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Early Life History of Estuarine Grapsid Crab, *Helice tridens latimera*

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Abstract: Early life history of *Helice tridens latimera* was observed in the laboratory conditions through observing the larval metamorphosis and salinity optimization for the larvae. Larval development consisted of 5 zoeal and 1 megalopal stages before they molted to the first crab stage. Hundred percent survival rate of zoea I-V and megalopa at water salinity of 30 and 20 ppt, respectively, suggest that larvae of *H. tridens latimera* pass a free swimming life in the offshore waters and recruit to the brackish water at the megalopal stage, and spend almost all of their life in the mangrove area.

Key words: *Helice tridens latimera*, salinity, early life history, larval metamorphosis

Introduction

Knowledge about the early life history of an animal i.e., development from embryo to juvenile is very essential for studies of its potential for culture, its nutritional requirements and its interactions with other organisms. In case of marine or estuarine crabs it is prerequisite to have a knowledge about their larval metamorphosis and salinity requirement in order to know their early life history. *H. tridens latimera*, is a medium sized grapsid crab (Fig. 1) inhabiting mangroves, sea shores, and muddy and rocky areas. This species is carnivorous, attacking ocypodid and grapsid crabs and insects. It has so far been found in eastern Asia along the coasts of Taiwan, China, and Japan (Miyake, 1983; Dai and Yang, 1991). In Japan, it is common in the Ryukyu Islands at Iriomote and Ishigaki Islands and in the Okinawa and Amami groups.

Fig. 1: Dorsal view of grapsid crab, *Helice tridens latimera.*

Within the genus *Helice* the complete larval development is known only for *H. tridens wuana*, *H. tridens tridens* and *H. leachi*, respectively (Mia and Shokita, 1996). As no study on the complete larval metamorphosis and salinity requirements of larvae of *H. tridens latimera* had been conducted, this experiment was performed to have a clear idea of the early life history of this species.

Materials and Methods

Ovigerous females of *H. tridens latimera* were caught by scoop net from the estuary of the Taiho River, northern Okinawa Island, Japan. They were brought to the laboratory and maintained in a plastic container (28 cm in diameter, 14 cm in depth), using moderately aerated seawater at 20 ppt. Hatched larvae were moved to the same type of container with seawater at 30 ppt and aerated by an air stone. Newly hatched *Artemia salina* Naupli were fed to the zoeae, and minced meat of the clam *Ruditapes philippinarum* to the megalopae and juveniles. The cultures were checked and the water partly (20-40%) renewed daily. The temperature was not controlled, but averaged about 18.5 °C with a range of 15-22 °C.

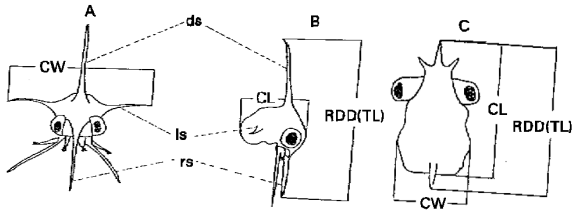

Fig. 2: Methods of larval measurement. A: zoea(front view), B: zoea (side view), C: megalopa (back view) CL: carapace length CW: carapace width RDD: rostral-dorsal spine distance, TL: total length, ds: dorsal spine ls: lateral spine, rs: rostral spine.

At least 10 larvae of each stage were fixed and preserved in a 50% ethylene glycol solution and dissected under binocular sterio-microscope. Ten specimens of each stage were measured. Measurements taken were: for the zoeal stages the distance between the tips of the dorsal and rostral spines (TL), between the tips of lateral spines and the carapace length (CL) from the base of rostral spine to the posterior margin of the carapace; for the megalopa, the carapace width (CW) maximum distance across the carapace, and (CL) as above (Fig. 2) (Rodriguez and Paula, 1993).

