



Larval stages of *Areopaguristes japonicus* (Miyake, 1961) (Decapoda: Anomura: Diogenidae) described from laboratory reared material*

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Abstract

Areopaguristes japonicus (Miyake, 1961) is recorded from South Korean waters for the first time with the collection of an ovigerous female. The zoeal and megalopal stages of this species are described from laboratory reared material and compared to larvae of eight other described Diogenidae species from the northwestern Pacific. The larvae of *A. japonicus* are distinguished from those of other diogenids by mediodorsal spines on zoeal pleomeres 3 and 4 and having a spine on the mediodorsal margin of the megalopal pleomere 2. A provisional key for identifying diogenid zoeas from the northwestern Pacific is provided.

Key words: larval stages, *Areopaguristes japonicus*, Diogenidae, Pacific

Introduction

Currently, there are 16 recognized species of Diogenidae recorded from Korea (Kim 1973; Kim & Kim, 1997; Kim & Son, 2006; Komai, 2009): one species of *Areopaguristes* (*A. nigroapiculus* Komai, 2009), two species of *Ciliopagurus* [*C. kremphi* (Forest, 1952) and *C. strigatus* (Herbst, 1804)], one species of *Clibanarius* [*C. virescens* (Krauss, 1843)], four species of *Dardanus* [*D. arrosor* (Herbst, 1796), *D. crassimanus* (H. Milne-Edwards, 1836), *D. impressus* (De Haan, 1849), and *D. pedunculatus* (Herbst, 1804)], three species of *Diogenes* [*D. edwardsii* (De Haan, 1849), *D. nitidimanus* Terao, 1913, and *D. penicillatus* Stimpson, 1858], and five species of *Paguristes* (*P. acanthomerus* Ortmann, 1892, *P. digitalis* Stimpson, 1858, *P. ortmanni* Miyake, 1978, *P. seminudus* Stimpson, 1858, and *P. versus* Komai, 2001). During a survey of Korean indigenous species by the National Institute of Biological Resources (NIBR) in 2011, an ovigerous specimen of *Areopaguristes japonicus* (Miyake, 1961) was collected from the southern part of Korea by SCUBA diving. This is the first time this species has been reported from Korea, although *A. japonicus* has a reported distribution in Japan and China from the subtidal zone to a depth of 25 m (Komai, 2009).

Larval descriptions of the Diogenidae are limited to eight species in the northwestern Pacific: *P. digitalis* by Kurata (1968b), *P. ortmanni* by Quintana and Iwata (1987), *D. edwardsii* by Kim *et al.* (2007), *D. nitidimanus* by Baba and Fukuda (1985) and Korn *et al.* (2008), *C. virescens* by Tirmizi and Siddiqui (1979), *D. arrosor* by Kurata (1968a), *D. crassimanus* by Imahara (1989, 1999) and *A. nigroapiculus* by Kornienko and Korn (2011). However, the larval stages of *A. japonicus* are unknown, therefore, the purpose of this study was to describe the complete developmental stages of this species and compare its morphology with larvae of the other described species in the family from the northwestern Pacific. Digital camera images of live larvae are also provided.

Materials and Methods

An ovigerous female of *A. japonicus* was collected by SCUBA diving at a depth of 10 m on June 6, 2011 from Kongseom Island (34°42.16'N, 128°04.05'E), Namhae-gun, Gyeongsangnam-do, Korea. On June 8, the larvae hatched in the laboratory and 36 zoeas were reared using methods described by Oh and Ko (2010) at water

temperature of $20 \pm 1^\circ\text{C}$ and 33‰ salinity. Molts and dead larvae were fixed and preserved in 95% ethanol for later examination. Dissected appendages were examined using a Leitz Laborlux S, a Wild M-5, or a Wild M-20 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 for zoeas and megalopas. Setal armatures of appendages were described from proximal to distal segments and in order of endopod to exopod. The first zoeal stage was completely described and for the subsequent zoeal stages only the principal differences from the previous stage were described. The long plumose natatory setae of the maxillipeds were drawn truncated. An ocular micrometer was used to obtain measurements, which included carapace length (CL), measured from the tip of the rostrum to the midpoint of the posterior carapace margin. Measurements to the second decimal place were taken for the zoeal and megalopal stages to facilitate comparisons with other species. Photos of zoeas and megalopas of *A. nigroapiculus* were obtained from an ovigerous female, which was collected by SCUBA diving in a depth of 15 m on August 20, 2011 from Daejin ($36^\circ34.00'\text{N}$, $129^\circ25.48'\text{E}$), Yeongdeok-gun, Gyeongsangbuk-do, Korea, that hatched in the laboratory on September 21. The larvae and the spent females were deposited at Silla University and National Institute of Biological Resources (NIBR), Korea.

Results

Three zoeal stages occurred before metamorphosis to the megalopa. The duration of each zoeal stage was approximately 3 days, so, the time required to reach the megalopal stage was approximately 9 days at a temperature of $20 \pm 1^\circ\text{C}$.

First zoea (Figs. 1, 6A, B)

Size. CL = 0.96 ± 0.04 mm.

Carapace (Fig. 1A, B). Rostrum well developed, approximately equal in length to antenna; anterolateral marginal spines absent; posterolateral carapace smooth, without spine; eyes sessile.

Antennule (Fig. 1C). Biramous; with 3 (2 stout and 1 thinner) aesthetascs, 3 (2 smaller) setae; 1 long plumose subterminal seta on future endopodal bud.

Antenna (Fig. 1D). Biramous; endopod fused with protopod, with 3 terminal plumose setae; scaphocerite with elongate distal spine, inner margin with 10 long plumose setae; protopod with 1 strong serrate spine at base of endopod.

Mandibles (Fig. 1E). Asymmetrically dentate; incisor process with strong teeth and few smaller teeth; molar process with few strong teeth and few acute small teeth; palp absent.

Maxillule (Fig. 1F). Coxal endite with 6 plumodenticulate setae marginally and 1 short simple seta submarginally; basal endite with 2 strong elongate spine-like teeth armed with few small denticles and 2 plumodenticulate (1 subterminal and 1 terminal) setae; endopod 3-segmented; setal formula progressing distally 1, 1, 3, proximal seta short; exopod absent.

Maxilla (Fig. 1G). Coxal endite bilobed, with 6 plumose setae on proximal lobe, 4 plumose setae on distal lobe; basal endite bilobed, with 5 plumose setae on proximal lobe, 4 plumose setae on distal lobe; endopod bilobed, with 3 plumose setae on proximal lobe and 5 (2 subterminal and 3 terminal) plumose setae on distal lobe; scaphognathite (exopod) with 5 marginal plumose setae.

