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Morphological differentiation of seven species of the genus *Heterocypris* Claus, 1892 (Ostracoda, Crustacea) based on the upper lip

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Abstract

Morphological differences of upper lip shape were analyzed in seven *Heterocypris* species occurring in the Mediterranean region. Descriptive observations and morphometric analysis of upper lip length, height and maximum height position are given for 17 populations from the Pannonian Plain, Balkan Peninsula and Iberian Peninsula. We found high variation in relative upper lip measurements between the species, indicating that upper lip traits can be used as additional taxonomic characters. The most distinctive upper lip shapes were noted in *H. exigua* and *H. gevgelica*, while the greatest intraspecific variability was present in *H. barbara*, *H. incongruens* and *H. rotundata*. Previously described qualitative characters in the form of differently arranged patches of pseudochaetae on the upper lip surface were also observed.

Key words: ostracods, exoskeleton, head capsule, morphology, labrum, shape, taxonomy

Introduction

Ostracoda are among the most common of arthropod groups, one which occurs in a wide variety of environments (Martens *et al.* 2008). They also have the most complete fossil record, extending from the Ordovician to the present (Rodríguez-Lazaro & Ruiz-Muñoz 2012). The growing interest in soft-part preservation in fossil ostracods has stressed the need to increase our knowledge of their morphology (Matzke-Karasz *et al.* 2007).

The head region of Ostracoda belonging to the order Podocopida comprises the forehead, upper lip and hypostome and represents an unexploited diagnostic feature of the exoskeleton (Meisch 2000). The upper lip of Podocopida, observed laterally, is a helmet-shaped structure (Bronshtein 1947), bluntly rounded at the anterior end, with subparallel sides (Kesling 1951). Its function is related to feeding and secretion of digestive fluids (Kesling 1951, Abe *et al.* 2000, Smith 2000b). Within the order Myodocopida, the upper lip has multiple functions such as secretion of mucus and luminescent substances (Huvard 1993, Abe *et al.* 2000), and it can also have a role in mating behavior (Tanaka 2013). The importance of morphology of the upper lip as an overlooked structure which can be used as a diagnostic character was emphasized by Schulz (1975) and Smith (2000b), who performed the first comparative study of upper lip morphology in the recent podocopid superfamily Cypridoidea, where great variation was recorded between species. Information on the upper lip is still generally lacking in publications on ostracod morphology, which occasionally include only a number of drawings without description (Petkovski *et al.* 2000, Karanović 2005, Karanović 2008). However, the upper lip or labrum is mentioned among the well-preserved soft-parts of fossil Cypridoidea species (Bate 1972, Smith 2000a, Williams *et al.* 2008, Wilkinson *et al.* 2010, Matzke-Karasz *et al.* 2013) as a convex structure, broadly triangular in shape.

A description of the ostracod head-case with drawings of it in several species was first given by Claus (1893), who established the genus *Heterocypris*. This genus has a cosmopolitan distribution and comprises 63 species worldwide (Martens & Savatenalinton 2011). The presence of both parthenogenetic and amphimictic populations in many *Heterocypris* species, with possible intra- and interspecific hybridization, has resulted in high genetic and morphological variability (Turgeon & Herbert 1994, Bellavere *et al.* 2002, Martens *et al.* 2002, Rossi *et al.* 2007). The taxonomy of this genus is based mostly on carapace characteristics, while distinctive features of appendages

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