

# Zoeal Stages of *Philyra kanekoi* Sakai, 1934 (Crustacea: Decapoda: Leucosiidae) Reared in the Laboratory

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The zoeal stages of *Philyra kanekoi* Sakai, 1934 were obtained by laboratory rearing. Three zoeal stages were described and illustrated in detail. Zoeal morphology was compared with those of other described species of the family Leucosiidae. Morphological comparisons with congeneric species revealed that zoeas of *P. kanekoi* were more similar to those of *P. pisum* and *P. platychira* than to other *Philyra*. The present material could be distinguished from other Philyrinae species by having no dorsal carapace spine, a spinous tip of the antenna, and no chromatophore on the base of a dorsal carapace spine. Within the family Leucosiidae, the zoeas of three *Philyra* (*P. kanekoi*, *P. pisum* and *P. platychira*) showed the greatest affinities with *Leucosia sima* and *L. pubescens* (Leucosiinae), and the number of setae on the basipod of the first maxilliped could be very useful characteristics for identification between *Philyra* and *Leucosia* zoeas.

The family Leucosiidae comprises more than 300 species in some 40 genera (Chace, 1951). However, the larvae are only known for 28 species: *Ebaliinae*, *Ebalia cranchii* by Lebour (1928), Salman (1982) and Ingle (1992); *E. laevis* by Wear and Fielder (1985); *E. longipedata* by Aikawa (1937); *E. tumefacta* by Salman (1982) and Ingle (1992); *E. tuberosa* by Lebour (1928), Salman (1982), Paula (1987) and Ingle (1992); *E. nux* by Rice (1980) and Ingle (1992); *Nucia laminata* by Quintana (1986); Leucosiinae, *Leucosia signata* by Gurney (1927) and Al-Kholy (1963); *L. obtusifrons* by Terada (1984); *L. longifrons* by Terada (1979); *L. sima* by Hashmi (1968); *L. craniolarlis* by Quintana (1984); *L. anatum* by Terada (1984); *L. pubescens* by Tufail and Hashmi (1964) and Hashmi (1968), and Philyrinae, *Arcania septemspinosa* by Sankolli (1961); *A. heptacantha* by Terada (1984); *A. undecimspinosa* by Terada (1984) and Quintana (1986); *A. undecimspinosa elongata* by Terada (1979); *Iliia nucleus* by Boraschi (1921), Bourdilon-Casanova (1960) and Heegard (1963); *Myra fugax* by Terada (1979); *M. coalita*, by Quintana (1986); *Philyra corallicola* by Sankolli (1961) and Hashmi (1970); *P. globus* by Chhapgar (1955); *P. pisum* by Aikawa (1929), Terada (1979), and Ko (1996); *P. syndactyla* by Terada (1979); *P. platychira* by Ko (2000); *Ixa cylindricus* by Raja Bai (1960); *Persephona mediterranea* by Negreiros-Fransozo et al. (1989).

*Philyra kanekoi* inhabits sandy bottoms of the inter-

tidal region. This crab is known to occur along the coasts of Japan and Korea (Sakai, 1976; Kim, 1973). Any larval stages are unknown. Therefore, the aims of this paper are to describe the zoeal stages of *P. kanekoi* and to compare them with the previously described leucosiid zoeas.

## Materials and Methods

An ovigerous female of *Philyra kanekoi* was collected from Cheju Island off the southern part of the Korea Peninsula in July 1999. The zoeas collected from laboratory hatched specimens were reared using methods described by Ko (1995) at a constant water temperature of 25°C. Larvae were fixed and preserved in 10% neutral formalin. Dissected appendages were examined using a Leitz laborlux s microscope and drawings were made with the aid of camera lucida. The setal counts on appendages and the measurements were based on the mean of 10 specimens for each zoeal stage. The chromatophore patterns were observed with living zoeas. The sequence of the zoeal description (see Clark et al., 1998) is based on the malacostracan somite plan and described from anterior to posterior. Setal armature on appendages is described from proximal to distal segments and in the order of endopod to exopod. The remaining zoeal stages and the spent female were deposited in Silla University, Korea.

