

## **Megalopal stages of three *Pugettia* species (Crustacea: Decapoda: Majidae) reared in the laboratory**

**Hyun Sook Ko and Sang Gu Hwang**

(Department of Biology, Pusan Women's University, Pusan 616-736, Korea)

### **ABSTRACT**

The megalopae of *Pugettia quadridens quadridens* (De Haan, 1850), *P. quadridens intermedia* Sakai, 1938, and *P. marissinica* Takeda and Miyake, 1972 were obtained in the laboratory. They are described and illustrated in detail. The megalopal morphology of these three *Pugettia* species is compared with other Epialtinae megalopae. *P. marissinica* is quite different from *P. quadridens intermedia* and *P. quadridens quadridens*. *P. quadridens intermedia* and *P. quadridens quadridens* are very closely resemble to each other.

Key words: Majidae, *Pugettia quadridens quadridens*, *P. quadridens intermedia*, *P. marissinica*, Megalopa.

### **INTRODUCTION**

*Pugettia* Dana, 1851 of Epialtinae is one of the few genera with species on both sides of the Pacific Ocean, but the genus appears to be confined to the northern hemisphere (Griffin and Tranter, 1986). In Korea, this genus consists of *P. quadridens quadridens* (De Haan, 1850), *P. quadridens intermedia* Sakai, 1938, *P. quadridens pellucens* Rathbun, 1932, *P. incisa* (De Haan, 1839) and *P. minor* Ortmann, 1893 (see Kim, 1973; Kim and Kim, 1985, 1986; Kim and Chang, 1985). *P. marissinica* Takeda & Miyake, 1972 is reported for the first time in Korea in this study.

The megalopal stages of 6 Epialtinae species are known; *Acanthonyx petiverii* H. Milne Edwards, 1834 by Hiyodo and Fransozo (1994); *Taliepus dentatus* Milne Edwards by Fagetti and Campodonico (1971); *Epialtus dilatatus* A. Milne Edwards, 1878 by Yang (1968); *E. brasiliensis* Dana, 1852 by Negreiros-Fransozo and Fransozo (1991); *Pugettia incisa* and *P. quadridens quadridens* by Kurata (1969).

To date the megalopal stages of *Pugettia marissinica* and *P. quadridens intermedia* are unknown and, in addition, the megalopal description of *P. q. quadridens* is incomplete. Therefore, the aims of this paper are to (1) describe the megalopal stages of *P. marissinica* and *P. q. intermedia*, (2) redescribe the megalopa of *P. q. quadridens*, and (3) compare them with previously described megalopae within the subfamily Epialtinae.

## MATERIALS AND METHODS

Ovigerous crabs of *Pugettia marissinica* Takeda and Miyake, 1972, *Pugettia quadridens intermedia* Sakai, 1938, and *Pugettia quadridens quadridens* (De Haan, 1850) were collected by SCUBA diving from islands off the southern part of Korea in October 1995, June 1996, and May 1997, respectively. The larvae collected among those hatched in the laboratory were reared using methods described by Ko (1995), under the constant water temperature of 25°C. The megalopae 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*. Setal counts on appendages and measurements were based on the mean of 10 specimens.

## RESULTS

### ***Pugettia marissinica* Takeda and Miyake, 1972**

Megalopa (Fig. 1)

Size. Carapace length 1.25 mm. Carapace width 0.86 mm.

Carapace (Fig. 1A). Subquadrate, with 2 anterogastric lateral, 2 posterogastric lateral, 1 median, and 1 posterior tubercles. A seta present in median tubercle.

Antennule (Fig. 1B). Exopod 3-segmented, second segment with 8 aesthetascs and 1 seta, third with 4 subterminal and 1 terminal aesthetascs. Endopod 2-segmented, distal with 1 subterminal and 2 terminal setae.

Antenna (Fig. 1C). 7-segmented, with 0, 2, 3, 0, 0, 4, and 4 setae.