Nine salinities (0, 5, 10, 15, 20, 25, 30, 35 and 40 ppm) were tested for all zoeal stages and for megalops of *H. tridens latimera*. Different test solutions were prepared with the combination of de-chlorinated tap water and sea water (34 – 35 ppt) collected from Mizugama sea beach, Okinawa, Japan. The tap water was stored in plastic container and aerated continuously at ambient room temperature. All salinities were checked with a hand-held refractometer to the nearest 1 ppt. Immediately after hatching, the larvae of *H. tridens latimera* were divided into 9 groups of 20 individuals. Most active larvae were separated from the hatch out container using a 50 ml glass pipette (Pyrex, Iwaki Glass) and then they were put into 1 liter plastic bowls containing the test solutions. The plastic bowls containing 20 individuals in the test solutions were then arranged side by side on a table. For the optimization of salinity levels required for the

larval metamorphosis of *H. tridens latimera* a total of 180 individuals were used for each larval stage.
The larvae in different test solutions were fed daily with newly hatched *Artemia salina* Naupli. Test solutions in each plastic bowl were replenished everyday with new supplies. At the time of replenishments of new test solutions, observation and counts were made for larval survival and mortalities of each zoeal stage. Alive larvae from previous test solutions were transferred into new test solutions while the dead larvae were preserved in 50% ethylene glycol for the identification of zoeal stage(Gerhard and Malcoln, 1981).

Results

The larvae of *H. tridens latimera* passed through 5 zoeal stages and 1 megalopal stage before moulting into the first crab stage. Major characteristics of each larval stage and first crab are described.

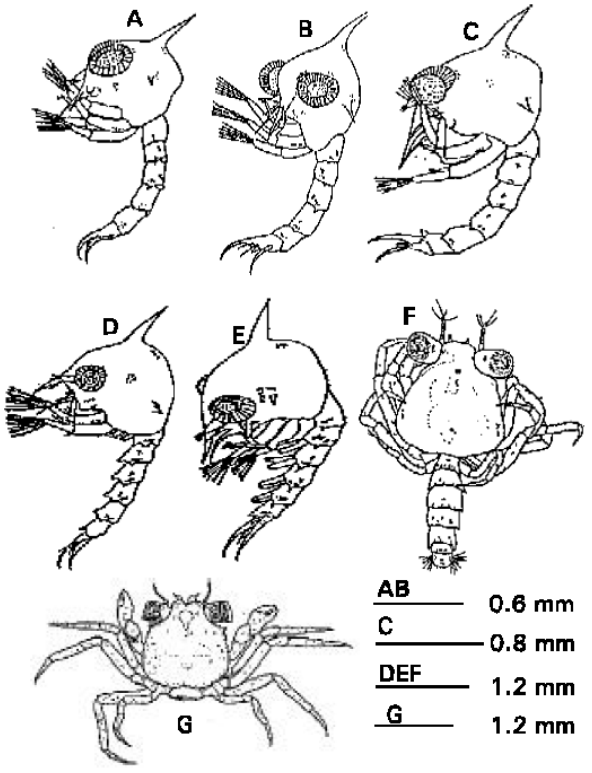

Fig. 3: *Helice tridens latimera*. A-E, zoea I-V; F, megalopa; G, first crab

First zoea (Fig. 3A): TL : 0.98 mm (0.96-1.00 mm); CL : 0.61 mm (0.59-0.62 mm). Cephalothorax bearing dorsal, rostral and lateral spines. Antennule unsegmented with 3 terminal aesthetascs and 1 short seta. Abdomen with 5 somites and telson. Somites 2 with anteriorly directed spines and somites 3-4 with posteriorly directed spines on dorsolateral margins in all zoeal stages. Lateral spine on somite 4 larger than that of somite 3. Somites 2-5 with pair of short setae on posterior of dorsum. Telson bifurcate and widening posteriorly, bearing minute hair on inner and outer margins; inner margin with 3 pairs of plumose setae.

Second zoea (Fig. 3B): TL : 1.17 mm (1.14-1.19 mm); CL : 0.71 mm (0.70-0.73 mm). Cephalothorax inflated; dorsal and rostral spine elongated; lateral spines developed. Base of antennule inflated. First somite of abdomen with a single medial seta and somite 2-5 each with a pair of short setae dorsally. Telson increased in size as compared to first zoea.

