

First Zoea of *Palaemon ortmanni* (Decapoda, Caridea, Palaemonidae) Hatched in the Laboratory, with Notes on the Larval Morphology of the Palaemonidae

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ABSTRACT

The first zoeal stage of *Palaemon ortmanni* (Rathbun, 1902) is re-described and illustrated in detail from laboratory-hatched material. The first zoeas of *Palaemon* are more closely related to those of *Palaemonetes* than to *Macrobrachium*, *Leptocarpus*, *Leander*, *Leanderites*, and *Brachycarpus* by having the endopod of maxillule with terminal seta and the endopod of maxilla with 2+1 setae. A provisional key to the zoeas between three genera *Palaemon*, *Macrobrachium*, and *Periclimenes* known from Korean waters is included.

Key words: first zoea, *Palaemon ortmanni*, Palaemonidae, Caridea, Decapoda

INTRODUCTION

The genus *Palaemon* from Korean waters is represented by 13 species belonging to two subgenera, of which nine species have been ascribed to subgenus *Palaemon* (Kim, 1977; The Korean Society of Systematic Zoology, 1997; National Fisheries Research and Development Institute, 2001). The genus *Palaemon* contains species occupying a wide variety of habitats from marine conditions to freshwater. Of the recognized, the following seven species inhabit marine or brackish waters: *Palaemon gravieri* (Yu, 1930), *Palaemon guandongensis* Liu, Liang and Yan,

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1990, *Palaemon macrodactylus* (Rathbun, 1902), *Palaemon ortmanni* (Rathbun, 1902), *Palaemon pacificus* (Stimpson, 1860), *Palaemon serrifer* (Stimpson, 1860), and *Palaemon tenuidactylus* Liu, Liang and Yan, 1990 (Kim, 1977; National Fisheries Research and Development Institute, 2001).

The larval descriptions of *Palaemon* are well documented from Korea and adjacent waters. The descriptions of larval developments have been made for *P. debilis* by Shokita (1977), *P. gravieri* by Liang and Zhou (1994), *P. macrodactylus* by Kurata (1968) and Shy and Yu (1987), *P. ortmanni* by Kurata (1968) and Tsou *et al.* (1989), *P. pacificus* by Kurata (1968), Han and Hong (1978), and Shy and Yu (1988), and for *P. serrifer* by Yokoya (1957), Utunomiya and Maekawa (1959), and Kurata (1968). Of these, the larval descriptions of *P. ortmanni* provided by Kurata (1968) and Tsou *et al.* (1989), however, are so brief and not informative for morphological comparison.

The present study is to re-describe and illustrate the first zoeal stage of *P. ortmanni* in detail, discuss on the larval morphology of the Palaemonidae, and to provide a provisional key to the zoeas between genera *Palaemon*, *Macrobrachium*, and *Periclimenes* known from Korean waters.

MATERIALS AND METHODS

On June 12, 2000, an ovigerous female of *Palaemon ortmanni* was collected from Geoje Island, Korea. In the laboratory, it was placed in a glass container (300 mm diameter × 200 mm depth) filled with seawater of 33.3‰ salinity and maintained in growth chamber at 20°C until hatching occurred.

The larvae successfully hatched in the laboratory on July 6, 2000. They were fixed in 7% formalin solution. Drawing was based on 10 specimens and made using a Leitz laborlux s microscope with a camera lucida. Setal armature on appendages was described from proximal to distal segmentation (see Clark *et al.*, 1998). Body length (BL) was measured from the posterorbital margin to the telson, excluding posterior setae. Carapace length (CL) was measured from the posterorbital margin to the posteromedian border of carapace. The chromatophore patterns were determined by observation of living larvae. Voucher specimens were deposited in Silla University.

RESULTS

First Zoea (Fig. 1)

BL. 1.86 mm (1.85–1.87 mm); CL. 0.32 mm (0.31–0.34 mm).