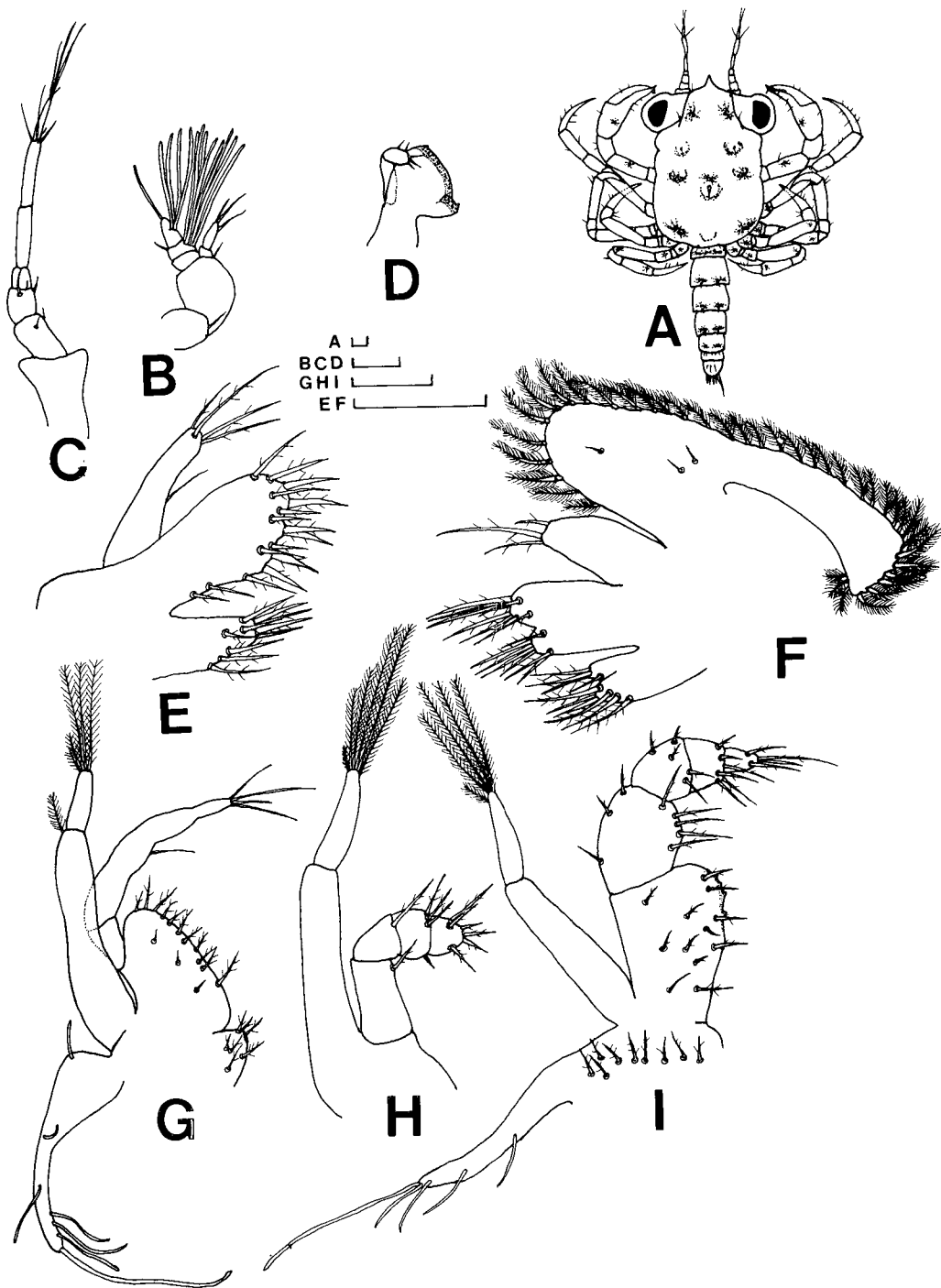
Mandible (Fig. 1D). Palp with 5 setae on distal segment.

