

Early Zoeas of Two Snapping Shrimps *Alpheus digitalis* De Haan, 1850 and *Alpheus japonicus* Miers, 1879 (Decapoda, Caridea, Alpheidae) with Notes on the Larval Characters of the Alpheidae

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Early zoeal stages of two snapping shrimps *Alpheus digitalis* De Haan, 1850 and *Alpheus japonicus* Miers, 1879 are described and illustrated in detail for the first time based on the laboratory-reared materials. The first zoeas of *Alpheus* are more related to those of *Vexillipar* than to *Athanas*, *Automate*, and *Synalpheus* by having rostrum absent, the tip of the endopod of the antenna with a long plumose seta as well as a spine, the endopod of the maxilla with a basal and two terminal setae, the exopod of the maxilla shorter than the endopod, and the endopod of the second maxilliped with a seta on the proximal segment. A list of larval descriptions and described stages of the Alpheidae reported from Indo-West Pacific waters are included.

Knowledge on caridean larvae is especially necessary for those studies related to life history strategies, stock-recruitment, and population dynamics including spatio-temporal distribution of the plankton (González-Gordillo and Rodríguez, 2000). The first step towards these studies is to have correct identification of caridean larvae in plankton samples. In most cases, larval descriptions available to caridean larvae, however, are very scanty and can not be used to identify them at the species level. Moreover, a recent study (González-Gordillo and Rodríguez, 2000) on the plankton from Cadiz Gulf, Spain revealed that the first larvae appeared with a high frequency (about 85%) relative to the coastal plankton in estuarine waters. For these reasons, descriptions of the early larval stage of caridean shrimps are essential for accurate larval identification.

The family Alpheidae contains at least 400 species belonging to 32 genera world-wide to date (Miya, 1995), of which larval descriptions are known for only seven genera (about 22%) from Indo-West Pacific waters. Seven alpheid species attributing to four genera, *Alpheus*, *Synalpheus*, *Betaeus*, and *Stenalpheops* (as *Chelomalpheus koreanus*) are known to occur in Korean waters (Kim, 1977; Kim and Kim, 1997; Kim, 1998). Of these, larval developments are documented for only two genera *Alpheus* and *Synalpheus*. Recently, larval stages of *Athanas parvus* De Man, 1910

are described by Yang (1999). However, information on the larvae of *Betaeus* and *Stenalpheops* still remains unknown. No descriptions on the larvae of *Alpheus digitalis* De Haan, 1850 and *Alpheus japonicus* Miers, 1879 are known.

The present study is to describe and illustrate in detail the early zoeal stages of *A. digitalis* and *A. japonicus* for the first time and discuss the larval characteristics of alpheid genera whose larvae are known.

Materials and Methods

On May 1996 and 1997, ovigerous females of *Alpheus digitalis* and *Alpheus japonicus* were collected from fine-meshed net for leptocephalus larvae of the eels *Anguilla* sp. in Kangwha Islands. They were placed in glass container filled with sea water with salinity of 33.3‰ at room temperature (20-25°C) until hatching occurred. Body length (BL) was measured from posterior orbital margin to the telson, excluding telsonic setae. Carapace length (CL) was measured from posterorbital margin to posteromedian border of the carapace. Setal armature on appendages was described from proximal to distal segmentation (see Clark et al., 1998). The first zoeal stages of both species are described in detail, of the following stages only the morphological changes from the preceding stages were given. Voucher specimens are deposited in Silla University. The other methods follow those used by Yang and Kim (1999).

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Results

Alpheus digitalis De Haan, 1850 (Figs. 1-2)

First zoea (Fig. 1)

BL. 1.90 mm (1.84-1.98 mm); CL. 0.35 mm (0.30-0.40 mm)

Carapace (Fig. 1A) without rostrum; pterygostomial spines present distinctly; eyes sessile. Abdomen (Fig. 1A) without spines; with 6 somites, last somite fused with telson. Telson (Fig. 1B) triangular, with moderate posterior indentation; posterior margin with 7+7 plumose setae; minute setules between setae 4-7; uropods absent. Antennule (Fig. 1C) with peduncle unsegmented; inner flagellum with long plumose seta; outer flagellum with 3 aesthetascs, short plumose seta, and long simple seta. Antenna (Fig. 1D) with peduncle with basal spine; endopod less than half the length of scale, with long plumose seta and small spine; scale 5-segmented at distal end, and with 11 plumose setae and distolateral spine. Mandible rudimentary, without palps. Maxillule (Fig. 1E) with endopod 1-segmented, with large denticulate seta; basal endite with 2 stout spines and short simple seta subterminally; coxal endite with 5 plumose setae. Maxilla (Fig. 1F) with coxal endite with plumose and simple seta; basal endite with 3 setae on proximal and distal lobes, respectively; endopod with simple seta at base, 2 setae terminally, and fine hairs on its margin; scaphognathite with 5 highly plumose setae. First maxilliped (Fig. 1G) with coxal endite with simple seta; basal endite with 4 spiniform and 3 simple setae; endopod with simple seta basally and 3 setae terminally; exopod with 4 natatory plumose setae. Second maxilliped (Fig. 1H) with coxal endite unarmed; basal endite with 3 spiniform setae and simple seta; endopod incompletely 4-segmented, with 1, 0, 1, 4 setae; exopod with 5 natatory plumose setae and short simple seta laterally. Third maxilliped (Fig. 1I) with coxal endite unarmed; basal endite with simple seta; endopod slightly longer than exopod and 4-segmented, with 0, 0, 2, 4 setae; exopod with 6 natatory plumose setae and short simple seta laterally. Pereiopods (Fig. 1J) with first pereopod biramous rudiment; second and fifth pereopods uniramous rudiments.

Bright red chromatophores also on base of rostrum, on carapace, and junction of thorax and abdomen. Interspersion of red chromatophores among yellow ones on anterior eyestalks, on distal antennular peduncle, on dorsal region of abdominal somites 2-5, and supra-region of telson. This pattern of chromatophores persisting in all zoeal stages.

