

Larval Development of *Ilyoplax dentimerosa* Shen, 1932 (Decapoda, Brachyura, Ocypodidae) Reared in the Laboratory

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Larvae of *Ilyoplax dentimerosa* Shen, 1932 were reared in the laboratory at 25°C and 33.3‰ salinity. Four zoeal stages were recognized in the larval development, and these are described and illustrated. The first zoeae of *I. dentimerosa* are distinguished from other *Ilyoplax* zoeae by having minute spinules on the rostral and dorsal carapace spines, a short dorsal carapace spine about half of the carapace length, a conspicuous antennal exopodite with a subterminal seta and acute spines on the postero-lateral border of the fourth abdominal somite.

KEY WORDS: Larval development, *Brachyura*, *Ilyoplax dentimerosa*

Within the family Ocypodidae, larval descriptions of 38 species are available: 15 species in Ocypodinae, 13 species in Scopimerae, and ten species in Macrophthalminae. However, many of these descriptions are first zoeal stages only. Aikawa (1929, 1933) especially described the first zoeal stages of *Scopimera globosa*, *Ilyoplax pusillus*, *Macrophthalmus depressus*, *M. japonicus* and *M. dilatatus*. According to his classification, that is, based on the type of antenna and the telson type, he gave generic names, such as *Xanthozoea* including genera *Scopimera* and *Ilyoplax*, and *Grapsizoea* including genus *Macrophthalmus*, to ocypodid zoeae. On the other hand, the complete larval development is known for *Ocypode quadrata* (see Diaz & Costlow, 1972), *O. stimpsoni* (see Terada, 1979), *Uca lactea lactea* (see Terada, 1979), *U. pugilator* (see Hyman, 1922), *U. arcuata* (see Ko & Kim, 1989), *Scopimera globosa* (see Terada, 1976), *S. inflata* (see Fielder & Greenwood, 1985), *S. longidactyla* (see Jang, 1989), *S. bitympana* (see Jang, 1989), *Ilyoplax pusillus* (see Terada, 1976), *I. pingi* (see Jang, 1989), *Dotilla sulcata* (see Gohar & Alkholi, 1957) and *Macrophthalmus dilatatus* (see Terada, 1979). But some of these descriptions are so brief that there is still a need for de-

tailed re-descriptions, even of single zoeal stage, where the previous descriptions are clearly inadequate.

Larval descriptions of four species have been presented in the genus *Ilyoplax*: *I. gangetica* (see Feest, 1969), *I. pusillus* (see Terada, 1976), *I. pingi* (see Jang, 1989) and *I. tansuiensis* (see Ko & Kim, in press). *Ilyoplax dentimerosa* Shen inhabits the mud-flats of estuaries and ranges to China and the Yellow Sea of Korea (Kim, 1973). Its larval stages are unknown.

The present paper provides details of the larval characteristics of *Ilyoplax dentimerosa* and compares the morphological characteristics of the first zoeal stage to those of the four other species of *Ilyoplax*.

Materials and Methods

In August, 1986, ovigerous female of *Ilyoplax dentimerosa* were collected at the mud-flat of the estuary, Chindo, Chollanam-do, Korea. In the laboratory, they were placed in a sand bottom aquarium at a salinity of 33.3‰ and a temperature of 25°C. As the eggs hatched, some of larvae

were fixed immediately. Larvae showing the greatest activity were separated into 10 groups. Each group consists of 10 larvae per glass bowl. They were fed on *Brachionus plicatilis* and recently hatched *Artemia* nauplii, and maintained in a culture cabinet at the same conditions of temperature and salinity described above. The larvae were moved into new bowls with freshly filtered sea water and were fed daily.

Specimens and exuviae of each developmental stage were preserved in 10% neutral formalin to check the setation of appendages. Drawings were made with the help of a camera lucida and measurements were based on the mean of 10 specimens in each zoeal stage. The decapod larval terminology used throughout this paper closely follows the nomenclature named by Goy et al. (1981). The chromatophore patterns were determined from the observation of living larvae.