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## Results

Only three zoeal stages were recognized and megalopa was not obtained. The first zoeal stage is described and illustrated completely. For the second zoeal stage only the main differences from the first zoea are described in detail.

### Zoea I (Fig. 1)

Size. Carapace length (from front of eye to posterior margin of carapace)  $0.45 \pm 0.01$  mm.

Carapace (Fig. 1A, B): globose, dorsal spine absent; rostral spine very short; lateral spine represented by a swollen protuberance; 1 pair of posterodorsal setae; ventral margin without setae; eyes sessile.

Antennule (Fig. 1C): uniramous, endopod absent; exopod unsegmented with 2 long, 1 shorter, slender terminal aesthetascs and 1 terminal seta.

Antenna (Fig. 1D): uniramous process with serrated apical process; endopod and exopod absent.

Mandibles (Fig. 1E): asymmetrical; endopod palp absent.

Maxillule (Fig. 1F): coxal endite with 6 setae; basal endite with 5 setal processes; endopod 2-segmented, proximal segment without setae; distal segment with 4 terminal setae; exopod seta absent.

Maxilla (Fig. 1G): coxal endite with 5 setae; basal endite with 8 setae; endopod with 1 subterminal and 2 terminal setae; exopod (scaphognathite) margin with 3 setae and 1 long distal stout process.

First maxilliped (Fig. 1A, H): coxal segment with seta; basis with 8 setae medially arranged 2, 2, 2, 2; endopod 5-segmented with 2, 2, 1, 2, 5 (1 subterminal and 4 terminal) setae, respectively; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 1A, I): coxal segment without setae; basis with 4 setae arranged 1, 1, 1, 1; endopod incompletely segmented with 3 (1 subterminal + 2 terminal) setae; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Third maxilliped (Fig. 1K): uniramous bud.

Pereiopods: absent.

Abdomen (Fig. 1A, J): 5 somites; somites 2 and 3 with 1 pair of dorsolateral processes; somite 1 without setae; somites 2-5 with 1 pair of posterodorsal setae; pleopod buds absent.

Telson (Fig. 1J): a more or less triangular plate; telson forks absent; 3 small teeth at each posterolateral margin; posterior margin slightly concave, with 3 pairs of setae arranged in a single row, innermost 2 setae approximately twice longer than outermost setae.

Chromatophores (Fig. 1A): predominantly dark brown, but ranging almost black to pale brown and yellow. These occurring on bases of antennule, antenna, labrum, and mandible, behind eyes, on abdominal

somites 1-4 and telson, and on marginal expansion of carapace.

### Zoea II (Fig. 2)

Size. Carapace length (from front of eye to posterior margin of carapace)  $0.51 \pm 0.02$  mm.

Carapace (Fig. 2A): eyes stalked.

Antennule (Fig. 2B): exopod with 6 aesthetascs plus 1 short seta.

Antenna and mandible (Fig. 2C, D): unchanged.

Maxillule (Fig. 2D): coxal endite with 6 setae; basal endite with 7 plumodenticulate setae; endopod unchanged; exopod seta present.

Maxilla (Fig. 2E): exopod (scaphognathite) margin with 7 setae, long distal stout process no longer prominent; otherwise unchanged.

First maxilliped (Fig. 2A, G): exopod distal segment now with 6 natatory setae; otherwise unchanged.

Second maxilliped (Fig. 2A, H): exopod distal segment now with 6 natatory setae; otherwise unchanged.

Abdomen (Fig. 2A): somite 1 with 2 dorsomedial setae; somites 2-5 with pleopod buds.

Pereiopod and abdominal pleopod: buds.

### Zoea III (Fig. 3)

Size. Carapace length (from front of eye to posterior margin of carapace)  $0.60 \pm 0.02$  mm.

