



Development of sexual characters in the cave shrimp genus *Troglocaris* (Crustacea: Decapoda: Atyidae) and their applicability in taxonomy

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Abstract

In most Atyidae species, male pleopods I–II are specifically shaped in adults. In some species, the same holds true for male pereopods III–V. Due to the age and sex-dependent morphology of these structures, which are presumably used during mating, certain taxonomic mistakes in species diagnoses and identifications have occurred in the past. We studied the morphological development of these appendages in males of the cave shrimp *Troglocaris* (*Troglocaris*) *planinensis* Birštejn, 1948 (= W-Slo phylogroup by Zakšek *et al.* 2009). In addition, we examined the ontogeny of these structures in males and females from other phylogroups of the subgenus *Troglocaris* Dormitzer, as well as in the subgenera *Spelaeocaris* Matjašič, 1956 and *Troglocaridella* Babić, 1922. Multivariate Principal Component Analysis (PCA) and Discriminant Function Analysis (DFA) on males from the subgenus *Troglocaris*, confirmed the division of late ontogenetic development into sequential phases. The results indicate that in atyids (1) only mature specimens should be considered when searching for reliable morphological differences between closely related species, (2) pleopods and pereopods show diverse differentiation between taxa, preventing the reliable ascertainment of maturity at all times, (3) body size is often not a reliable indicator of maturity, (4) generally, only very rich samples ensure the presence of the fully mature males that are needed for adequate morphological studies.

Key words: Morphometry; Multivariate statistical analysis; Ontogenetic development; Sexual dimorphism; Taxonomy; *Troglocaris*

Introduction

A freshwater cave-dwelling shrimp genus *Troglocaris* Dormitzer (Decapoda, Atyidae), shows extensive variation in morphological traits due to sex and ontogenetic changes, preventing recognition of taxa. Many attempts have been made to resolve the morphological taxonomy of the genus (Kollar 1848; Babić 1922; Bouvier 1925; Sadovsky 1930; Fage 1937; Birštejn 1948; Matjašič 1956a, 1956b; Gottstein-Matočec 2003). Eventually (Sket & Zakšek 2009), the genus was split into four subgenera: sg. *Troglocaris* Dormitzer, 1853 (*Troglocaris* s. str. hereafter), sg. *Spelaeocaris* Matjašič, 1956, sg. *Troglocaridella* Babić, 1922, and sg. *Xiphocaridinella* Sadovsky, 1930, of which only the first three inhabit the Dinaric karst.

Molecular analyses confirmed the presence of several new species within the genus (Zakšek *et al.* 2007; Sket & Zakšek 2009). While species within the subgenera *Spelaeocaris* and *Troglocaridella* can be distinguished morphologically, in *Troglocaris* s. str. only *Troglocaris* (*Troglocaris*) *bosnica* Sket *et al.* 2009 is morphologically distinct enough to be identified. Recently, molecular analyses (Zakšek *et al.* 2009) demonstrated that four molecularly and geographically well-defined phylogroups (1) the W-Slo (i.e. West Slovenia), (2) the E-Slo (i.e. East Slovenia), (3) the Adriatic and (4) the Soča phylogroups are separate species, along with *T. (T.) bosnica*. A fifth Istra phylogroup was only weakly supported in the study and so its status within the type subgenus remains uncertain.

Past research on early ontogeny in cave shrimps (Matjašič 1958; Juberthie-Jupeau 1974, 1975) indicated that to a large extent, differences between subsequent ontogenetic stages could be important for increasing