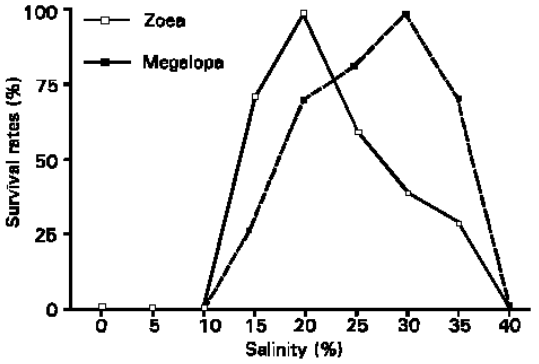

Fig. 4: Mean survival rates of the larvae of *Helice tridens latimera* under various salinities.

Third zoea (Fig. 3C): TL : 1.52 mm (1.50-1.53 mm); CL : 0.88 mm (0.87-0.89 mm). Lateral spines somewhat smaller proportionally. An additional short aesthetasc present on antennule. Abdomen with 6 somites. Posterior margin of telson with 4 pairs of plumose setae, innermost pair shortest.

Fourth zoea (Fig. 3D): TL : 1.97 mm (1.94-1.98 mm); CL : 1.12 mm (1.11-1.14 mm). Fundamental morphology of cephalothorax unchanged from preceding stage; lateral spines relatively smaller. Base of antennule more inflated; 3 terminal and 2 subterminal aesthetascs. First somite of abdomen now with 3 setae on dorsal surface; pleopod buds present on ventral surface of somites 2-5. Telson increased in size.

Fifth zoea (Fig. 3E): TL : 2.58 mm (2.55-2.60mm); CL : 1.36 mm (1.34-1.38 mm). Posterior margin of carapace fringed with short setae; lateral spines smaller than before. Base of antennule rounded; 7 long and 3 short aesthetascs; endopod present as a small knob. First somite of abdomen with 5 setae on its dorsal surface. Pleopods biramous; uropodal buds present on somite 6. Fork longer than basal portion of telson; posterior margin with 5 pairs of plumose setae, innermost pair shortest; telson with a pair of short dorsal setae.

Megalopa (Fig. 3F): CL : 1.48 mm (1.47-1.49 mm); CW : 1.49 mm (1.47-1.50 mm). Dorsal surface of carapace smooth; length and width nearly equal, narrowing anteriorly. Antennule having enlarged basal segment with 2 posterior setae. Peduncle 3 segmented; basal segment with 3 setae; second segment with unarticulated flagellum bearing 2 terminal setae; distal segment with 11 aesthetascs, 1 short naked seta, and 1 long plumose seta. Abdomen having 6 somites; posterolateral margins of somites 1-3 somewhat rounded and those of segments 4-5 successively more pointed. Somites 1-3 with 2 posterolateral setae on each side and somites 1-6 with several dorsal setae. Functional pleopods present on somite 2-5; each endopod one-segmented with 3 minute terminal hooks; one-segmented exopods of pleopods 1-4 bearing 20, 20, 19 and 17 natatory setae, respectively. Uropods of 6th abdominal somite uniramous, 2-segmented, and bearing 9 plumose natatory setae on distal segment, 1 on basal segment. Telson rounded and longer than 6th somite, with 3 posterior marginal setae.

First crab (Fig. 3G): CL : 1.77 mm (1.76-1.78 mm); CW : 1.77 mm (1.76-1.78 mm). Carapace quadrangular, lateral

margin with 4 teeth, anterior tooth more pointed than others; frontal region medially hollowed; antenna excluded from orbit. Base of antennule with 13 setae; 1st segment of peduncle with 3 simple setae; 2nd segment with single seta and 3-segmented flagellum bearing 0, 2, 2 setae; distal segment with 13 aesthetascs. Each somite of abdomen with several setae on dorsal surface and both lateral margins. Posterior margin of telson rounded with numerous setae. Pleopods and uropods degenerated.

The larval survival of *H. tridens latimera*, with variation in 9 different salinity levels 0, 5, 10, 15, 20, 25, 30, 35 and 40 ppt are shown in Fig. 4. Best larval survival was found at 30 ppt for zoeae and 20 ppt for megalopa, respectively. Survival (0%) was observed at 0, 5 and 10 ppt both for zoeal and megalopal stages. The survival rates of zoeae increased with an increase in salinity levels, up to a certain stage and 100% survival was observed at 30 ppt. When salinity was increased from 30 to 35 and 40 ppt the survival rate decreased and 100% mortality was apparent at 40 ppt. In case of megalopa, the survival rate gradually decreased when the salinity increased. Hundred percent mortality was observed at the salinity level of 40 ppt.