Maxillule (Fig. 1E). Endopod bearing 1+4 plumodenticulate setae. Basial and coxal endites each with 16 and 10 plumodenticulate setae, respectively.

Maxilla (Fig. 1F). Endopod with 3 plumodenticulate setae. Basial and coxal endites each with 15 and 10 plumodenticulate setae, respectively. Scaphognathite bearing 39 marginal plumose setae and 3 plumodenticulate surface setae.

First maxilliped (Fig. 1G). Endopod with 1 subterminal and 4 terminal setae. Basial and coxal endites each with 14 and 7 plumodenticulate setae, respectively. Exopod 2-segmented, proximal segment with 1 plumose setae and distal segment with 5 plumose setae. Epipod with 7 long curved simple setae.

Second maxilliped (Fig. 1H). Endopod 4-segmented with 0, 1, 4, and 6 plumodenticulate setae. Exopod 2-segmented, with 6 plumose setae on distal segment.



**Fig. 1.** *Pugettia marissinica* Takeda and Miyake, 1972, megalopal stage: A, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped. Scale bars = 0.1 mm

Third maxilliped (Fig. 1I). Endopod 5-segmented with 12, 8, 5, 6, and 4 plumodenticulate setae. Coxa/basis with 9 plumodenticulate setae. Exopod 2-segmented with 5 plumose setae on distal segment. Epipod with 5 long curved simple setae.

***Pugettia quadridens intermedia* Sakai, 1938**

Megalopa (Fig. 2)

Size. Carapace length 1.11 mm. Carapace width 0.79 mm.

Carapace (Fig. 2A). Subquadrate, with 2 anterogastric lateral, 2 posterogastric lateral, 1 median, and 1 posterior tubercles.

Antennule (Fig. 2B). Exopod 4-segmented, second segment with 8 aesthetascs and 1 seta, third with 4 aesthetascs, fourth with 1 terminal aesthetasc. Endopod 2-segmented, distal with 1 subterminal and 2 terminal setae.

Antenna (Fig. 2C). 7-segmented, with 0, 2, 3, 0, 0, 4, and 4 setae.

Mandible (Fig. 2D). Palp with 5 setae on distal segment.

Maxillule (Fig. 2E). Endopod bearing 1 + 2 plumodenticulate setae. Basial and coxal endites each with 16 and 10 plumodenticulate setae, respectively.

Maxilla (Fig. 2F). Endopod naked. Basial and coxal endites each with 13 and 9 plumodenticulate setae, respectively. Scaphognathite bearing 33 marginal plumose setae and 2 plumodenticulate surface setae.

First maxilliped (Fig. 2G). Endopod naked. Basial and coxal endites each with 11 and 6 plumodenticulate setae, respectively. Exopod 2-segmented, proximal segment with 1 plumose setae and distal segment with 4 plumose setae. Epipod with 5 long curved simple setae.

Second maxilliped (Fig. 2H). Endopod 4-segmented with 0, 1, 3, and 6 plumodenticulate setae. Exopod 2-segmented, with 4 plumose setae on distal segment.

Third maxilliped (Fig. 2I). Endopod 5-segmented with 12, 8, 4, 6, and 4 plumodenticulate setae. Coxa/basis with 7 plumodenticulate setae. Exopod 2-segmented with 5 plumose setae on distal segment. Epipod with 5 long curved simple setae.

***Pugettia quadridens quadridens* (De Haan, 1850)**

Megalopa (Fig. 3)

Size. Carapace length 1.08 mm. Carapace width 0.93 mm.

Carapace (Fig. 3A). Subquadrate, with 2 anterogastric lateral, 2 posterogastric lateral, 1 median, and 1 posterior tubercles.