Second zoea (Fig. 2)

BL. 1.92 mm (1.84-2.10 mm); CL. 0.46 mm (0.44-0.50 mm)

Carapace (Fig. 2A) with rostrum untoothed; longer than the previous stage; supraorbital spines absent; eyes stalked. Telson (Fig. 2B) with posterior margin with 8+8

setae; uropod visible within cuticle. Antennule (Fig. 2C) with peduncle 2-segmented: 2 plumose setae on proximal and 2 plumose and simple setae on distal segments; outer flagellum with 5 aesthetascs and simple seta. Antenna (Fig. 2D) with scale 3-segmented at distal end, with 11 plumose setae and distolateral spine. Mandible (Fig. 2E) asymmetrical, without palps; incisor and molar processes well developed; left mandible unarmed between incisor and molar processes; right mandible with tooth in that angle. Maxilla (Fig. 2G) with basal endite with 2 plumose and 3 simple setae on proximal lobe and 4 simple setae on distal lobe. Second maxilliped (Fig. 2I) with basal endite with 2 spiniform and 2 simple setae; endopod 5-segmented, with 1, 0, 0, 1, 4 setae. Third maxilliped (Fig. 2J) with endopod 5-segmented, with 0, 0, 0, 2, 4 setae; dactylus long, sharply pointed, with 4 denticles distally. Pereiopods (Fig. 2K) with second pereopod biramous rudiment.

Alpheus japonicus Miers, 1879 (Figs. 3-6)

First zoea (Fig. 3)

BL. 2.01 mm (1.86-2.24 mm); CL. 0.47 mm (0.44-0.50 mm)

Carapace (Fig. 3A) without rostrum; pterygostomial spines present; eyes sessile. Abdomen (Fig. 3A) without any spines; with 6 somites, last somite fused with telson. Telson (Fig. 3B) triangular, with more deep posterior indentation; posterior margin with 7+7 plumose setae; minute setules between setae 4-7; uropods absent. Antennule (Fig. 3C) with peduncle unsegmented; inner flagellum with long plumose seta; outer flagellum with 3 aesthetascs, short plumose and long simple seta. Antenna (Fig. 3D) with peduncle with basal spine; endopod less than half the length of scale, with long plumose seta and small spine; scale 4-segmented at distal end, and with 11 plumose setae and distolateral spine. Maxillule (Fig. 3E) with coxal endite with 3 terminal setae; basal endite with 2 stout spines and 2 plumose setae; endopod 1-segmented, with large denticulate seta. Maxilla (Fig. 3F) with coxal endite with 2 plumose setae; proximal and distal lobes of basal endite with 2 and 4 plumose setae, respectively; endopod with simple seta at base, 2 terminal setae, and fine hairs on its margin; scaphognathite with 5 highly plumose setae. First maxilliped (Fig. 3G) with coxal endite with simple seta; basal endite with 4 spiniform and 3 simple setae; endopod with simple seta at base and 3 terminal setae; exopod with 4 natatory plumose setae. Second maxilliped (Fig. 3H) with basal endite with 3 spiniform and 2 simple setae; endopod 3-segmented, with 1, 1, 5 setae; exopod with 5 natatory plumose setae. Third maxilliped (Fig. 3I) with coxal endite unarmed; basal endite with simple seta; endopod slightly longer than exopod and 2 segmented, with 2, 4 setae; exopod with 6 natatory plumose setae. Pereiopods (Fig. 3J) with first pereopod biramous rudiment; second and fifth pereopods