First maxilliped (Fig. 1H). Coxa with 1 seta; basis with setal formula progressing distally 2, 3, 3, 3; endopod 5-segmented, segmental setation 3, 2, 1, 2, 4+I (Roman numeral denotes dorsolateral plumose seta) and additional fine setules on dorsolateral margins of segments 1–3; exopod with 4 terminal natatory setae.

Second maxilliped (Fig. 1I). Coxa unarmed; basis with 1 short simple seta near distal half, 2 setae near distal angle; endopod 4-segmented, segments 1–3 each with 2 plumose setae, distal segment with 4+I plumose setae and additional fine setules on dorsolateral margins of segments 2, 3; exopod with 4 terminal natatory setae.

Third maxilliped (Fig. 1J). Biramous; endopod unsegmented, unarmed; exopod 2-segmented, with minute terminal spine.

Pereiopods (Fig. 1A) visible as small buds.

Pleon (Figs. 1A, B, 6B). Five pleomeres; segments 2–5 with 1 pair of mediodorsal setae; pleomere 2 with 1 larger spine, pleomeres 3, 5 each with 1 smaller spine and pleomere 4 with 1 smallest spine on mediodorsal margin; pleomere 5 with acute posterolateral spines; pleopods absent.

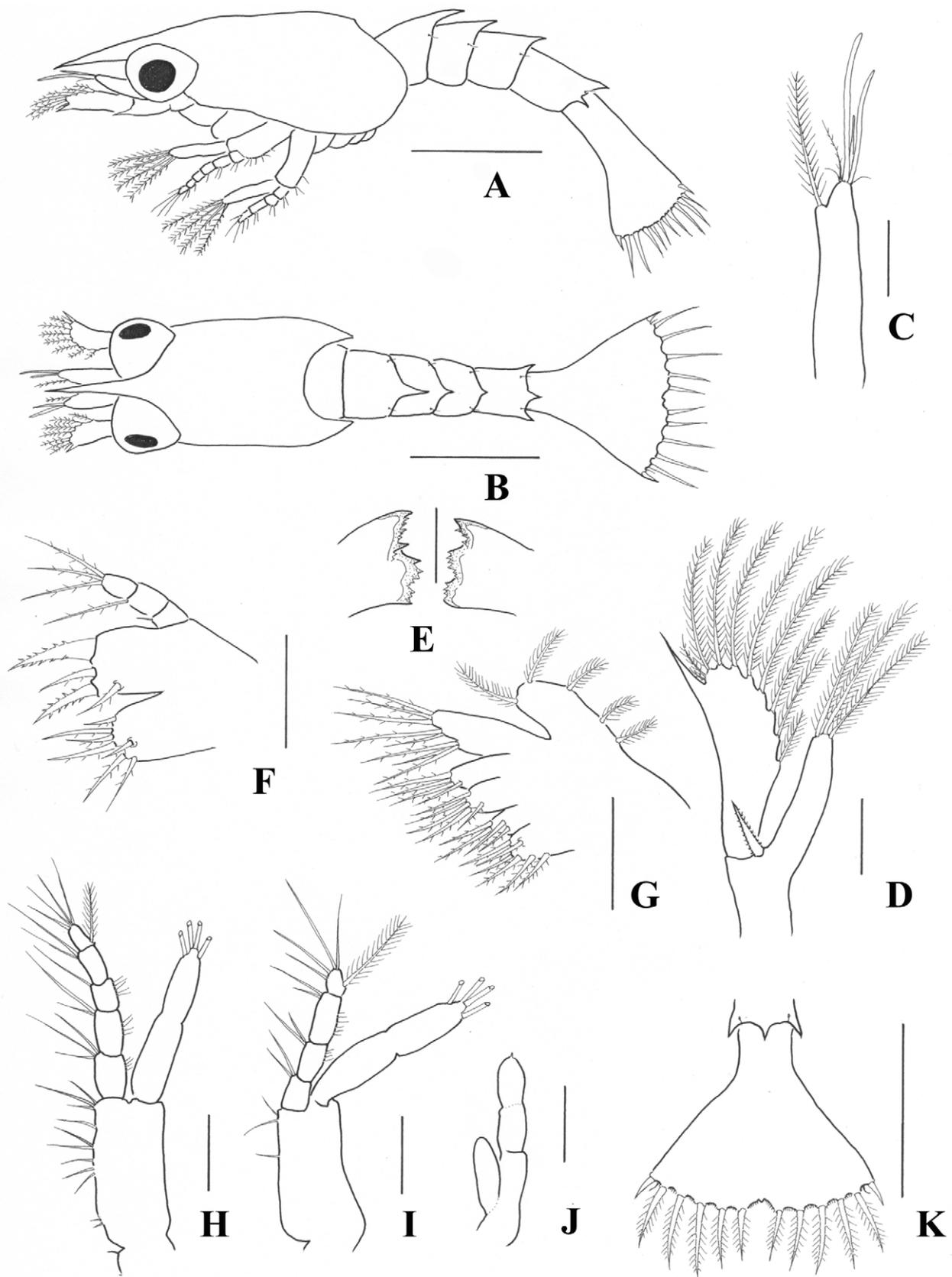


FIGURE 1. *Areopaguristes japonicus* (Miyake, 1961), first zoea: A, lateral view; B, dorsal view; C, antennule; D, antenna; E, mandibles; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, third maxilliped; K, telson. Scale bars = 0.5 mm (A, B, K), 0.1 mm (B–J).

Telson (Fig. 1A, B, K). Fan-shaped posteriorly; posterior margin with shallow median cleft, tiny spiniform process on midpoint, 7+7 processes; outermost smooth spine, second anomuran hair, third through seventh plumodenticulate setae; anal spine absent.

Coloration (Fig. 6A). Red chromatophore on tip of rostrum; black and reddish brown chromatophores on dorsal surfaces of carapace, pleomeres 1–3, pleomeres 4, 5 laterally, telson; brown chromatophores on mandibles, at basis of each maxilliped.

