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Captive spawning, hatching and larval development of crucifix crab, *Charybdis feriatus* (Linnaeus, 1758)

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Abstract

Charybdis feriatus (Linnaeus, 1758), commonly known as crucifix crab, forms one of the important commercial crabs in India. Considering its increasing demand and scope for aquaculture, attempts were made to study its breeding and larval stages in captivity. Spawning took place invariably during night hours and the duration of incubation varied between 9 and 11 days. Healthy larvae were produced in all the spawnings and the number of zoea larvae released varied between 40,000 and 14,00,000/ hatching. The larva passes through six zoeal stages and a megalopa stage before it metamorphoses into first crab instar. The average period of zoeal phase ranged between 19 and 26 days.

Keywords: *Charybdis feriatus*, embryonic development, larval stages, zoea

Introduction

Majority of the Indian marine edible crabs belong to the family Portunidae, which are widely distributed along the Indian coast. *Charybdis feriatus* (Linnaeus, 1758), commonly known as crucifix crab forms one of the important commercial crabs and the most important species of the genus *Charybdis*. It is widely distributed in the Indo-Pacific region from Japan to China to Australia in the east, to eastern and southern Africa, Gulf of Oman and Arabian Gulf in the west, encompassing Pakistan, India, Sri Lanka and Indonesia (Stephenson *et al*., 1957; Stephenson, 1972; Apel and Spiridonov, 1998; Ng, 1998). Recently the species has been reported from the Mediterranean Sea for the first time, most probably the introduction vector must be a merchant ship (Abello and Hispano, 2006). The species can be easily distinguished with prominent white cross on the median part of the dorsal carapace and legs and pincers with numerous scattered white spots. It grows to a maximum size of 20 cm in carapace width and prefers to inhabit area of sandy to sandy muddy substrates at depths from 30 to 60m (Ng, 1998). The crab is often landed by bottom trawls along with other portunids from certain pockets along the Indian coast and fishing season varies from place to place. Because of the large size and market demand it is being exported in frozen form to different southeast Asian countries. It is important in markets of east Asia where it commands substantially higher prices (frozen form: US $ 8 to 15 per kg) than *Portunus* spp. However in recent years it is noticed that the catch of the crucifix crab is decreasing and for future development and conservation of the species, aquaculture is an option to increase the production. The species has got good potential and scope as a candidate species for culture.

In India very few studies have been carried out to study the reproductive biology and population characteristics of the crucifix crab (Padayatti, 1990). No studies have been reported on the life cycle and seed production of the species. Few attempts have been made in the west Asian countries on the larval stages and seed production (Motoh and Villaluz, 1976; Hu *et al*., 1983; Parado-Estepa *et al*., 2002, 2007). Knowledge on the life history of the species is very important for captive seed production. Considering the potential of the species experiments were initiated in the larval rearing of the crucifix crab *Charybdis feriatus*.

Material and Methods

Broodstock rearing, spawning and hatching: To study the life cycle of the crab captive broodstock and larval rearing experiments were carried out at the marine hatchery of the CMFRI, Cochin during 2006-'07. Adult and mated crabs (Fig. 1) were collected from trawl catches off Cochin and brought to the hatchery. These crabs were acclimatized for 4 days in FRP tank (capacity 1000 liters) with filtered sea water of same quality of the broodstock tank. Healthy crabs were transferred to 2,000 liters capacity black parabolic FRP broodstock tank with *in situ* biological filter and recirculating sea water at the stocking rate of 2 no./m^2. During the captive period the salinity was maintained at 34 ± 1‰, water temperature at 27-29^{o}C, dissolved oxygen at >5 mg/l and nitrite and ammonia at < 1 ppm. The crabs were fed *ad libitum* with fresh clam and prawn meat.

The captive female crabs were spawned in the broodstock tank. The spawned eggs form a 'round mass' and were carried by the female under its abdominal flap throughout the embryonic period till hatching. This spawned egg mass is commonly known as 'berry' and the mother as 'berried crab'. All the berries produced in the hatchery were healthy and are determined by the round shape and compactness of the berry and finally confirmed through microscopic observations of the egg.

When the berry attains a deep grey colour, it is ready for hatching in 24 hours. When the egg colour reaches grey, that particular mother was transferred to a 1000 litres capacity hatching tank filled with 500 litres of filtered sea water. The hatching tank is covered to minimize the light and aeration was provided to saturation level. Mixed diatoms dominated with *Chaetoceros* spp. were added to the hatching tank at a concentration of 10,000 cells /ml so that the zoeae larvae can feed immediately when they are hatched out.