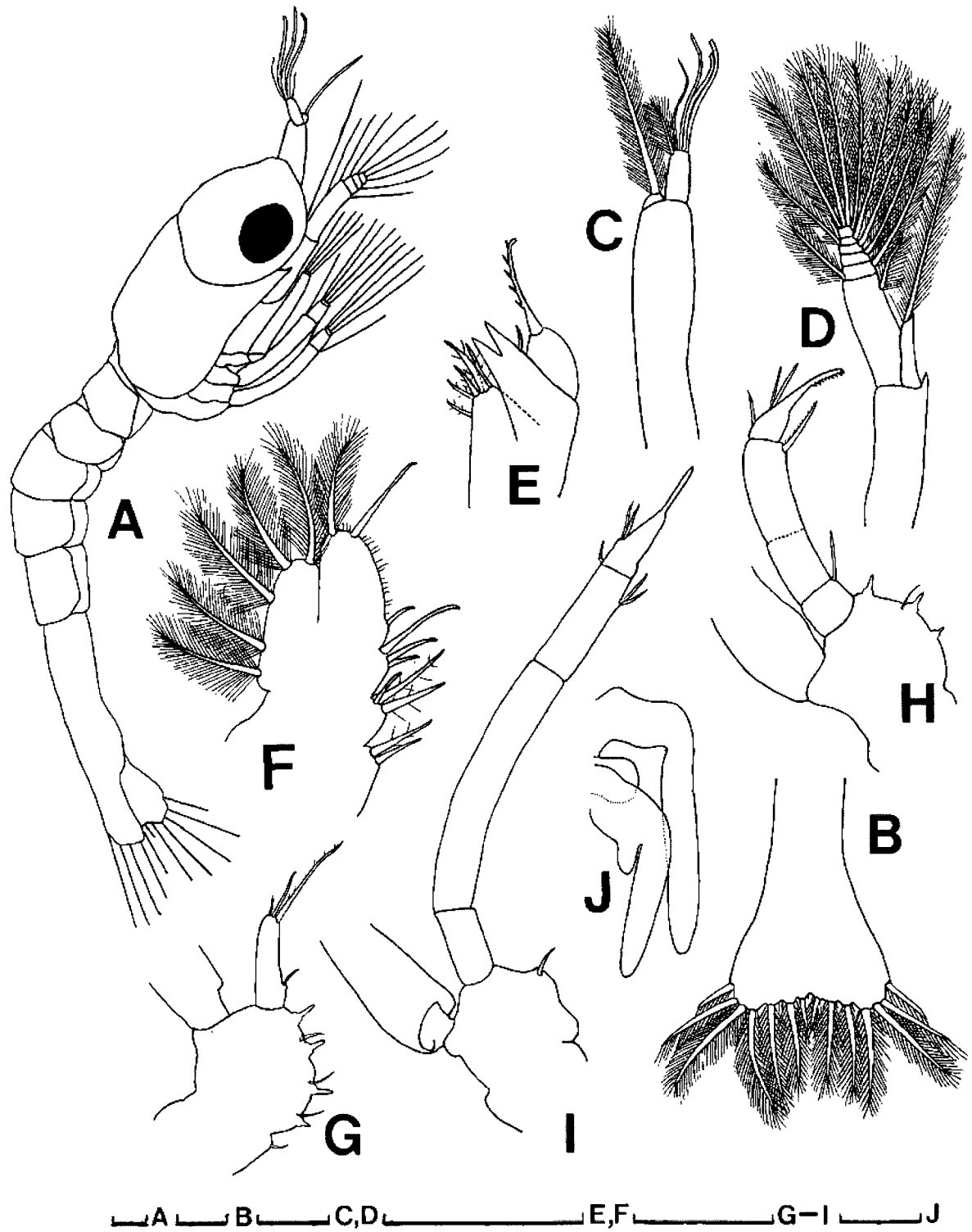


Fig. 1. First zoea of *Alpheus digitalis* De Haan, 1850. A, Lateral view. B, Telson. C, Antennule. D, Antenna. E, Maxillule. F, Maxilla. G, First maxilliped. H, Second maxilliped. I, Third maxilliped. J, Pereiopods. Scale bars = 0.1 mm.

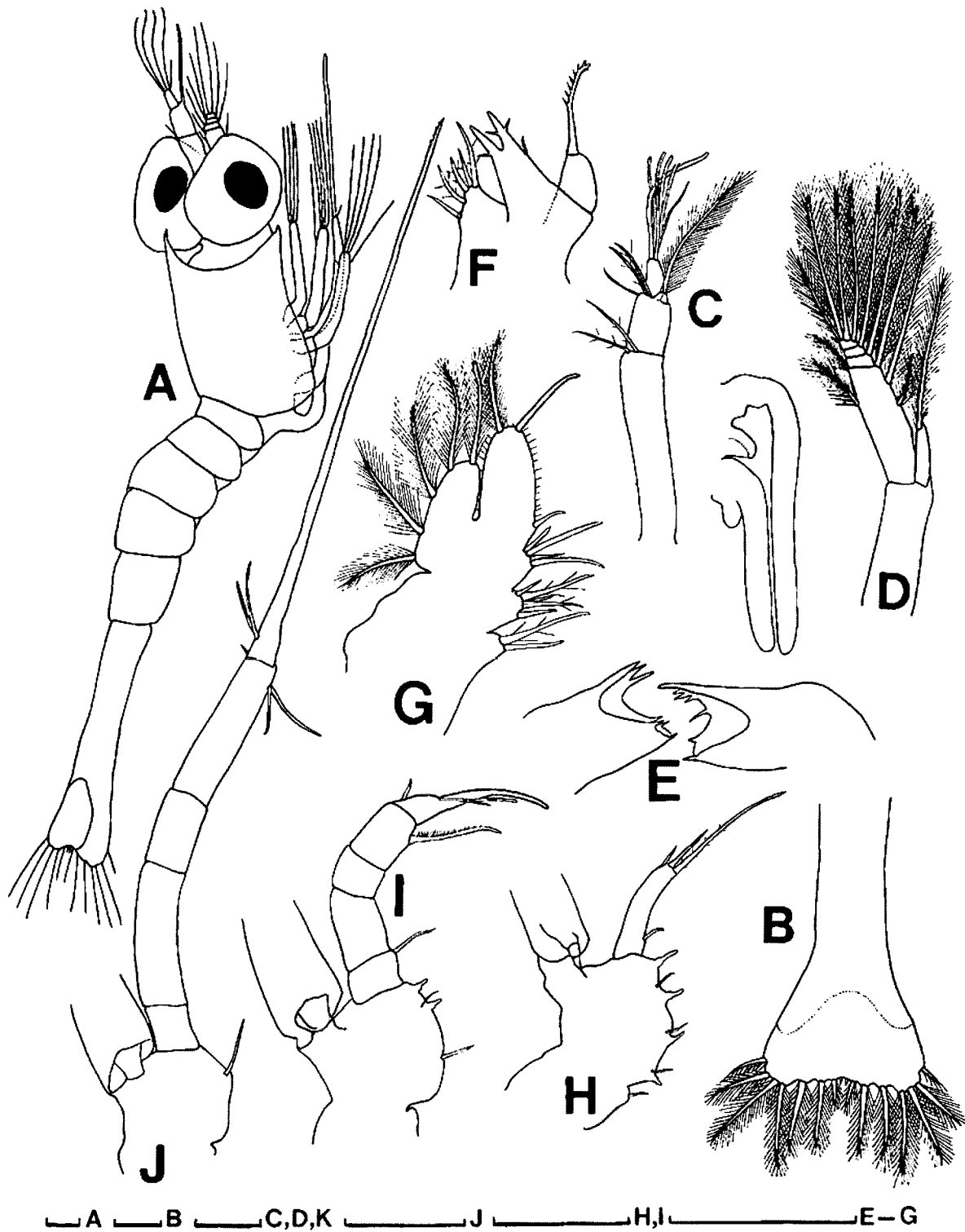


Fig. 2. Second zoea of *Alpheus digitalis* De Haan, 1850. A, Lateral view. B, Telson. C, Antennule. D, Antenna. E, Mandible. F, Maxillule. G, Maxilla. H, First maxilliped. I, Second maxilliped. J, Third maxilliped. K, Pereiopods. Scale bars = 0.1 mm.