Carapace (Fig. 3A, B): swollen protuberance not developed into lateral spine; 2 pairs of anterodorsal setae; otherwise unchanged.

Antennule (Fig. 3C): exopod unsegmented with 2 long, 1 shorter, slender terminal aesthetascs and 1 terminal seta.

Antenna (Fig. 3D): with rounded endopod bud.

Mandibles: unchanged.

Maxillule (Fig. 3E): coxal endite with 6 setae; basal endite with 8 setae; otherwise unchanged.

Maxilla (Fig. 3F): exopod (scaphognathite) with 8 setae; otherwise unchanged.

First maxilliped (Fig. 3G): unchanged.

Second maxilliped (Fig. 3H): unchanged.

Third maxilliped (Fig. 3J): segmented bud.

Pereiopods (Fig. 3K): developing.

Abdomen (Fig. 3A, I): somite 1 with 3 dorsomedial setae; pleopod buds of somites 2-5 developing.

Telson (Fig. 3I): unchanged.

## Discussion

Ko (2000) reported that the zoeas of the subfamily Philyrinae seemed to be significantly heterogeneous and could be divided into four groups. The zoeas of *Philyra* could belong to the third or fourth groups according to her division. The common zoeal charac-

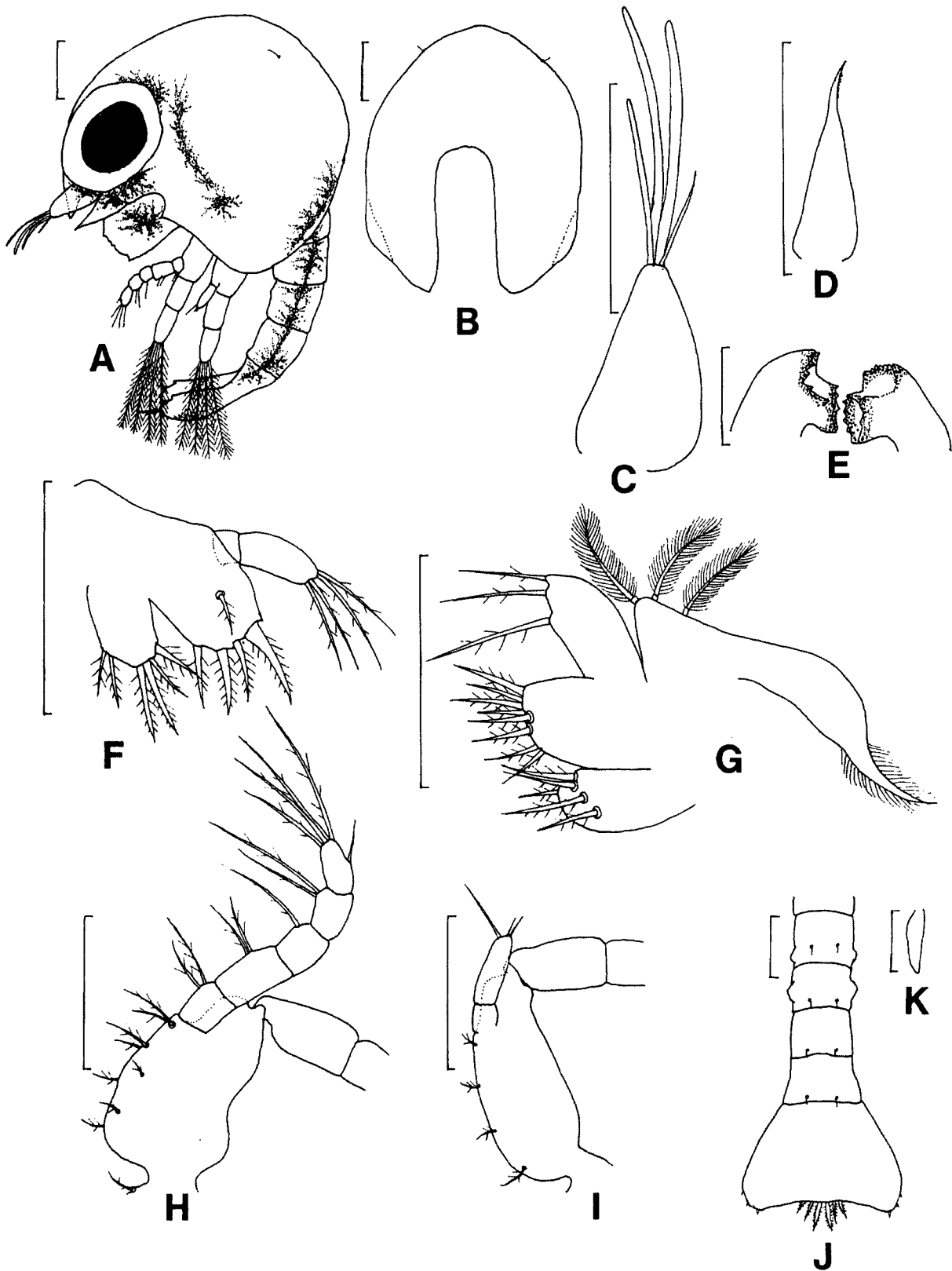


Fig. 1. *Philyra kanekoi*, first zoeal stage. A, Lateral view. B, Posterior view of carapace. C, Antennule. D, Antenna. E, Mandible. F, Maxillule. G Maxilla. H, First maxilliped. I, Second maxilliped. J, Dorsal view of abdomen and telson. K, Third maxilliped. Scale bars = 0.1 mm.