Results

In this study, four zoeal stages and one megalopal stage were recognized and completion of the four zoeal stages required 19 days. Only one megalopal larva was obtained. No pre-zoeae were observed. The main characteristics of each larval stage in this species are as follows:

First Zoea (Fig. 1)

Size. Carapace length 0.40-0.43mm (mean 0.42mm). Tip of dorsal carapace spine to tip of rostral carapace spine 0.90-1.05mm (mean 0.98mm).

Carapace (Fig. 1A). Dorsal, rostral and lateral carapace spines present. Dorsal and rostral spines both with minute spinules: dorsal carapace spine about half of carapace length, rostral carapace spine about equal of carapace length. Lateral carapace spines very short. Postero-ventro-lateral carapace border naked, cardiac region with a pair of setae. Postero-lateral carapace border naked, cardiac region with a pair of setae. Postero-dorsal carapace protuberance present. Eyes sessile.

Antennule (Fig. 1B). Two aesthetascs unequal in length and two setae present.

Antenna (Fig. 1C). Protopodite about seven-eighth length of rostral carapace spine, with two rows of spinules. Exopodite short, about one-fifth length of spinous process, with a simple seta. No endopodite.

Mandibles (Fig. 1D). Asymmetrical: incisor and molar processes irregularly dentate. Right molar process with two unequal and small teeth joining margin of incisor process.

Maxillule (Fig. 1E). Endopodite two-segmented: distal segment with four terminal plumodenticulate setae throughout all zoeal stages, proximal naked. Basal and coxal endites bearing five and four plumodenticulate setae, respectively.

Maxilla (Fig. 1F). Endopodite-two lobed, each with three and two plumodenticulate setae respectively throughout all zoeal stages: upper lobe with three plumodenticulate setae and lower lobe with two plumodenticulate setae. Coxal endite with five plumodenticulate setae. Scaphognathite bearing four marginal plumose setae and a terminal plumose process.

First maxilliped (Figs. 1A, G). Coxopodite with a plumodenticulate seta, basipodite with 10 plumodenticulate setae, progressing distally 2,2,3 and 3, throughout all zoeal stages. Endopodite five-segmented with 2,2,1,2 and 4+1 plumodenticulate setae, progressing distally. Exopodite with four plumose natatory setae.

Second maxilliped (Figs. 1A, H). Coxopodite unarmed, basipodite with three plumodenticulate setae throughout all zoeal stages. Endopodite three-segmented with 0,1 and 6 plumodenticulate setae, progressing distally, throughout all zoeal stages. Exopodite with four plumose natatory setae.

Abdomen (Figs. 1A, H). Composed of five somites: somites two and three with small knobs, those of somite three very small.

Postero-dorsal border of somites two to five with a pair of small simple setae. Somites three to five with a process on postero-middorsal border. Somite four with acute spines on postero-lateral border which about half length of somite five.

Telson (Figs. 1A, I). Forks naked. Three pairs of denticulate setae less than half length of fork, present on inner margin of telson.