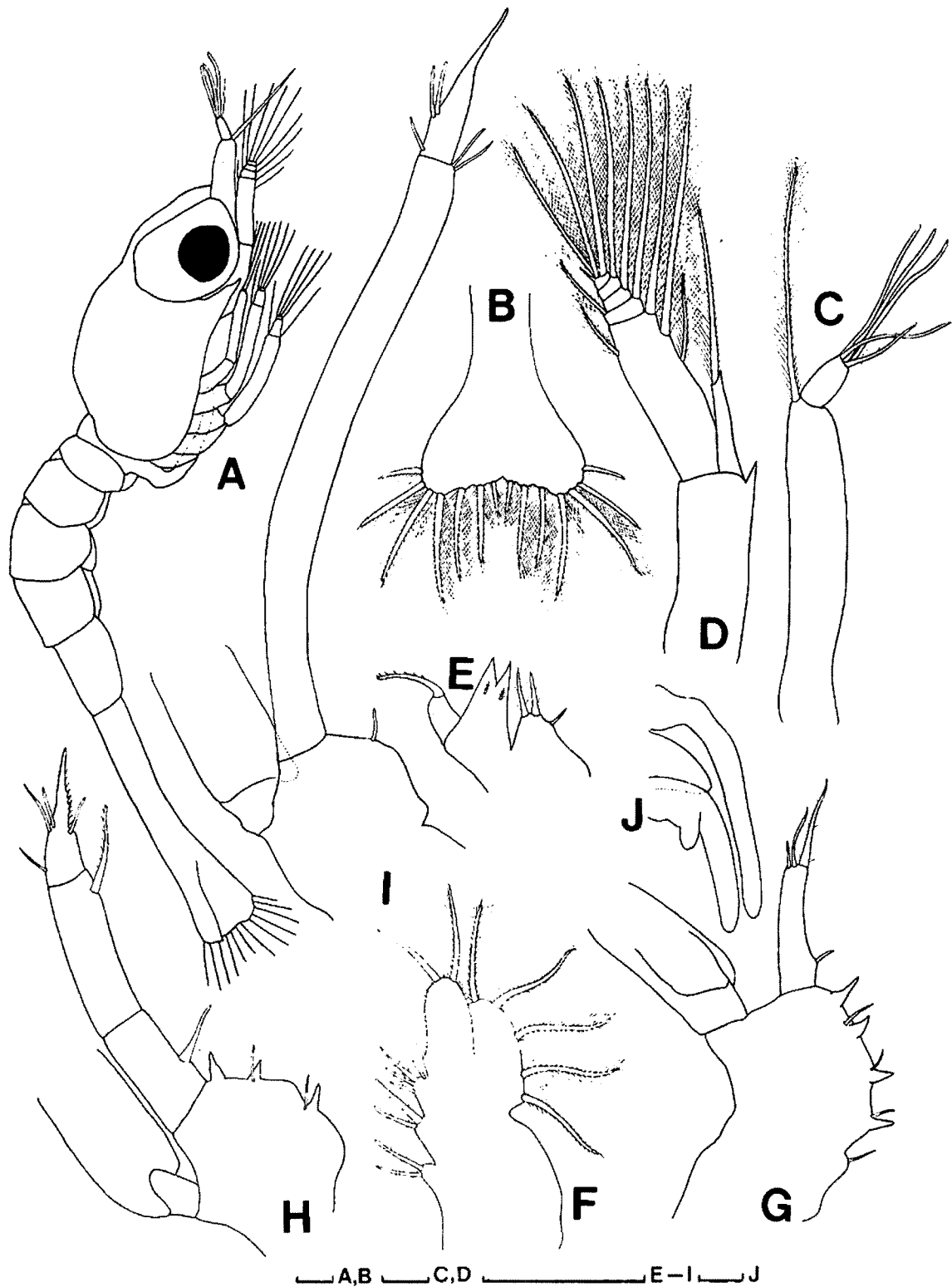


Fig. 3. First zoea of *Alpheus japonicus* Miers, 1879. A, Lateral view. B, Telson. C, Antennule. D, Antenna. E, Maxillule. F, Maxilla. G, First maxilliped. H, Second maxilliped. I, Third maxilliped. J, Pereiopods. Scale bars = 0.1 mm.