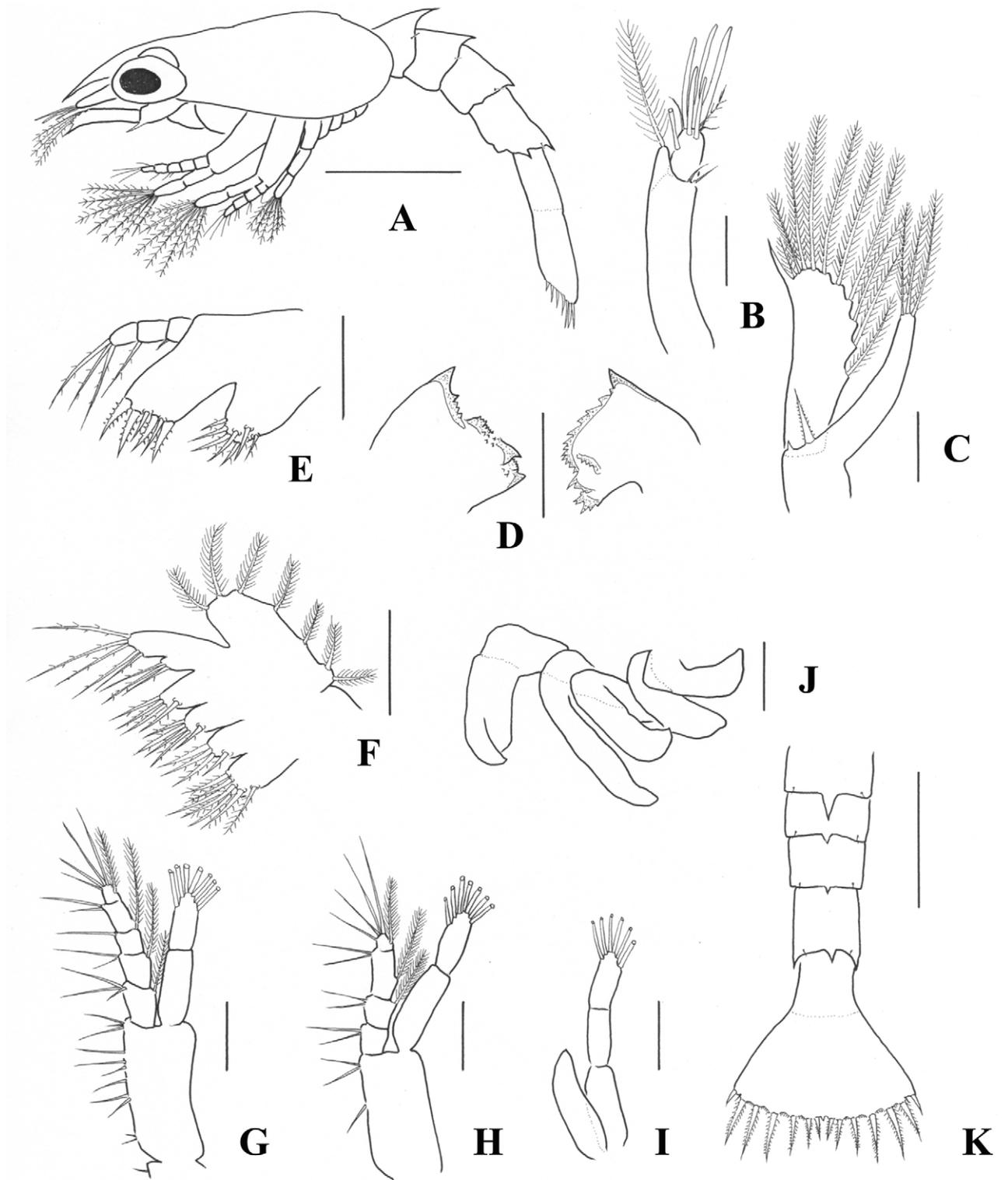


FIGURE 2. *Areopaguristes japonicus* (Miyake, 1961), second zoea: A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped; J, pereiopods; K, telson. Scale bars = 0.5 mm (A, K), 0.1 mm (B–J).

Second zoea (Fig. 2)

Size. CL = 1.06±0.02 mm.

Carapace (Fig. 2A). Rostrum not longer than antennae; eyes stalked.

Antennule (Fig. 2B). Biramous; protopod with 2 short setae; endopod bud with 1 long plumose seta; exopod with 3 smaller subterminal and 3 terminal aesthetascs, 3 short terminal setae.

Antenna (Fig. 1C). Protopod now with small spine near junction of scaphocerite; otherwise unchanged.

Mandibles (Fig. 2D). Incisor and molar processes with more teeth than previous stage.

Maxillule (Fig. 2E). Basial endite with 4 strong elongate spine-like teeth, each armed with few small denticles and 2 short simple setae; otherwise unchanged.

Maxilla (Fig. 2F). Coxal endite with 7 plumose setae on proximal lobe; scaphognathite with 7 marginal plumose setae; otherwise unchanged.

First maxilliped (Fig. 2G). Endopod 5-segmented, segmental setation 3+I, 2+I, 1+I, 2, 4+I; exopod with 7 terminal natatory setae; otherwise unchanged.

Second maxilliped (Fig. 2H). Endopod 4-segmented, segmental setation 2, 2+I, 2+I, 4+I; exopod with 7 terminal natatory setae; otherwise unchanged.

Third maxilliped (Fig. 2I). Exopod completely segmented, with 6 plumose setae.

Pereiopods (Fig. 2J). More developed; chela bilobed.

Pleon (Fig. 2A, K). Incompletely 6-segmented; otherwise unchanged.

Telson (Fig. 2K). Median cleft absent; posterior margin with 8+8 processes; otherwise unchanged.

Third zoea (Fig. 3)

Size. CL = 1.20±0.04 mm.

Carapace (Fig. 3A). Unchanged.

Antennule (Fig. 3B). Protopod with 2 plumose long and 4 short setae; exopod with 4 subterminal and 3 terminal aesthetascs, 3 short terminal setae; otherwise unchanged.

Antenna (Fig. 3C). Endopod 2-segmented, distal segment with 1 short simple setae; otherwise unchanged.

Mandibles (Fig. 3D). Palp present as bud.

Maxillule (Fig. 3E). Coxal endite with 8 plumodenticulate setae; otherwise unchanged.

Maxilla (Fig. 3F). Scaphognathite with 8 marginal plumose setae; otherwise unchanged.

First maxilliped (Fig. 3G). Unchanged.

Second maxilliped (Fig. 3H). Unchanged.

Third maxilliped (Fig. 3I). Endopod with 3 simple setae (1 subterminal and 2 terminal); exopod with 7 plumose setae.

Pereiopods (Fig. 3J). More developed; segmentation visible.

Pleon (Fig. 3K). Six pleomeres; pleomeres 2–5 with pleopod buds; endopod buds absent; otherwise unchanged.

Telson (Fig. 3K). Uropods present; endopod bud; exopod with 8 plumose setae on inner margin, with 1 smooth spine terminally. Dorsal surface of telson with 2 pairs of small setae; posterior margin with 9+9 processes; otherwise unchanged.

Megalopa (Figs. 4, 5, 6C)

Size. CL = 0.71±0.03 mm.

Carapace (Figs. 4A, 6C). Subquadrate, slightly longer than broad, often swollen posterolaterally; rostrum prominent, broad, blunt; carapace surface with several pairs of simple setae.

Ocular peduncles. Short, stout.

Antennule (Fig. 4B). Biramous, overreaching ocular peduncles; peduncle 3-segmented, first segment with 1 distolateral spine and 2 setae, second and third each with 3 setae; endopod 2-segmented, basal segment with 1 short seta, distal segment with 4 subterminal and 3 terminal setae; exopod 4-segmented, first and second segments unarmed, third with 2 aesthetascs and 4 simple setae, fourth elongate, with 2 subterminal and 1 terminal aesthetascs, 2 short and 1 long simple setae distally.

