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First Zoea of *Pugettia gracilis* (Crustacea: Decapoda: Majidae) Reared in the Laboratory

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Abstract: The first zoea of *Pugettia gracilis* is described and illustrated for the first time. Its morphological characteristics are compared with those of other known species of the genus from the northern Pacific waters. Although the *Pugettia* zoeas of the northwestern and the northeastern Pacifics are very similar, they can be easily distinguished by their dorsal carapace spine. In the northwestern Pacific it is spinulate with a spinous tip, while in the northeastern Pacific it is smooth with a blunt tip.

Key words: Majidae, *Pugettia gracilis*, zoea, northeastern Pacific, dorsal carapace spine

The crabs of the genus *Pugettia* appear to be confined to the northern Pacific. There are 12 species in the northwestern Pacific (Griffin and Tranter, 1986) and five species in the northeastern Pacific (Williams et al., 1989). Among them, the larval stages of five species are known from the former: *P. incisa* (De Haan, 1837), *P. intermedia* Sakai, 1938, *P. similis* Rathbun, 1932, *P. quadridens* (De Haan, 1837), and *P. marissinica* Takeda and Miyake, 1972 (see Aikawa, 1929; Kurata, 1969; Terada, 1981; Ko, 1998). However, no larval stage is known from the latter.

The graceful kelp crab, *Pugettia gracilis* Dana, 1851, usually wears a piece of algae on its rostrum. It is found among rocks and algae both on the outer coast and in protected inshore waters from Aleutian Islands to Monterey of America (Jensen, 1995). To date, the larval stage of *P. gracilis* is unknown. Therefore, the aims of this paper are to describe the first zoeal stage of this species and compare its morphology to the previously described zoeas of the genus, *Pugettia*.

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MATERIALS AND METHODS

An ovigerous female of *Pugettia gracilis* was collected in the low intertidal of exposed beach (48°30'N, 122°45'W) on 22 January 2004, Anacortes, WA, USA. The zoeas hatched in the laboratory were reared by using the methods described by Ko (1995), at a constant water temperature of 15 ± 1°C. The zoeas were fixed and preserved in 10% neutral formalin for later use. Dissected appendages were examined using a Leitz laborlux S microscope and drawings were made with the aid of a camera lucida. Setal counts on appendages and measurements were based on the mean of 10 specimens. Setal armature on appendages was described from proximal to distal segments and in order of endopod to exopod. The chromatophore patterns were observed with living zoeae. The remaining zoeas and the spent female were deposited at Silla University, Korea (accession number: SUZ Cr 103247).

RESULTS

Pugettia gracilis
Fig. 1

Zoea 1

Size: Carapace length 0.72 ± 0.02 mm. Distance from tip of dorsal spine to tip of rostral spine 1.48 ± 0.04 mm.

Carapace (Fig. 1A, E): Dorsal longer than rostral spine, with blunt tip; rostral spine much smaller than dorsal, about a third length of antenna; lateral spines absent; pairs of anterodorsal and posterodorsal setae; each ventral margin with 7 setae; eyes sessile.

Antennule (Fig. 1B): Uniramous, with 2 long and 1 shorter terminal aesthetascs plus 1 long and 1 minute terminal setae.

Antenna (Fig. 1C): Protopod spinulate to terminal; endopod about 1/5 length of protopod; exopod bearing