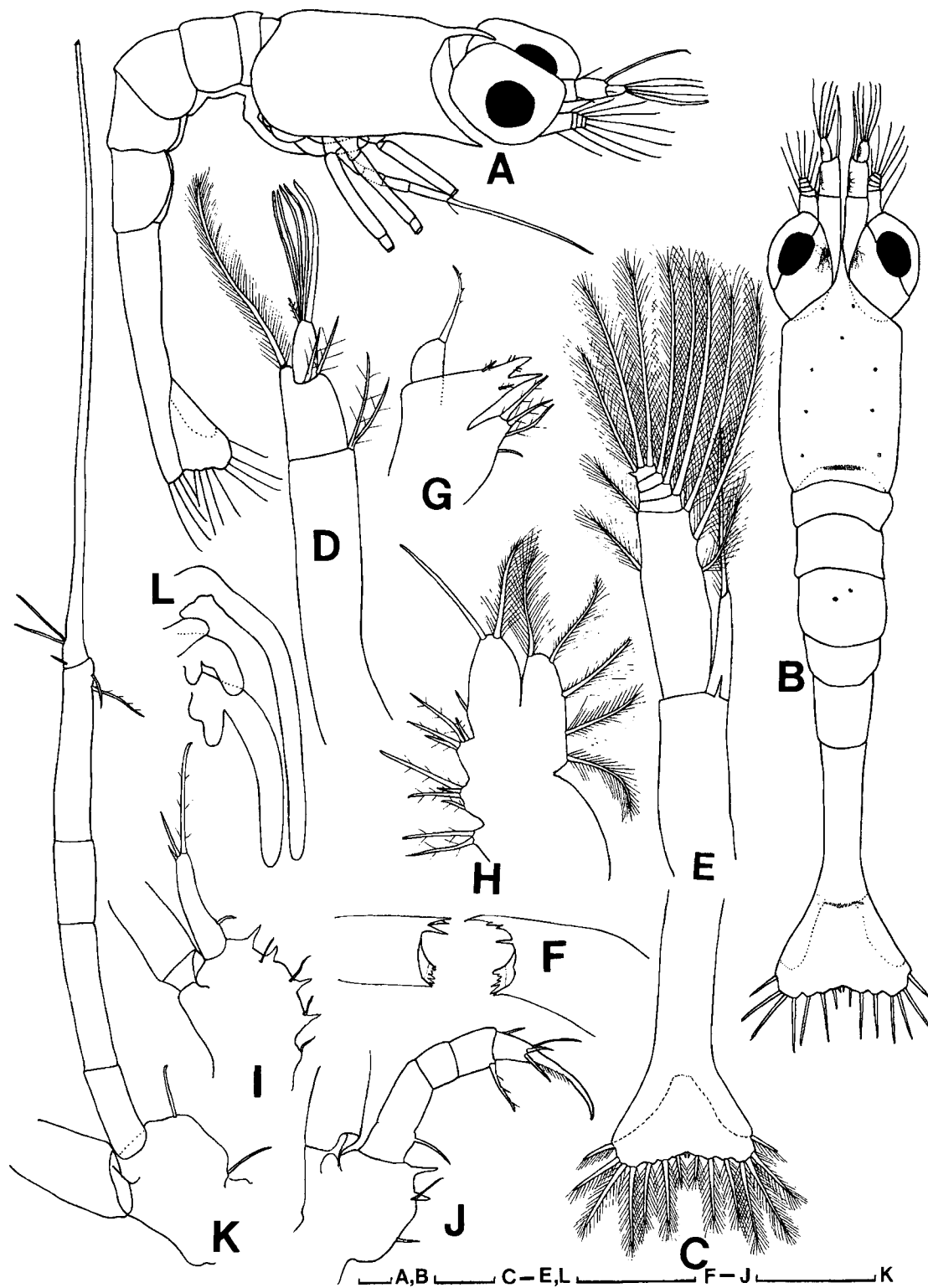


Fig. 4. Second zoea of *Alpheus japonicus* Miers, 1879. A, Lateral view. B, Dorsal view. C, Telson. D, Antennule. E, Antenna. F, Mandible. G, Maxillule. H, Maxilla. I, First maxilliped. J, Second maxilliped. K, Third maxilliped. L, Pereiopods. Scale bars = 0.1 mm.

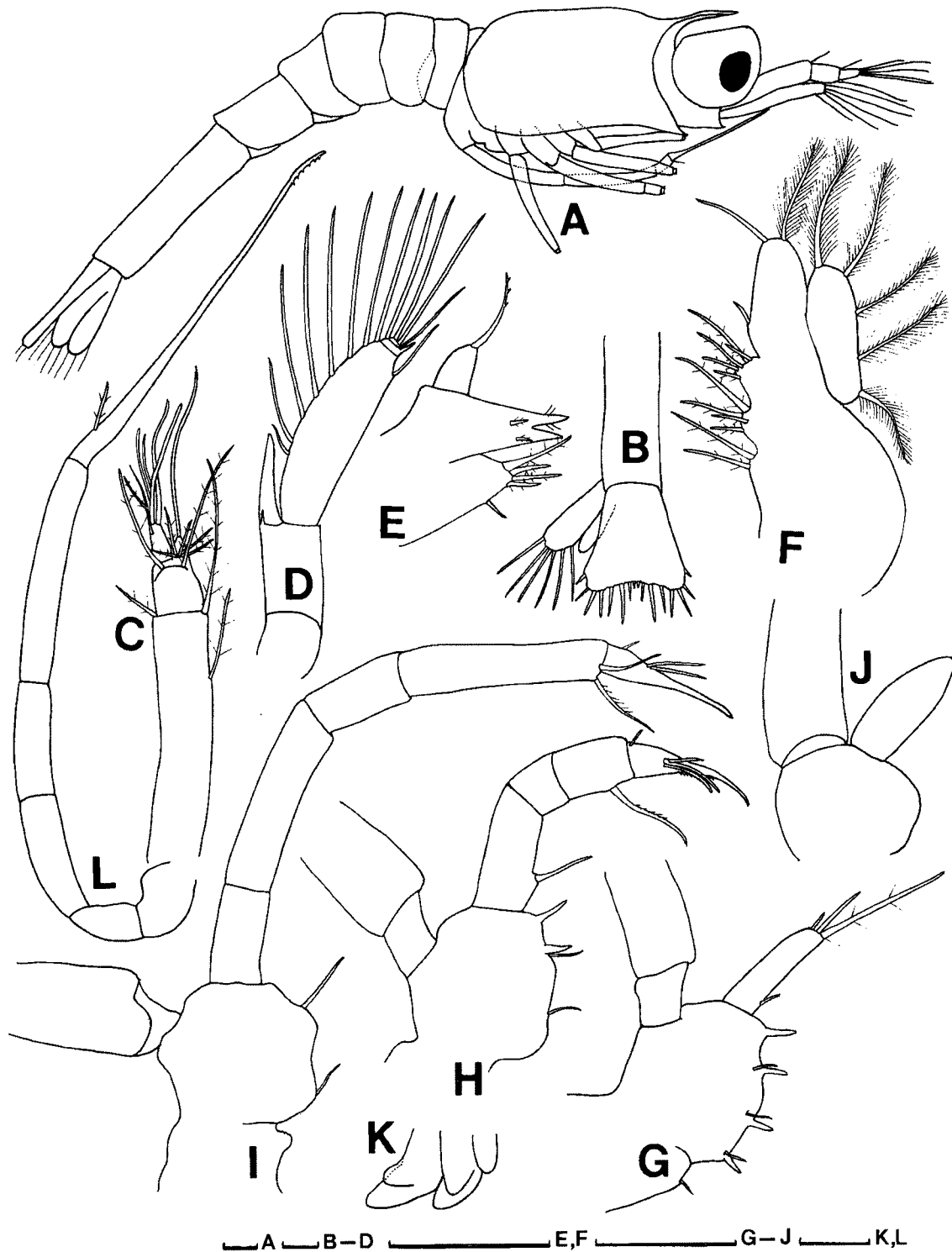


Fig. 5. Third zoea of *Alpheus japonicus* Miers, 1879. A, Lateral view. B, Telson and uropod. C, Antennule. D, Antenna. E, Maxillule. F, Maxilla. G, First maxilliped. H, Second maxilliped. I, Third maxilliped. J, First pereiopod. K, Second, third, and fourth pereiopods. L, Fifth pereiopod. Scale bars = 0.1 mm.