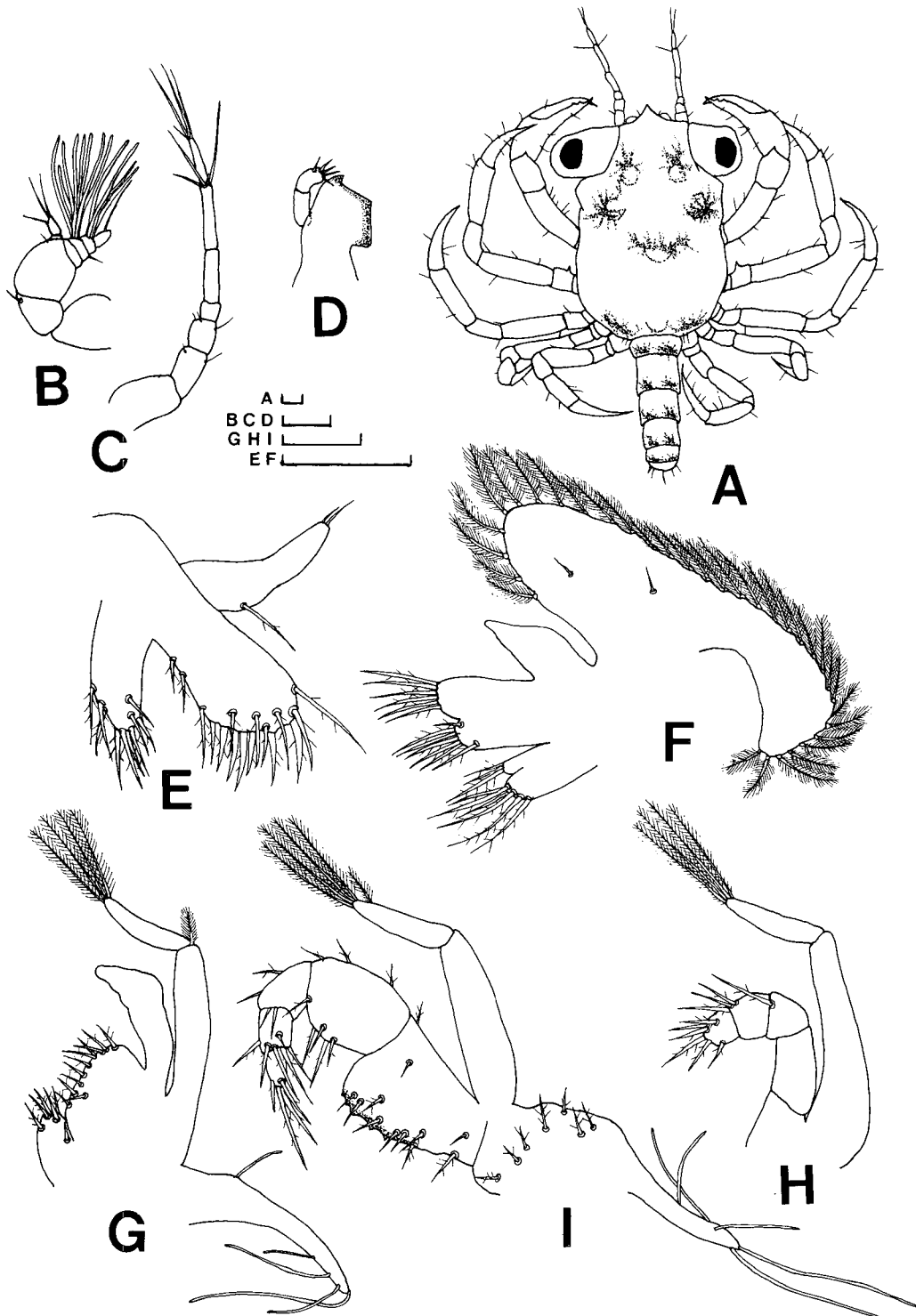
Antennule (Fig. 3B). Exopod 4-segmented, second segment with 9 aesthetascs and 1 seta, third with 4 subterminal, fourth with 1 terminal aesthetasc. Endopod 2-segmented, distal with 1 subterminal and 2 terminal setae.

Antenna (Fig. 3C). 7-segmented, with 1, 2, 3, 0, 0, 4, and 4 setae.