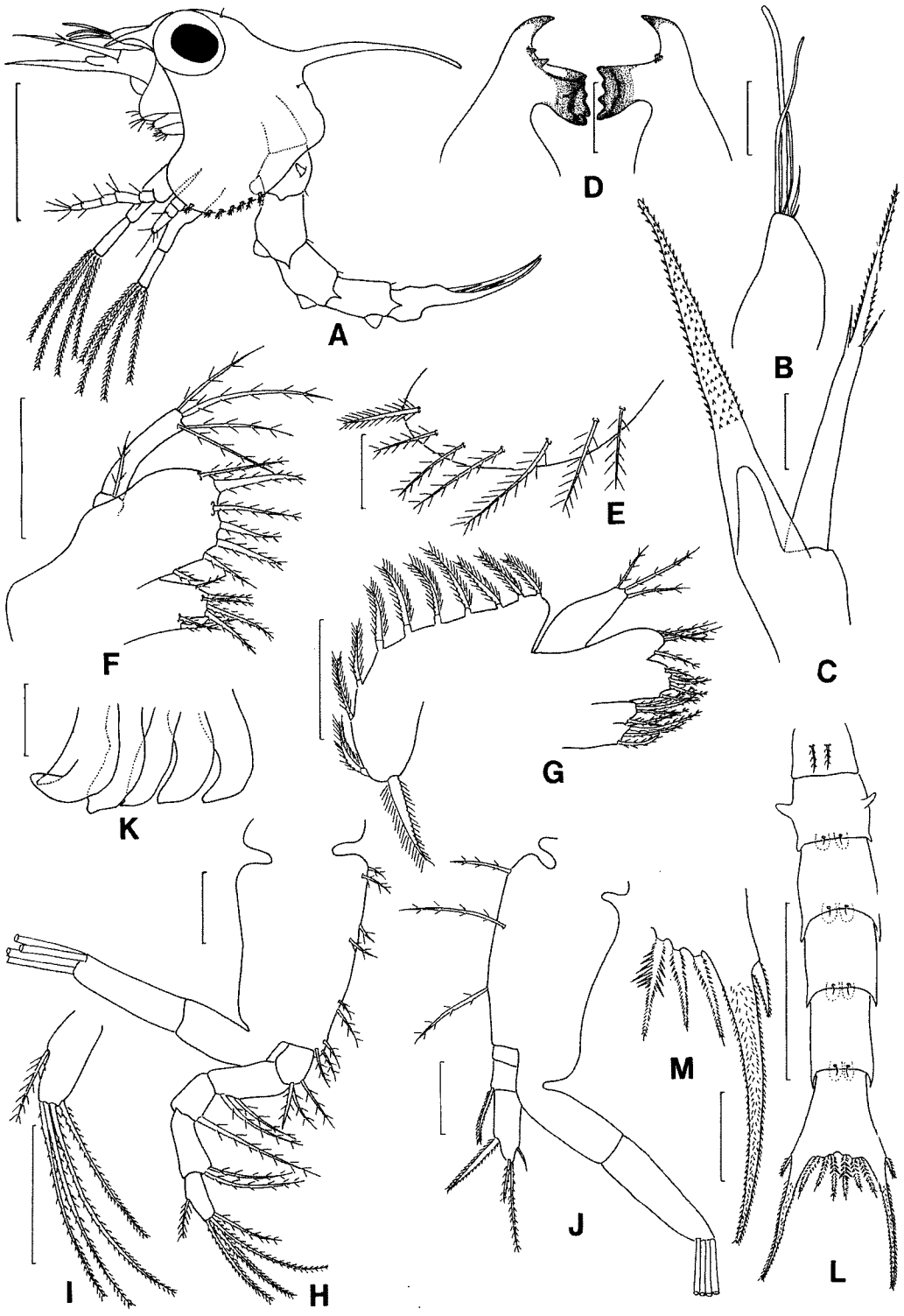

Fig. 1. *Pugettia gracilis*, first zoeal stage. A, Lateral view. B, Antennule. C, Antenna. D, Mandibles. E, Lateral expansion of carapace. F, Maxillule. G, Maxilla. H, First maxilliped. I, Distal segment of endopod in first maxilliped. J, Second maxilliped. K, Pereopods. L, Dorsal view of abdomen and telson. M, Fork of telson. Scale bars = 0.5 mm (A, L) and 0.1 mm (B-K, M).

minute spinules to terminal, with 2 subterminal simple setae.

Mandibles (Fig. 1D): Asymmetrical; right and left molar processes with 4 and 1 teeth, confluent with incisor process respectively; endopod (palp) absent.