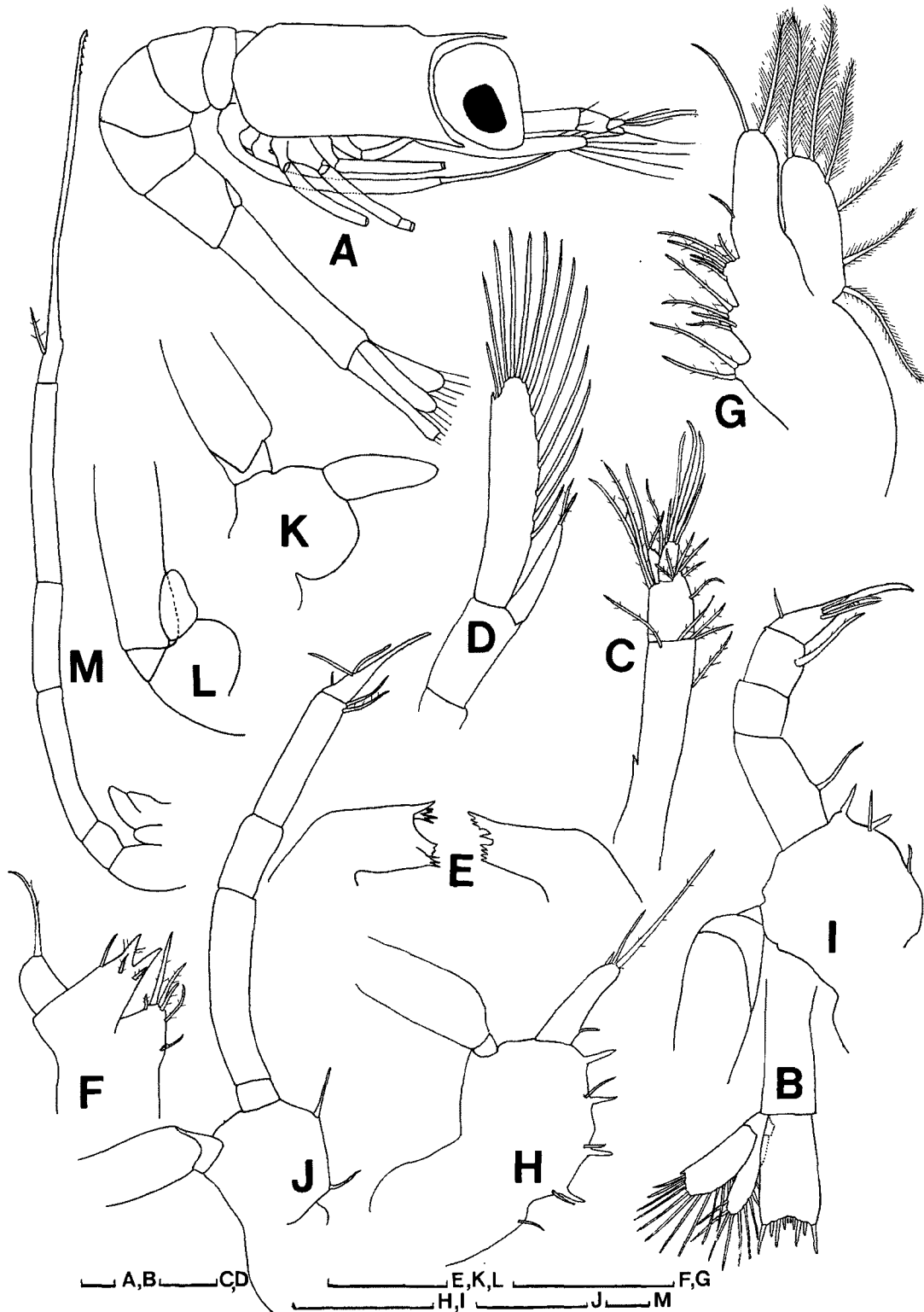


Fig. 6. Fourth zoea of *Alpheus japonicus* Miers, 1879. A, Lateral view. B, Telson and uropod. C, Antennule. D, Antenna. E, Mandible. F, Maxillule. G Maxilla. H, First maxilliped. I, Second maxilliped. J, Third maxilliped. K, First pereiopod. L, Second pereiopod. M, Third, fourth, and fifth pereiopods. Scale bars = 0.1 mm.

Table 1. List of larval descriptions of the Alpheidae reported from Indo-West Pacific waters

Species	Described stages	Locality	References
<i>Alpheus brevicristatus</i> De Haan, 1844*	Z1-4	Japan, Korea	Miyazaki, 1937; Yang and Kim, 1998
<i>Alpheus digitalis</i> De Haan, 1850*	Z1-2	Korea	Present study
<i>Alpheus euphrosyne richardsoni</i> Yaldwyn, 1971*	Z1-3	New Zealand, Korea	Packer, 1985; Yang and Kim, 1996
<i>Alpheus heeia</i> Banner and Banner, 1975*	Z1-3	Korea	Yang and Kim, 1999
<i>Alpheus japonicus</i> Miers, 1879*	Z1-4	Korea	Present study
<i>Alpheus lobidens</i> De Haan, 1850*	Z1-4	Korea	Yang, 1999
<i>Alpheus rapacida</i> De Man, 1908	Z2	India	Prasad and Tampi, 1957
<i>Alpheus strenuus</i> Dana, 1852	Z1	India	Prasad and Tampi, 1957
<i>Alpheus sudara</i> Banner and Banner, 1966*	Z1-3	Korea	Yang, 1999
<i>Alpheus socialis</i> Heller, 1865	Z3	New Zealand	Packer, 1985
<i>Alpheopsis garricki</i> Yaldwyn, 1971	Z3	New Zealand	Packer, 1985
<i>Athanas dimorphus</i> Ortmann, 1894	Z1-3	India	Bhuti et al., 1977
<i>Athanas parvus</i> De Man, 1910*	Z1-3	Korea	Yang, 1999
<i>Automate dolichognatha</i> De Man, 1888	Z1	India	Bhuti et al., 1977
<i>Betaeopsis aequimanus</i> (Dana, 1852)	Z3	New Zealand	Packer, 1985
<i>Synalpheus tumidomanus</i> (Paulson, 1875)*	Z1-3	India	Bhuti et al., 1977
<i>Vexillipar repandum</i> Chace, 1988	Z1	Japan	Saito et al., 1998

Bold face, new records to Korea; *, shrimps occurred in Korean waters; Z, zoeal stages

uniramous rudiments.