Antenna (Fig. 4C). Peduncle with 1 distolateral spine, acicle well-developed, terminating acutely, with 3 spines and 3 setae laterally; flagellum 7-segmented, segmental setation 1, 1, 3, 0, 2, 6, 8.

Mandibles (Fig. 4D). Reduced and simplified; palp 2-segmented, with 4 small marginal spinules terminally.

Maxillule (Fig. 4E). Coxal endite with 3 plumose setae; basial endite with 11 teeth, 3 plumose setae; endopod unarmed.

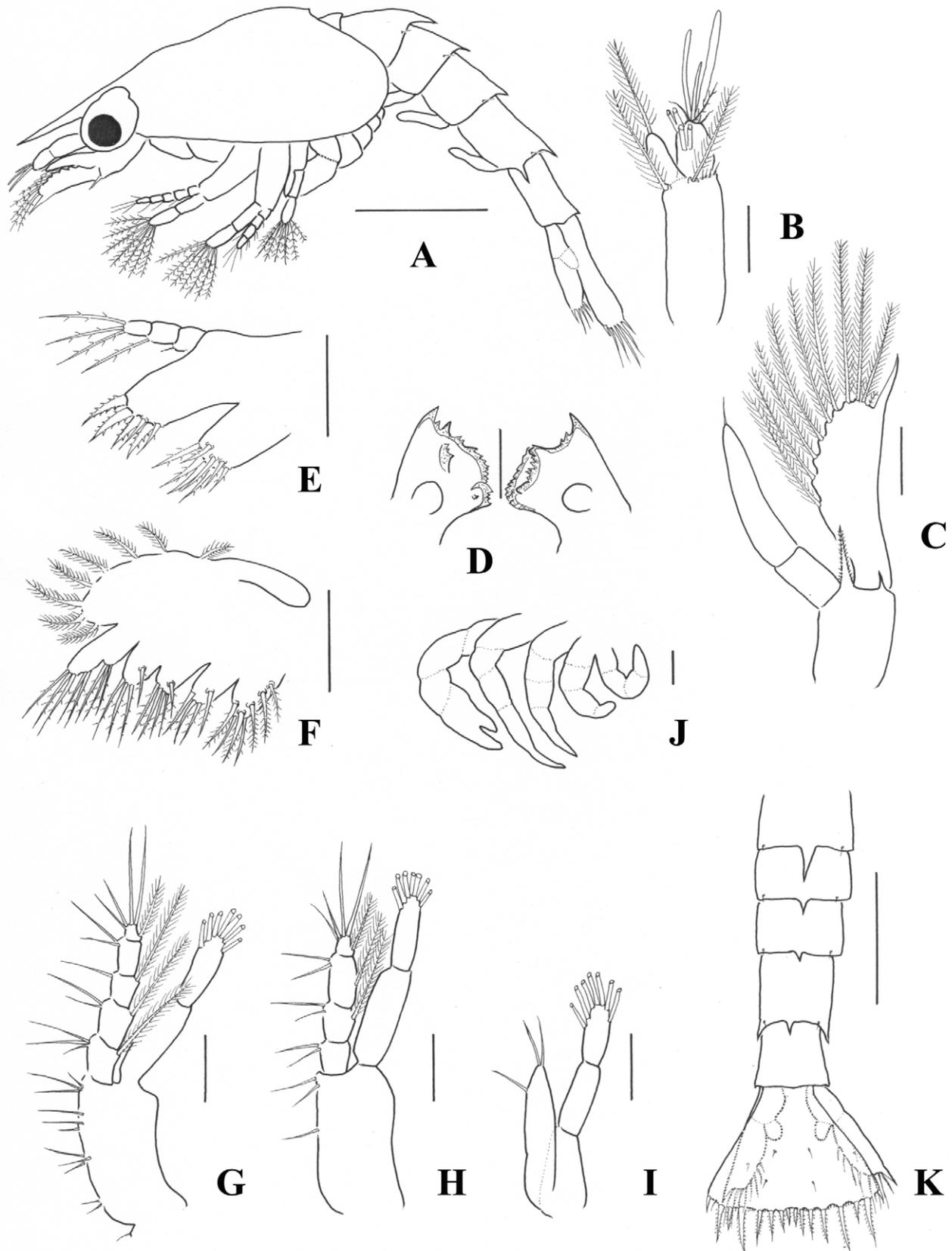


FIGURE 3. *Areopaguristes japonicus* (Miyake, 1961), third zoea: A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped; J, pereiopods; K, telson. Scale bars = 0.5 mm (A, K), 0.1 mm (B–J).