Chromatophores (Fig. 1A) show the pattern of

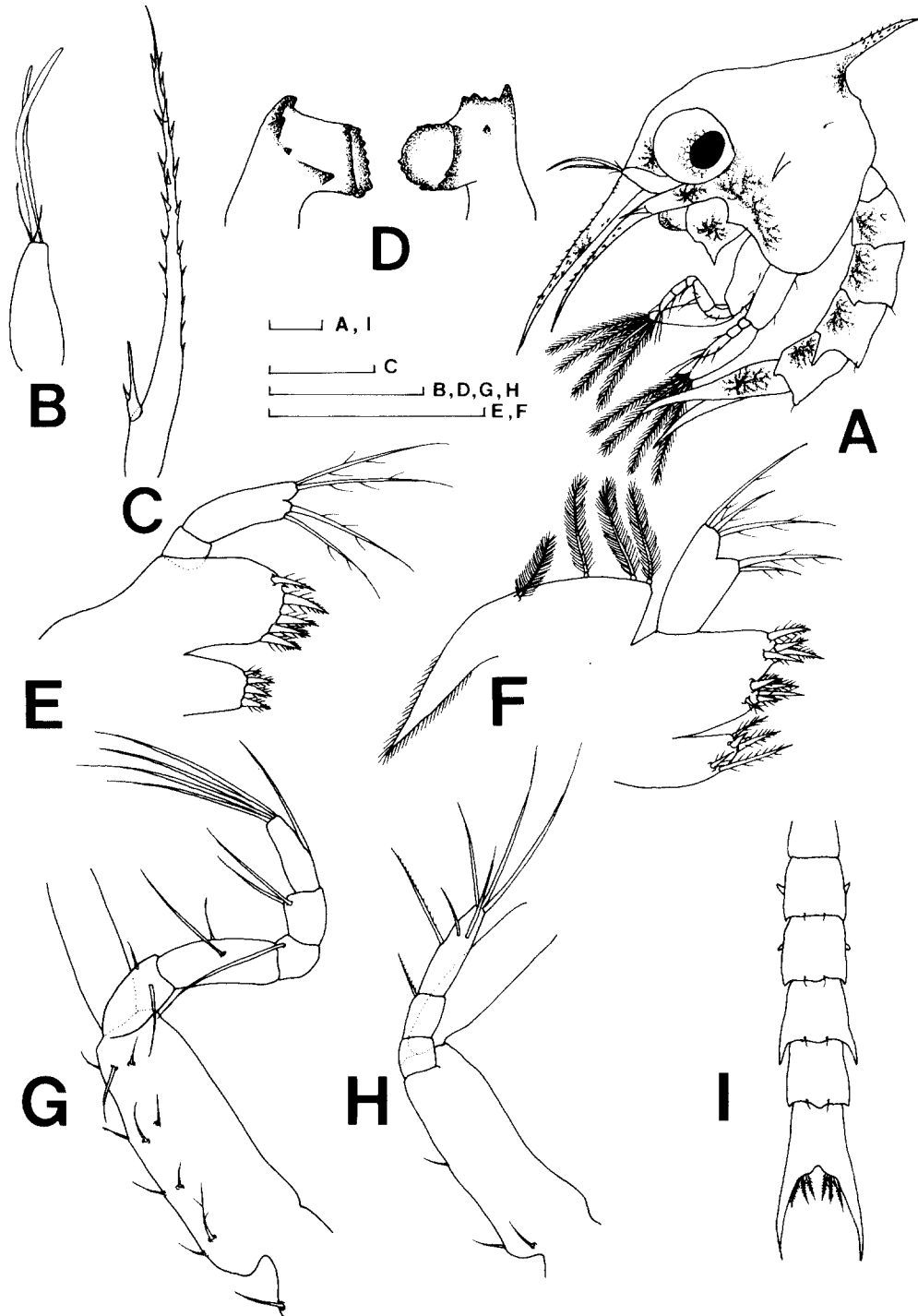


Fig. 1. *Ilyoplax dentimerosa* Shen, First zoeal stage, A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, protopodite and endopodite of first maxilliped; H, protopodite and endopodite of second maxilliped; I, dorsal view of abdomen. Scale bars = 0.1 mm.

mixed dominant brown series: dark brown near to black and red spots. The majority of dark brown series occurs on bases of antennule, antenna, labrum and mandible, median and ventral to eyes, along abdominal somites and telson, on marginal expansion of carapace and along rostral carapace spine. Red chromatophores are present on each abdominal somite, telson, ventral to eyes and at base of dorsal spine. This pattern is unchanged throughout all zoeal stages.

Second Zoea (Fig.2)

Size. Carapace length 0.45-0.50 mm (mean 0.48 mm). Tip of dorsal carapace spine to tip of rostral carapace spine 1.00-1.28 mm (mean 1.13 mm).

Carapace (Fig. 2A). Increasing in size of carapace, dorsal and rostral carapace spines. A pair of minute simple setae on base of rostral carapace spine and above eye.

Antennule (Fig. 2B). Four aesthetascs unequal in length and a simple seta present.

Antenna (Fig. 2C). Protopodite slightly longer than rostral carapace spine. Exopodite unchanged from previous stage.

Mandibles (Fig. 2D). Right molar process with two small and large teeth joining margin of incisor process.

Maxillule (Fig. 2E). Basal endite with seven plumodenticulate setae. Disto-lateral margin with a long plumose seta.

Maxilla (Fig. 2F). Basal endite with 10 plumodenticulate setae. Coxal endite with six plumodenticulate setae. Scaphognathite with five marginal and three terminal plumose setae.