Red pigments present on carapace, on junction of thorax and abdominal somites, and abdominal somites 2-3 dorsally. Interspersion of yellow among red pigments on antennular peduncle, anterior to eyestalk, and supra-region of telson. Yellow pigments on abdominal somites 2-3 laterally.

Second zoea (Fig. 4)

BL. 2.32 mm (2.28-2.40 mm); CL. 0.60 mm (0.56-0.62 mm)

Carapace (Figs. 4A, B) with rostrum untoothed, longer than the previous stage; supraorbital spines absent; eyes stalked. Telson (Fig. 4C) with posterior margin with 8+8 setae; uropod visible within cuticle. Antennule (Fig. 4D) with peduncle 2-segmented: 2 plumose setae on both proximal and distal segments; outer flagellum with 4 aesthetascs, simple, and plumose seta. Mandible (Fig. 4F) asymmetrical, without palps; incisor and molar processes well-developed; left mandible unarmed between incisor and molar processes; right one with tooth in that angle. Maxillule (Fig. 4G) with coxal endite with 3 terminal and subterminal plumose setae. Maxilla

(Fig. 4H) with basal endite with 4 plumose setae on both proximal and distal lobes. Second maxilliped (Fig. 4J) with basal endite with 2 spiniform and 2 simple setae. Third maxilliped (Fig. 4K) with basal endite with 2 simple setae; endopod 5-segmented, with 0, 0, 0, 2, 3 setae; dactylus long and sharply pointed, without denticles distally. Pereiopods (Fig. 4L) with first and second pereiopods biramous rudiment; third and fifth pereiopods uniramous rudiments.

Third zoea (Fig. 5)

BL. 2.41 mm (2.32-2.60 mm); CL. 0.65 mm (0.52-0.70 mm)

Abdomen (Fig. 5A) composed of six segments, last distinct from telson. Telson (Fig. 5B) with 8+8 marginal plumose setae. Uropod (Fig. 5B) free: endopod rudimentary; exopod with 6 plumose setae on terminal margin. Antennule (Fig. 5C) with peduncle 2-segmented: 3 and 7 setae on proximal and distal segments, respectively; Inner flagellum with long simple seta. Antenna (Fig. 5D) with endopod short spine-like; scale 2-segmented at distal end, with 13 plumose setae and distolateral spine. Maxillule (Fig. 5E) with coxal endite

Table 2. First zoeal characteristics in the known larvae of the genera within the Alpheidae

Species	Rostrum	Antennule EN	Maxillule EN	Maxilla		Maxilliped 2 SPEN	References
				EN	EX/EN		
<i>Alpheus brevicristatus</i> De Haan, 1844	-	1LS,1SP	1	1,2(3)	EX < EN	+	Yang and Kim, 1998
<i>Alpheus heeia</i> Banner and Banner, 1975	-	1LS,1SP	1	1,2(3)	EX < EN	+	Yang and Kim, 1999
<i>Alpheus sudara</i> Banner and Banner, 1966	-	1LS,1SP	1	1,2(3)	EX < EN	+	Yang, 1999
<i>Alpheus lobidens</i> De Haan, 1850	-	1LS,1SP	1	1,2(3)	EX < EN	+	Yang, 1999
<i>Alpheus euphrosyne richardsoni</i> Yaldwyn, 1971	-	1LS,1SP	1	1,2(3)	EX < EN	+	Yang and Kim, 1996
<i>Alpheus digitalis</i> De Haan, 1850	-	1LS,1SP	1	1,2(3)	EX < EN	+	present study
<i>Alpheus japonicus</i> Miers, 1879	-	1LS,1SP	1	1,2(3)	EX < EN	+	present study
<i>Athanas parvus</i> De Man, 1910	-	1SP	2	1,2(3)	EX < EN	-	Yang, 1999
<i>Athanas dimorphus</i> Ortmann, 1894	-	1SP	2	1,2(3)!	EX < EN	-	Bhuti et al., 1977
<i>Athanas djiboutensis</i> Coutière, 1897	-	1SP	2*	?	EX < EN	?	Gurney, 1938
<i>Vexillipar repandum</i> Chace, 1988	-	1LS,1SP	2	1,2(3)	EX < EN	+	Saito et al., 1998
<i>Automate dolichognatha</i> De Man, 1888	minute	1LS,1SP	2	0,4(4)	EX = EN	+	Bhuti et al., 1977
<i>Synalpheus minus</i> Say, 1818	minute	2SS	2*!	? , 3(?) *!	EX > EN	-*	Weise, 1975
<i>Synalpheus pectiniger</i> Coutière, 1909	minute	2SS	?	? , 3(?) *	EX > EN	-	Weise, 1975
<i>Synalpheus fritzmulleri</i> Coutière, 1909	minute	2SS	2*!	? , 3(?) *!	EX > EN	-	Weise, 1975
<i>Synalpheus tumidomanus</i> (Paulson, 1875)	minute	2SS	2	2,3(5)	EX > EN	-	Bhuti et al., 1977

+ or, presence or absence; *, data from figure; ?, no data; !, larval characteristic in the third stage; EN or EX, endopod or exopod; LS or SS, long seta or short seta; SP, spine; SPEN, seta on the proximal segment of the endopod.

with 4 terminal and subterminal setae. Maxilla (Fig. 5F) with basal endite with 4 and 5 plumose setae on proximal and distal lobes, respectively. Third maxilliped (Fig. 5I) with dactylus of endopod much shorter than the previous stage. First pereopod (Fig. 5J) functional: endopod rudimentary; exopod functional, with 6 natatory plumose setae. Pereiopods (Fig. 5K) with second and third pereiopods biramous rudiment; fourth pereopod uniramous rudiment. Fifth pereopod (Fig. 5L) with endopod 5-segmented, with 0, 0, 0, 0, 2 setae: dactylus, straight and sharply pointed, with simple seta proximally and 6 denticles distally.

