of the 9th abdominal segment appendages (plesiomorphic state). Old World species (Fischerotrephinae, Helotrephinae, Trephotomasinae) have gonostyloids fussed into unpaired conical posteromedial apical "style" (well developed in the most of Helotrephini spp., somewhat reduced in *Indotrephes* spp.) or totally reduced (e.g., Limnotrephini, Fischerotrephinae, Trephotomasinae) (apomorphic state).

Features of the 8th ventrite have generic specific character (Papáček, 2002). Right and left posterolateral appendages of this ventrite, interpreted mainly as the 1st valvulae in the literature (see, e.g., Esaki and Miyamoto, 1959; plate 9, figures H - J), are horizontally oriented, slightly asymmetrical and basomedially coupled together by anchoring apparatus, that is developed to a different degree in individual genera. These appendages are broken by a longitudinal anteroposterior sulcus and subdivided into two, laterally and mesally located sclerites (e.g., in Helotrephini; more plesiomorphic state) or completely compact and obliterated on the ventral surface (e.g., in Limnotrephini, apomorphic state) in the Helotrephinae.

Ovipositors in most genera of Helotrephini have similar features; only the ovipositor of *Indotrephes* spp. differs from them.

Parts of posterolateral appendages of the 8th ventrite in Helotrephini can be homologized as follows: laterally located horizontal sclerite = outer part; mesally located horizontal sclerite forming coupling apparatus = inner

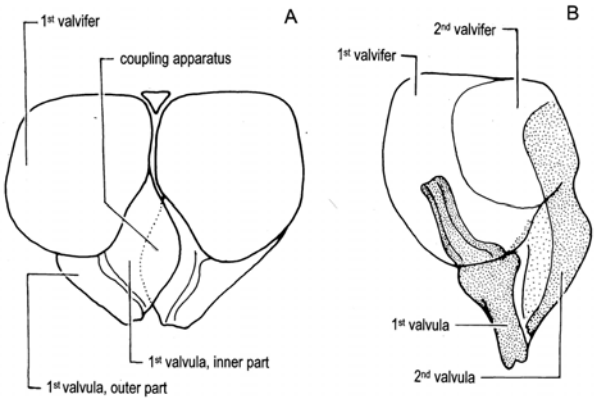

Figure 1. Ovipositor of *Esakiella* spp.; ventral view of the 8th abdominal ventrite. A) *E.* (*Megesakiella*) *marlieri marlieri* Poisson 1960; only surface structures are presented, dotted line indicates underlying inner margin of the 1st left valvula. B) *E.* (*Megesakiella*) *chiani flavicolis* Poisson 1951; the right half of the ventrite; both surface and underlying structures are drawn, dotted parts are well pigmented and sclerotized.

part of the vertically oriented 1st valvula of the notonectid and pleid type.

The ovipositor of some *Esakiella* spp. has both parts of the appendage each other subdivided by a deep groove. Structures forming complex of its 8th abdominal ventrite are relatively slightly fused, and lateral structure of this appendage is not dorsoventrally flattened but really peg-shaped. Its morphology can indicate certain possibility of the alternative interpretation of architecture of these appendages: lateral (outer) sclerite = 1st valvula; mesal (inner) sclerite forming coupling apparatus = 2nd valvula (derivate of the 9th abdominal ventrite). It suggests that appendages of the 8th abdominal ventrite could be represented by a complex of sclerites of both 8th and 9th abdominal ventrite nature. Only partly fused structures of the 8th and 9th abdominal ventrite can be interpreted as plesiomorphic character of ovipositor within the genera of Helotrephinae or within all the Helotrephidae genera respectively. Two above mentioned alternative hypotheses on the homology of structures of the ovipositor in *Esakiella* are illustrated in figure 1.

Conclusions

The results of this study (i) illustrate that the genus *Esakiella* China 1932 has probably the most ancestral ovipositor within the Old World helotrephid genera and (ii) support the hypothesis on the basal position of the genus *Esakiella* in the phylogeny of Helotrephini published by Zettel and Papáček (2004).

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