First Zoeal Stage of *Helice tridens tientsinensis* Rathbun and its Taxonomic Significance

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갈게 *Helice tridens tientsinensis*의 제1기 Zoea유생과 그 분류학적 의미

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Summary

The first zoeal character of present species is compared with known species of *Sesarma* and *Chasmagnathus*. The zoea can be easily differentiated from *Sesarma* by a combination of lateral spines on carapace, size of zoeae, 4 setae on coxal endite of maxillule, and 2+2 setae formula on the endopodite of the maxilla. Evidence from larval morphological characters congruents with the classification based on adult characters, that *Helice* are more closely related to *Chasmagnathus* than *Sesarma*.

Introduction

From the results of many researchers, such as Williamson (1915), Hyman (1920), Lebour (1927), and Aikawa (1929, 1933, 1937, 1941), it becomes quite clear that we can identify and classify the larvae with their characters such like spines on carapace, antennular setation, antennal structure, abdominal segment armature, telson armature, setal formulae on the first and second maxillipeds, size of larvae just after hatching and distribution pattern of chromatophores. Rice (1980) also hypothesized the potentiality of setal formulae and morphologies of maxillule and maxilla as an index of elucidating relationships among the various brachyuran crab families.

During the recent thirty years, general standard of decapoda larvae has improved greatly because of abundant rearing studies under laboratory condition. Researches on the decapoda larval stages occur frequently in literatures from the recognition of the significance of larval characters to reflect some phylogenetic affinities between taxa and to reilluminate the conventional classification based on the adult characters vulnerable to restrictive changes in environment.

Helice tridens tientsinensis is a subspecies of genus *Helice* which is distributed in high tidal zones along the coast of Korea Strait, Yellow Sea, East Sea of Korea, and North China. (Kim, 1973). This species shares common habitat with the ocypoid crab *Macrophthalmus japonicus* and occupies highest region of tidal zones with hard mud subtrata.

Descriptions of larval development of *sesarma* are abundant. Conn (1884) firstly included some appendages and telson of *Searma* before and after hatching in comparing portions of larvae of Brachyura and Macrura. Hyman (1924) gave a description of the first zoeal appendages of *Sesarma reticulata* and notices the morphological similarities to *S. cinereum*. Aikawa (1929, 1937) described the first zoeae of *Sesarma sp.* briefly and figured the first stage of *S. (P.) picta* and compared setation of some appendages with the description given by Hyman (1924). Costlow and bookhout (1960, 1962) made first complete larval descrip-

tion of *S. cinereum* and *S. reticulatum* reared in the laboratory. Diaz and Ewald (1968) furnished details of zoeal characters of Venezuelan species of *Sesarma*. Baba and Miyata (1971) described larval development of *S. dehanni*. and compared their description with the illustration given by Yatsuzuka (1957) for the same species and discussed some characters differentiating from *Sesarma cinereum* or *S. reticulatum*. Baba and Fukuda (1975, 1976) described first zoea of *S. erythrodaclylum* and discussed the relationships of the known species of *Sesarma* species and they also got the complete larval stages of *Chiromantes bidens*, *Holometopus haematocheir*, *Parasesarma plicatum*, *Sesarmops intermedium* and made a comparison with available description from other species of the estuarine Sesarminae and gave a key to those species for the zoea. The previous studies on genus *Helice* were made by Baba and Moriyama (1972) and Kim and Ko (1982). Baba and Moriyama (1972) described and compared *Helice tridens wuana* and *H. t. tridens*. Kim and Ko (1982) described first zoea of *Helice tridens sheni*.

The purpose of present study is to describe the first zoeal stage of *Helice tridens tientsinensis* RATHBUN and to add some knowledge of the first zoeal stage which would differentiate *Helice* from *Sesarma*.

