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First Zoea of *Chasmagnathus convexus* (Decapoda: Brachyura: Varunidae) Hatched in the Laboratory

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ABSTRACT

First zoea of cyclograpsinine crab *Chasmagnathus convexus* (De Haan, 1835) belonging to the family Varunidae, is described and illustrated in detail based on laboratory-hatched material from an ovigerous female collected in Seumjingang river mouth, southern Korea. Morphological comparison is made with previous description of *C. convexus* from Japan. The first zoea of *C. convexus* can be readily distinguished from those of six species of *Cyclograpsus intermedius* Ortmann, 1894, *Helicana japonica* (K. Sakai and Yatsuzuka, 1980), *Helicana wuana* (Rathbun, 1931), *Helice tientsinensis* Rathbun, 1931, *Helice tridens* (De Man, 1835), and *Pseudohelice quadrata* (Dana, 1851), the other known cyclograpsinine species in Korea by having the lateral carapace spine, a pair of dorsolateral processes on the fourth abdominal somite, the exopod of antenna with three setae, and the exopod of antenna as being 24.7% length to the protopod.

Key words: first zoea, *C. convexus*, Cyclograpsinae, Varunidae, Korea

INTRODUCTION

An intertidal estuarine crab *Chasmagnathus convexus* (De Haan, 1835) belonging to the varunid subfamily Cyclograpsinae, is reported in Korea, Japan, China, and Taiwan (Dai and Yang, 1991).

The family Varunidae currently contains six subfamilies, Cyclograpsinae, Gaeticinae, Glyptograpsinae, Thalassograpsinae, Varuninae, and Xenograpsinae. Eleven genera are presently attributed to the Cyclograpsinae: *Austrohelice, Chasmagnathus, Cyclograpsus, Helicana, Helice, Heliograpsus, Metaplax, Neohelice, Paragrapsus, Parahelice*, and *Pseudohelice*. Among them, seven genera (*Austrohelice, Chasmagnathus, Cyclograpsus, Helicana, Helice, Neohelice*, and *Pseudohelice*) comprising 16 species are known for larval description (Table 1).

Detailed description of the decapod first larvae in particular plays an important role in brachyuran systematic or phylogenetic studies (Rice, 1980). The accuracy of the description and setation pattern is essential for those studies (González-Gordillo et al., 2000). Older description, therefore, needs to be revised, especially regarding the setation pattern (Schubart and Cuesta, 1998). Larvae of *C. convexus* have been previously described by Baba and Fukuda (1972) from Japanese waters. Unfortunately, the descriptions given by the former authors are somewhat brief, particularly on the carapace, the maxilla, the first and second maxillipeds, the abdominal somites, and the telson, and thus, inadequate for modern comparative morphological study.

In the present study, therefore, the first zoeal stage of *C. convexus* is described and illustrated in detail from laboratory-hatched material, and morphological comparison is made with previous descriptions for Japanese *C. convexus*. Larval morphology of the first zoea of *C. convexus* is compared with that of six species of *Cyclograpsus intermedius* Ortmann, 1894, *Helicana japonica* (K. Sakai and Yatsuzuka, 1980), *Helicana wuana* (Rathbun, 1931), *Helice tientsinensis* Rathbun, 1931, *Helice tridens* (De Man, 1835), and *Pseudohelice quadrata* (Dana, 1851), the other known cyclograpsinine species from Korea.

MATERIALS AND METHODS

On 10 May 2006, an ovigerous female of *C. convexus*, 35.0 mm in carapace length and 46.0 mm in carapace width was collected by hand from a deep burrow in Suemjingang river mouth off Shinwal, Hadong, southern Korea. The crab was transported to the Laboratory of Systematics and Molecular Evolution, School of Biological Sciences, Seoul National University, and subsequently kept in a plastic trough containing freshwater to imitate presumable habitat conditions in Suemjingang river mouth where this female lives.