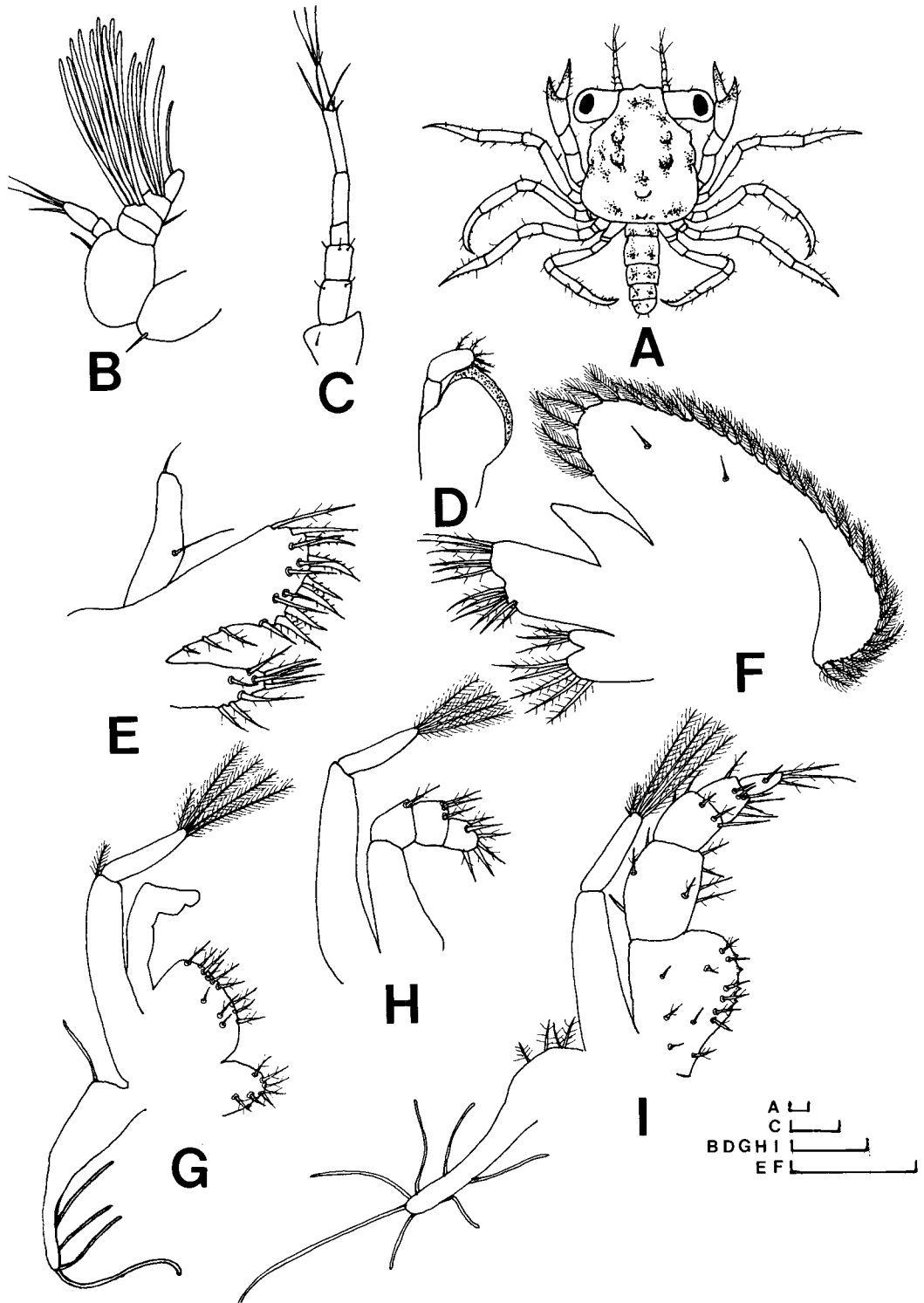
Mandible (Fig. 3D). Palp with 5 setae on distal segment.