Hatching normally takes place in the early morning hours. Following hatching the mother crab was taken out of the hatching tank, and thoroughly washed with fresh sea water to remove the hatching wastes attached to its exoskeleton and abdominal flap. The body weight was recorded and the crab was re-introduced into the broodstock rearing tank. Among the different larval rearing trials, the best result was obtained from a berry weighing 29.8 g (mother crab size: 110.8 mm carapace width; 263.6 g weight).

Immediately after hatching, the aeration was stopped for a few minutes for settling the hatching waste and the weak larvae. The settled waste was siphoned out of the tank and after thorough mixing of water, three samples were collected and zoeal count was made.

Larval rearing: Larval rearing was carried out in 1,000 litre FRP tanks with an optimum stocking density of 50/ l. On day one of larval rearing, tanks were filled to half capacity; on the second day the water level was raised to 3/4th, and by day three the tank was filled full. Fresh mixed diatom dominated with *Chaetoceros* spp. (15,000 - 20,000 cells/ml) was added to the tanks at the beginning of larval rearing. Rotifers were added from day two onwards (3-5 no. / ml) and *Artemia* nauplii from 4th zoeal stage. Rotifers (100-150 µ) after collection were thoroughly washed with running sea water and enriched with the green microalga, *Nannochloropsis* sp. for 6 hours before feeding to the larvae. On day 4, fifty per cent of water exchange was made to each larval rearing tank and thereafter 30-40% water exchange was made daily. After the daily water exchange, required quantities of fresh live foods were provided. During each transitional stage of zoea, 90% of water was exchanged using appropriate filters. When the larvae reached 5th zoeal stage the algal concentration in the rearing tanks was considerably reduced (5,000 cells/ml). In addition to the live foods, the inert feed, prawn-egg custard was provided during the 6th zoeal stage and megalopa stage.

Results

Spawning took place invariably during night hours. The newly spawned eggs were bright yellow/ orange in colour and subsequently with the progress of embryonic development, the colour changed to dull brown and on the penultimate day of hatching, the colour changed to deep grey. The duration of incubation varied between 9 and 11 days depending on the berry size and temperature of the rearing water. The size of the newly spawned eggs was 298 ± 8.93 µm and by the time of hatching (Fig. 2), the size increased to 369.3 ± 9.73 µm. The larvae produced were healthy in all the cases and the number varied between 40,000 and 14,00,000 /hatching. Hatching was full in all the observations and the emerged larvae were in zoea-I stage. Occurrence of pre-zoea stage was not recorded. The active zoeae are phototactic, they aggregate themselves along the sides and upper layers of the water. The weak larvae settled down at the bottom of the hatching tank.

Larval stages: The larval development of *C. feriatus* includes six zoeal stages and a megalopa stage, which metamorphoses into the crab stage. Each zoea has a long rostrum, a dorsal spine and a pair of short lateral spines on the carapace. Zoeae resemble the typical portunid larva in morphology and are very active and photopositive. The total duration of the zoeal phase varied between 19 and 26 days during different trials. The stages were identified based on the setation of the telson, number of abdominal segments and pleopods of the abdominal somites. Details of different zoeal stages are given below:

Zoea-I: Eyes are sessile. Abdomen is five segmented plus the telson. Telson forked with each fork bearing one inner and one dorsal spine. Inner margin of each fork bears three, long serrated seate (3+3) (Figs. 3, 9). Duration: 4-5 days*

Zoea-II: Development of stalked eyes. Abdomen is five segmented as in the previous stage. Abdominal somites 3-5 bear more distinct lateral spines. Telson bears a pair of short, plumose setae on median margin of cleft part (4+4) (Figs. 4, 10). Duration: 3-4 days*

Zoea-III : Abdomen develops 6 segments and lateral spines on 3-5 somites are longer. Telson is similar to that of previous stage (4+4) (Figs. 5, 10). Duration: 3-4 days*

Zoea-IV: Abdomen as in the previous stage. Pleopod buds just started appearing at the ventral posterior end of somites 2-5. Telson adds one additional short seta on inner margin (4+1+4) (Figs. 6, 11). Duration: 3-4 days*

Zoea-V: Pleopod buds on the abdominal somites second to sixth developed. Telson has developed additional short setae on the inner margin (5+5) (Figs. 7, 12). Duration: 3-4 days*

Zoea-VI : Abdominal somites and telson are similar to previous stage. Pleopod buds well developed, biramous on somites 2-5 and uniramous on somite 6. Telson setation same as in the previous stage (5+5) (Figs. 8, 12). Duration: 3-4 days*

(*The duration refers to the maximum number of zoeae that metamorphosed to the next stages.)

