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Larval Development of *Philyra pisum* De Haan, 1841 (Crustacea: Decapoda: Leucosiidae) Reared in the Laboratory

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ABSTRACT

The complete larval development of *Philyra pisum* De Haan, 1841 from hatching to the megalopal stage was obtained by culture in the laboratory. Two zoeal and one megalopal stages are described and illustrated in detail. The first zoea of the present species is very similar to those of other two *Philyra* species except for the reduced carapace spines. The first zoeae belonging to the subfamily Philyrinae can be divided into two groups based on the zoeal characteristics: the first group is composed of *Arcania septemspinosa, A. undecimspinosa elongata,* and *Myra fugax,* whereas the second group is composed of *Philyra corallicola, P. syndactyla,* and *P. pisum.*

Key words: Larvae, *Philyra pisum*, Philyrinae, Brachyura, Korea

INTRODUCTION

The crab of *Philyra pisum* De Haan, 1841 inhabits the sandy or muddy flats between the high and low tidal marks. This crab is known to occur on the coasts of Japan, Korea, and China (Sakai, 1976).

The larvae, at least including the first zoeal stages, of 15 crab species of the family Leucosiidae are now known: in the subfamily Ebaliinae, *Ebalia cranchii* Leach, *E. laevis* (Bell), *E. tumefacta* (Montague), *E. tuberosa* (Pennant), and *E. nux* A. Milne-Edwards (see Lebour, 1928; Rice, 1980b; Salman, 1980), in the subfamily Philyrinae, *Arcania septemspinosa* (Fabricius), *A. undecimspinosa elongata* Yokoda, *Myra fugax* Fabricius, *Philyra corallicola* (Alcock), *P. pisum* De Haan, and *P. syndactyla* Ortmann (see Sankolli, 1961; Terada, 1979; Aikawa, 1929), and in the subfamily Leucosiinae, *Leucosia signata* Paulson, *L. longifrons* De Haan, *L. sima* (Alcock), and *L. pubescens* (Miers) (see Al-Kholy, 1963; Terada, 1979; Hashimi, 1968).

Although, Aikawa (1929) and Terada (1979) described the first zoeal and a complete larval stages

of *P. pisum*, respectively, their descriptions were very brief. Therefore, there is a need of detailed re-description.

In this paper all the larval stages of *P. pisum* are described in detail and compared with previously described larvae of the leucosiid crab within the subfamily Philyrinae. The phylogenetic relationship of the genus *Philyra* is discussed based on the larval morphology.

MATERIALS AND METHODS

In July, 1994, an ovigerous female of *Philyra pisum* was collected on muddy flats in Chindo Island, Republic of Korea. In the laboratory, the crab was maintained in an aquarium containing sea water (salinity 33.3‰) at 25°C. When the eggs hatched, some larvae were immediately preserved in 10% neutral formalin for later examination. The remaining larvae were reared individually in the 24 polystyrene cell wells and placed in a growth chamber of 25°C. They were fed on *Brachionus* sp. and newly hatched nauplii of *Artemia* everyday. The larvae were moved daily into new containers with freshly filtered sea water.

Specimens and exuviae of each developmental stage were preserved in 10% neutral formalin. Drawings were made using a camera lucida. The chromatophore patterns were determined by observation of living larvae.

RESULTS

Two zoeal and one megalopal stages were recognized. The morphological descriptions of the larval stages are presented below. Three zoeae molted into megalopa. Completion of zoeal stages required at least 11 days.

First Zoea (Fig. 1)

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

Carapace (Fig. 1A). Globose, with very short rostral spine. No dorsal and lateral carapace spines.

Antennule (Fig. 1B). With 3 aesthetascs and simple seta.

Antenna (Fig. 1C). A simple unsegmented uniramous process with serrated apical process.

Mandibles (Fig. 1D). Asymmetrical.

Maxillule (Fig. 1E). Endopod 2-segmented, distal segment with 4 terminal plumodenticulate setae. Basal and coxal endites both with 5 plumodenticulate setae.

Maxilla (Fig. 1F). Endopod with 2 terminal and 1 subterminal plumodenticulate setae. Basal and coxal endites each with 8 and 5 plumodenticulate setae, respectively. Scaphognathite bearing 3 marginal plumose setae and terminal process.