First and second maxillipeds (Fig. 2A). Both exopodite with six plumose natatory setae.

Abdomen and telson (Figs. 2A, I). As in first stage, each process on postero-middorsal border of somites three to five more pronounced: processes on somites four and five larger than that on somite three.

Third Zoea (Fig. 3)

Size. Carapace length 0.63-0.70 mm (mean 0.66 mm). Tip of dorsal carapace spine to tip of

rostral carapace spine 1.50-1.65 mm (mean 1.59 mm).

Carapace (Fig. 3A). Distinctly increased in size. Five plumose setae on postero-ventro-lateral carapace border. Buds of thoracic appendages visible through carapace.

Antennule (Fig. 3B). Three aesthetascs and a small simple seta present.

Antenna (Fig. 3C). Protopodite slightly shorter than rostral carapace spine. Endopodite present, as small as basal protuberance.

Mandibles (Fig. 3D). Unchanged from previous stage.

Maxillule (Fig. 3E). Basal endite with nine plumodenticulate setae. Coxal endite with five plumodenticulate setae.

Maxilla (Fig. 3F). Basal endite with 11 plumodenticulate setae. Coxal endite with seven plumodenticulate setae. Scaphognathite bearing seven marginal and five terminal plumose setae.

First maxilliped (Figs. 3A, G). Endopodite setation now with 2,2,2,2 and 4 + 1 + 1, progressing distally. Exopodite with eight plumose natatory setae.

Second maxilliped (Fig. 3A). Exopodite with eight plumose natatory setae.

Abdomen and telson (Figs. 3A, I). Abdomen composed of six somites: somite one with a long dorsal seta, pleopod buds on somites two to five and acute spines of somite four less pronounced than those of previous stage. Telson shorter than in second zoeal stage.

Fourth Zoea (Fig. 4)

Size. Carapace length 0.80-1.03mm (mean 0.92mm). Tip of dorsal carapace spine to tip of rostral carapace spine 1.80-2.15mm (mean 2.05mm).

Carapace (Fig. 4A). As in previous stage, seven plumose setae on postero-ventro-lateral carapace border. Buds of thoracic appendages much more elongated, chela well developed.

Antennule (Fig. 4B). Four terminal, a subterminal aesthetascs and a simple seta present.

Antenna (Fig. 4C). Endopodite more developed than that of previous stage.