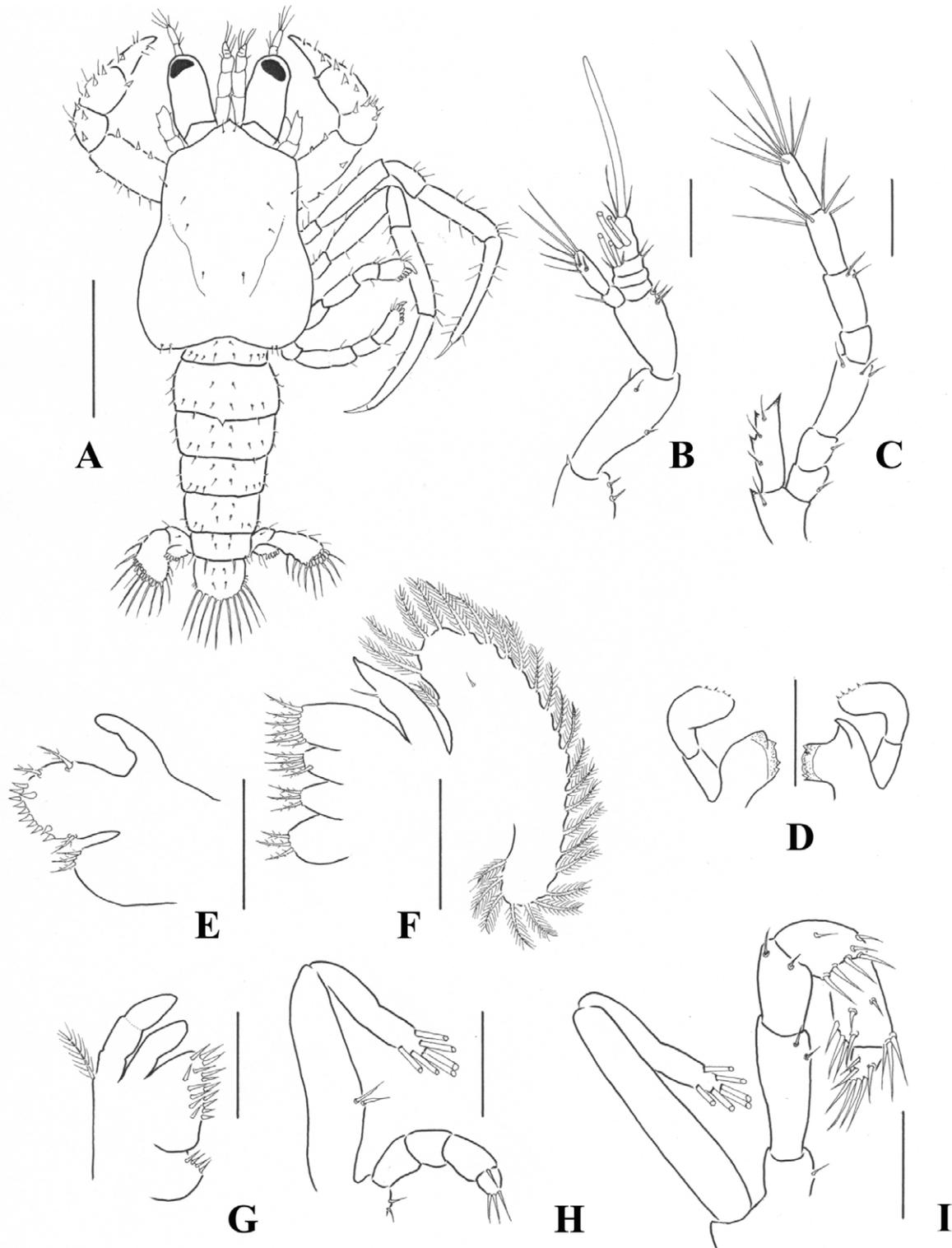


FIGURE 4. *Areopaguristes japonicus* (Miyake, 1961), megalopa: A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped. Scale bars = 0.5 mm (A), 0.1 mm (B–I).

Maxilla (Fig. 4F). Coxal endite bilobed, each with 3 and 3 plumose setae, respectively; basal endite bilobed, each with 4 and 6 plumose setae, respectively; endopod with 1 subterminal simple seta; scaphognathite with 26 marginal plumose, 1 short surface seta.

First maxilliped (Fig. 4G). Coxal endite with 4 short setae; basal endite broad, with 16 setae; endopod unsegmented, naked; exopod unsegmented, with 1 short proximal plumose seta.

Second maxilliped (Fig. 4H). Endopod 4-segmented, each segment with 0, 0, 1, 3 setae, respectively; exopod 2-segmented, proximal segment with 2 medial setae on inner margin, distal segment with 6 terminal plumose setae.

Third maxilliped (Fig. 4I). Endopod 5-segmented, segmental setation 2, 2, 7, 9, 7 setae; exopod 2-segmented, distal segment with 6 terminal plumose setae.

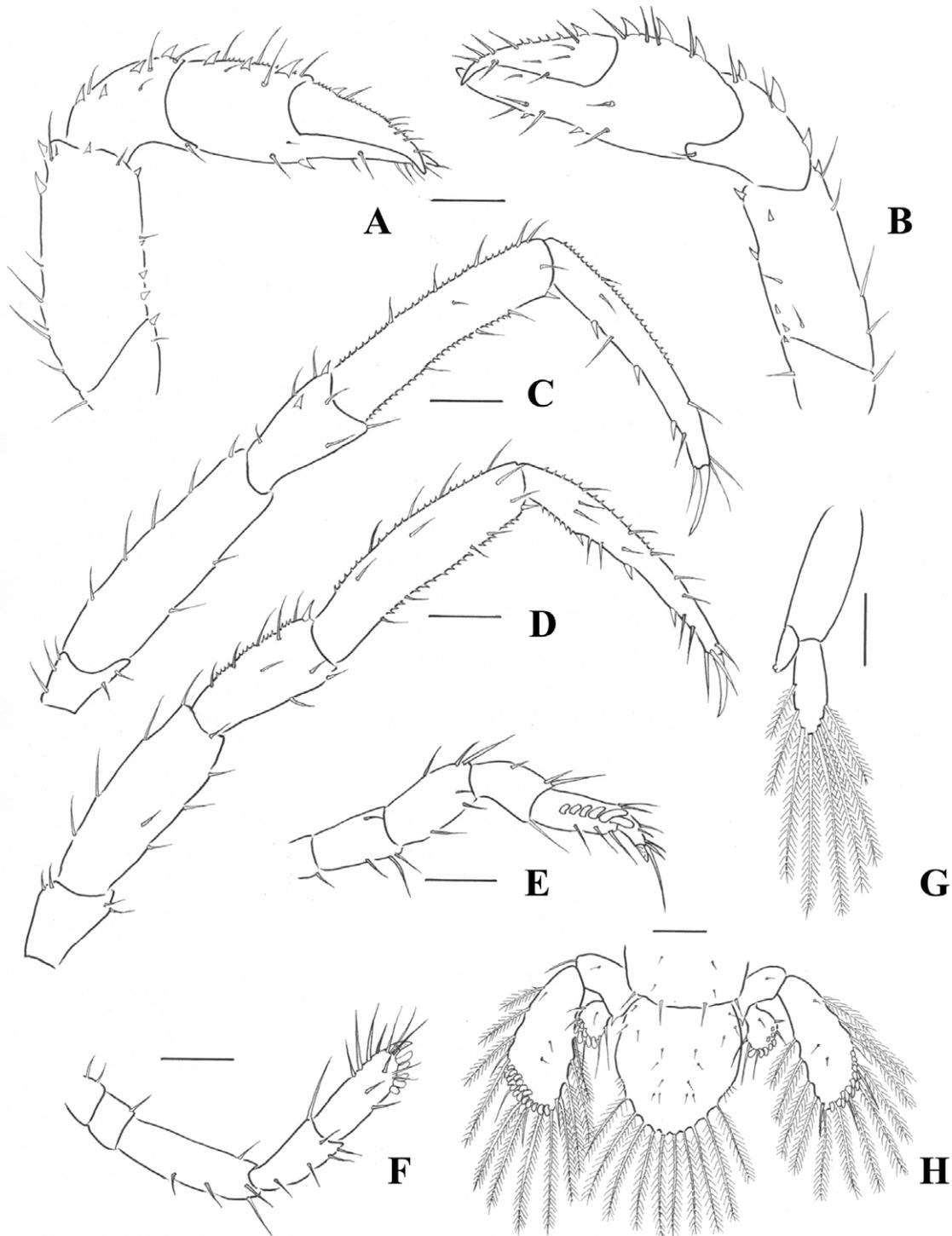


FIGURE 5. *Areopaguristes japonicus* (Miyake, 1961), megalopa: A, left cheliped; B, right cheliped; C–F; pereiopods 2–5; G, pleopod 2; H, telson and uropods. Scale bars = 0.1 mm (A–H).