First maxilliped (Fig. 1A, G). Basis with 2, 2, 2, and 2 plumodenticulate setae, endopod 5-segmented with 2, 2, 1, 2, and 1+4 plumodenticulate setae, from proximal to distal segment. Exopod with 4 plumose natatory setae.

Second maxilliped (Fig. 1A, H). Basis with 1, 1, 1, and 1 plumodenticulate setae. Endopod

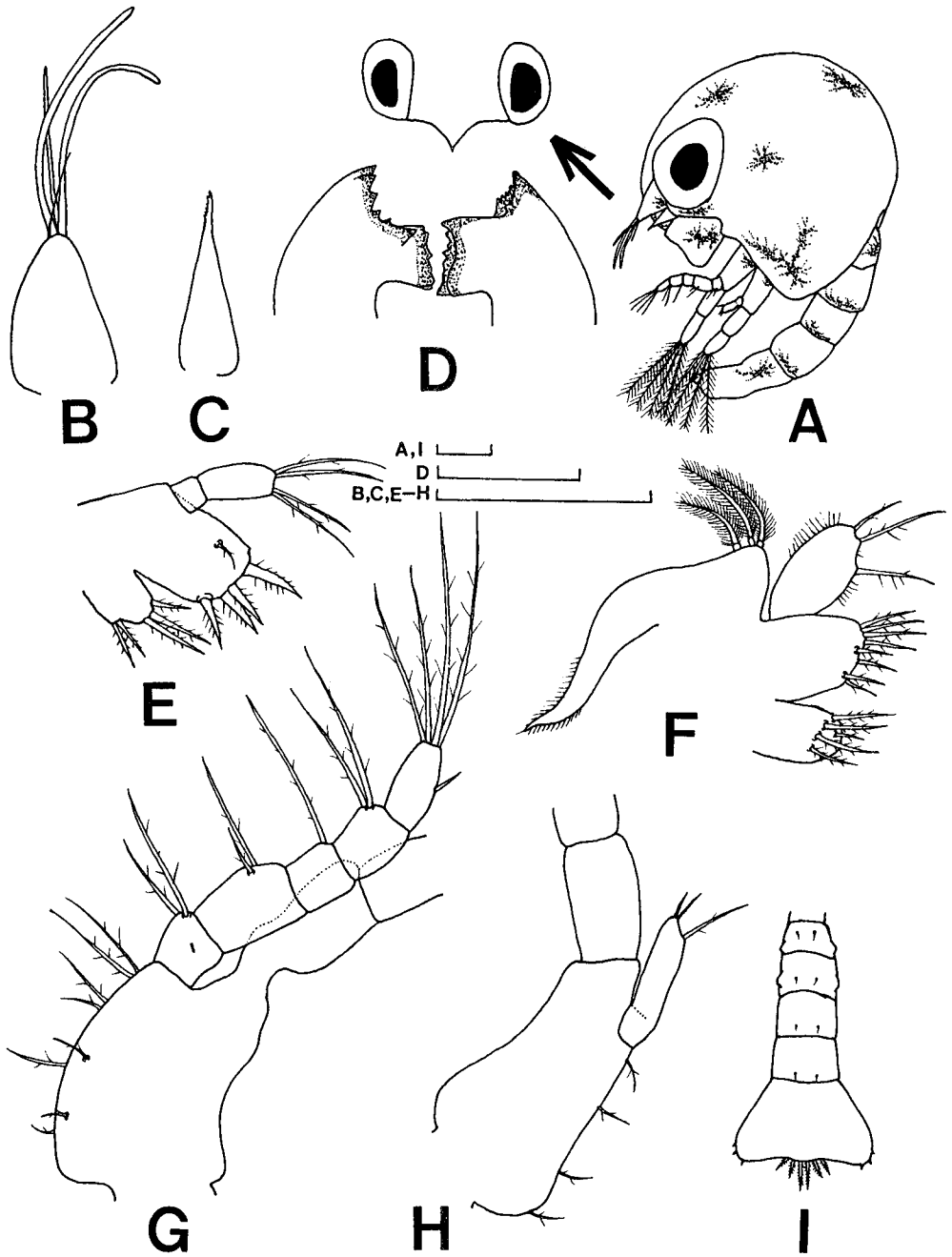

Fig. 1. *Philyra pisum* De Haan, 1841, first zoeal stage: A, lateral view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, dorsal view of abdomen and telson. Scale bars = 0.1 mm.

incompletely 2-segmented, with 2 terminal and 1 subterminal setae. Exopod with 4 plumose natatory setae.