Carapace (Figs. 1A, B). Rostrum straight, pointed, overreaching to peduncle of antennule with 6 teeth distoventrally. Anteroventral margin of carapace with pterygostomial spine. Anterior dorsomedian papilla present. Eye sessile.

Abdomen (Figs. 1A, C) composed of 6 somites, last somite fused with telson. Abdominal somites 3, 4, 5, and 6 with three, two, one, and three pairs of dorsal setae, respectively. Abdominal somite 3 slightly dorsal hump-backed. Abdominal somite 4 with dorsal tuft of setae. Abdominal somite 5 with posterolateral spine.

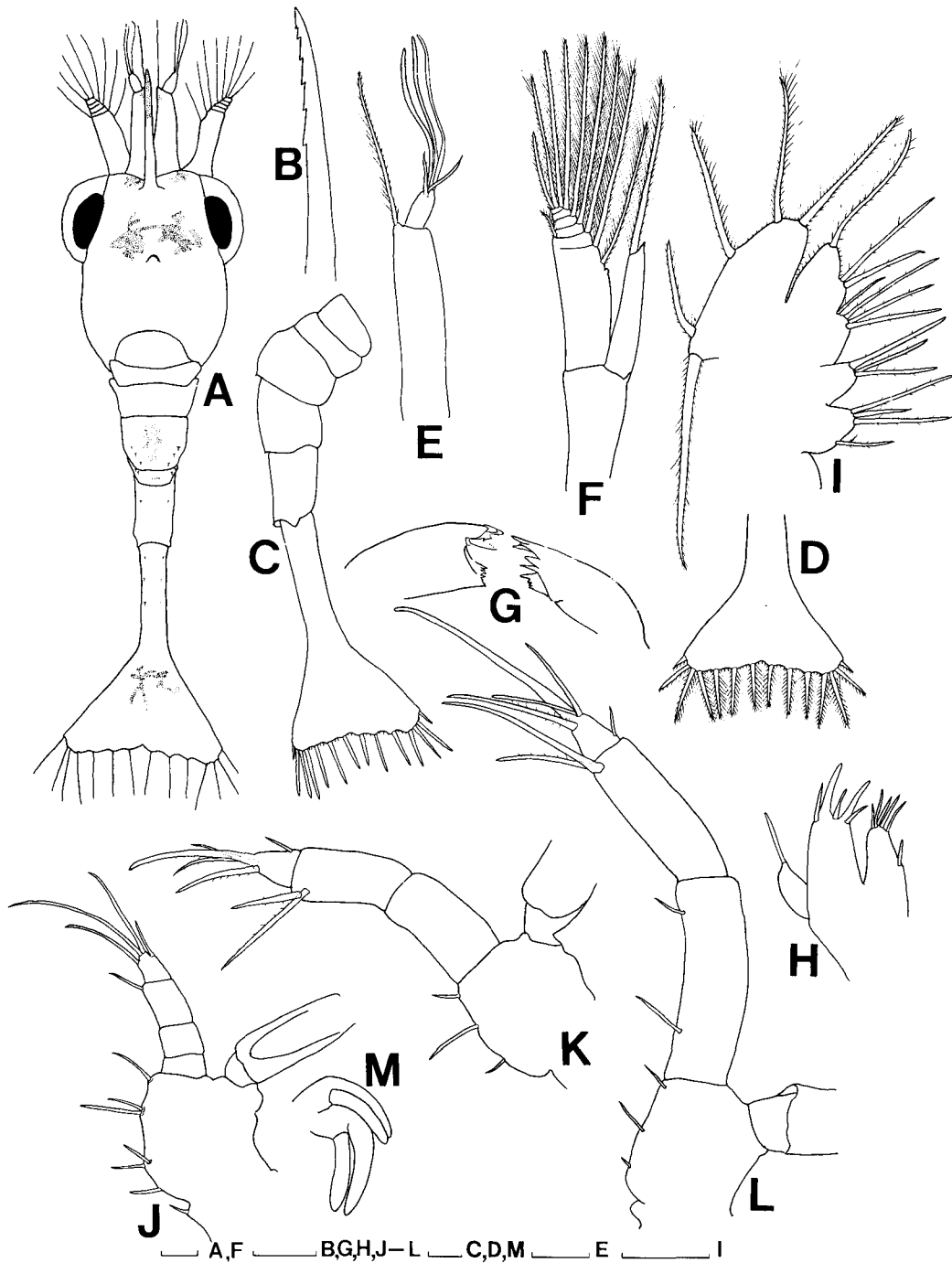


Fig. 1. First zoea of *Palaemon ortmanni* (Rathbun, 1902). A, habitus; B, tip of rostrum; C, lateral view of abdomen and telson; D, telson; E, antennule; F, antenna; G, mandibles; H, maxillule; I, maxilla; J, first maxilliped; K, second maxilliped; L, third maxilliped; M, first and second pereiopods. J-L, exopods truncated. Scales are 0.1 mm.

Telson (Fig. 1D) broad, triangular with 7+7 posterior setae. Base of setae 2-13 with row of minute spinules. Anus opening on ventral side of telson.

Antennule (Fig. 1E). Peduncle unsegmented. Inner flagellum with long plumose seta. Outer flagellum with 3 aesthetascs, plumose seta, and simple seta.

Antenna (Fig. 1F). Peduncle with basal spine. Endopod overreaching to half the length of scale with long plumose seta and spine distally. Scale flattened, 5-segmented distally with small internal papilla, 10 plumose setae, and disolateral spine.