Pereiopods (Fig. 5A–F). Chelipeds slightly dissimilar in size, movable fingers each with 1 spine, outer surfaces of palms each with 3 spines, carpi each with 3–4 spines, meri each with 6–7 spines; all segments covered with small simple setae. Pereiopods 2, 3 moderately long; dactyls each with row of 3 spines on ventral margin; propodi

each with 1 spine on ventrodorsal margin; carpi each with 1–2 spines on dorsal margin. Propodi of pereopods 4, 5 each with 6 and 5 large corneous scales on ventral margin; all segments covered with small simple setae.

Pleon (Figs. 4A, 5G). Consisting of 6 pleomeres and telson, with scattered short setae on dorsal and lateral surfaces; pleomere 2 with 1 spine on mediodorsal margin; pleopods present on pleomeres 2–5, biramous; endopods each with appendix interna consisting of 2 apical hooks; exopods well developed, each with 8, 9, 8, 8 marginal plumose setae, respectively.

Telson (Fig. 5H). Dorsal surface with several pairs of simple setae; posterior margin with 5+5 long plumose setae. Uropods biramous, slightly asymmetrical (left slightly larger); protopods each with 2 setae; exopod of left uropod with 12 long plumose and 4 short simple setae, 17 corneous scales; exopod of right uropod with 12 long plumose and 4 short simple setae, 15 corneous scales; endopods both with 5 short simple setae, 7–8 corneous scales.

Coloration (Fig. 6C). Brown chromatophore on rostrum; several pairs of reddish brown chromatophores on dorsal surface of carapace; black chromatophore on mediodorsal surface of pleomere 2; pair of brown chromatophores on pleomeres 4, 5; brown chromatophore on uropod; 2 pairs of brownish black chromatophores on telson; reddish brown chromatophores scattered over pereopods.

Discussions

Komai (2009) transferred *Paguristes* species with 12 pairs of gills to *Stratiotes* and identified the Korean *P. japonicus* Miyake, 1961 described by Kim (1973) as *S. nigroapiculus* Komai, 2009. Recently, Rahayu and McLaughlin (2010) assigned *S. nigroapiculus* to *Areopaguristes*. Hence, *A. nigroapiculus* is the only known species of the genus in Korea. For the present study, *A. japonicus* (Miyake, 1961) was collected for the first time in the region and its larval stages were described.

The larval stages of *A. nigroapiculus* were described by Kornienko and Korn (2011), therefore, a morphological comparison is possible between *A. nigroapiculus* and *A. japonicus*. Larvae of both species are similar in general morphology. However, they show some differences in number of characters including the antenna, maxillule, maxilla, pleon, telson and uropod (Table 1). One remarkable difference is that the mediodorsal spines on zoeal pleomeres 3 and 4, which are extremely short in *A. nigroapiculus* (Fig. 7B), are longer in *A. japonicus* (Fig. 6B). Additionally, the spine on megalopal pleomere 2 is absent in *A. nigroapiculus*, but present in *A. japonicus* (Fig. 4A). Furthermore, megalopal pleomere 5 has three chromatophores in *A. nigroapiculus* (Fig. 7C), whereas *A. japonicus* (Fig. 6C) has a pair of chromatophores. These characters may be useful for identifying planktonic larvae of these two species without dissection.

Kornienko and Korn (2011) reported that *Areopaguristes* zoeas were distinguished from *Paguristes* species by the absence of infraorbital carapace spine and by the fused fourth telson process in zoea III. In the northwestern Pacific, the zoeas of *Areopaguristes* appear most similar to two species of *Paguristes* (*P. ortmanni* and *P. digitalis*), but significantly different from five other species (*Dardanus arrosor*, *D. crassimanus*, *Clibanarius virescens*, *Diogenes edwardsii*, *D. nitidimanus*), particularly with respect to the endopodal setation characters of the maxillule, maxilla and basal setation of the first and second maxillipeds (Table 2). Additionally, *A. japonicus* zoeas were markedly different from those of three Brazilian diogenid species [*Paguristes spinipes* A. Milne-Edwards, 1880, *Paguristes tortugae* Schmitt, 1933, and *Clibanarius sclopetarius* (Herbst, 1796)] in mouthpart setation, including the endopod of maxillule with 1, 0, 3 setae in *P. tortugae* and 1+2 setae in *C. sclopetarius*; an endopod of maxilla with 2+3 setae in *P. spinipes* and 2+2 setae in *C. sclopetarius*, and basipod of the first maxilliped with 1+2+3+3 setae in *P. spinipes*, 1+1+2+3 setae in *P. tortugae*, and 3+2+2 setae in *C. sclopetarius* (Provenzano, 1978; Hebling & Negreiros-Fransozo, 1983; Bossi-Garcia, 1987). These zoeal characters suggest that the Diogenidae could be a heterogeneous group.

Larval descriptions of the Diogenidae are now available for nine species in the northwestern Pacific (Table 2). Zoeal characters of the family, which are consistent in all stages, can be summarized as follows: posterolateral carapace smooth, an endopod of antenna with 1–3 setae, an exopod of antenna with 10 setae (11 setae in *Clibanarius*), an endopod of the maxillule with 1, 1, 3 setae (1, 2 setae in *Clibanarius* and *Diogenes*, 2 setae in *Dardanus*), the endopod of the maxilla with 3+2+3 setae (2 setae in *Diogenes*, 2+2 setae in *Clibanarius* and *Dardanus*), the basis of the first maxilliped with 2+3+3+3 setae (1+3+2 setae in *Diogenes* and *Clibanarius*), the basis of the second maxilliped with 1+2 setae (1+1 setae in *Diogenes*), and the largest mediodorsal spine on pleomere 2 (on pleomere 5 in *Diogenes*) or the absence of the mediodorsal spine on pleomere in *Clibanarius* and *Dardanus*. The following provisional key for identifying diogenid zoeas from planktonic samples is provided for the northwestern Pacific.

TABLE 1. List of larval differences between *Areopaguristes nigroapiculus* and *A. japonicus*.

Species	<i>Areopaguristes nigroapiculus</i>	<i>Areopaguristes japonicus</i>
Sources	Kornienko and Korn 2011	Present study
ZOEAE I		
Pleomeres III, IV		
Mediodorsal spines	Extremely short	Longer
Telson		
Midpoint	No process	Spiniform process
ZOEAE II		
Maxilla		
Coxal endite	6+4 setae	7+4 setae
Pleomeres III, IV		
Mediodorsal spines	Extremely short	Longer
ZOEAE III		
Antenna		
Endopod	2 setae	1 seta
Maxillule		
Basial endite	5(6) teeth+2 setae	4 teeth+2 setae
Coxal endite	9 setae	8 setae
Maxilla		
Coxal endite	6+4 setae	7+4 setae
Pleomeres III, IV		
Mediodorsal spines	Extremely short	Longer
MEGALOPA		
Pleomere II	No mediodorsal spine	1 mediodorsal spine
Uropods		
Exopod	10(11) plumose setae	12 plumose setae
	8–11 corneous scales	15–17 corneous scales
Endopod	4(5) corneous scales	7(8) corneous scales

A provisional key to the known zoeas of Diogenidae in the northwestern Pacific

Posterolateral carapace smooth, endopod of antenna with 1–3 terminal setae.