Abdomen (Fig. 1A, I). Five somites. Somites 2 and 3 with small blunt lateral knobs. Somites 2-5 each with a pair of fine short setae on postero-dorsal border.

Telson (Fig. 1A, I). A more or less triangular plate with 3 small teeth at each postero-lateral margin. Posterior margin slightly concave, with 3 pairs of setae arranged in a single row (innermost 2 setae approximately twice longer than other setae).

Chromatophores (Fig. 1A) predominantly brown, but ranging from dark brown or 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, on marginal expansion of carapace, on basis of first and second maxillipeds, and on dorsal carapace.

Second Zoea (Fig. 2)

Size. Carapace length 0.63 mm.

Antennule (Fig. 2B). With endopod bud.

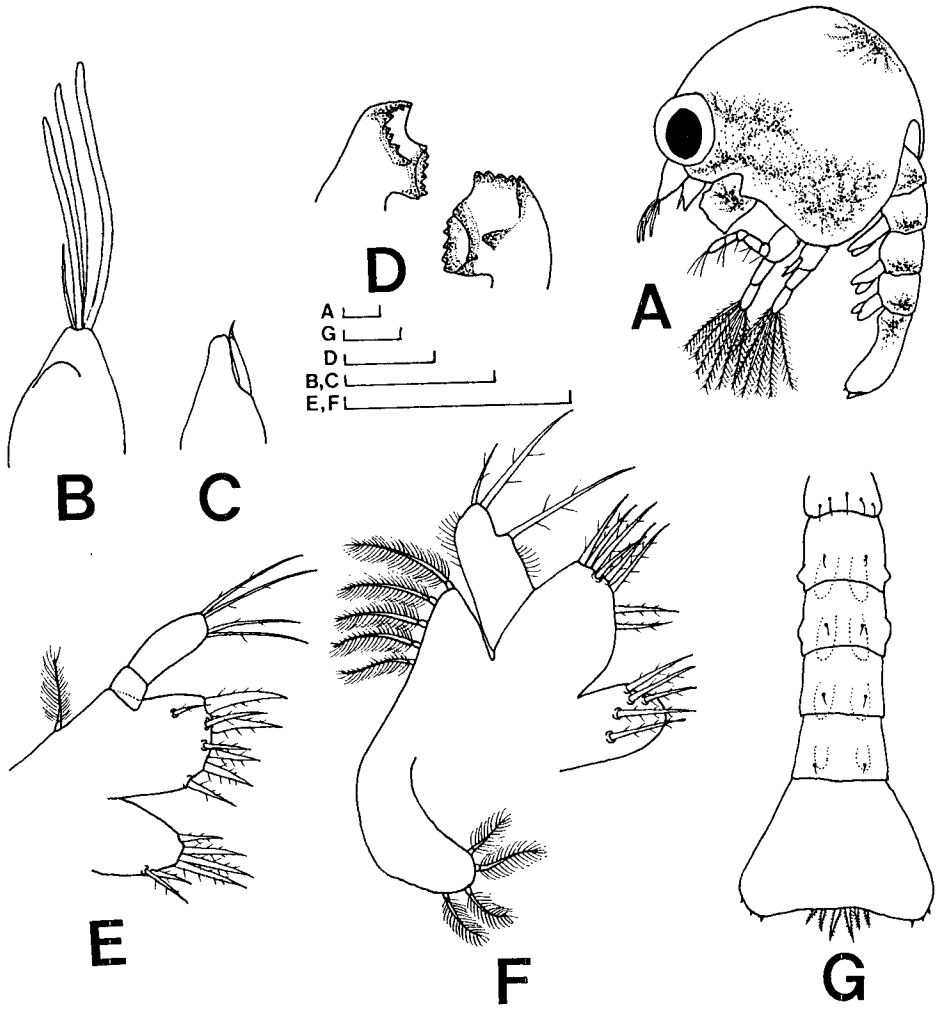

Fig. 2. *Philyra pisum* De Haan, 1841, second zoeal stage: A, lateral view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, dorsal view of abdomen and telson. Scale bars = 0.1 mm.