The female released more than 300 larvae on 11 May 2006. Newly hatched larvae were preserved in 5% neutral

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Table 1. Descriptions of the known larvae of the varunid subfamily Cyclograpsinae

Species	References
Austrohelice crassa Sakai, Türkay, and Yang, 2003	Wear (1970) as *Helice crassa*
Chasmagnathus convexus (De Haan, 1835)	Baba and Fukuda (1972)
Cyclograpsus cinereus Dana, 1851	Costlow and Fagetti (1967)
Cyclograpsus insularum Campbell and Griffin, 1966	Wear (1970)
Cyclograpsus integer H. Milne Edwards, 1837	Gore and Scotto (1982)
Cyclograpsus intermedius Ortmann, 1894	Terada (1976)
Cyclograpsus intermedius Ortmann, 1894	Kim and Jang (1986)
Cyclograpsus lavauxi H. Milne Edwards, 1853	Wear (1970)
Cyclograpsus punctatus H. Milne Edwards, 1837	Fagetti and Campodonico (1971)
Helicana japonica (K. Sakai and Yatsuzuka, 1980)	Baba and Moriyama (1972) as *Helice tridens wuana*
Helicana wuana (Rathbun, 1931)	Kim and Ko (1982) as *Helice tridens sheni*
Helice formosensis Rathbun, 1931	Mia and Shokita (1997)
Helice latimera Parisi, 1918	Mia et al. (2001) as *Helice tridens latimera*
Helice tientsinensis Rathbun, 1931	Park (1983) as *Helice tridens tientsinensis*
Helice tridens (De Haan, 1835)	Baba and Moriyama (1972) as *Helice tridens tridens*
Helice tridens (De Haan, 1835)	Terada (1974) as *Helice tridens tridens*
Neohelice granulatus (Dana, 1851)	Boschi et al. (1967) as *Chasmagnathus granulata*
Pseudohelice quadrata (Dana, 1851)	Baba et al. (1984) as *Helice leachi*
Pseudohelice quadrata (Dana, 1851)	Mia and Shokita (1996) as *Helice leachi*

formalin, and dissected in lactophenol. Dissected appendages were examined by using an Olympus BX60 microscope. Drawings were made with the aid of a *camera lucida*. Measurements and setal counts were based on ten specimens. All measurements were made by an ocular micrometer. Rostrodorsal length (RDL) was measured from the tip of the dorsal spine to the tip of rostral spine and carapace length (CL) from the base of the rostrum to the posterior margin of the carapace. The setal armature of the appendages is described from proximal segment to distal and endopod to exopod, and somites are described from anterior to posterior. The long natatory setae on the exopods of the first and second maxillipeds are drawn truncated. The chromatophore pattern was determined by observing living zoea. Voucher specimens of the female crab from which the larvae hatched and its first zoea were deposited at the Invertebrate Resources Bank of Korea (IRBK), Seoul National University, Korea, under accession number IRBKAR003767 and IRBKAR003768, respectively.

RESULTS

***Chasmagnathus convexus* (De Haan, 1835)**

First zoea (Fig. 1)

RDL, 1.39 (1.36-1.40) mm; CL, 0.58 (0.56-0.60) mm.

Carapace (Fig. 1A). Dorsal spine long, slightly curved, longer than rostral spine; rostral spine slightly longer than protopod of antenna; lateral spine present; pair of anterodorsal setae present; pair of posterodorsal setae present; posteroventral margin with 9 denticles and 9 minute denticles; eye sessile.

Antennule (Fig. 1B). Uniramous; endopod absent; exopod unsegmented, with 3 (2 stout, 1 thinner) aesthetascs and seta.

Antenna (Fig. 1C). Protopod slightly shorter than rostral spine, with 2 rows of spinules distally; exopod about 24.7% length to protopod, with 3 (1 long, 2 shorter) terminal setae; endopod absent.

Mandibles (Fig. 1D). Asymmetrical; left mandible with 3 teeth between incisor and molar processes; right mandible unarmed in that site; palps absent.

Maxillule (Fig. 1E). Coxal endite with 5 plumodenticulate setae; basal endite with 5 (4 cuspidate and 1 plumodenticulate) setae; endopod 2-segmented, with 1 plumose seta on proximal segment and 5 (1 subterminal, 4 terminal) plumodenticulate setae on distal segment.

Maxilla (Fig. 1F). Coxal endite bilobed, with 4+3 plumodenticulate setae; basal endite bilobed, with 4+4 plumodenticulate setae; endopod unsegmented, bilobed, with 2+2 plumodentculate setae; scaphognathite (exopod) with 4 plumose marginal setae and long setose posterior process.

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

Second maxilliped (Fig. 1H). Coxa without setae; basis with 4 medial setae arranged 1,1,1,1; endopod 3-segmented, with 0,1,6 (3 subterminal+3 terminal) setae; exopod with 4 long, terminal, plumose, natatory setae.

Third maxilliped. Not developed.