Materials and Methods

On July 2, 1982,the ovigerous females of *Helice tridens tientsinensis* for this investigation were collected by net at Daebusari, Seomyeon, Seocheon, Chungnam. The collecting area consisted of brackishy water surface and reed marshes with mud-sand substrata. On collecting, crabs were put into a fishing cooler and were transported by train to the Laboratory of Developmental Biology of Busan National University. During the transportation crabs were submerged in the clean water of collecting area and aeration were kept on by handy aeration pump. In the laboratory the crab spent two days before hatching. The newly hatched strong zoeae that floated and swam very actively on the surface merged to the direction of light. By using this phototaxism the zoea were chosen with pipette in high density and preserved in 70% alchol-glyceroid solution. Descriptions and illustrations of zoeal stages were made with the aid of binocular dissecting microscope and camera lucida attached moncular microscope. The measurements of body length and other appendages was made with eyepiece micrometer. The chromatophore pattern was determined from living zoea. Terminology of setal types in description is based on that of Costlow (1981) used in his study of *Nithrax pleuranthus* and the way of description was tried to follow the suggestion of Rice (1979).

Results

The major characters observed in the first zoea are as follows:

Size ····· Carapace length 0.48mm.
Tip of rostral spine to tip of dorsal spine 0.95mm.

Carapace (Fig. 1A) with three spines; rostral, dorsal and lateral spine: the lateral spines slender and shorter, rostral spine extending and curving-downward smoothly. Small hind head protuberance. Posteroventrolateral carapace border slightly dilated and expanded, with 5 minute and stout fine denticles. Eyes sessile.

Abdomen (Figs. 1A, I) with 5 somites, somites 2–4 with dorso-lateral knobs, those on the third somites are smallest,fifth somite fused to telson. A pair of middorsal setae on the terminal margin of each somite.

Telson (Figs. 1A, I) with two forks and with well developed median knotch, each inner telson margin with three denticulate setae.

Antennule (Fig. 1B) conical with 2 long aesthetes and simple seta.

Antenna (Fig. 1C) with protopodite bearing 2 rows of spinules on distal half, exopodite about half length of the spinous process of protopodite, with simple seta.

Mandibles (Fig. 1D) asymmetrical, left incisor margin with 2 small and 1 very large acute teeth,

.molar process is irregularly dentate.

Maxillule (Fig. 1E) with 2-segmented endopodite: proximal segment with 1 simple seta, distal segment longer bearing 4 terminal and 1 subterminal setae. Basal endite with 5 plumodenticulate cuspidate setae, coxal endite with 4 plumodenticulate cuspidate setae.

Maxilla (Fig. 1F) scaphognathite bearing 4 marginal plumose seta and 1 terminal plumose process. Endopodite unsegmented with 4 long setae. Proximal and distal lobes of basal and coxal endites each with 4, 4 and 2, 4 plumodenticulate setae, respectively.

First maxilliped (Figs. 1A, G) coxopodite short with seta, basipodite with 10 medium sized setae, progressing distally 2, 2, 3, 3. Endopodite 5