Fourth zoea (Fig. 6)

BL. 2.66 mm (2.60-2.72 mm); CL. 0.74 mm (0.68-0.80 mm)

Telson (Fig. 6B) narrow, lateral sides parallel, with 5+5 terminal spines. Uropod (Fig. 6B) well-developed: 9 plumose setae on endopod, and 12 plumose setae and distolateral spine on exopod. Antennule (Fig. 6C) with peduncle 2-segmented: 5 plumose setae and basal spine on proximal segment and 8 plumose setae on distal segment; inner flagellum with simple and plumose seta. Antenna (Fig. 6D) with endopod with 2 plumose setae terminally; scale unsegmented at distal end, with 13 plumose setae and distolateral spine. Maxillule (Fig. 6F) with coxal endite with 5 plumose setae and simple seta terminally; basal endite with 2 stout spines and 3 plumose setae. Maxilla (Fig. 6G) with scaphognathite with 6 highly plumose setae. Second pereopod (Fig. 6L) with endopod rudimentary; exopod functional, with 6 natatory plumose setae.

Discussion

From the Indo-West Pacific waters, larval descriptions of the family Alpheidae are known for 17 species represented by seven genera (Table 1). The descriptions provided by earlier authors, however, were not likely accurate, making it difficult to distinguish the first larvae of *Alpheus* from those of other genera. Prasad and Tampi (1957) reported that the first larva of *Alpheus rapacida* De Man, 1908 from Indian waters had broad rostrum, stalked eyes, telson with 8+8 marginal setae, and the endopod dactyl of the third maxilliped with long spine. These characteristics provided by Prasad and Tampi (1957) are those of the second stage of *Alpheus* larvae. Based on the descriptions (Packer, 1985; Yang and Kim, 1996, 1998, 1999; Yang, 1999) recently provided by other authors, the first larvae of *Alpheus* have sessile eyes, telson with 7+7 marginal setae, and do not have the endopod dactyl of the third maxilliped produced into a long spine as well as rostrum. Barkati (1980) observed the time spent by the larvae in different stages of *Alpheus inopinatus* Holthuis and Gottlieb, 1958 and reported that the first larval stage lasted on average 19 h. This is quite short when compared with that of other

caridean larvae (3-4 d). This discrepancy, therefore, may be resulted from Prasad and Tampi's the first larva of *A. rapacida* actually being in the second stage. The endopod of the maxillule of the first zoea of *Alpheus strenuus* Dana, 1852 given by Prasad and Tampi (1957) was armed with two terminal setae. However, the setations of the endopods of the maxillule and maxilla of *Alpheus* larvae appear to be homogeneous and the former always have a denticulate seta terminally, while those of *Athanas*, *Automate*, and *Vexillipar* zoeas were with two setae terminally (Table 2). The difference in setation of *A. strenuus* could be explained by misidentification or inaccurate description.

Based on the descriptions available for the first zoeas of *Alpheus*, morphological characteristics of the first larvae of *Alpheus* can be summarized as follows: rostrum absent; telson triangular with 7+7 marginal setae; endopod of antenna with long plumose and short spine terminally; exopod of antenna with distal segmentation; endopod of maxillule with denticulate seta; endopod of maxilla with basal and two (plumose and simple seta) terminal setae; exopod shorter than endopod; basis of first maxilliped with usually four spiniform setae and with or without simple setae; endopod with basal and three terminal setae; basis of second maxilliped with usually three spiniform setae (rarely two in *Alpheus lobidens* De Haan, 1850 and *Alpheus sudara* Banner and Banner, 1966) and with or without simple setae; endopod with seta on both the proximal and penultimate segments; basis of third maxilliped with seta; endopod with two setae on the penultimate segment; the presence of first pereopod biramous rudiment as well as of fifth pereopod uniramous rudiment.

As shown in Table 2, the first zoeas of *Alpheus* are more similar to those of *Athanas* and *Vexillipar* than to *Automate* and *Synalpheus* by having rostrum absent, the endopod of the maxilla with a basal and two terminal setae, and the exopod of the maxilla shorter than the endopod. *Athanas* zoeas, however, have the tip of the endopod of the antenna spine-like and the endopod of the second maxilliped without a seta on the proximal segment. These characteristics are quite different from those of *Alpheus* and *Vexillipar* zoeas. *Vexillipar* zoeas are similar to *Athanas* zoeas by having the endopod of the maxillule with two setae, but are similar to *Alpheus* zoeas by having the tip of the endopod of the antenna with a long plumose seta as well as a spine and the endopod of the second maxilliped with a seta on the proximal segment. Therefore, the first zoeas of the genus *Alpheus* seems to be more related to those of *Vexillipar* than to *Athanas*, *Automate*, and *Synalpheus*.

Packer (1985) summarized the larval characteristics of the Alpheidae based on the laboratory-hatched materials from New Zealand waters and regarded the maxilla with three endites and the exopod of the

maxilla shorter than the endopod in early stage as the characters of the larvae of the Alpheidae. However, these characters can not be used to apply to all the larvae of the Alpheidae. The number of the maxilla endite is variable depending on the species. The maxilla usually consists of three endites because the proximal coxal endite of the maxilla is reduced in the first larvae. On the other hand, it is retained in the first zoeas of *Automate dolichognatha* De Man, 1888, *Racilius compressus* Paulson, 1875, *Synalpheus neomeris* De Man, 1897, and *Synalpheus goodei* Coutière, 1909 (see Yang and Kim, 1999). The exopod of the maxilla of *Alpheus*, *Athanas*, and *Vexillipar* is shorter than the endopod, but that of *Automate* and *Synalpheus* zoeas do not support Packer's viewpoint. For example, the exopod of the maxilla of *A. dolichognatha* is as long as the endopod of the maxilla. In addition, *Synalpheus* zoeas [*Synalpheus tumidomanus* (Paulson, 1875), *Synalpheus pectiniger* Coutière, 1909, *Synalpheus fritzmuelleri* Coutière, 1909, and *Synalpheus minus* Say, 1818] have the exopod of the maxilla longer than the endopod. One of the two characteristics established by Packer (1985), the relative length of the exopod and endopod of the maxilla, seem to be of importance for distinguishing the first larvae of *Alpheus*, *Athanas*, and *Vexillipar* from those of *Automate* and *Synalpheus*.

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