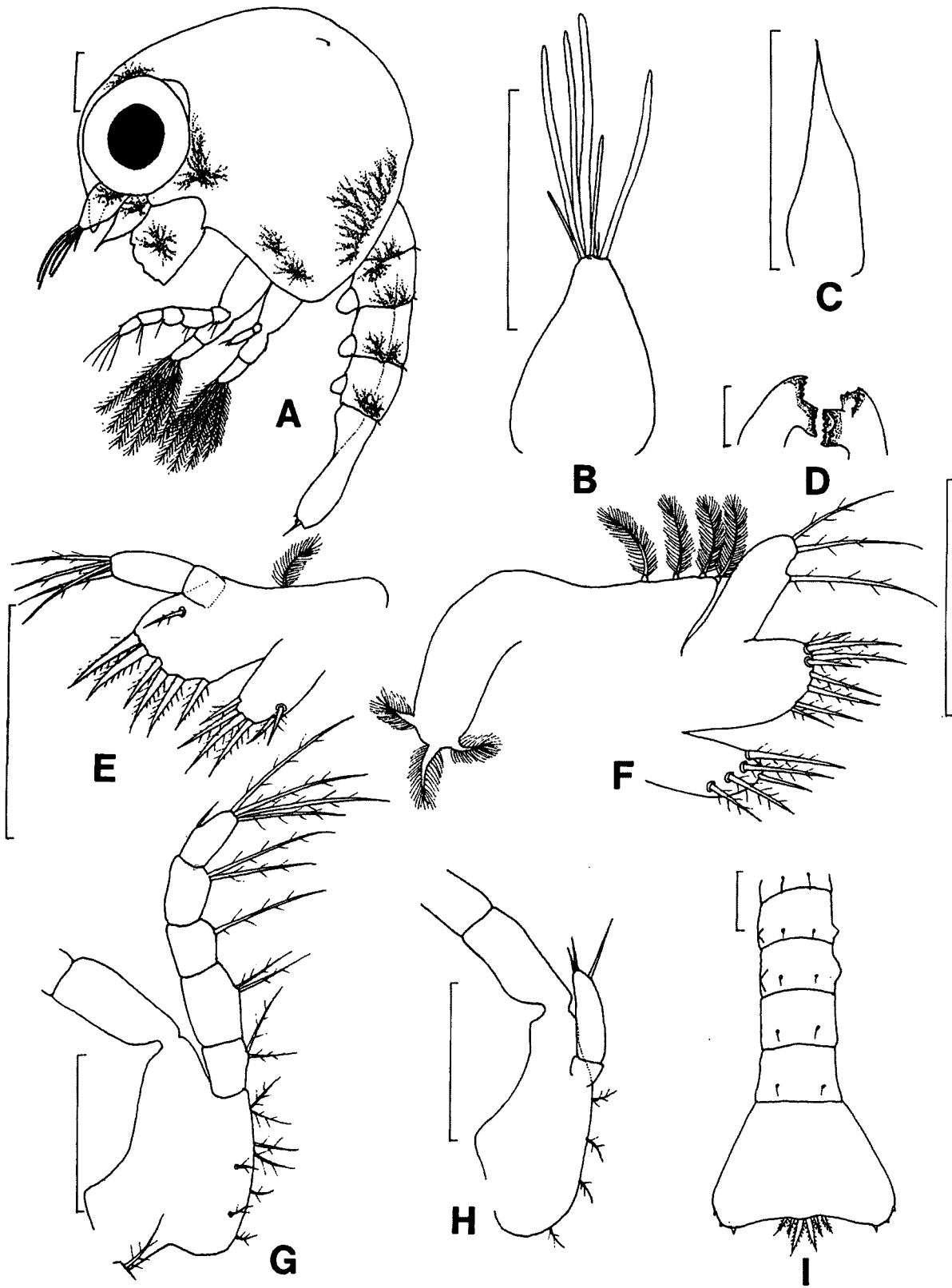


Fig. 2. *Philyra kanekoi*, second zoal stage. A, Lateral view. B, Antennule. C, Antenna. D, Mandible. E, Maxillule. F, Maxilla. G, First maxilliped. H, Second maxilliped. I, Dorsal view of abdomen and telson. Scale bars = 0.1 mm.