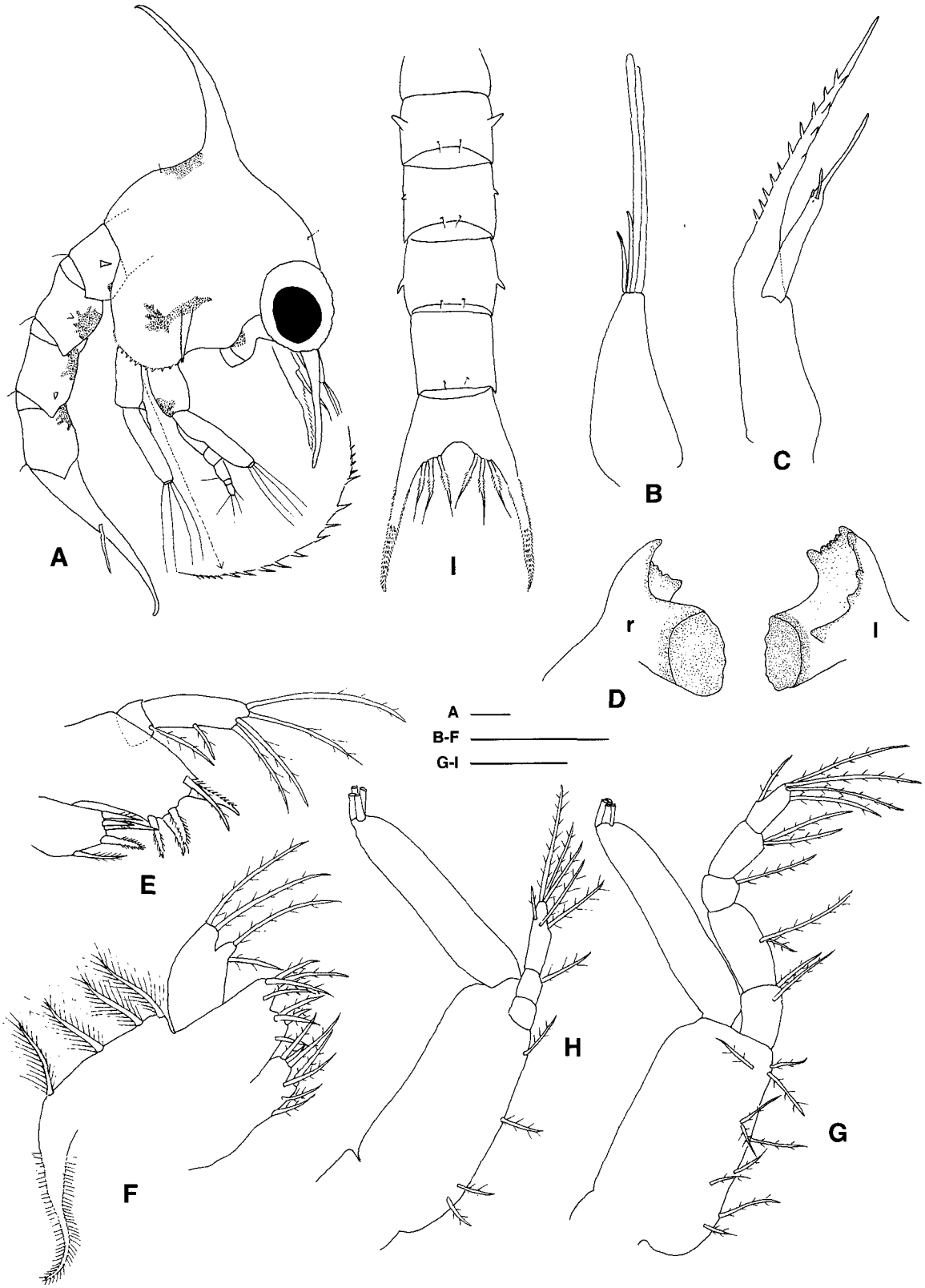

Fig. 1. First zoea of *Chasmagnathus convexus*. A, habitus, lateral view; B, antennule; C, antenna; D, mandibles (r, right; l, left); E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, abdomen and telson, dorsal view. Scale bars=0.1 mm.

Pereopods. Not developed.

Abdomen (Fig. 1I). Five abdominal somites present; first somite without setae; second somite with pair of forwardly directed dorsolateral processes; third and fourth somites with pair of backwardly directed dorsolateral processes; second to fifth somites with pair of posterodorsal setae; pleopods not developed.

Telson (Fig. 1I). Bifurcated, with 3 pairs of serrulate setae on posterior margin; cornua slightly curved distally, inner and outer margin, and dorsal surface of cornua with small teeth.

