

The First Zoeal Stage of *Echinoecus nipponicus* (Decapoda: Pilumnidae: Eumedoninae) Hatched in the Laboratory

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ABSTRACT

Ovigerous crab of *Echinoecus nipponicus* of subfamily Eumedoninae in Pilumnidae was collected from Seogwipo, Jeju and hatched in the laboratory. The first zoeal stage of *E. nipponicus* is reported for the first time in the world and its digital image of live zoeas is provided. The first zoea of *E. nipponicus* has yellowish red chromatophores which occurring behind eyes, on dorsal spine and on anterior margin of telson, reddish brown chromatophores on abdominal somites 2–5 ventrally, dorsal, rostral, and lateral spines shorter than carapace length, three aesthetascs and two setae on the antennule, two medial setae on the antennal exopod, lateral processes on the abdominal somites 2, 3, and two lateral spine and one dorsomedial spine on the telson.

Keywords: Eumedoninae, Pilumnidae, first zoea, *Echinoecus nipponicus*, Korea

INTRODUCTION

Crabs of the family Pilumnidae Samouelle, 1819 contain more than 390 species of 69 genera in five subfamilies (Calmaniinae Števčić, 1991, Eumedoninae Dana, 1852, Pilumninae Samouelle, 1819, Rhizopinae Stimpson, 1858, Typhlocarcinopinae Rathbun, 1909, and Xenophthalmodinae Števčić, 2005) (Ng et al., 2008; WoRMS, 2020). Fifteen species of 3 subfamilies of Eumedoninae, Pilumninae, and Rhizopinae have been recorded from Korean waters (Lee et al., 2015). Among them, zoeal descriptions of Pilumnidae are known for nine species: *Echinoecus pentagonus* (A. Milne-Edwards, 1879), *Harrovia japonica* Balss, 1921, *Benthopanope indica* (De Man, 1887), *Heteropilumnus ciliatus* (Stimpson, 1858), *Pilumnopeus granulatus* Balss, 1933, *P. makianus* (Rathbun, 1931), *Pilumnus longicornis* Hilgendorf, 1878, *Pi. minutus* De Haan, 1835, and *Pi. trispinosus* (Sakai, 1965) from Korean waters (Lee and Ko, 2016).

The genus *Echinoecus* Rathbun, 1894 of subfamily Eumedoninae, is usually symbiotic with sea urchin and contains three species [*Echinoecus nipponicus*, *E. pentagonus*, and *E. sculptus* (Ward, 1935)] (Chia et al., 1999). Larval descriptions are known for only *E. pentagonus* described by Van Dover et

al. (1986). The larval stage of *E. nipponicus* is unknown until now.

In the present study, the first zoeal stage of *E. nipponicus* is described and illustrated for the first time and provided color digital image. Its morphological characteristics are compared with those of other known congeneric species of *E. pentagonus*.

MATERIALS AND METHODS

Ovigerous crab of *Echinoecus nipponicus* was collected by SCUBA diving in about 15m depth in Seogwipo, Jeju, Korea collecting date is on 12 Aug 2010 and its zoea was hatched in the laboratory on 16 Aug 2010. First zoeas were preserved in 95% ethyl alcohol for examination. Living zoeas were taken digital photos with Leica EZ40 microscope (Wetzlar, Germany) and then processed in Photoshop. Zoeal specimens were dissected using Leitz zoom stereomicroscope and appendages were examined under a Leitz Laborlux S microscope. Appendages were mounted in ethylene glycol and drawings were made with the camera lucida. Setal counts on appendages and measurements were based on the mean of 10

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specimens. The sequence of the zoeal description follows that of Clark et al. (1998). The long plumose natatory setae of the first and second maxillipeds were drawn truncated. The chromatophore patterns were observed with living zoeas. A micrometer was used for the zoeal measurements: CL (carapace length) from the base of the rostral spine to the most posterior carapace margin and RDL (rostral and dorsal spine length) from the tip of rostral carapace spine to the tip of the dorsal carapace spine. Specimens examined and spent female was deposited in Silla University, Korea.

RESULTS

Order Pilumnoidea Samouelle, 1819

Family Pilumnidae Samouelle, 1819

Genus *Echinoecus* Rathbun, 1894

¹**Echinoecus nipponicus* Miyake, 1939 (Fig. 1A)

First zoea (Figs. 1B, 2).

Size: CL 0.59 ± 0.02 mm; SL 0.98 ± 0.05 mm.

Chromatophores (Fig. 1B): Yellowish red chromatophores which occurring behind eyes, on dorsal spine and on anterior margin of telson; reddish brown chromatophores on abdominal somites 2–5 ventrally.