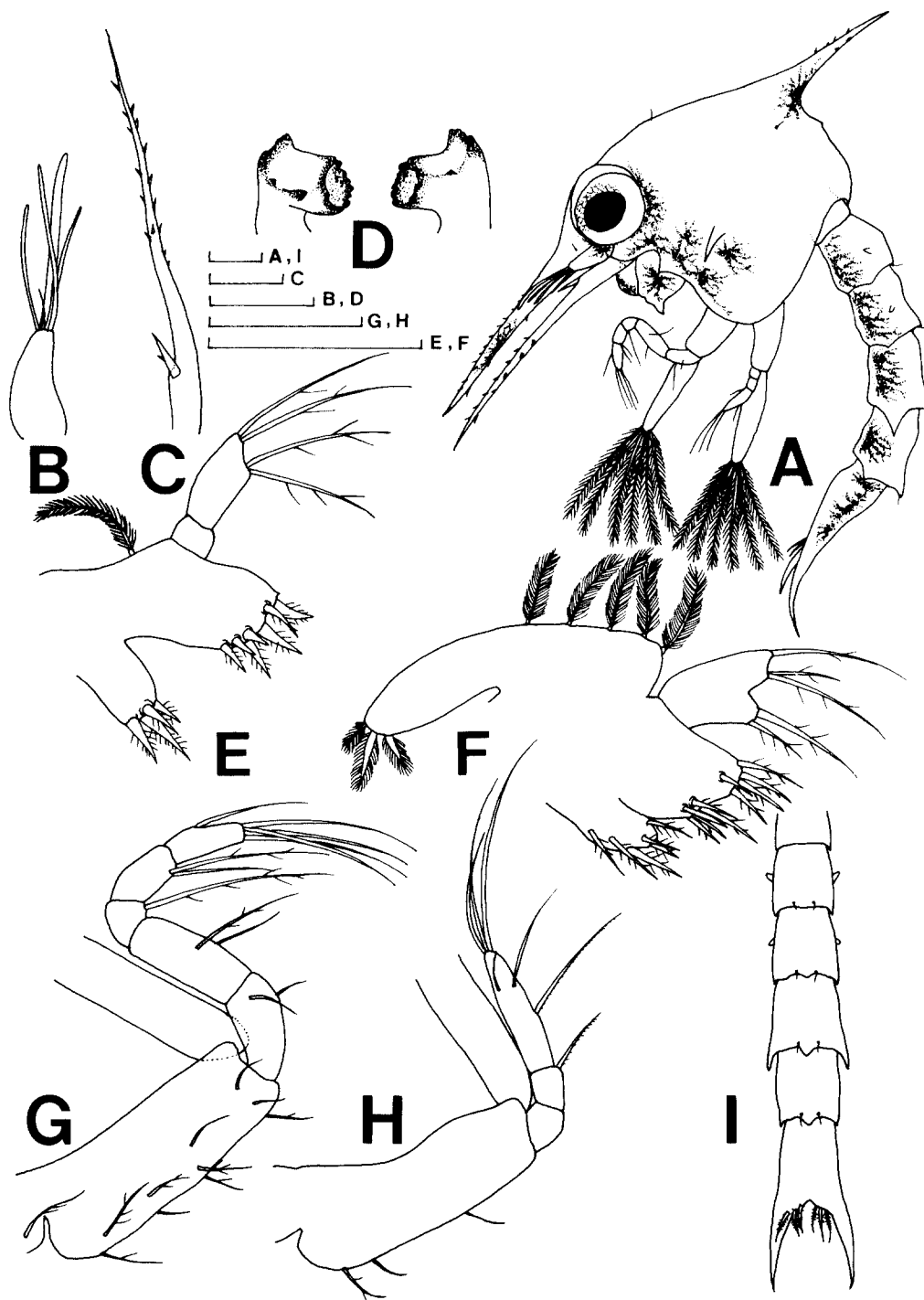


Fig. 2. *Ilyoplax dentimerosa* Shen, Second zoeal stage, A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, protopodite and endopodite of first maxilliped; H, protopodite and endopodite of second maxilliped; I, dorsal view of abdomen. Scale bars = 0.1 mm.