Antenna (Fig. 2C). With rounded endopod bud.

Mandibles (Fig. 2D). Unchanged.

Maxillule (Fig. 2E). Basal and coxal endites each with 8 and 6 plumodenticulate setae, respectively. Disto-lateral margin with plumose seta.

Maxilla (Fig. 2F). Scaphognathite with 9 plumodenticulate setae.

First and second maxillipeds (Fig. 2A). Exopod with 6 plumose natatory setae.

Abdomen (Fig. 2A, G). First somite with 5 dorsal setae. Somites 2-5 with pleopod buds.

Megalopa (Fig. 3)

Size. Carapace length 0.74 mm. Carapace width 0.63 mm.

Carapace (Fig. 3A). Round shape, with 2 antero-gastric-lateral, 2 postero-gastric-lateral, 1 median, and 1 postero-median tubercles.

Antennule (Fig. 3B). Exopod 3-segmented, segment 3 with 3 aesthetascs and seta,and segment 2 with aesthetasc and seta. Endopod with terminal seta.

Antenna (Fig. 3C). Five -segmented, with 1, 0, 0, 0, and 3 setae, from proximal to distal segment.

Mandible (Fig. 3D). Palp with 4 setae distally.

Maxillule (Fig. 3E). No endopod. Basal and coxal endites with 10 and 7 plumodenticulate setae, respectively.

Maxilla (Fig. 3F). Endopod and coxal endite naked. Basal endite with 5 plumodenticulate setae. Scaphognathite bearing 29 marginal plumose setae and 4 surface setae.

First maxilliped (Fig. 3G). Endopod with 2 setae. Basal and coxal endites with 14 and 5 plumodenticulate setae, respectively. Exopod 2-segmented, distal segment with 4 plumose setae. Epipod with 2 long simple setae.

Second maxilliped (Fig. 3H). Endopod 4-segmented, with 0, 1, 3, and 4 plumodenticulate setae, from proximal to distal segment. Exopod 2-segmented, distal segment with 4 plumose setae.

Third maxilliped (Fig. 3I). Endopod 5-segmented, with 8, 5, 1, 1, and 4 plumodenticulate setae, from proximal to distal segment. Exopod with 8 plumodenticulate setae.

Chela (Fig. 3J). Propodus with a few small setae; tip slightly hooked.

DISCUSSION

The number of zoeal stages is rather constant according to the family of the crab. For example, it is two in the family Majidae crab, usually four in the family Xanthidae crab, and four in the family Pilumnidae crab. In the specific level it is nearly constant. As shown in Table 1, it is interesting that *Philyra pisum* described by Terada (1979) has three zoeal stages, while my material shows two zoeal stages. I assume that an extra larval stage is due to the appearance of the interstage. The interstages in the laboratory-reared larvae are often induced by the environmental factors, especially seawater temperature. Terada's larvae were reared in the laboratory at room temperature of Japan in June and July, whereas in the present study the larvae were kept constantly at 25°C. Also, it is unusual that the first and second maxillipeds of the third zoea have 6 natatory setae like those of the second zoea. Moreover, all the chracteristics of Terada's third zoea almost coincide with those of the present