Maxillule (Fig. 1F): Coxal and basial endites both with 7

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

Species	*P. marissinica*	*P. intermedia*	*P. quadridens*	*P. similis*	*P. incisa*	*P. gracilis*
Authors	Ko, 1998	Ko, 1998	Ko, 1998	Terada, 1981	Terada, 1981	Present study
CARAPACE						
lateral expansion	5 setae	5 setae	5 setae	ND	ND	7 setae
DORSAL SPINE						
surface	spinulate	spinulate	spinulate	spinulate	ND	smooth
tip	spinous	spinous	spinous	spinous	ND	blunt
ANTENNULE						
aesthetascs+seta	3+2	4+1	4+2	5+1	ND	3+2
MAXILLULE						
endopod	1, 4 setae	1, 4 setae	1, 4 setae	1, 4 setae	1, 4 setae	1, 4 setae
MAXILLA						
endopod	4 setae	4 setae	4 setae	4 setae	3 setae	3 setae
scaphognathite	10+1 setae	10+1 setae	10+1 setae	ND	9+1 setae	10+1 setae
FIRST MAXILLIPED						
subterminal seta on distal segment of endopod	spinous	spinous	spinous	ND	ND	plumose

ND = no data.

setae; endopod 2-segmented, proximal segment with 1 seta, distal segment with 4 terminal setae; exopod setae absent.

Maxilla (Fig. 1G): Coxal endite bilobed, with 4+4 setae; basial endite bilobed, with 5+4 setae; endopod not bilobed, with 3 setae; exopod (scaphognathite) margin with 10 setae plus 1 distal stout process.

First maxilliped (Fig. 1H, I): Basis with 9 setae arranged 2, 2, 2, 3; endopod 5-segmented with 3, 2, 1, 2, 5 (1 subterminal + 4 terminal) setae; exopod 2-segmented, distal segment with 4 natatory setae.

Second maxilliped (Fig. 1J): Basis with 3 setae; endopod 3-segmented, with 0, 1, 4 (2 subterminal and 2 terminal) setae; exopod 2-segmented, distal segment with 4 terminal natatory setae.

Pereopods (Fig. 1K): Cheliped bilobed; ambulatory legs developing as buds.

Abdomen (Fig. 1L): Five somites; somite 1 with pair of dorsomedial setae; somite 2 bearing 1 pair of lateral processes; somites 2-5 with 1 pair of short posterodorsal setae, bearing pleopod buds; somites 3-5 with short posterolateral spines.

Telson (Fig. 1L, M): Each fork long and spinulate, with 1 lateral spine; posterior margin with 3 pairs of setae.

DISCUSSION

Ko (1998) reported that in the northwestern Pacific *Pugettia* zoeas, except *P. incisa*, had common characteristics including a carapace with a dorsal and a rostral carapace spines, a lateral expansion of carapace with 5 setae, an endopod of the maxillule with 1, 4 setae and an endopod of the maxilla with 4 setae. However, the zoea of *P. gracilis* from the northeastern Pacific is somewhat different from them by having a lateral expansion of carapace with 7 setae and an endopod of the maxilla with 3 setae. Especially, it is interesting that the present zoea and *P. incisa* of the northwestern Pacific have 3 setae on an endopod of the maxilla. The endopod of a maxilla has been considered as an important character by brachyuran larval researchers [ex. from Aikawa (1929) to Rice (1980)]. Therefore, it is suggested that *P. gracilis* shows more similarity to *P. incisa* than to the other known *Pugettia* zoeas.

Although the zoeal description of the *Pugettia* is limited to the present species in the northeastern Pacific, the difference in zoeas between the northwestern and the northeastern Pacifics seems to be in the characteristics of the dorsal carapace spine and the subterminal seta on the distal segment of endopod of the first maxilliped. As shown in Table 1, the smooth and blunt tip of the dorsal carapace spine appears in the present zoea of the northeastern Pacific, whereas in the northwestern Pacific, it is spinulate and has a spinous tip. In addition, the zoeas of three species (*P. marissinica*, *P. intermedia*, and *P. quadridens*) consistently show a seta on the distal segment of endopod of the first maxilliped to be stout and spinous, whereas in the northwestern Pacific, the seta is plumose.

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