Mandibles (Fig. 1G) asymmetrical. Left mandible with *lacinia mobilis* between molar and incisor processes. Right mandible with 2 teeth at corresponding site.

Maxillule (Fig. 1H). Coxal endite with subterminal seta and 5 terminal setae. Basial endite with 5 setae. Endopod with seta distally.

Maxilla (Fig. 1I). Coxal endite with subterminal plumose seta and 3 terminal setae. Basial endite bilobed with 3 and 4 plumose setae. Endopod with 2 basal setae, terminal seta, and minute marginal setules. Scaphognathite with 5 plumose setae and minute marginal setules.

First maxilliped (Fig. 1J). Coxa with seta. Basis with 1+2+2+1 setae. Endopod 4-segmented with 0, 0, 1, 4 setae. Exopod with 4 terminal natatory setae.

Second maxilliped (Fig. 1K). Coxa unarmed. Basis with 1+1+1 setae. Endopod 3-segmented with 0, 2, 4+1 setae. Exopod with 2 subterminal and 4 terminal natatory setae.

Third maxilliped (Fig. 1L). Coxa unarmed. Basis with 1+1+1 setae. Endopod 3-segmented with 1+1, 2, 4+1 setae. Exopod with 8 natatory setae.

Pereiopods (Fig. 1M). Pereiopods 1-2 biramous rudiments.

Red chromatophores which were interspersed with yellow chromatophores present on carapace, on rostrum distally, on peduncle of antennule, anterior to eyestalk, on mandibles, on endopods of second and third maxillipeds, on coxa of second maxilliped, on basis of third maxilliped, on abdominal somite 3 dorsally, and telson.