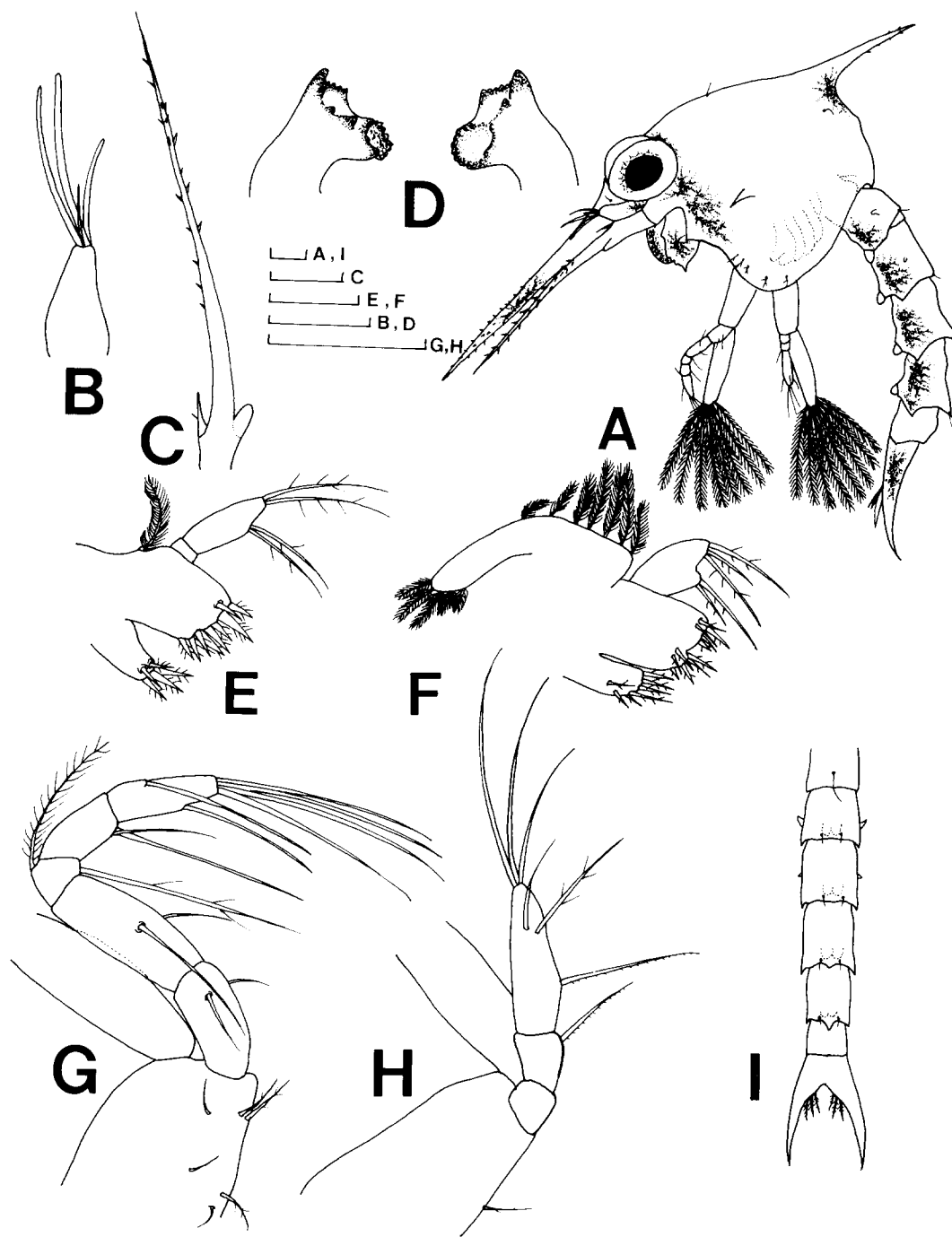


Fig. 3. *Ilyoplax dentimerosa* Shen, Third zoeal stage, A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, protopodite and endopodite of first maxilliped; H, protopodite and endopodite of second maxilliped; I, dorsal view of abdomen. Scale bars = 0.1 mm.

