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The number of zoeal stages in larval development of *Nihonotrypaea petalura* (Stimpson, 1860) (Decapoda: Axiidea: Callianassidae) from Russian waters of the Sea of Japan

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Abstract

Zoeal stages of the mud shrimp *Nihonotrypaea petalura* (Stimpson, 1860) (Decapoda: Axiiidea: Callianassidae) inhabiting Peter the Great Bay (Sea of Japan) is described and illustrated from the larvae reared in the laboratory individually. The development included seven zoeal stages before molting to the megalopa. At 22–23°C the first megalopa was attained 26 days after hatching. A range of the number of zoeal stages in the family Callianassidae is analyzed. The possibility of variation of the number of zoeal stages of burrowing shrimps in different populations of the same species and/or under different laboratory conditions is discussed.

Key words: Axiiidea, Callianassidae, larva, zoea, Sea of Japan

Introduction

There are considerable differences in the number of larval stages within the infraorders Gebiidea and Axiidea, ranging from direct development in *Upogebia savignyi* (see Gurney 1937) to eight zoeal stages in *Boasaxius princeps* (see Kornienko *et al.* 2014). In callianassids, the number of zoeal stages varies from two zoeae in *Callichirus kraussi*, *C. masoomi, Sergio mirim*, *Lepidophthalmus sinuensis, L. louisianensis* and *Pestarella tyrrhena* (abbreviated development) (see Forbes 1973; Sankolli & Shenoy 1975; Rodrigues 1984; Nates *et al.* 1997; Thessalou-Legaki 1990; Thessalou-Legaki *et al.* 1999) to three zoeae in *Pestarella candida* and *Lepidophthalmus siriboia* (see Dolgopolskaia 1969; Abrunhosa *et al*. 2005), four zoeae in *Necallianassa truncata* (incomplete development) (see Dolgopolskaia 1969; dos Santos 1999) and finally to five zoeal stages in *Callianassa subterranea, Biffarius filholi, Neotrypaea californiensis, Callichirus seilacheri, Neotrypaea uncinata, Nihonotrypaea japonica* and *N. harmandi* (see Gurney 1942; Devine 1966; McCrow 1972; Aste & Retamal 1983, 1984; Miyabe *et al.* 1998; Konishi *et al*. 1999). Thus, five zoeal stages are more common.

Dakin & Colefax (1940) described six zoeal stages in *Trypaea australiensis* from Australian coastal waters, but their figures indicate that their first zoea is really a prezoeal stage. This stage has no rostrum, no dorsal abdominal spine and no posterior median spine on the telson. All setae are incompletely developed. The telson of their second zoea has only 7+1+7 posterior spines (it is really a zoea I); the telson of the third zoea has 8+1+8 posterior spines (it is really a zoea II); uropods appear at the fourth zoeal stage, but in all callianassid larvae they always appear at the third one. Thus, *T. australiensis* probably has only five zoeal stages. Moreover, only first two stages of this species were lab-reared, the rest were obtained from the plankton.

Six zoeae were also described in *Nihonotrypaea petalura* from Ariake Bay, Kyushu (Konishi *et al.* 1990) but later, after finding of five zoeae in *N. japonica* and *N. harmandi*, authors concluded that five zoeal stages are standard in the larval development of callianassid species except for those with abbreviated development. In their opinion, zoea IV and zoea V of *N. petalura* did not possess clear differences in both carapace length and morphology of appendages, therefore zoea VI could be regarded as a "true" zoea V (Miyabe *et al.* 1998).

Nihonotrypaea petalura and *N. japonica* are widely spread in the Russian waters of the Sea of Japan. At a

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The data obtained in the larval development of *N. petalura* confirmed that in contrast to anomurans and brachyurans, the number of zoeal stages in several axiidean species may vary in the different populations of the same species and/or under moderate differences in laboratory rearing. The appearance of the additional larval stage may be a result of suboptimal rearing conditions and may not occur in natural habitat. However, not all axiidean species change the number of larval stages. Regardless of the rearing conditions for *N. japonica* in Japanese and Russian laboratories also somewhat differed, this species always passed through five zoeal stages. It is possible, that *N. japonica* occurring in muddy sand is a more eurybiotic species than *N. petalura* inhabiting rocky and mixed bottoms. Therefore, the survival rate of the larvae of *N. japonica* was higher.

Thus, five zoeal stages are not a limit in larval development of callianassid species. Larval development of *N. petalura* probably includes not five but at least six zoeal stages. Only finding all larval series of this species in the plankton samples can confirm their presence under natural conditions. However, the late zoeal stages were observed in the plankton very seldom. We have never found more than fourth zoeae of *N. petalura* in numerous plankton surveys.

It is pertinent to note that the larvae of most callianassid species having five zoeal stages were described from plankton material. Only *Nihonotrypaea japonica* and *N. harmandi* (Miyabe *et al.* 1998; Konishi *et al.* 1999) were reared under laboratory conditions. In case of *Neotrypaea uncinata* (Aste & Retamal 1984), the megalopa was not obtained in the laboratory, so we do not know the exact number of zoeal stages in this species. The larvae of all species except for *Callichirus islagrande* and *C. major* (Strasser & Felder 1999a, 2000) were reared in mass culture, so stages may be missed and an error in the number of larval stages is quite possible.

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