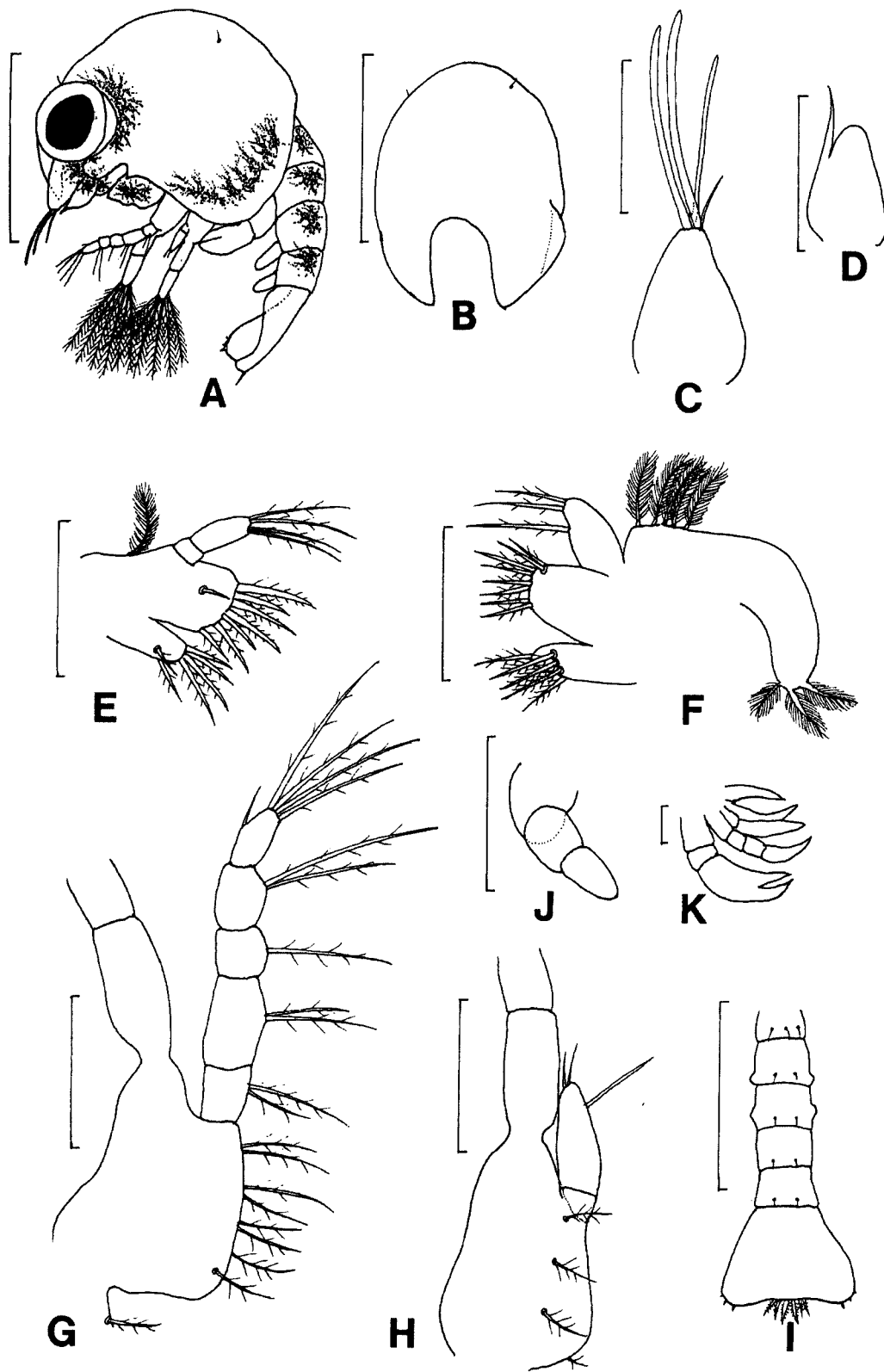


Fig. 3. *Philyra kanekoi*, third zoeal stage. A, Lateral view. B, Posterior view of carapace. C, Antennule. D, Antenna. E, Maxillule. F, Maxilla. G, First maxilliped. H, Second maxilliped. I, Dorsal view of abdomen and telson. J, Third maxilliped. K, Pereiopods. Scale bars = 0.5 mm (A, B, I) and 0.1 mm (C-H, J, K).