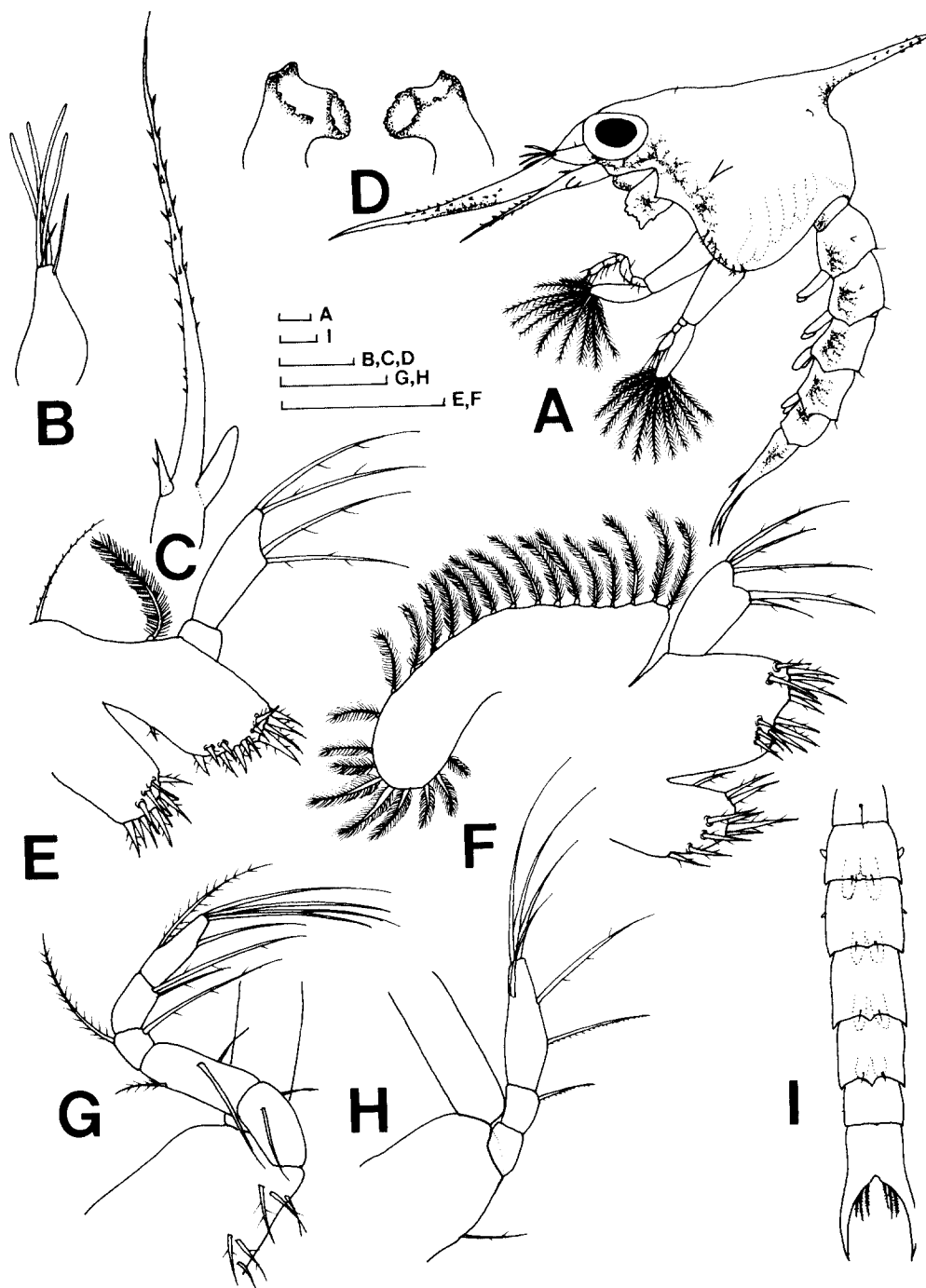


Fig. 4. *Ilyoplax dentimerosa* Shen, Fourth zoeal stage, A, lateral view; B, antennule; C, antenna; D, mandibles; E, maxillule; F, maxilla; G, protopodite and endopodite of first maxilliped; H, protopodite and endopodite of second maxilliped; I, dorsal view of abdomen. Scale bars = 0.1 mm.

Mandibles (Fig. 4D). Similar in form to previous stage.

Maxillule (Fig. 4E). Basal endite with 14 plumodenticulate setae. Coxal endite with 10 plumodenticulate setae. A seta now present on proximo-lateral margin.

Maxilla (Fig. 4F) Basal endite with 14 plumodenticulate setae. Coxal endite with 10 plumodenticulate setae. Scaphognathite bearing 24 plumose setae.

First maxilliped (Figs. 4A, G). Endopodite setation now with 2,3,2,2 and 4 + 1 + 1, progressing distally. Exopodite with 10 plumose natatory setae.

Second maxilliped (Fig. 4A). Exopodite with 10 plumose natatory setae.

Abdomen and telson (Figs. 4A, I). Pleopod buds more developed on somites two to five than those of previous stage. Telson unchanged.

Discussion

Aikawa(1937) studied the first zoeal larvae belonging to the genera *Macrophthalmus*, *Uca*, *Ilyoplax* and *Scopimera*. He could recognize groups corresponding to the subfamilies on the basis of the presence or absence of lateral carapace spines, the types of antenna and telson, and the setation of maxilla and second maxilliped. Rice(1975, 1980) used the setation of the endopodite of the maxillule, maxilla and second maxilliped to classify ocyropodid zoeae into distinct groups. On the basis of the mouthpart setation, the first zoeae of the genus *Ilyoplax* are morphologically similar to each other: the endopodite of the maxillule and the maxilla usually have 0,4 and 2,3

setation, the basipodite of the second maxilliped usually have three plumodenticulate setae, and the medial segment of the endopodite of the second maxilliped usually bears a seta. Especially, the first zoeae of *I. dentimerosa* are very similar to those of *I. pingi* by having antennal exopodite and lateral carapace spine. But, there are some minute differences on the other characteristics. As shown in Table 1, the first zoeae of *I. dentimerosa* can be easily distinguished from those of *I. pingi* on the features of the lateral carapace spine, antennule, abdominal somite four and telson.