1. Endopod of maxillule with 2 setae 2
Endopod of maxillule with 1, 2 or 1, 1, 3 setae 3
2. Dorsal surface of carapace with scales *Dardanus arrosor*
Dorsal surface of carapace smooth *D. crassimanus*
3. Pleon with mediodorsal spine 4
Pleon without mediodorsal spine *Clibanarius virescens*
4. Carapace with infraorbital spine 5
Carapace without infraorbital spine 8
5. Pleomeres 2–5 each with mediodorsal spine 6
Pleomeres 4, 5 each with mediodorsal spine 7
6. Mediodorsal spine of pleomere 5 larger than that on pleomere 3 *Paguristes digitalis*
Mediodorsal spine of pleomere 5 equal sized to that on pleomere 3 *P. ortmanni*
7. Mediodorsal spine smaller than posterolateral spine on pleomere 5 *Diogenes edwardsii*
Mediodorsal spine subequal length of posterolateral spine on pleomere 5 *D. nitidimanus*
8. Mediodorsal spines of pleomeres 3, 4 extremely short *Areopaguristes nigroapiculus*
Mediodorsal spines of pleomere 3, 4 longer *A. japonicus*

TABLE 2 . Larval comparison of nine Diogenidae species of from the northwestern Pacific.

Species	<i>Dardanus arrosor</i>	<i>Dardanus crassimanus</i>	<i>Diogenes edwardsii</i>	<i>Diogenes nitidimanus</i>	<i>Clibanarius virescens</i>
Sources	Kurata 1968a	Imahara, 1989, 1990	Kim <i>et al.</i> 2007	Korn <i>et al.</i> 2008	Tirmizi and Siddiqui 1979
ZOEA I					
Carapace					
Dorsal surface	With scales	Smooth	Smooth	Smooth	Smooth
Infraorbital spine	ND	ND	Present	Present	Absent
Posterolateral	Smooth	Smooth	Smooth	Smooth	Smooth
Antenna					
Exopod (endopod)	10 (3) setae	10 (3) setae	10 (3) setae	10 (3) setae	11 (3) setae
Maxillule					
Endopod	2 setae	2 setae	1, 2 setae	1, 2 setae	1, 2 setae
Maxilla					
Endopod	2+2 setae	2+2 setae	2 setae	2 setae	2+2 setae
Maxilliped I					
Basis	ND	ND	1+3+2 setae	1+3+2 setae	1+3+2 setae
Maxilliped II					
Basis	ND	ND	1+1 setae	1+1 setae	1+2 setae
Pleon					
Mediodorsal spine	Absent	Absent	4th < 5th	4th < 5th	Absent
MEGALOPA					
Antenna					
Flagellum	ND	11-segmented	9-segmented	9-segmented	13-segmented
Maxillule					
Endopod	ND	3 setae	1 seta	1(2) setae	3 setae
Maxilla					
Endopod	ND	3 setae	1 seta	No seta	No seta
Maxilliped I					
Exopod	ND	ND	3 distal setae	3 medial setae	10 setae
Pleomere II					
Mediodorsal spine	Absent	Absent	Absent	Absent	Absent
Telson					
Posterior margin	ND	8+8 setae	ND	ND	6+6 setae

ND = no data.

TABLE 2. Continued.

Species	<i>Paguristes ortmanni</i>	<i>Paguristes digitalis</i>	<i>Areopaguristes japonicus</i>	<i>Areopaguristes nigroapiculus</i>
Sources	Quintana and Iwata 1987	Kurata 1968b	Present study	Kornienko and Korn 2011
ZOEA I				
Carapace				
Dorsal surface	Smooth	Smooth	Smooth	Smooth
Infraorbital spine	Present	Present	Absent	Absent
Posterolateral	Smooth	Smooth	Smooth	Smooth
Antenna				
Exopod (endopod)	10 (3) setae	10 (3) setae	10 (3) setae	10 (3) setae
Maxillule				
Endopod	1, 1, 3 setae	1, 1, 3 setae	1, 1, 3 setae	1, 1, 3 setae
Maxilla				
Endopod	3+2+3 setae	3+2+3 setae	3+2+3 setae	3+2+3 setae
Maxilliped I				
Basis	2+3+3+3 setae	ND	2+3+3+3 setae	2+3+3+3 setae
Maxilliped II				
Basis	1+2 setae	ND	1+2 setae	1+2 setae
Pleon				
Mediodorsal spine	2nd > 3rd–5th	2nd>5th>4th>3rd	2nd>5th>3rd>4th	2nd>5th>4th,3rd
MEGALOPA				
Antenna				
Flagellum	6(7)-segmented	ND	7-segmented	7-segmented
Maxillule				
Endopod	1 seta	ND	No seta	No seta
Maxilla				
Endopod	2 setae	ND	1 seta	1 seta
Maxilliped I				
Exopod	1 proximal seta	ND	1 proximal seta	1 medial seta
Pleomere II				
Mediodorsal spine	Absent	Absent	Present	Absent
Telson				
Posterior margin	5+5 setae	5+5 setae	5+5 setae	5+5 setae

ND = no data.

