Zootaxa 2274: 1–44 (2009)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Larval morphology of *Paroster* Sharp, 1882 (Coleoptera: Dytiscidae: Hydroporinae): reinforcement of the hypothesis of monophyletic origin and discussion of phenotypic accommodation to a hypogaeic environment

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Accepted by I. Ribera: 19 Sept. 2009; published: 28 Oct. 2009

Abstract

The larvae of 13 species (six epigaeic and seven hypogaeic) of the Australian endemic genus *Paroster* Sharp, 1882 are described with an emphasis on chaetotaxy of the head capsule, head appendages, legs, last abdominal segment and urogomphi. A cladistic analysis of 41 Hydroporinae species and 63 informative characters supports a monophyletic origin of members of *Paroster*, which share a labial palpus comprised of three palpomeres and the absence of the primary seta FE7. Contrary to their epigaeic counterparts, larvae of hypogaeic *Paroster* species have turned out to be very divergent morphologically. In addition to the common characteristics associated with hypogaeic living (i.e., absence of eye, reduced pigmentation, and thin or soft exoskeleton), larvae of these species have undergone a relative elongation/enlargement of the head capsule and a more elongate and narrower mandible and have developed a variable number of secondary temporal spines. Compared to the other stygobitic species studied, larvae of *Paroster hinzeae* (Watts & Humphreys, 2001), *P. macrosturtensis* (Watts & Humphreys, 2006), *P. stegastos* (Watts & Humphreys, 2003) and *P. darlotensis* (Watts & Humphreys, 2003) evolved a disproportionately large head capsule relative to body size. Larvae of *P. wedgeensis* (Watts & Humphreys, 2003) and *P. mesosturtensis* (Watts & Humphreys, 2006) are deemed to have deviated the least from the hypothetical epigaeic *Paroster* groundplan.

Key words: Dytiscidae, Hydroporini, *Paroster*, stygobitic, larval chaetotaxy

Introduction

Paroster Sharp, 1882 is an Australian endemic genus of 47 known species (Hendrich & Fery, 2008; Watts & Leys, 2008; Watts & Humphreys, 2009). Members of this genus are small (adult head length varying from 0.50 mm to 2.23 mm) and are comprised of 14 epigaeic and 33 hypogaeic (= stygobitic) species (most of these previously included in the genus *Nirripirti* Watts & Humphreys, 2001), which inhabit lentic, shallow ephemeral water bodies and calcrete aquifers in southwestern Australia respectively. Whereas adults of the hypogaeic species evolved a large range of body shapes and aberrant character states, epigaeic species in contrast are rather similar morphologically showing a narrow range of morphologies. All these species are postulated to share a monophyletic origin (Leys & Watts, 2008).

In terms of classification, *Paroster* is included in the tribe Hydroporini (Dytiscidae: Hydroporinae) that consists of a large and diverse group of water beetles mostly distributed in boreal and temperate regions of the northern hemisphere. Worldwide, Hydroporini currently comprises about 700 species classified in 34 genera (Nilsson, 2001, 2003, 2004; Nilsson & Fery, 2006). Recent studies based on larval morphologies (Alarie & Michat, 2007a; Michat et al., 2007), suggested that Hydroporini is probably polyphyletic.

Larval morphology of *Paroster* is practically unknown. Indeed the third instar of only one species, *P. nigroadumbratus* (Clark, 1862) has been superficially described (Watts, 1963). Larval morphology is important in the study of phylogenetic relationships among Holometabola. As different expressions of the same genotype, larval characters help to complement adult characters that have been traditionally the primary basis for classification.

The objectives of this paper are: (1) to describe the larvae of six epigaeic and seven stygobitic species of *Paroster* with an emphasis on morphometry and chaetotaxy, (2) to provide a key for the identification of the third instar of these species, and (3) to compare the groundplan of larval features of *Paroster* with those of other hydroporine genera for which the larvae have been described in detail to test the hypothesis of monophyletic origin of this genus using larval morphology. Comparison of terrestrial and hypogaeic *Paroster* larvae also provides us with an opportunity to look at the selectable phenotypic variations that are likely to have evolved within the stygobitic *Paroster* species as a result of adaptation to a hypogaeic environment.

Material and methods

Larvae examined

The descriptions of the larval stages and the taxonomic conclusions reported in this paper are based on the