**Table 1.** Comparisons of the first zoecal characteristics in the family Leucosiidae.

Species	Carapace spine			Maxillule end	Maxilla end	Telson outer spine	Sources
	DS	LS	RS				
Subfamily Philyrinae							
<i>Persephona mediterranea</i>	+	+	+	2 + 2	2 + 2	1	Negreiros-Fransozo et al., 1989
<i>Arcania heptacantha</i>	+	+	+	2 + 2	2 + 2	1	Terada, 1984
<i>A. undecimspinosa</i>	+	+	+	2 + 2	2 + 2	1	Terada, 1984
<i>A. undecimspinosa elongata</i>	+	+	+	2 + 2	2 + 2	1	Terada, 1979
<i>A. septemspinosa</i>	+	+	+	2 + 2	2 + 2	1	Sankolli, 1961
<i>Myra fugax</i>	+	+	+	2 + 2	2 + 2	1	Terada, 1979
<i>M. coalita</i> (zoea 3)	+	+	+	2 + 2	2 + 2	1	Quintana, 1986
<i>Ilia nucleus</i>	+	+	+	2 + 2	2 + 1	ND	Heegard, 1963
<i>Philyra corallicola</i>	+	-	+	2 + 1	2 + 1	3	Sankolli, 1961
<i>P. syndactyla</i>	+	-	+	2 + 2	2 + 1	4	Terada, 1979
<i>P. scabriuscula</i>	+	-	+	2	2 + 1	3	Raja Bai, 1960
<i>P. pisum</i>	-	-	+	2 + 2	2 + 1	3	Ko, 1996
<i>P. platychira</i>	-	-(S)	+	2 + 2	2 + 1	3	Ko, 2000
<i>P. kanekoi</i>	-	-(S)	+	2 + 2	2 + 1	3	Present study
Subfamily Leucosiinae							
<i>Leucosia craniolaris</i> (zoea 3)	+	+	+	2 + 2	2 + 1	4	Quintana, 1984
<i>L. longifrons</i>	+	+	+	2 + 2	2 + 1	4	Terada, 1979
<i>L. obtusifrons</i>	+	+	+	2 + 2	2 + 1	4	Terada, 1984
<i>L. sima</i>	-	-	+	2 + 2	2 + 1	3	Hashmi, 1968
<i>L. pubescens</i>	-	-(S)	+	2 + 2	2 + 1	3	Hashmi, 1968
Subfamily Ebalinae							
<i>Ebalia nux</i>	-	-(S)	-	2 + 1	2 + 1	3	Rice, 1980b
<i>E. tuberosa</i>	-	-(S)	-	2 + 2	2 + 1	1	Salman, 1982
<i>E. tumefacta</i>	-	-(S)	-	3	2 + 1	4	Salman, 1982
<i>E. cranchii</i>	-	-(S)	-	3	2 + 1	4	Salman, 1982
<i>E. longipedata</i>	-	+	-	4	2 + 1	1	Aikawa, 1937
<i>E. laevis</i>	-	-	-	ND	ND	4	Wear and Fielder, 1985

DS, dorsal spine; RS, rostral spine; LS, lateral spine; end, endopod; ND, no data; + and -, present and absent; S, swollen protuberance.

teristics of this genus was without lateral carapace spines, with a rostral carapace spine, 2+1 setae on an endopod of the maxilla, and 3 or 4 outer spines on the telson (Table 1). The zoea of *P. kanekoi* coincides well with those of five other *Philyra* with respect to the above characteristics and could belong to the fourth group (*P. pisum* and *P. platychira*) which has no dorsal carapace spine.

Although the zoeas of the *Philyra* are somewhat similar, they can be distinguished from each other on the basis of the characteristics of a dorsal carapace spine, an endopod of the maxillule, an antenna, and a chromatophore as below.

1. Dorsal carapace spine present.
  - A. Endopod of maxillule with 2+1 setae ..... *P. corallicola*
  - B. Endopod of maxillule with 2+2 setae ..... *P. syndactyla*
  - C. Endopod of maxillule with 2 setae ..... *P. scabriuscula*
2. Dorsal carapace spine absent.
  - A. Tip of antenna round; chromatophore on base of dorsal carapace spine ..... *P. platychira*

- B. Tip of antenna spinous; chromatophore on base of dorsal carapace spine ..... *P. pisum*
- C. Tip of antenna spinous; no chromatophore on base of dorsal carapace spine ..... *P. kanekoi*

Ko (2000) recognized that the characteristics of *P. pisum* and *P. platychira* (Philyrinae) were very similar to those of *Leucosia sima* and *L. pubescens* (Leucosiinae). The only difference was that in the former species the basipod of the first maxilliped had 8 setae, but in the latter it was 9 or 10. Hence, she suggested that there was a need to reexamine the taxonomical status of the above four species. Also, the zoea of *P. kanekoi* is more closely related to the above two *Leucosia* zoeas than those of *P. corallicola*, *P. syndactyla* and *P. scabriuscula*. It has 8 setae on the basipod of the first maxilliped, too. Therefore, it is considered that the number of setae on the basipod of the first maxilliped could be very useful for indentifying between *Philyra* and *Leucosia* zoeas.

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