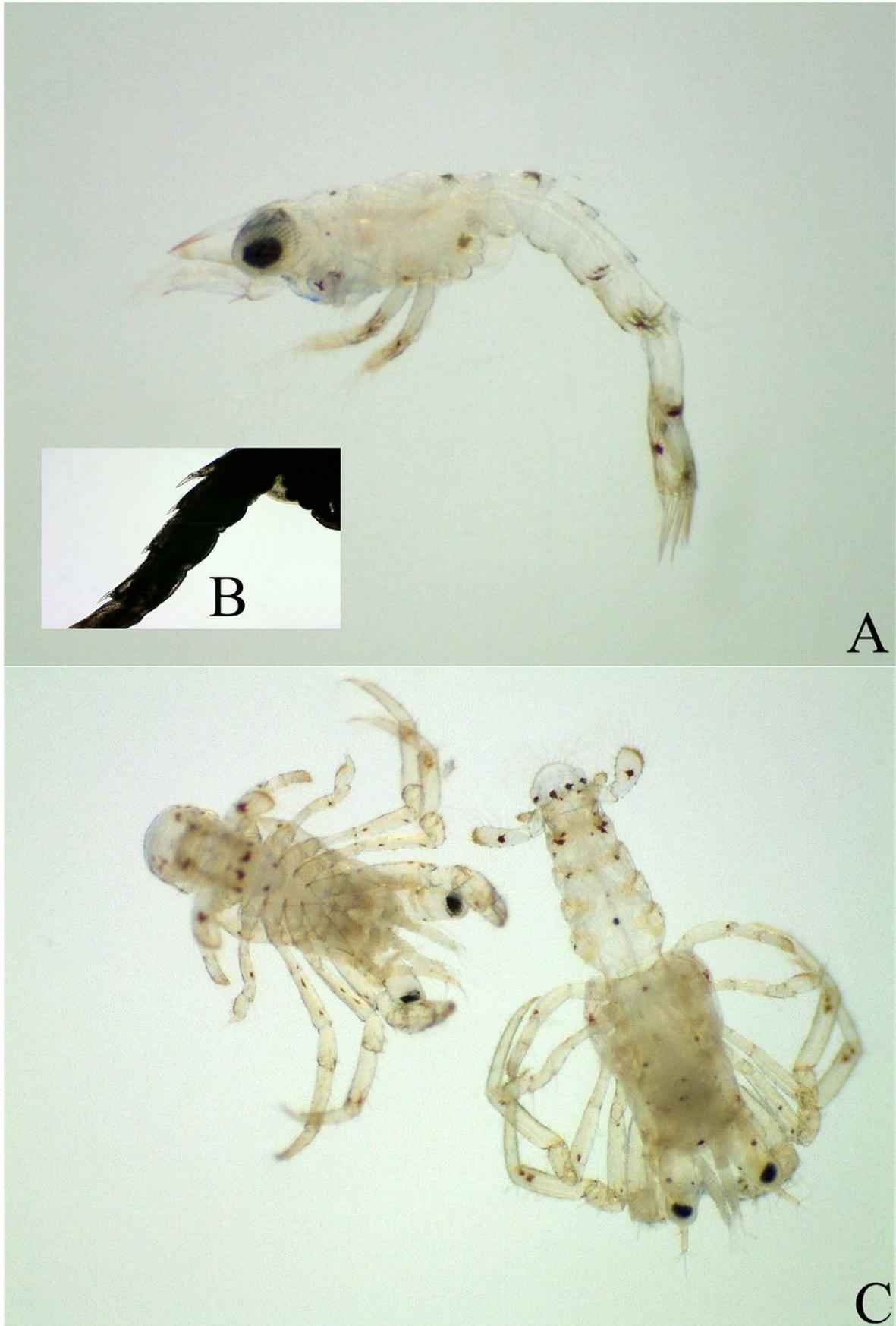


FIGURE 6. Live larvae of *Areopaguristes japonicus*: A, first zoea; B, lateral view of pleon of first zoea; C, megalopas.

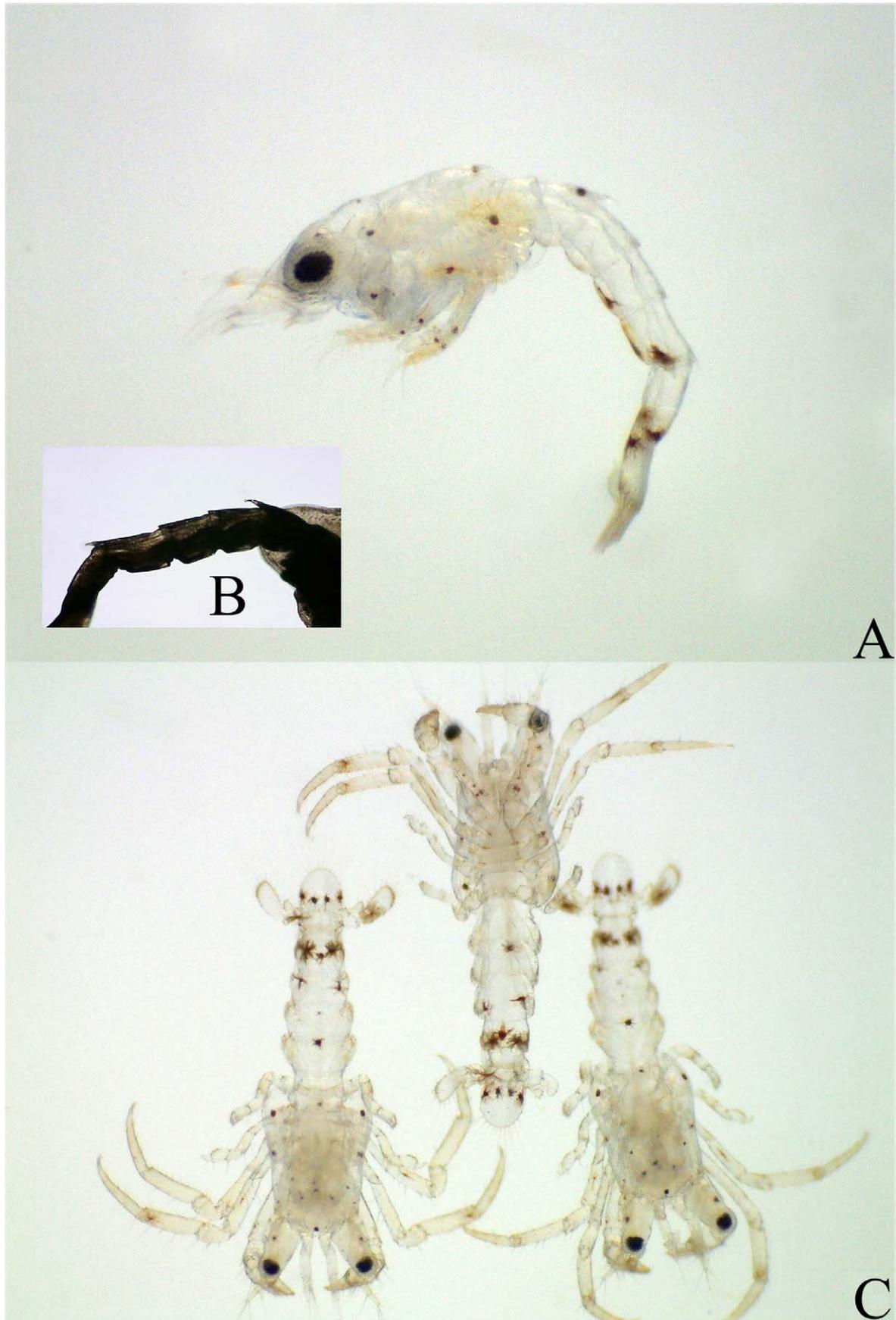


FIGURE 7. Live larvae of *Areopaguristes nigroapiculus*: A, first zoea; B, lateral view of pleon of first zoea; C, megalopas.

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