In all the larval rearing runs, successive larval stages showed a decreasing trend on survival. Maximum mortality was recorded at zoea-I to zoea-II stage and zoea-VI to megalopa stage. In the best results obtained, 5 % of the larvae completed six zoeal stages. A few number of zoea VI metamorphosed into megalopa, but could not moult to baby crabs. Experiments are continued to complete the life cycle of *C. feriatus* in captivity, which will pave the way for hatchery production of crucifix crab seeds.

Discussion

The spawning, embryonic development, hatching and larval development of *C. feriatus* resemble other portunid crabs with variations in number of zoeal stages (Greenwood and Campbell, 1980; Greenwood and Fielder, 1983; Fielder *et al*., 1984; Anil, 1997; Dineen *et al*., 2001; Josileen and Menon, 2004). Crucifix crab has six zoeal stages, the maximum number recorded for a portunid crab in the Indo-Pacific region. The larval stages recorded in the present study are found to be similar to the larval stages of *C. feriatus*, reported from other regions (Motoh and Villaluz, 1976; Parado-Estepa *et al*., 2002, 2007).

The reproductive potential of the crab is expressed as the number of zoeae per female per hatching. The maximum number of zoeae recorded in this study was 1.4 million. The only report of fecundity from the region was by Padayatti (1990) who reported the maximum of 3,09,000 eggs, which is too small compared with the present findings. The closest observation recorded for the species was one million zoeae / hatching by Parado-Estepa *et al*. (2007) from Philippines.

The occurrence of repeated spawning in captivity in the same moult cycle is common in portunids. On a few occasions some crabs spawned the very next day of hatching and produced viable larvae at the end of embryonic development. This phenomenon has not been observed in other commercial crabs from the present study area, atleast in captive breeding. The duration of embryonic development (9-11 days) was similar to other portunid crabs of

Fig. 1. *Charybdis feriatus* (L.) adult female

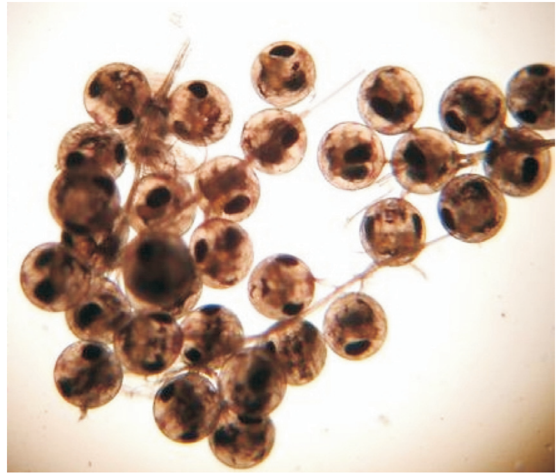

Fig. 2. Ready to hatch eggs of *Charybdis feriatus* (L.)