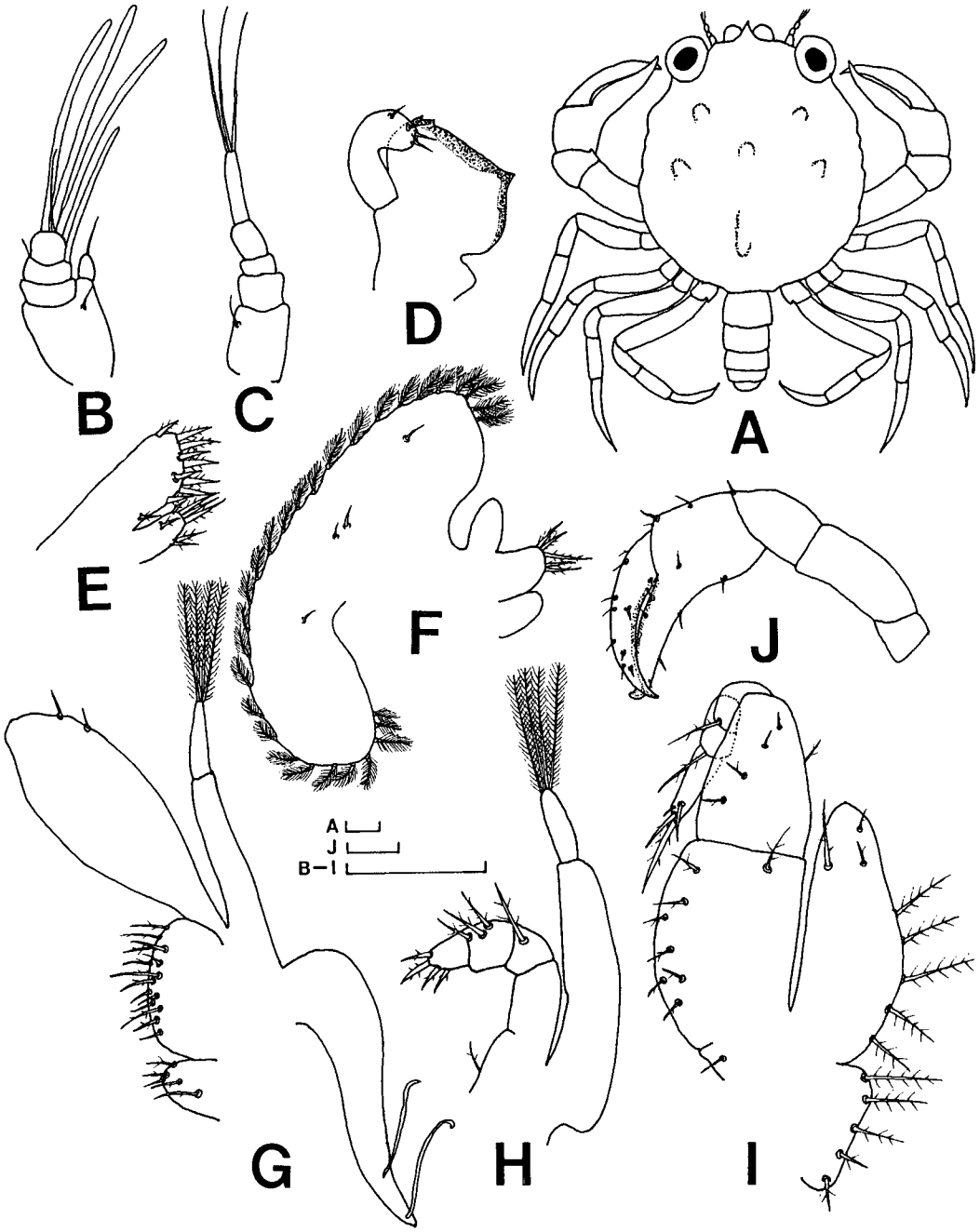

Fig. 3. *Philyra pisum* De Haan, 1841, megalopal stage: A, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped; J, chela. Scale bars = 0.1 mm

second zoea. Thus, the author consider that Terada's second zoea seems to be an interstage.

It is generally accepted that the characteristics of the first zoea show a great taxonomical significance because of no variation. In the comparison with the first zoeae of Terada and the present

Table 1. Comparison of the characteristics of the zoeae of *Philyra pisum* as given by Terada (1979) with those obtained in the present study.

	Terada(1979)	Present study
Zoeal stage	3 stages	2 stages
Maxillipeds 1,2		
Exopods	4,6, and 6 natatory setae in successive stages	4 and 6 natatory setae in successive stages
Maxillule of zoea 1		
Coxal endite	6 setae	5 setae
Abdominal segment 1 of last zoeal stage	3 dorsal setae	5 dorsal setae

study, the only difference exists on the characteristic of the coxal endite of the maxillule as shown in Table 1. I can not be sure whether such morphological difference may result from a geographical variation or not. Therefore, a further careful comparison is needed between adult species from Japan and Korea.

As shown in Table 2, the first zoeae of *Philyra pisum* are very similar to those of the other two *Philyra* species. They have no lateral carapace spine, 5 setae on the basal endite of the maxillule, 3 setae on the endopod of the maxilla, 8 and 5 setae on basal and coxal endites of the maxilla, 3 setae on the endopod of the second maxilliped, abdominal somites 2 and 3 with lateral knobs, and 3 lateral spines of the telson. But, in carapace spines, they have no dorsal spine and a tendency to reduce a rostral spine, therefore, these characteristics can be used for identifying these zoeae of this species within the genus *Philyra*.