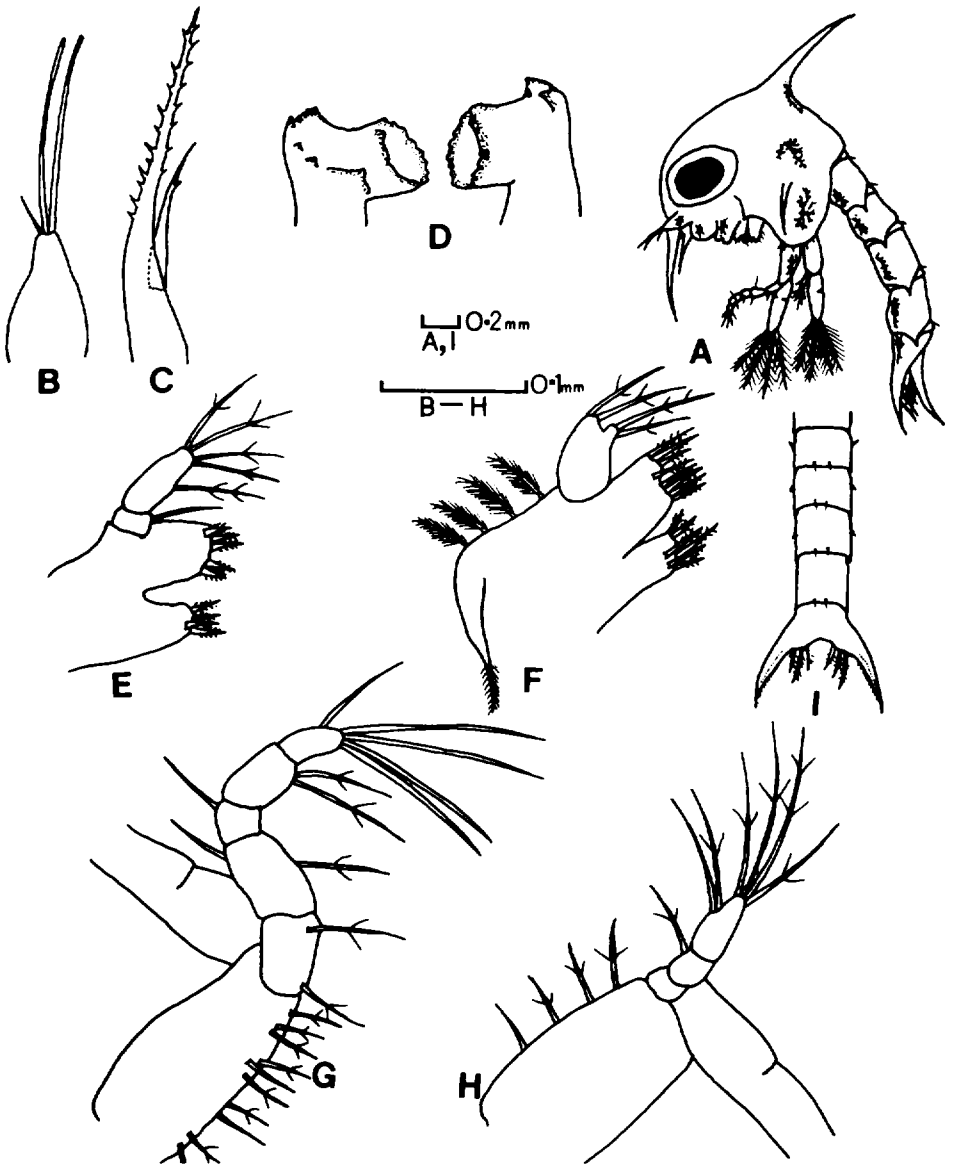

Figure 1. *Helice tridens tientsinensis* RATHBUN, first zoeal stage.
A. Lateral view; B. antennule; C. antenna; D. mandibles, E. maxillule; F. maxilla; G. first maxilliped H. second maxilliped; I. abdomen.

Table 1. Comparison of contant first zoeal characters of *Helice, Sesarma* and *Chasmognethus*.

Species	References	Carapace spines R D L	R–D length (mm)	Antennule	Maxillule Basal / Coxal / Endopod	Maxilla Basal / Coxal Endopod / Scaphognathite	First Maxilliped Endopod / Exopod	Second Maxilliped Endopod / Exopod
Helice. H. t. tientsinensis.	Present work	+ + +	0.95	2 + 1	5 4 1.5	8 6 4 4	22125 4	016 4
H. t. tridens	Baba & Moriyama 1972	+ + +	1.16	2 + 1	5 4 1.5	6 5 4 4	22125 4	016 4
H. t. wuana	"	+ + +	1.12	3 + 1	5 4 1.5	8 5 4 4	22125 4	016 4
H. t. sheni	Kim & Ko (1982)	+ + +	1.05	3 + 1	5 4 1.5	9 5 4 4	22125 4	016 4
Sesarma. S.(H.) haemalocheir	Fukuda & Baba 1976	+ + –	0.69	3 + 1	5 5 1.5	9 7 5 4	22125 4	016 4
S.(H.) dehaani	Baba & Miyata 1970	+ + –	0.85	3 + 1	5 5 1.5	9 6 5 4	22125 4	016 4
S.(P.) plicatum	Baba & Fukuda 1975 Fukuda & Baba 1976	+ + –	0.70	3 + 1	5 6 1.5	9 5 5 4	22125 4	016 4
S.(P.) pictum	Baba & Miyata 1970 Aikawa 1937	+ + –	0.63	3 + 1	5 6 1.5	9 8 5 4	22125 4	016 4
S.(Sesarma) intermedium	Baba & Fukuda 1975 Fukuda & Baba 1976	+ + –	0.73	3 + 1	5 6 1.5	9 5 5 4	22125 4	016 4
Chiromantes bidens	Fukuda & Baba 1976	+ + –	0.67	3 + 1	5 5 1.5	9 7 5 4	22125 4	016 4
S. erythrodactylum	Baba & Fukuda 1975	+ + –	0.74	3 + 1	5 6 1.5	7 7 5 4	22125 4	016 4
S. cinereum	Costlow & Bookhout 1960	+ + –	?	3 + 2	5 5 1.5	9 7 5 4	11124 4	015 4
Chasmagnathus C. convexus	Baba & Fukuda 1972	+ + +	1.50	3 + 1	5 5 1.5	9 7 4 4	22125 4	016 4