Carapace (Figs. 1B, 2A, A'): Surface with minute postero-medial protuberance; dorsal spine less than CL, extremely curved distally, with several minute tubercles; rostral and lateral spines short; 1 pair of posterodorsal setae present; each ventral margin with spinules; eyes sessile.

Antennule (Fig. 2B): Uniramous; endopod absent; exopod with 2 long, stout aesthetascs, 1 shorter, thinner aesthetasc, 2 simple setae, all terminal.

Antenna (Fig. 2C): Biramous; endopod bud absent; protopod with 2 rows of spinules on distal half; exopod with spinulate on distal half, tip overreaching tip of protopod, with 2 (1 long, 1 shorter) medial setae.

Mandibles (Fig. 2D): Asymmetrical; right molar with 2 teeth, left molar with 3 teeth, confluent with incisor process; palps absent.

Maxillule (Fig. 2E): Coxal endite with 7 setae; basal endite with 5 setae and 2 teeth; endopod 2-segmented, proximal segment with 1 seta, distal segment with 6 (2 subterminal, 4 terminal) setae; exopod seta and epipod absent.

Maxilla (Fig. 2F): Coxal endite bilobed, with 6 + 4 setae; basal endite bilobed, with 5 + 4 setae; endopod bilobed, with 3 + 5 setae; exopod (scaphognathite) margin with 4 plumose setae, 1 distal process.

First maxilliped (Fig. 2G): Coxa without seta; basis with 10 setae, arranged 2 + 2 + 3 + 3; endopod 5-segmented with 3, 2, 1, 2, 5 (1 subterminal, 4 terminal) setae; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 2H): Coxa without seta; basis with 4 setae, arranged 1 + 1 + 1 + 1; endopod 3-segmented, with 1, 1, 6 (3 subterminal, 3 terminal) setae; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Abdomen (Fig. 2I): With 5 somites; somite 2 with 1 pair of lateral processes directed laterally; somite 3 with 1 pair of lateral processes directed posteriorly; somites 2–5 each with 1 pair of posterodorsal setae, respectively, each posterior margin with spines, 6–8 denticles, posterolateral spines laterally



Fig. 1. Color photos of adult and the first zoeas of *Echinoecus nipponicus*. A, Adult of *E. nipponicus*; B, First zoeas of *E. nipponicus*.

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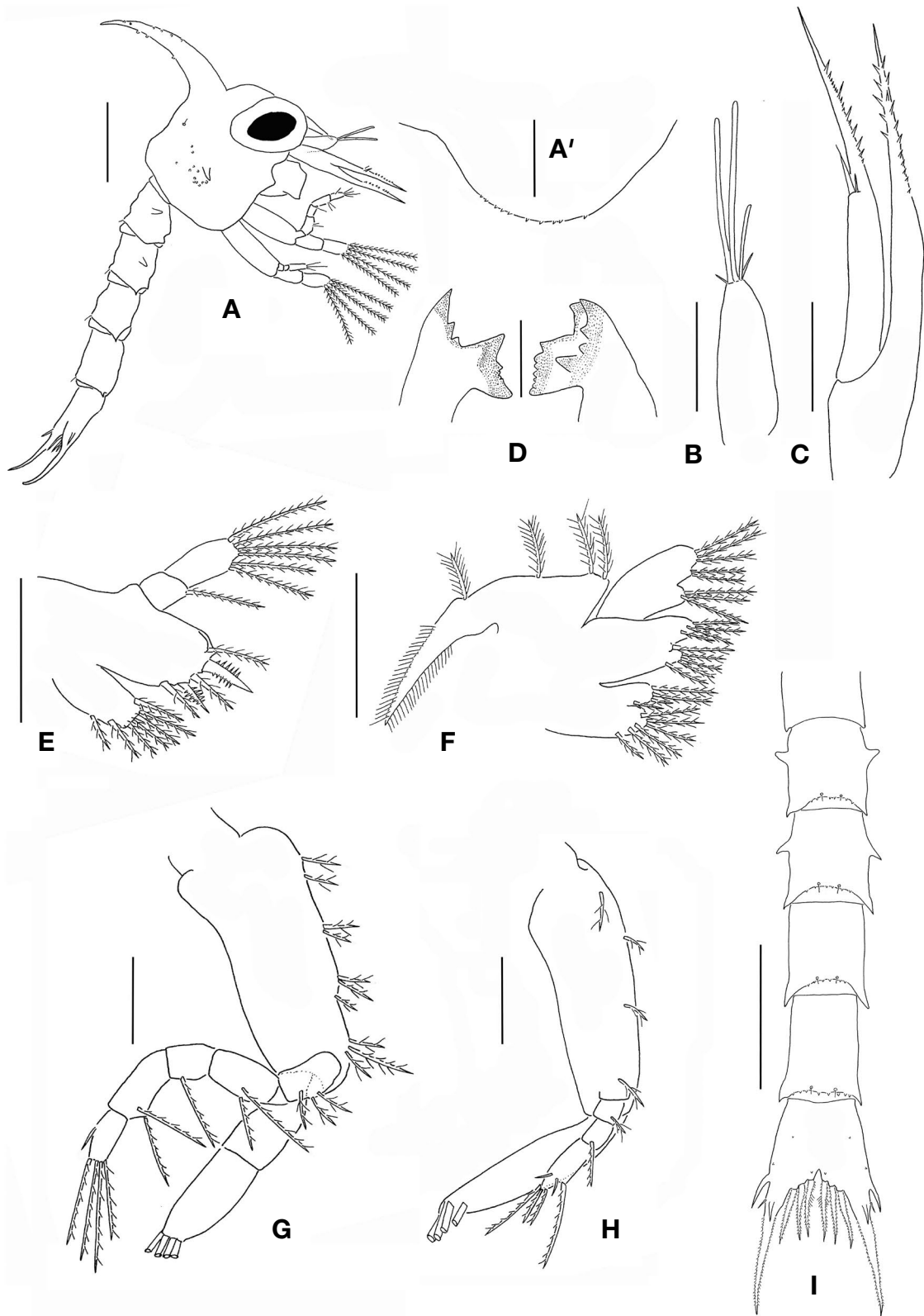