Chromatophores (Fig. 1A). Brownish chromatophores present on posterior base of dorsal carapace spine; base of lateral carapace spine; mandibles; basis of first maxilliped; and ventrally on second to fifth abdominal somites.

DISCUSSION

Baba and Fukuda (1972) described the complete larval development of Japanese estuarine crab *C. convexus*. However, some morphological characteristics of the first zoea of *C. convexus* described in the present study, particularly on the carapace, the maxilla, the first and second maxillipeds, the abdominal somites, and the telson, differ from those of the earlier description (Table 2). Baba and Fukuda (1972) described that the inner margin of the cornua of telson was fringed with very fine teeth. Moreover, the earlier authors had no comment on the presence of a pair of dorsal setae on the carapace, and a pair of posterodorsal setae on the abdominal somites. Our study, however, revealed that small teeth are present on the inner and outer margins of the cornua of

Table 2. Morphological differences between the descriptions of the first zoea of *Chasmagnathus convexus* given by Baba and Fukuda (1972) and that obtained in the present study. ?=data unknown; *=data from figure.

	Baba and Fukuda (1972)	Present study
Carapace		
posterolateral margin	7 denticles	9 denticles and 9 minute denticles
pair of anterodorsal setae	?	+
pair of posterodorsal setae	?	+
Maxilla		
coxal endite	unilobed, with 7 setae*	bilobed, with 4+3 setae
basal endite	bilobed, with 9 setae	bilobed, with 4+4 setae
First maxilliped		
coxa	?	unarmed
basis	6 setae*	2,2,3,3 setae
Second maxilliped		
coxa	?	unarmed
basis	4 setae*	1,1,1,1 setae
Abdomen		
posterodorsal setae	?	second to fifth somites
Telson		
small teeth in cornua	inner margin	inner and outer margins as well as dorsal surface

Table 3. Diagnostic features between the first zoeas of seven cyclograpsinine species from Korea. + or −=presence or absence; *=data from figure.

Species	Lateral carapace spine	Pair of dorsal processes on fourth abdominal somite	Number of setae of exopod of antenna	Length of exopod of antenna to protopod	References
Chasmagnathus convexus (De Haan, 1835)	+	+	3	24.7%	Present study
Helicana wuana (Rathbun, 1931)	+	+	2	17%*	Kim and Ko (1982) as *Helice tridens sheni*
Helice tientsinensis Rathbun, 1931	+	+	2	27%*	Park (1983) as *Helice tridens tientsinensis*
Helice tridens (De Haan, 1835)	+	+	2	21%*	Baba and Moriyama (1972) as *Helice tridens tridens*
Helicana japonica (K. Sakai and Yatsuzuka, 1980)	+	−	2	14.7%*	Baba and Moriyama (1972) as *Helice tridens wuana*
Cyclograpsus intermedius Ortmann, 1894	−	−	2	25%*	Kim and Jang (1986)
Pseudohelice quadrata (Dana, 1851)	−	−	2	24.8%*	Mia and Shokita (1996) as *Helice leachi*

telson, as well as its dorsal surface. We also observed a pair of anterodorsal and posterodorsal setae on the carapace and a pair of posterodorsal setae on the second to the fifth abdominal somites. The previous authors probably overlooked the teeth in the cornua of telson, and the setae on the carapace and the second to the fifth abdominal somites, because these teeth and setae are minute.

Six other cyclograpsinine crabs are reported in Korea: *C. intermedius, H. japonica, H. wuana, H. tientsinensis, H. tridens*, and *P. quadrata* (Kim and Kim, 1997). Larvae are known for all these species in Korea and Japan (Table 1), and they are similar by having the endopods of the maxillule and maxilla with 1,5 and 2+2 setae, respectively. However, as indicated in Table 3, the first zoeas of *C. convexus, H. japonica, H. wuana, H. tientsinensis, H. tridens*, and *P. quadrata* can be readily separated from each other by the following characteristics: 1) presence or absence of lateral carapace spine; 2) presence or absence of pair of dorsolateral processes on fourth abdominal somite; 3) number of setae of exopod of antenna; and 4) length of exopod of antenna to protopod. The first zoea of *C. convexus* can be readily separated from that of *C. intermedius, H. japonica, H. wuana, H. tientsinensis, H. tridens*, and *P. quadrata* by having the lateral carapace spine, a pair of dorsolateral processes on the fourth abdominal somite, the exopod of antenna with three setae, and the exopod of antenna as being 24.7% length to the protopod (Table 3).

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