Zootaxa 3768 (4): 428–436
www.mapress.com/zootaxa/
Copyright © 2013 Magnolia Press

Article

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

http://dx.doi.org/10.11646/zootaxa.3768.4.2
http://zoobank.org/urn:lsid:zoobank.org:pub:B26D8C16-B96C-47C5-AB46-DBE1B0586F26

Morphology of the first zoeal stage of three deep-water pandalid shrimps, *Heterocarpus abulbus* Yang, Chan & Chu, 2010, *H. hayashii* Crosnier, 1988 and *H. sibogae* De Man, 1917 (Crustacea: Decapoda: Caridea)

GUO-CHEN JIANG[1], TIN-YAM CHAN[1,2] & TUNG-WEI SHIH[3,4]

[1] *Institute of Marine Biology, National Taiwan Ocean University, Keelung 202, Taiwan, R.O.C.*
[2] *Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung 202, Taiwan, R.O.C.*
[3] *National Museum of Marine Science & Technology, Keelung 202, Taiwan, R.O.C.*
[4] *Corresponding author. E-mail: stw@mail.nmmst.gov.tw*

Abstract

The eggs of three deep-sea pandalid shrimps *Heterocarpus abulbus, H. hayashii* and *H. sibogae* are successfully hatched in the laboratory. The first zoeal stage of these shrimps are described, with those of *H. abulbus* and *H. hayashii* being reported for the first time. First zoeae of different *Heterocarpus* species can be distinguished by the spination at the anteroventral carapace, body size, rostral length and appendage setation.

Key words: *Heterocarpus*, caridean shrimp, morphology, zoea

Introduction

Members of the pandalid genus *Heterocarpus* A. Milne-Edwards, 1881, are widely distributed in the tropical and subtropical seas at depths of 73–2834 m (Chace 1985). At present 30 species are known for this genus (De Grave & Fransen 2011) and some of them have commercial values or potential (Holthuis 1980; Ralston 1986; Chan 1998; Pérez 2007; Wehrtmann & Echeverría-Sáenz 2007). However, little is known for the larval development of these deep-water shrimps. Only the larval characters of two species *H. ensifer* A. Milne-Edwards, 1881 (Landeira *et al*. 2010) and *H. sibogae* De Man, 1917 (Iwata *et al*. 1986) have been reported.

The present work succeeded in hatching the eggs of three *Heterocarpus* species collected in Taiwan, namely *H. abulbus, H. hayashii* and *H. sibogae*. The morphological characteristics of the first zoeae of these three species are reported herein, with those of *H. abulbus* and *H. hayashii* being described for the first time. The first zoeae of all known *Heterocarpus* species are compared and found that they can be readily separated by some distinctive characters.

Materials and methods

Ovigerous females of three *Heterocarpus* species (*H. abulbus*, *H. hayashii* and *H. sibogae*) were captured by commercial trawls at depth of 200–300 m off northeastern Taiwan (24°52.395' N – 121°59.264' E) from September to November in 2012. Each individual was separated in different aquaria (100 l volume) and raised in sea water (salinity of 35 PSU) at 14 ± 1°C. Once the eggs hatched, about 10 first stage zoeae were immediately collected and preserved in 70% ethylene glycol solution. More than ten larvae from each species were dissected and examined on glass slides under a stereo microscope (OLYMPUS SZX12) using fine entomological needles. Appendages were drawn using compound microscope (OLYMPUS BX50) installed with a camera lucida. Morphological terminology generally follows Yang & Ko (2004) and Landeira *et al*. (2010). Abbreviations of larval measurements were as follows: Carapace length (CL), from the postorbital margin to the posteromedian end

 Accepted by J. Goy: 30 Nov. 2013; published: 27 Feb. 2014

With respect to the genus *Heterocarpus*, the first zoeae of only two species were known, namely *H. ensifer* (Landeira *et al*. 2010) and *H. sibogae* (Iwata *et al*. 1986). However, the description of *H. sibogae* is rather brief and the present work re-describes the first zoea of this species in details. With the addition of *H. abulbus* and *H. hayashii*, the first zoeae of four species in this genus are now known. All of them share the common characters of anteroventral margin of carapace bearing spines, carapace with dorsomedian tubercles on anterior and posterior parts, and antennule with spatulate seta. On the other hand, the first zoeae of these four species can be readily distinguished by the following characters (also see Table 1):

(1) Spines on anteroventral margin of carapace: Other than the pterygostomian spine, *H. sibogae* differs from the other three species in bearing only one additional spine at the anteroventral margin of carapace (vs. 2 spines in others). *Heterocarpus abulbus* can also be separated from *H. ensifer* and *H. hayashii* in the one of the two additional spines at the anteroventral carapace being rather weak (both spines very distinct in *H. ensifer* and *H. hayashii*).

(2) Body size and rostral length: The size of the zoea is much larger for *H. abulbus* (body length 2.44 mm) as compared to the other three species (body lengths 1.93 mm, 1.89 mm, 1.88 mm in *H. ensifer*, *H. hayashii* and *H. sibogae*, respectively). The rostrum of *H. ensifer* is distinctly shorter than the other three species in only extending to the middle of the antennular peduncle (vs. reaching or overreaching distal margin of antennular peduncle).