DISCUSSION

Ewald (1969) mentioned that the setation of the endopods of maxillule and maxilla is conserved to the larvae of hippolytid shrimp *Tozeuma carolinense* Kingsley, 1878 from the first larval stage to subsequent stages. Rice (1980) stressed the setal counts of the endopods of maxillule and maxilla could reflect phylogenetic relationships between decapod larvae, and the characters are important to separate them at subfamily or family level. The setations of the endopod of the maxilla of *Palaemon ortmanni* reported by Tsu *et al.* (1989) from Keelung, Taiwan, however, are variable from larval stage to stage. In addition, Tsu *et al.* (1989) described the first zoea of *P. ortmanni* had the outer flagellum of antennule with three aesthetascs and seta, and the scale of antenna with 11 plumose setae. Our observations, however, are not coincided with those of Tsu *et al.* (1989), because the first zoea of *P. ortmanni* has the outer flagellum of antennule with three aesthetascs and two setae, and the scale of antenna with ten plumose setae, distolateral spine, and inner papilla. In the larval development of *Palaemon*, the distolateral spine on the scale of antenna is minute in the first stage and becomes prominent from the third or fourth stages (Fincham, 1977,

1979b; Han and Hong, 1978). Tsu *et al.* (1989) described the fourth stage zoea of *P. ortmanni* had prominent distolateral spine on the scale of antenna. Such a difference, therefore, could be explained by an inaccurate observation because the distolateral spine on the scale of antenna is so minute that it is easily missed in the description of the first zoeas of the Caridea. Kurata (1968) also

Table 1. Morphological characteristics of the first zoeas in the Palaemonidae

	Maxillule endopod	Maxilla endopod	References
Palaemoninae			
<i>Macrobrachium carcinus</i>	2sp	2+1	Choudhury, 1971
<i>Macrobrachium equidens</i>	2sp	2+1	Ngoc-Ho, 1976
<i>Macrobrachium grandimanus</i>	2sp	2+1	Shokita, 1985
<i>Macrobrachium idella</i>	2sp	2+1	Pillai and Mohamed, 1973
<i>Macrobrachium lar</i>	2sp	2+1	Atkinson, 1977
<i>Macrobrachium niloticum</i>	2sp	2+1	Williamson, 1972
<i>Macrobrachium novaehollandiae</i>	2sp ¹	2+1	Greenwood <i>et al.</i> , 1976
<i>Macrobrachium olfersii</i>	2sp	2+1	Dugger and Dobkin, 1975
<i>Macrobrachium rosenbergii</i>	2sp ²	2+1	Uno and Kwan, 1969
<i>Macrobrachium sp.</i>	2sp	2+1	Ngoc-Ho, 1976
<i>Macrobrachium walvanensis</i>	2sp	2+1 ¹	Almelkar <i>et al.</i> , 2000
<i>Leptocarpus potamiscus</i>	2sp	2+1	Pillai, 1973
<i>Palaemon adspersus</i> as <i>P. (Palaemon) adspersus</i>	1	2+1	Fincham, 1985
<i>Palaemon elegans</i> as <i>P. (Palaemon) elegans</i>	1	2+1	Fincham, 1977
<i>Palaemon longirostris</i> as <i>P. (Palaemon) longirostris</i>	1	2+1	Fincham, 1979b
<i>Palaemon pacificus</i>	1	2+1	Han and Hong, 1978
<i>Palaemon pandaliformis</i>	1	2+1	Gamba, 1998
<i>Palaemon ortmanni</i>	1	2+1	present study
<i>Palaemon xiphias</i>	1	2+1	Carli and Marchi, 1979
<i>Palaemonetes intermedius</i>	1	2+1*	Hubschman and Broad, 1974
<i>Palaemonetes pugio</i>	1	2+1	Broad, 1957
<i>Palaemonetes varians</i> as <i>P. (Palaemonetes) varians</i>	1	2+1*	Fincham, 1979a
<i>Brachycarpus biunguiculatus</i>	1+1	2+1	Gurney, 1938
<i>Leander tenuicornis</i>	1+1	1	Gurney, 1938
<i>Leanderites celevensis</i>	2	1	Pillai, 1974
Pontoniinae			
<i>Coraliocaris graminea</i>	2	1	Gurney, 1938
<i>Harpiliopsis beaupresii</i> as <i>Harpilius beaupresii</i>	1, 1sp	1	Gurney, 1938
<i>Periclimenes pandionis</i> as <i>P. (Periclimenes) pandionis</i>	1, 1sp	1	Gore <i>et al.</i> , 1981
<i>Pontonia flavomaculata</i>	1, 1sp	1	Costanzano <i>et al.</i> , 1996
<i>Pontonia pinnophylax</i>	2, 1sp	1	Calafiore <i>et al.</i> , 1991

sp = spine; ¹ and ² = larval characteristic from the second and third stages, respectively; * = data from figure.