However, the first zoeae of *I. dentimerosa* and *I. pingi* are different from the other zoeae of the same genus on the basis of the type of antenna. This type of antenna can be seen in the subfamily Macrophthalminae. According to the Table 2, there are somewhat lesser uniform larval characteristics in the subfamily Macrophthalminae. The characteristics of the species of *Paracleistostoma cristatum* and *Cleistostoma dilatatum* significantly differ from those of the other species in the same subfamily: the endopodite of the maxillule and the maxilla have 0,4 and 2,3 setation, and the basipodite of the second maxilliped bears three plumodenticulate setae, as in the subfamily Scopimerinae. We recognize that they have the closest affinities with those of *I. dentimerosa* and *I. pingi*. Their zoeal characteristics may support Manning & Holthuis'(1981) suggestion that *Paracleistostoma cristatum* and *Cleistostoma dilatatum* go into the new subfamily Camptandrininae. Furthermore, we consider that the critical evaluation of the systematic position of *I. dentimerosa* should be necessary on the basis of the larval morphology.

Table 1. Distinctive characteristics of the first zoeal stages of *Ilyoplax dentimerosa* and *I. pingi*.

Species Authors	<i>I. dentimerosa</i> Present work	<i>I. pingi</i> Jang, 1989
Lateral carapace spine	Present	Present with minute spinules
Antennule	2 aesthetascs + 2 setae	2 aesthetascs + 1 seta
Abdominal somite four Postero-lateral border	Acute spine about half length of somite five	Acute spine about 1/3 length of somite five
Surface of telson	No denticulettes	Clusters of denticulettes

Table 2. Comparison of characteristics of the first zoeal stages in the family Ocypodidae.

	Maxillule endopodite	Maxilla endopodite	Maxilliped 2 basipodite	Antenna exopodite	Lateral carapace spine	Authors
Ocypodinae						
<i>Ocypode quadrata</i>	0, 4	1, 2(3)	4	+	—	Diaz & Costlow, 1972
<i>Uca arcuata</i>	0, 4	1, 2(3)	4	+	—	Ko & Kim, 1989
Scopimerinae						
<i>Scopimera globosa</i>	0, 4	2, 3(5)	3	—	+	Terada, 1976
<i>Ilyoplax pusillus</i>	0, 4	2, 3(5)	3	—	+	Terada, 1976
<i>Ilyoplax gangetica</i>	0, 4	(4-5)	?	—	—	Feest, 1969
<i>Ilyoplax tansuiensis</i>	0, 4	2, 3(5)	3	—	—	Ko & Kim, in press
<i>Ilyoplax pingi</i>	0, 4	2, 3(5)	3	+	+	Jang, 1989
<i>Ilyoplax dentimerosa</i>	0, 4	2, 3(5)	3	+	+	Present work
Macrophthalminae						
<i>Paracleistostoma cristatum</i>	0, 4	2, 3(5)	3	+	+	Terada, 1979
<i>Cleistostoma dilatatum</i>	0, 4	2, 3(5)	3	+	+	Kim & Lee, 1982
<i>Macrophthalmus depressus</i>	1, 5	2, 2(4)	4	+	—	Rice, 1975
<i>Macrophthalmus dilatatus</i>	1, 5	2, 2(4)	4	+	—	Aikawa, 1929

(+) and (—) = the presence and absence. (?) = no description.

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실험실에서 사육된 털콩게 *Ilyoplax dentimerosa* Shen, 1932의 유생발생
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실험실에서 사육된 털콩게는 4 zoea 기와 1 megalopa 기를 가졌고, 각 zoea기는 상세히 기술, 도시하였다. 털콩게 제 1 zoea 유생은 갑각에 거치상의 이마가시와 등가시를 가지고, 제 2 촉각 외지를 가지며, 제 4 복부절의 후측부에 예리한 가시를 가짐으로서 이미 보고된 넓적콩게속의 다른 종들의 zoea 유생과는 뚜렷한 차이점들을 가지고 있다.