(3) Appendage setation: The endopod of maxillule has three subterminal setae in *H. ensifer*, whilst the other three species have only two subterminal setae. *Heterocarpus abulbus* can be further separated from *H. hayashii* and *H. sibogae* in having two instead of one seta on the coxa of the second maxilliped. Moreoever, *H. sibogae* has a somewhat different endopod setation at the second maxilliped (2, 1, 2, 4 vs. 3, 1, 2, 4–5 in the other three species, see Table 1).

As in adults, the first zoeae of *H. ensifer*, *H. hayashii* and *H. sibogae* are more similar than with *H. abulbus*, which belongs to a different species group than the former three. On the other hand, although adults of *H. ensifer*, *H. hayashii* and *H. sibogae* are rather similar, distinct differences are already present amongst the zoeae of these closely related species. All these suggested that larval characters can provide important insights to the understanding of the taxonomy and phylogenetic relationships amongst *Heterocarpus* shrimps.

Acknowledgements

This work is supported by research grants from the National Science Council, Taiwan, R.O.C.

References

Chace, F.A. Jr. (1985) The caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine expedition, 1907–1910, part 3: families Thalassocarididae and Pandalidae. *Smithsonian Contributions to Zoology*, 411, 1–143. http://dx.doi.org/10.5479/si.00810282.411

Chan, T.Y. (1998) Shrimps and prawns. *In:* Carpenter, K.E. & Niem, V.H. (Eds.), *FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific.* FAO, Rome, pp. 851–971.

De Grave, S. & Fransen, C.H.J.M (2011) Carideorum catalogus: the recent species of the dendrobranchiate, stenopodidean, procaridideanand caridean shrimps (Crustacea: Decapoda). *Zoologische Mededelingen*, 85 (9), 195–589.

Heegaard, P. (1969) The first larval stage of *Chlorotocus crassicornis* (Decapoda, Pandalidae). *Crustaceana*, 17, 151–158. http://dx.doi.org/10.1163/156854068x00043

Holthuis, L.B. (1980) FAO species catalogue. Shrimps and prawns of the world. An annotated catalogue of species of interest to fisheries. *FAO Fisheries Circular*, 125 (1), 1–271.

Iwata, Y., Sugita, H., Kobashi, T. & Deguchi, Y. (1986) Larval development of the Pandalid shrimp *Heterocarpus sibogae* De Man. *Bulletin of the College of Agriculture and Veterinary Medicine - Nihon University*, 43, 140–150.

Landeira, J.M., Lozano-Soldevilla, F. & González-Gordillo, J.I. (2009) Morphology of first seven larval stages of the striped soldier shrimp, *Plesionika edwardsii* (Brandt, 1851) (Crustacea: Decapoda: Pandalidae) from laboratory reared material. *Zootaxa*, 1986, 51–66.

Landeira, J.M., Lozano-Soldevilla, F., Almansa, E. & González-Gordillo, J.I. (2010) Early larval morphology of the armed nylon shrimp *Heterocarpus ensifer ensifer* A. Milne-Edwards, 1881 (Decapoda, Caridea, Pandalidae) from laboratory culture. *Zootaxa*, 2427, 1–14.

Lebour, M.V. (1940) The larvae of the Pandalidae. *Journal of Marine Biological Association of the United Kingdom*, 24, 239–252.
http://dx.doi.org/10.1017/s0025315400054540
Pérez, E.P. (2007) An economic analysis of the *Heterocarpus reedi* and *Cervimunida johni* fisheries off northern-central Chile, from 1997 to 2000. *Investigaciones Marinas*, 35 (2), 45–52.
http://dx.doi.org/10.4067/s0717-71782007000200005
Pike, R.B. & Williamson, D.I. (1964) The larvae of some species of Pandalidae (Decapoda). *Crustaceana*, 6, 265–284.
http://dx.doi.org/10.1163/156854064x00038
Ralston, S. (1986) An intensive fishing experiment for the caridean shrimp, *Heterocarpus laevigatus*, at Alamagan Island in the Mariana archipelago. *Fishery Bulletin*, 84 (4), 927–934.
Thatje, S. & Bacardit, R. (2000) Larval development of *Austropandalus grayi* (Cunningham, 1871) (Decapoda: Caridea: Pandalidae) from the southwestern Atlantic Ocean. *Crustaceana*, 73 (5), 609–628.
http://dx.doi.org/10.1163/156854000504697
Wehrtmann, I.S. & Echeverría-Sáenz, S. (2007) Crustacean fauna (Stomatopoda: Decapoda) associated with the deepwater fishery of *Heterocarpus vicarius* (Decapoda: Pandalidae) along the pacific coast of Costa Rica. *Revista de Biologia Tropical*, 55, 121–130.
http://dx.doi.org/10.1651/10-3400.1
Yang, H.J. & Ko, H.S. (2004) Zoeal stages of *Conchodytes nipponensis* (Decapoda: Palaemonidae) reared in the laboratory. *Journal of Crustacean Biology*, 24 (1), 110–120.
http://dx.doi.org/10.1651/c-2407