segmented, setal formula progressing distally 2, 2, 1, 2, 4+1.

Exopodite incompletely 2-segmented, with 4 plumose natatory setae.

Second maxilliped (Figs. 1A, H) coxopodite unarmed, basipodite with 4 medium size ventral setae, progressing distally 1, 1, 1, 1. Endopodite three segmented with 1 ventral seta on middle segment: 6 long setae on distal segment.

Exopodite incompletely 2 segmented, with 4 plumose natatory setae.

Chromatophores (Fig. 1A) showing the pattern of mixed dominant brown series; dark brown near to black or mild brown, and weak yellow series or variable red spots. The majority of dark brown series occur in the region of mouth parts: base of antennule, on labrum and mandible; along the abdominal somites and distal end of first maxilliped. On post cardiac and base of lateral spine reddish yellow pigments similar pattern to the base of dorsal spine.

Discussion

Differences in the first zoeal characters among 4 subspecies of *Helice* are summarized and comparison of the first zoea of *Helice tridens tientsinensis* with those of known *Sesarma* species is presented in Table 1.

Zoeae of all the species of *Sesarma* reported have no lateral spines on the carapace. This character is quite reverse in the present species *Helice tridens tientsinensis* as well as other three subspecies of *Helice*.

The difference of the length between tip of rostral spine to tip of dorsal spine of *Helice* is so slight that it seems not useful in classifying the larvae of subspecies of *Helice*. However it seems more important character in separating *Helice* from *Sesarma*, since the carapace size of *Helice* and *Sesarma* is about 1.10, 0.70mm, respectively.

Antennular setation of *Helice tridens tientsinensis* is different from other subspecies of *Helice*.

The first zoea of *helice* has 4 setae on coxal endite of maxillule, on the other hand *Sesarma* has 5 or 6 setae.

A comparison of setation of the maxillule and maxilla of *helice tridens tientsinensis* with those of *H. t. tridens* or *H. t.wuana* reveals insufficent difference to base identification.

Helice tridens tientsinensis posesses only 2+2 setae on the endopodite of the maxilla. In contrast, the genus *Sesarma* have 2+3 setae on the endopodite of maxilla.

The setation of the endopodite of the first and the second maxilliped shows no differences among four subspecies of *Helice*.

Helice tridens tientsinensis has a pair of minute postero-lateral knobs on the fourth abdominal somite in the first zoeal stage. While *H. t. wuana* does'nt have those spines. *H. t. tridens* and *H. t. sheni* have them.

Chasmagnathus is more related than *Sesarma* to *Helice* with larval characters such as the presence of lateral spines on carapace, large size of the first zoea, maxilla endopodal setation 2+2 in the first zoeal stage.

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國 文 抄 錄

본 연구종이 속하는 방게 속과 사각게 속 및 갯게 속의 여러 종들의 제1기 유생의 부속지의 형태적 특징을 비교 검토해 본 결과, 홍갑의 측극, Zoea의 크기, 제1소악의 저절모식, 제2소악의 내지의 장모식등을 근거로 방게 속과 사각게 속의 유생의 구별이 가능하며 방게 속은 사각게 속보다 갯게 속과 더 가까운 유연관계가 있었다. 이 유생분류는 기존 성체분류와 같은 결과이다.