Maxillule (Fig. 3E). Endopod bearing 1 + 1 plumodenticulate setae. Basial and coxal endites each with 17 and 10 plumodenticulate setae, respectively.

Maxilla (Fig. 3F). Endopod naked. Basial and coxal endites each with 12 and 8 plumodenticulate setae, respectively. Scaphognathite bearing 34 marginal plumose setae and 2 plumodenticulate



**Fig. 2.** *Pugettia quadridens intermedia* Sakai, 1938, megalopal stage: A, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped. Scale bars = 0.1 mm



**Fig. 3.** *Pugettia quadridens quadridens* (De Haan, 1850), megalopal stage: A, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped. Scale bars = 0.1 mm

surface setae.

First maxilliped (Fig. 3G). Endopod naked. Basial and coxal endites each with 12 and 7 plumodenticulate setae, respectively. Exopod 2-segmented, proximal segment with 1 plumose setae and distal segment with 5 plumose setae. Epipod with 5 long curved simple setae.

Second maxilliped (Fig. 3H). Endopod 4-segmented with 0, 1, 3, and 6 plumodenticulate setae. Exopod 2-segmented, with 4 plumose setae on distal segment.

Third maxilliped (Fig. 3I). Endopod 5-segmented with 12, 8, 5, 7, and 4 plumodenticulate setae. Coxa/basis with 4 plumodenticulate setae. Exopod 2-segmented with 5 plumose setae on distal segment. Epipod with 7 long curved simple setae.

## DISCUSSIONS

The megalopal descriptions of the subfamily Epialtinae are limited to six species, but those of *Pugettia quadridens quadridens* (De Haan, 1850) and *P. incisa* (De Haan, 1839) by Kurata (1969) are too brief because the setae of the mouthpart appendages are not scored. Hence, a comparison of the megalopae from the remaining and the present descriptions is tabulated as table 1. The megalopa of species belonging to the subfamily Epialtinae can be easily distinguished from each other on the basis of the characteristics of an antenna, a mandible and the mouthpart setations. Also, the megalopae of species belonging to the genus *Pugettia* differ from those of the genera, *Acanthonyx*, *Epialtus*, and *Taliepus*, by having the setation of an exopod of the maxilliped 3 being 0, 5.

In the zoeae of three *Pugettia* species, they are very similar to each other, so, the only distinguishing characteristic is chromatophore pattern on the dorsal carapace spine (Ko, unpublished). But, in the megalopal stage, they show various morphological characteristics in the mouthpart appendages (maxillule, maxilla, maxilliped 1, and maxilliped 2). Especially, in the maxilliped 2, it is interesting that the proximal segment of an endopod has a seta in the *P. marissinica*, but in almost all Epialtinae it is without a seta. Also, the setation of an exopod is 0, 6 in *P. marissinica*, whereas it is 0, 4 in other *Pugettia* species. Therefore, it is considered that *P. marissinica* is quite different from *P. q. intermedia* and *P. q. quadridens*. However, *P. q. intermedia* and *P. q. quadridens* are very closely resemble to each other according to table 1. Griffin and Tranter (1986) considered *P. q. intermedia* as a distinct species, but Sakai (1938, 1976) gave it only subspecies status. It is suggested that Sakai (1938)'s recognition rather than Griffin and Tranter (1986)'s is supported on the basis of the megalopal morphology.

## ACKNOWLEDGEMENTS

The author thanks Dr. M. Takeda (Department of Zoology, National Science Museum of Tokyo, Japan) for identifying majid crabs. The author is very grateful to Paul F. Clark (Natural History Museum, London, England) for providing me the majid references.