The first zoeae belonging to the subfamily Philyrinae can be divided into two groups (Table 2). The first group is composed of *Arcania septemspinosa, A. undecimspinosa elongata*, and *Myra fugax*. They are characterized by having all carapace spines, the endopod of the maxilla with 4 setae, and telson with a lateral spine. The second group is composed of *Philyra corallicola, P. syndactyla*, and *P. pisum*. They are characterized by having no lateral carapace spine, the endopod of the maxilla with 3 setae, and telson with 3 lateral spines. Among the three characteristics used on the separating into two groups, a characteristic of the endopod of the maxilla is more important than the other two characteristics. Rice (1980a) recognized that the endopod of the maxilla is important as a character of the family and the subfamily. And he reported that the endopod of the maxilla shows 6 setae in the Subfamily Portuninae, 4 or 5 setae in the families Grapsidae and Ocypodidae, and 3 setae in the families Pinnotheridae and Leucosiidae. Hence, it seems to be very significant that the endopod of the maxilla has 4 (the first group) or 3 (the second group) setae within the subfamily Philyrinae. Consequently, I recognize that the genus *Philyra* and the other two genera (*Arcania* and *Myra*) can not be coexisted within the subfamily Philyrinae on the basis of zoeal characteristics.

Table 2. Morphological characteristics of the first zoeae of six species of the subfamily Philyrinae.

	Species					
	Arcania septemspinosa	*Arcania undecimspinosa elongata*	*Myra fugax*	*Philyra corallicola*	*Philyra syndactyla*	*Philyra pisum*
	Authors					
	Sankolii (1961)	Terada (1979)	Terada (1979)	Sankolii (1961)	Terada (1979)	Present study
Carapace						
Dorsal spine	+	+	+	+	+	−
Rostral spine	+	+	+	+	+	+(very short)
Lateral spine	+	+	+	−	−	−
Maxillule						
Setae of endopod	2+2 (4)	2+2 (4)	2+2 (4)	2+1 (3)	2+2 (4)	2+2 (4)
Setae of basipod	4	5	5	5	5	5
Setae of coxipod	6	6	6	5	6	5
Maxilla						
Setae of scaphognathite	3+1	4+1	4+1	3+1	4+1	3+1
Setae of endopod	3+1 (4)	2+2 (4)	2+2 (4)	2+1 (3)	2+1 (3)	2+1 (3)
Setae of basipod	8	8	8	8	8	8
Setae of coxipod	5	5	5	5	5	5
Maxilliped 1						
Setation of endopod	2,2,1,2,5	2,2,1,2,5	2,2,1,2,5	2,2,2,2,4	2,2,1,2,5	2,2,1,2,5
Maxilliped 2						
Setae of endopod	3	3	3	3	3	3
Abdomen						
Lateral knobs	somites 2,3	somites 2,3	somites 2,3	somites 2,3	somites 2,3	somites 2,3
Telson						
Lateral spines	1	1	1	3	3	3

*+ = present, − = absent.

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밤게(갑각강: 십각목: 밤게과)의 유생발생

고 현 숙
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요 약

실험실에서 사육된 밤게의 유생은 2조에아 유생기와 1메가로파 유생기를 가졌고, 조에아 유생기를 완전발생 시키는데 25°C 수온에서 최저 11일이 걸렸다. 각 유생기의 형태적 특징을 상세히 기재 및 도시하였다. 밤게의 제1조에아 유생은 갑각에 아주 짧은 액극을 가지고 배극이 없다는 것을 제외하고는 그 외의 모든 특징에서 이미 알려진 밤게 속의 다른 유생과 잘 일치하고 있었다. 밤게가 속하고 있는 subfamily Philyrinae의 조에아 유생은 그 특징에 의거 *Arcania septemspinosa*, *A. undecimspinosa elongata*, 긴손밤게(*Myra fugax*)을 포함한 군과 *Philyra corallicola*, 납작손밤게(*P. syndactyla*), 밤게(*P. pisum*)을 포함한 군으로 나눌 수 있다.