Seed production and farming of blue swimmer crab Portunus pelagicus

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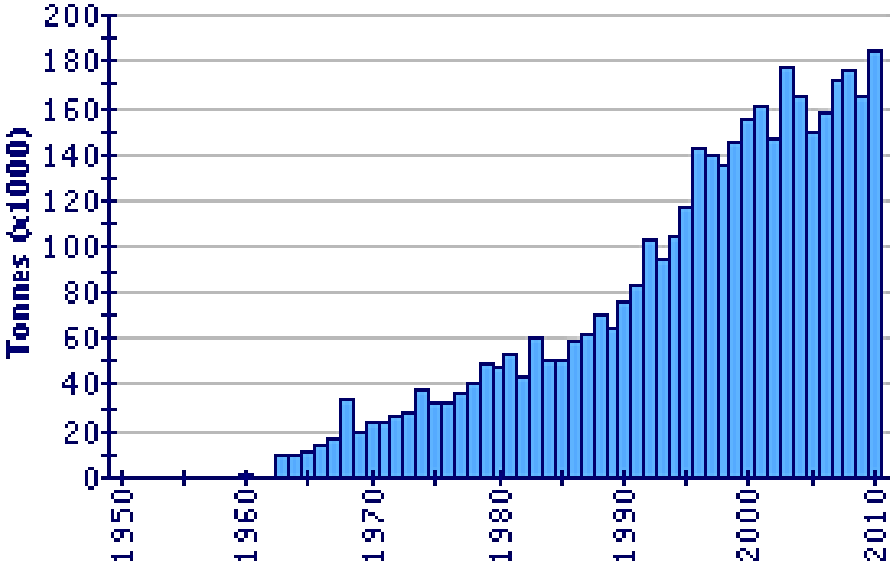
Introduction

The demand for Blue Swimmer Crab, Portunus pelagicus (Linnaeus, 1758) as a delicacy has increased many fold during the recent past; in the fishery, its status as a `by catch' is changing towards `target fishing'. Studies conducted in CMFRI has proved the suitability of the species for mass seed and farming (Josileen, 2001, 2005 and Maheswarudu et. al., 2008).

P. pelagicus is one of the major marine crab species landed in India. Though it is distributed throughout Indian coast, bulk of the landing is from Palk Bay and the Gulf of Mannar region, along the south-eastern coast. Crabs are mainly caught in bottom trawl nets, operated in deeper waters upto 50 metres and in some indigenous gears like modified gill nets which are used exclusively to catch crabs (locally known as Aedi bale, Nandu valai and Peethu valai), and mostly restricted to shallow grounds upto 15 metres. In other countries, several types of fishing gears are used to catch Blue Swimmer Crabs and among them crab pots being more common.

World fisheries for blue swimmer crabs are dominated by three species, Portunus trituberculatus (Japanese "gazami") (50%), P. pelagicus ("blue swimming crab") (25%) and Callinectes sapidus ("blue crab") (25%) (Secor et al., 2002). The market for this species has expanded considerably with the export of processed crab meat into the U.S.The global landing of the species during 1950-2010 is shown in the following graph.

Global catch of Portunus pelagicus during 1963-2010 (FAO)



Distribution

Geographical distribution of P. pelagicus ranges from Red sea, Mediterranean, East coast of Africa, Persian Gulf, Pakistan, India, Sri Lanka, Mergui Archipelago, Singapore and Philippines to Australia, New Zealand, Tahiti, China and Japan. The Blue Swimmer Crab consisted of one species until 2010, when new genetic information resulted in the division of this species into four separate species (Lai et al. 2010).

Availability of quality seed in required quantity during a prefixed time is one of the essential requirements for the successful crab culture. Marine crab seed is not easily available from the wild

and if at all available, it should not be collected from the wild for the sake of conservation. A thorough knowledge in biology and larval cycle of the species is very much required for the mass seed production and culture; hence different aspects are briefly described here.

Biology

In Portunus pelagicus, sexes can be easily differentiated from their colour patterns of dorsal exoskeleton. Male crabs, are bigger and more colourful than the females, with a dark-blue carapace, pale belly and rich blue on their legs and claws (hence the name, blue swimmer crab). But female crabs are dull brown in colour with small irregular white patches on the carapace and tips of chelate and walking legs are dark brown. Males also have longer claws in proportion to their carapace than females. However the easiest way to check if a blue swimmer crab is male or female is to turn it upside down and look at the shape of the abdominal flap. A male's flap is narrow and angular (inverted "T" shaped), while a female's flap is broad, conical/oval to rounded depending on its maturity stage (Josileen, 2001).

Blue Swimmer Crabs are a fast growing species of crab that can live up to 2.5 - 3 years, weigh up to 1 kg and reach a width of 20 cm depending on its sex and region. Length-weight relationship analysis in P. pelagicus shows that in juveniles and pre-adult crabs, weight gain is almost uniform; females are slightly heavier than males until they attain 120-125 mm carapace width. Thereafter males are heavier than females at any given length (Josileen, 2011b).

Male has pleopods modified as copulatory organs on the first and second abdominal somites. In the case of females the first four abdominal somites carry pleopods, and are biramous and possess setae for attachment of the extruded eggs till hatching.

Food and Feeding

Knowledge of the dietary habits of a species is essential for understanding its nutritional requirements and thus useful for its successful culture. The diet of Portunus pelagicus was similar in several aspects to the diet of other portunid crabs. Studies conducted in the Palk Bay- Gulf Mannar region, confirmed that they are opportunistic omnivores with a preference for animal food. There are also significant differences in the preference for food items in the different size groups of the crab and P. pelagicus exhibits, in this region at least, a clear preference for crustaceans (Josileen, 2011a).

