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The complete larval development of the mud shrimp *Upogebia vasquezi* (Gebiidea: Upogebiidae) reared in the laboratory

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Abstract

The larval development of *Upogebia vasquezi* consists of four zoeal stages and a megalopa. In the present study, each larval stage was described and illustrated in detail. The first two stages are re-described in order to provide a detailed comparison with the data available for this species recorded in a previous study. The morphological features of all the stages are compared with those of the larvae of other *Upogebia* species reported previously in the literature. Broad morphological similarities and distinctions were found among most *Upogebia* species. The main interspecific variations in the morphology of the zoeal stages are the segmentation pattern of the antennular endopod and number of aesthetascs, the number of setae on the scaphognathite and the presence or absence of a mandibular palp.

Key words: Decapoda, taxonomy, thalassinideans, zoea, megalopa, larvae

Introduction

The thalassinideans comprise the infraorders Axiidea de Saint Laurent, 1979 and Gebiidea de Saint Laurent, 1979 (Robles *et al*. 2009), two distinct groups of decapods that have converged morphologically and ecologically as burrowing forms, commonly known as mud lobsters and mud or ghost shrimps (Dworschak *et al*. 2012). These groups are an important component of the macroinfauna of intertidal and subtidal environments and are distributed throughout the world (Kornienko 2013), with species diversity increasing from high latitudes towards the equator (Dworschak 2000).

By the early twenty-first century the total number of known thalassinidean species (Kornienko 2013) had increased to approximately 646 (De Grave *et al*. 2009; Ahyong *et al*. 2011). Given the contentious status of some species and the difficulties of identifying the larvae of most taxa, detailed information on larval development is available for only around one quarter of known genera (Pohle *et al*. 2011). *Upogebia* Leach, 1814 and the synonymized genders *Gebiacantha* Ngoc-Ho, 1989 and *Austinogebia* Ngoc-Ho, 2001 (Sakai 2006) constitute the thalassinidean group for which larval development is best understood (Pohle *et al*. 2011).

Few studies are available on the larval stages of the *Upogebia* species found on the Brazilian coast (Boschi 1981), that is, *Upogebia acanthura* Coelho, 1973, *U. brasiliensis* Holthuis, 1956, *U. careospina* Williams, 1993, *U. inomissa* Williams, 1993, *U. omissa* Gomes Corrêa, 1968, *U. omissago* Williams, 1993, *U. marina* Coelho, 1973, *U. noronhensis* Fausto-Filho, 1969, *U. paraffinis* Williams, 1993, and *U. vasquezi* Ngoc-Ho, 1989 (Melo 1999; Nucci & Melo 2001; Oliveira *et al*. 2012a). Complete larval development has been documented only in *U. paraffinis* (Melo & Brossi-Garcia 2000). More recently, the two initial stages of the larvae of *U. vasquezi* were described in detail by Oliveira *et al*. (2012b).

Upogebia vasquezi inhabits coastal habitats in the western Atlantic, between southern Florida and the Bahamas, in the north, and Central and South America, to the south, including Brazil (Melo 1999; Hernández-

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antennal flagellum (endopod) is poorly segmented in *U. darwini*, *U. deltaura* and *U. quddusiae*, with between fourteen and sixteen segments. *Upogebia vasquezi*, *U. kempi*, *U. major* and *U. pusilla* have nineteen segments, while *U. yokoyai*, *U. paraffinis*, *U. issaeffi*, *U. edulis*, *U. affinis* and *U. stellata* have nineteen to twenty-seven segments (Tab. 5).

The mandible palp is unsegmented in *U. kempi*, *U. edulis* and *U. pusilla*, 2-segmented in *U. affinis*, *U. paraffinis* and *U. yokoyai*, and 3-segmented in *U. darwini*, *U. major*, *U. quddusiae*, *U. issaeffi* and *U. vasquezi* (Tab. 5). This is thus one of the traits that can be used to differentiate the megalopae of *Upogebia* species (Melo & Brossi-Garcia 2000). The endopod of the maxillule is unarmed in most cases, but in *U. affinis*, *U. paraffinis,* and *U. yokoyai*, it bear one, three or even six plumose setae, respectively (Tab. 5). The scaphognathite has fewer plumose setae in *U. edulis* (13) but up to 35–37 in *U. issaeffi* (Tab. 5).

There are considerable contrasts in the structure and arrangement of the setae on the maxillipeds of the different *Upogebia* species. The first endopod may be unarmed, for example, in *U. edulis* and *U. pusilla*, or have as many as 10–15 setae, as observed in *U. yokoyai* (Tab. 5). The second exopod is unsegmented in *U. darwini*, but 3-segmented in *U. kempi* and *U. pusilla*, and may be unarmed in some species, but have as many as seven plumose setae in others, such as *U. kempi* (Tab. 5). The third exopod is already vestigial in *U. edulis*, *U. paraffinis* and *U. vasquezi* (see Shy & Chan 1996; Melo & Brossi-Garcia 2000). The pereopods have many setae and spines in all species, as do the telson and uropods, with interspecific differences in the shape and spinulation pattern (Tab. 5).

Kornienko *et al*. (2013) concluded that the reduced number of larval stages observed in *U. major* may contribute to the ability of this species to reproduce more than once each breeding season. While the larvae of *U. vasquezi* pass through four zoeal stages, this species reproduces throughout the year on the coast of northern Brazilian, forming large populations in the intertidal zone of rocky shores, between the boulders that overlie sandy mud. It thus seems likely that the initial zoeal stages of this species are common in the near-shore plankton community, although the megalopa stage has not been recorded previously in zooplankton samples from this region (Oliveira *et al*. 2012a). The rarity of planktonic megalopae may be related to their strong affinity with the substrate (Andrysak 1986).

The main differences found among the *Upogebia* species in the present are broadly similar to those found by Ngoc-Ho (1981), that is, in the number of antennular aesthetascs and setae on the scaphognathite, as well as the presence or absence of a mandibular palp. The telson is the most conservative trait, with little or no variation among the *Upogebia* species. While it cannot be used to diagnose species, it is the most valuable character for the differentiation of the zoeal stages of a given species (Melo & Brossi-Garcia 2000).

The species found on the Brazilian coast (*U. paraffinis* and *U. vasquezi*) closely resemble one another in many aspects, but present a number of important differences during their larval development, as shown in Tables 2–6. This study provides a detailed morphological comparison of the larval stages of *Upogebia* species from around the world. Despite their considerable geographic variation, the different species presented many morphological similarities with one another.

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