Discussion

H. tridens latimera has the same number of larval stages as the other three *Helice* species (Baba *et al.*, 1984; Mia and Shokita, 1996). Characteristics that are useful for distinguishing *H. tridens latimera* include: the presence of a lateral spine on the carapace, the setation patterns of the antennule, the setation of the exopods, the posterior marginal setae of the telson, and the presence of dorsomedian setae on abdominal somites. The fourth abdominal somite has posteriorly directed lateral spines in *H. tridens latimera* and *H. tridens tridens*, but such spines are absent in *H. tridens wuana* and *H. leachi*. In all zoeal stages of *H. tridens latimera* the carapace has lateral spines and the dorsal spine lacks simple setae. This is also in the case of *H. tridens wuana* and *H. tridens tridens*, but the reverse occurs in *H. leachi*. In 5th zoeal stage of *H. tridens latimera* there are 5 posterior marginal setae on the telson, the same as in *H. tridens wuana* and *H. tridens tridens*, but these are only 4 in *H. leachi*. No remarkable differences are observed in the megalopal stage among the species of *Helice*. In *H. tridens latimera* telson has 3 posterior marginal setae, but 4, 3 and no setae in *H. tridens wuana*, *H. tridens tridens* and *H. leachi*, respectively. In the first crab stage, the lateral margin of the carapace of *H. tridens latimera* and *H. tridens wuana* bears four distinct teeth as compared to three teeth *in H. leachi*.

A low critical salinity between 0 to 10 ppt could never be accepted because no larvae moulted to the next stage. High salinities 35 and 40 ppt, showed same metamorphosis. During the early life history of any estuarine or marine organism, salinity tolerance differs both for zoeae and megalops. In case of *H. tridens latimera* found in present study, maximum survival rates for zoea and for megalopa were observed at 30 ppt and 20 ppt, respectively.

Mitten crab, *Eriocheir sinensis* larvae were able to develop from hatching through metamorphosis at temperatures ranging from 12 to 18 ^{0}C and at salinity levels from 15 to 32 ppt. At 6 to 9 ^{0}C and at any salinity, complete mortality occurred within the 1st zoeal stage, with longest time of survival at intermediate salinities (20 to 25 ppt) (Anger, 1991)

Growth and morphogenesis were also affected at lower and higher salinities. The retardation of growth and morphogenesis in present study resulted from lower food consumption in low and high salinities. Wienberg (1982), examined the influence of environmental factors including salinity on survival, feeding, and growth of *Pandalus borealis* larvae, and suggested that low salinity slightly retarded growth, owing to a lower food consumption. The present results support this suggestion.

Generally the highest mortality rate was observed in zoea V and in the megalops, which both displayed a marked increase in mortality as compared with that in the other zoeal stages (Mene *et al.*, 1991). But in present study, mortality rate was the same for all zoeal stages, for all salinity combinations used in *H. tridens latimera*. Mortality, as a function of development stage, also varies considerably between species. Larvae would seem to have more difficulty in moulting to the megalop and first crab stage. Perhaps this is due to the major morphological changes which occur at this time, or perhaps the larvae have become weakened by the time they reach the final stage of development.

The optimum salinity for rearing zoeae of *H. tridens latimera* are 20 to 35 ppt, but 30 ppt showed higher survival rate. A salinity between 15 to 25 ppt may be considered optimal for rearing megalopa of this species. But 20 ppt are suitable for high (100%) survival rate found in present study. To improve rearing techniques, additional investigation should be made on the physiological influence of salinity on larval osmoregulation. Since the salinity of mangrove swamps is lower than sea water (nearly 15 to 20 ppt) and the highest survival rate (100%) of the larvae of *H. tridens latimera* was observed at 30 ppt, above discussion suggests that the life history of this species might be similar to the mangrove crab *Scylla* spp. After hatching the larvae of *Scylla* spp. pass a free swimming life in sea, migrate into the mangrove area at megalopa stage and spend rest of their life there (Ohshiro, 1991). Larvae of *H. tridens latimera* may pass a free swimming life in the offshore waters and recruit to the brackish water at the megalopal stage, and spend almost all of their life in the mangrove area.

Acknowledgment

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