**Table 1.** Comparison of the megalopa stage in known species of the subfamily Epialtinae

| Species             | <i>Acanthonyx<br/>petiverii</i> | <i>Epialtus<br/>dilatatus</i> | <i>Epialtus<br/>brasiliensis</i> | <i>Taliepus<br/>dentatus</i>            | <i>Pugettia<br/>marissinica</i> | <i>Pugettia<br/>quadridens<br/>intermedia</i> | <i>Pugettia<br/>quadridens</i> |
|---------------------|---------------------------------|-------------------------------|----------------------------------|---|---------------------------------|---|--------------------------------|
| Authors             | Hiyodo &<br>Fransozo<br>(1994)  | Yang<br>(1968)                | Negreiros-<br>Fransozo<br>(1991) | Fagetti &<br>Campo-<br>donico<br>(1971) | Present<br>study                | Present<br>study                              | Present<br>study               |
| <b>Antenna</b>      |                                 |                               |                                  |   |                                 |   |                                |
| distal segment      | 4 setae                         | 4 setae                       | 3 setae                          | 3 setae                                 | 4 setae                         | 4 setae                                       | 4 setae                        |
| <b>Mandible</b>     |                                 |                               |                                  |   |                                 |   |                                |
| palp                | 5 setae                         | 4 setae                       | 5 setae                          | 5 setae                                 | 5 setae                         | 5 setae                                       | 5 setae                        |
| <b>Maxillule</b>    |                                 |                               |                                  |   |                                 |   |                                |
| setation of endopod | 1, 1                            | 0                             | 0                                | 1+2                                     | 1+4                             | 1+2   | 1+1                            |
| basial endite       | 17 setae                        | 16 setae                      | 13 setae                         | 17 setae                                | 16 setae                        | 16 setae                                      | 17 setae                       |
| coxal endite        | 9                               | 8 setae                       | 8 setae                          | 10 setae                                | 10 setae                        | 10 setae                                      | 10 setae                       |
| <b>Maxilla</b>      |                                 |                               |                                  |   |                                 |   |                                |
| endopod             | no seta                         | no seta                       | no seta                          | 2 setae                                 | 3 setae                         | no seta                                       | no seta                        |
| basial endite       | 13 setae                        | 10 setae                      | 9 setae                          | 12 setae                                | 15 setae                        | 13 setae                                      | 12 setae                       |
| coxal endite        | 10 setae                        | 7 setae                       | 7 setae                          | 10 setae                                | 10 setae                        | 9 setae                                       | 8 setae                        |
| <b>Maxilliped 1</b> |                                 |                               |                                  |   |                                 |   |                                |
| endopod             | no seta                         | no seta                       | no seta                          | 2 minute<br>setae                       | 1+4 setae                       | no seta                                       | no seta                        |
| setation of exopod  | 1, 4                            | 1, 4                          | 1, 2                             | 1, 4                                    | 1, 5                            | 1, 4  | 1, 5                           |
| <b>Maxilliped 2</b> |                                 |                               |                                  |   |                                 |   |                                |
| setation of endopod | 0, 1, 3, 6                      | 0, 1, 3, 5                    | 0, 1, 3, 6                       | 0, 1, 3, 6                              | 1, 1, 4, 6                      | 0, 1, 3, 6                                    | 0, 1, 3, 6                     |
| setation of exopod  | 0, 4                            | 0, 4                          | 0, 4                             | 0, 5                                    | 0, 6                            | 0, 4  | 0, 4                           |
| <b>Maxilliped 3</b> |                                 |                               |                                  |   |                                 |   |                                |
| setation of endopod | 7, 6, 3, 5, 4                   | ???, 4, 4                     | 6, 1, 4, 3, 6                    | 12, 7, 4, 6, 4                          | 12, 8, 5, 6, 4                  | 12, 8, 4, 6, 4                                | 12, 8, 5, 7, 4                 |
| setation of exopod  | 0, 4                            | 0, 3                          | 0, 2                             | 0, 4                                    | 0, 5                            | 0, 5  | 0, 5                           |