Fig. 2. *Echinoecus nipponicus*, first zoeal stage. A, Lateral view; A', Lateral expansion of carapace; B, Antennule; C, Antenna; D, Mandibles; E, Maxillule; F, Maxilla; G, First maxilliped; H, Second maxilliped; I, Dorsal view of abdomen and telson. Scale bars: A, I=0.3 mm, A'–H=0.1 mm.

Table 1. Comparison of the first zoeal characteristics in the genus *Echinoecus*

	<i>Echinoecus nipponicus</i> Present study	<i>E. pentagonus</i> Van Dover et al., 1986
Carapace		
Dorsal, rostral, lateral spines	Long, short, short	Long, short, short
Antennule	3 aesthetascs, 2 setae	3 aesthetascs, 3 setae
Antenna		
Protopod	Spinulate	Spinulate
Exopod	Longer than protopod, spinulate, 2 unequal medial setae	As long as protopod, spinulate, 2 unequal medial setae
Maxillule		
Coxal endite	7 setae	7 setae
Basial endite	5 setae	5 setae
Endopod	1, 2+4 setae	1, 2+4 setae
Maxilla		
Coxal endite	6+4 setae	6+4 setae
Basial endite	5+4 setae	5+4 setae
Endopod	3+5 setae	3+5 setae
1st maxilliped		
Basis	2, 2, 3, 3 setae	2, 2, 3, 3 setae
Endopod	3, 2, 1, 2, 5 setae	3, 2, 1, 2, 5 setae
2nd maxilliped		
Basis	1, 1, 1, 1 setae	1, 1, 1, 1 setae
Endopod	1, 1, 6 setae	1, 1, 6 setae
Abdomen		
Lateral processes	Somites 2, 3	Somites 2, 3
Telson		
Fork	2 lateral spines, 1 dorsomedial spine Spinulate	1 lateral spine, 1 lateral seta, 1 dorsomedial spine Spinulate

and 6–8 denticles medially; pleopod absent.

Telson (Fig. 2I): With 6 spinules on dorsal surface; each fork long, covered with setules laterally, with 1 stout lateral spine, 1 minute lateral spine and 1 stout dorsomedial spine; posterior margin with 3 pairs of setae.

DISCUSSION

The first zoeal stage of *Echinoecus nipponicus* is described for the first time in the world. The first zoea of *E. nipponicus* has yellowish red chromatophores which occurring behind eyes, on dorsal spine and on anterior margin of telson, reddish brown chromatophores on abdominal somites 2–5 ventrally, dorsal, rostral, and lateral spines shorter than carapace length, three aesthetascs and two setae on the antennule, two medial

setae on the antennal exopod, lateral processes on the abdominal somites 2, 3, and two lateral spine and one dorsomedial spine on the telson (Table 1).

Including present study, the first zoeal stages of two species of the genus *Echinoecus* are known to the Korea: *E. nipponicus* and *E. pentagonus*. The first zoea of *E. nipponicus* is distinguished from that of *E. pentagonus* by having three aesthetascs and two setae on the antennule, and the antenna longer than the protopod. The antennule has three aesthetascs and three setae, and the antenna is as long as potopod in *E. pentagonus* (Table 1).

The first zoea of *E. nipponicus* is almost identical to common characteristics of pilumnoid zoeas suggested by Ko and Lee (2012), however, it has slightly differs from the others in having a longer antennal exopod and a fork of the telson bearing three spines.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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