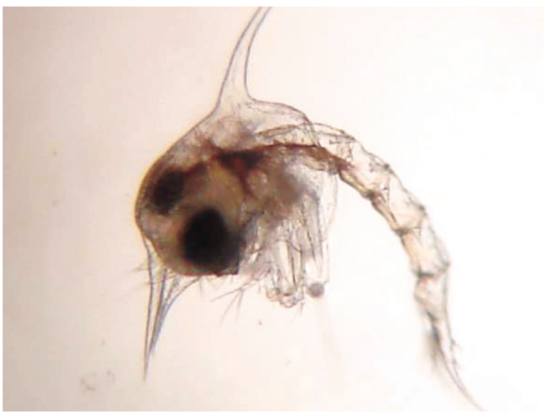

Fig. 3. Zoea-I

Fig. 4. Zoea-II

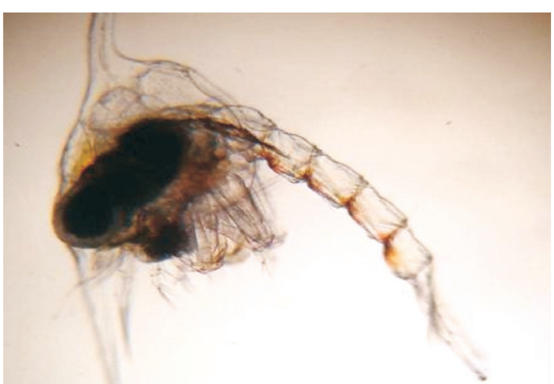

Fig.5. Zoea-III

Fig. 6. Zoea-IV

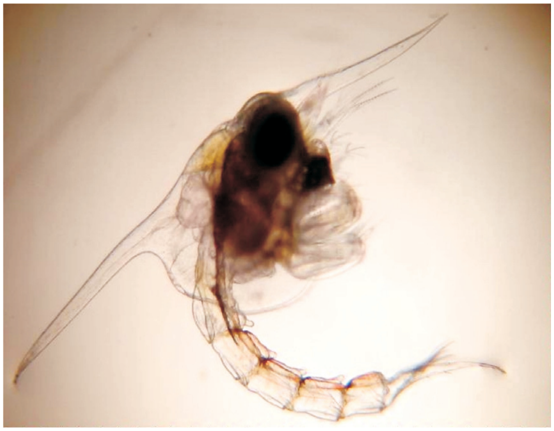

Fig. 7. Zoea-V

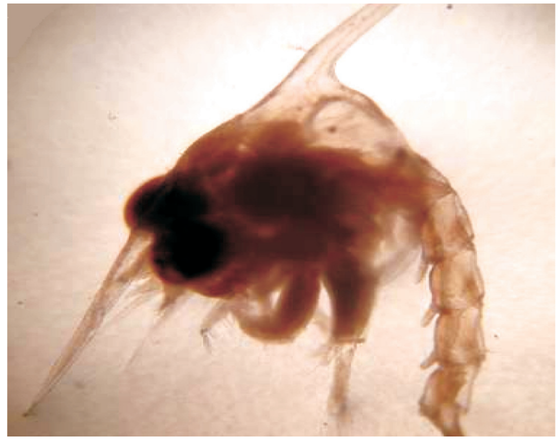

Fig. 8. Zoea-VI

Fig. 9. Caudal furca of Zoea-I (100 X)

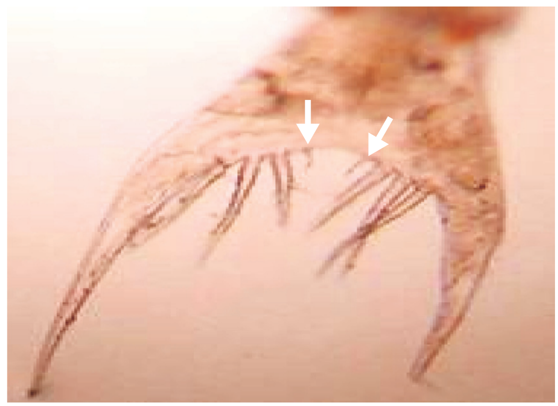

Fig. 10. Caudal furca of Zoea-II & III (100 X)

Fig. 11. Caudal furca of Zoea-IV (100 X)

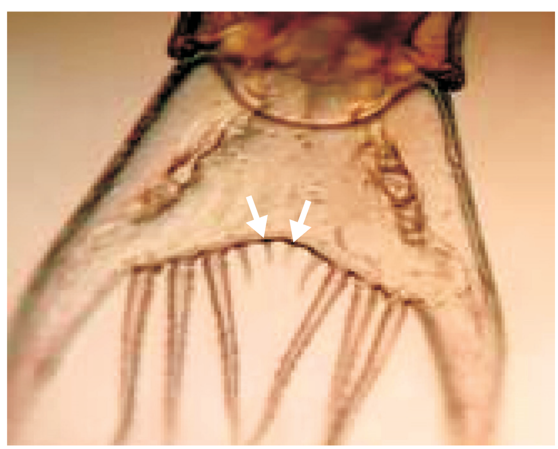

Fig. 12. Caudal furca of Zoea-V & VI (100 X)

the tropical seas (Anil, 1997; Josileen, 2001).

C. feriatus has been listed as one of the six suitable species for stock enhancement and culture in the international forum on the culture of portunid crabs (Williams and Primavera, 2001). The present study also found that the species is suitable for seed production.

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