described the larvae of *P. ortmanni* from Arasaki, Sagami Bay, Japan, but there is no available information on the mouthparts of the first zoea of *P. ortmanni* from his description.

Larval developments are known for 11 genera within the Palaemonidae (Table 1). The first zoeas of *Palaemon* have two subterminal setae and terminal seta on the endopod of maxilla and share with those of *Macrobrachium*, *Leptocarpus*, *Palaemonetes*, and *Brachycarpus*. These genera are easily distinguished from *Pontonia*, *Periclimenes*, *Harpiliopsis*, and *Coralliocaris* of the Pontoniinae because the last four genera have only terminal seta on the endopod of maxilla. However, *Leander tenuicornis* (Say, 1818) and *Leandrites celevensis* (De Man, 1881) have terminal seta only on the endopod of maxilla. Therefore, the two genera have more affinities with the Pontoniinae than with the Palaemoninae. The setation of the endopod of the maxillule of the first zoeas of the Palaemoninae is somewhat variable between genera. Except for *Brachycarpus biunguiculatus* (Lucas, 1846) and *L. tenuicornis*, of which endopod of maxillule is bilobed and armed with 1+1 setae, the endopod of the maxillule of *Macrobrachium*, *Leptocarpus*, *Palaemon*, and *Palaemonetes* is not bilobed and armed with seta or two spines terminally. Of the last four genera recognized, the first zoeas of *Palaemon*, however, share with those of *Palaemonetes* by having long terminal seta on the endopod of maxillule. The first zoeas of *Macrobrachium* and *Leptocarpus* have two short spines on the endopod of maxillule. Therefore, it is suggested that *Palaemon* is more closely related to *Palaemonetes* than to *Macrobrachium*, *Leptocarpus*, *Leander*, *Leanderites*, and *Brachycarpus*.

The following provisional key is based on the zoeas with extended development which belong to the Palaemonidae and given to aid to identify them between three genera *Palaemon*, *Macrobrachium*, and *Periclimenes* known from Korean waters. *Exopalaemon orientis* Holthuis, 1950 is known to occur in Korean waters (National Fisheries Research and Development Institute, 2001) and its larval development was extended type (Shy and Yu, 1989). The authors excluded, however, the zoeas of *E. orientis* in the following key because of Shy and Yu (1989)'s too brief description.

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| 1. Maxilla endopod with 2+1 setae | 2 |
| – Maxilla endopod with 1 terminal seta | <i>Periclimenes</i> |
| 2. Maxillule endopod with 2 spines | <i>Macrobrachium</i> |
| – Maxillule endopod with 1 seta | <i>Palaemon</i> |

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긴발줄새우 (십각목, 생이하목, 징거미새우과)의
제1조애아 유생과 징거미새우과 유생의 형태

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요 약

긴발줄새우 제1조애아 유생기의 형태적인 특징을 상세히 재기재 및 도시하였다. 줄새우속 제1조애아 유생은 제1소악 내지에 1개의 말단 강모와 제2소악 내지에 2+1의 강모를 가져 징거미새우아과내 징거미새우속, *Leptocarpus*속, *Leander*속, *Leanderite*속, *Brachycarpus*속보다는 *Palaemonetes*속에 더욱 가깝다. 한국 연안에 보고된 줄새우속, 징거미새우속, 예쁜이해면속살이새우속의 조애아유생 검색표를 제시하였다.