## REFERENCES

- Fagetti, E., and I. Compodonico, 1971. Desarrollo larval en el laboratorio de *Taliepus dentatus* (Milne-Edwards) (Crustacea Brachyura: Majidae, Acanthonychinae). *Revista de Biología Marina, Valparaiso* **14**(3): 1-14.
- Griffin, D. J. G. and H. A. Tranter, 1986. The Decapoda Brachyura of the Siboga Expedition. Part VIII. Majidae. *Siboga-Expeditie. Leiden (Monograph)* 39, C4, Livraison **148**: 1-335.
- Hiyodo, C.M. and A. Fransozo, 1994. Larval development of the spider crab *Acanthonyx petiverii* H. Milne Edwards, 1834 (Decapoda, Majidae) in the laboratory. *Crustaceana* **66**(1): 53-66.
- Kim, H.S., 1973. Anomura, Brachyura. *Illustrated Encyclopedia of Fauna and Flora of Korea*. The Ministry of Education, Korea (in Korean) **14**: 458-506.



- Kim, H.S. and C.Y. Chang, 1985. The brachyuran crabs of Cheju Island, Korea (Crustacea: Decapoda). The Korean Journal of Systematic Zoology **1**(1-2): 41-60.
- Kim, H.S. and I.H. Kim, 1985. Marine invertebrate fauna of Komundo I., Taesambudo I. and Sangpaekdo I. Report on the Survey of Natural Environment in Korea, No. 4. The Islands Adjacent to Komundo and Paekdo: 181-206 (in Korean, with English summary).
- Kim, H.S. and I.H. Kim, 1986. Marine invertebrate fauna of Chújado Islands. Report on the Survey of Natural Environment on Korea, No. 5. The Chúja Archipelago: 309-332 (in Korean, with English summary).
- Ko, H.S., 1995. Larval development of *Benthopanope indica* (De Man, 1887) (Decapoda: Brachyura: Pilumnidae) in the laboratory. Journal of Crustacean Biology **15**(2): 280-290.
- Kurata, H., 1969. Larvae of decapod Brachyura of Arasaki, Sagami Bay. IV. Majidae. Bulletin of the Tokai Regional Fisheries Research Laboratory 57: 81-127.
- Negreiros-Fransozo, M.L. and A. Fransozo, 1991. Larval stages of *Epialtus brasiliensis* Dana, 1852 (Decapoda, Brachyura, Majidae) reared in the laboratory, with notes on characters of the majid subfamilies. Crustaceana **60**(2): 200-212.
- Sakai, T., 1938. Studies on the crabs of Japan, 3. Brachygnatha Oxyrhyncha. Yokendo Company, Tokyo, pp. 193-364, figs. 1-55, pls. 20-41.
- Sakai, T., 1976. Crabs of Japan and the adjacent seas. Kodansa, Tokyo, pp. 1-773, pls. 1-251.
- Yang, W.T., 1968. The zoeae, megalopa and first crab of *Epialtus dilatatus* (Brachyura, Majidae) reared in the laboratory. Crustaceana **2**: 181-202.

RECEIVED: 29 October 1997

ACCEPTED: 5 December 1998

## 물맞이게속(갑각강: 십각목: 물맞이게과) 3종의 메갈로파 유생

고 현 숙 · 황 상 구  
(부산여자대학교 자연대 생물학과)

## 요 약

실험실에서 물맞이게 속의 3종, 빨물맞이게 (*Pugettia quadridens quadridens*), *P. marissinica*, 중간빨물맞이게 (*P. quadridens intermedia*)로부터 메갈로파 유생을 얻었다. 이들 3종의 메갈로파 유생을 상세히 기재 및 도시하고 이미 보고된 Epialtinae아과 다른 종의 메갈로파 유생들과 그 형태적 특징을 비교하였다. *P. marissinica*는 2종, 중간빨물맞이게 와 빨물맞이게의 유생들과 그 특징에서 상당히 큰 차이를 보여 서로 다른 종임을 알 수 있었으나, 중간빨물맞이게 와 빨물맞이게는 형태적으로 매우 유사하였다. 따라서, 중간빨물맞이게를 종 수준으로 간주한 Griffin과 Tranter(1986)의 제안보다 오히려 빨물맞이게의 아종 수준으로 간주한 Sakai(1938, 1976)의 제안이 타당하다고 사료된다.