Fecundity

The number of eggs present in the sponge/berry in P. pelagicus ranged between 60000 and 1976398. The average number of eggs for the different classes is given in the following Table*.

Size range (mm)	Average tot. no. eggs	Egg mass index
100-109	203455	15.95
110-119	214175	11.39
120-129	640431	16.78
130-139	470092	12.97
140-149	936731	13.51
150-159	1267022	10.56
160-169	1230900	10.78
170-179	1472240	12.24
180-189	1677168	10.03

*(Josileen, 2013)

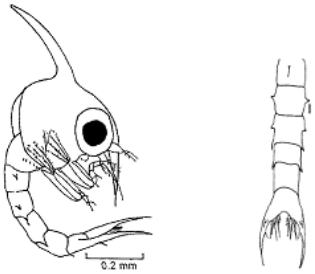
Larval stages

The larval stages included four zoeal stages and a megalopa stage. The megalopa moulted to the first crab instar. The zoeae and megalopa were very similar to those of other portunids. Each Zoea has a long rostrum, a dorsal spine and a pair of short lateral spines on the carapace. The duration of each of the first two zoeal stages was 3-4 days, the following two stages 2-3 days, and the megalopa 3-5 days, reaching the first crab stage in 15-17 days.

First zoea

Carapace length varies from 0.44 to 0.54 mm

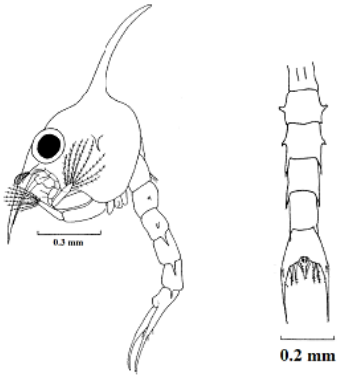
and abdomen – telson length from 1.07 to 1.23 mm. Eyes are sessible. The first abdominal segment bears a short seta on its dorsal surface. Abdomen five segmented plus the telson. Telson forked, with each fork bearing, one inner and one dorsal spine. Inner margin of each fork bears three long and serrated setae.



Zoea-I

Second zoea

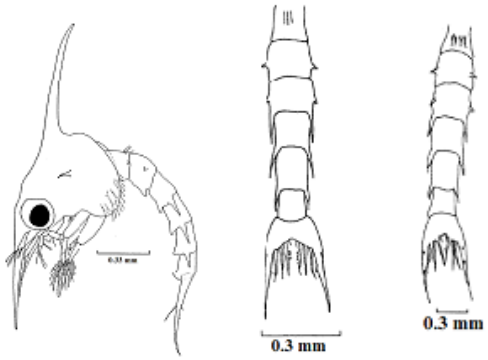
Carapace length 0.72-0.77 mm abdomen-telson length 1.46-1.54 mm. Eyes are stalked. Abdomen as in previous stage, except for pair of medium-sized setae on dorsal surface of first somite. Abdominal somites 3-5 have more distinct lateral spines. In telson a pair of short, plumose setae added on median margin of cleft part.Other structures as in previous stage.



Zoea- II

Third zoea

Carapace length varies from 0.79 to 0.87 mm and abdomen-telson length between 2.02 to 2.21 mm respectively. Dorsal surface of the first abdominal segment has 3 median short setae. Rudimentary buds of the thoracic appendages are developed behind the second maxilliped. Abdomen six segmented; dorsal surface of first abdominal somite has three median short setae. Lateral spines on somites 3-5 longer. Paired pleopod buds at ventral posterior end of somites 2-5 and telson similar to that of previous stage.



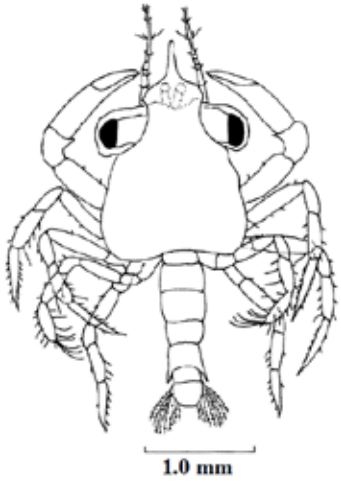
Zoea- III *Zoea- IV*

Fourth zoea

Carapace length 0.98 -1.06 mm; abdomen-telson length 2.61-3.03 mm. Pleopodal buds in the abdomen well developed: biramous on somites 2-5, uniramous on somite 6. Dorsal surface of first abdominal somite has four median short setae. Telson similar to that Zoea-III, except for additional short seta on inner margin.

Megalopa

Very similar to that of other portunids. Rostral spine present. Eyes project as far as lateral margin of carapace. Carapace length (including rostrum) 1.69-1.81 mm, width 1.16-1.31 mm. Abdomen six-segmented, with dorso-ventrally flattened telson. Abdominal length (including telson) 1.31-1.35 mm. Total length including rostrum 3.0-3.2 mm.



* For details of larval description refer Josileen and Menon (2004).

Larval rearing and seed production

Collection of broodstock: Portunus pelagicus is a continuous breeder, so the berried crabs are available throughout the year. Healthy ovigerous females with characteristic yellow/orange coloured eggs can be collected from sea and brought to the laboratory in jerry can with sea water. These crabs are kept in 1.5 t capacity fiberglass tanks at a salinity of 32 1 ppt, pH 8.2 0.1 and temperature 28 1o C with continuous aeration. Only filtered seawater is used for the entire rearing operation and 50% of water exchange must be daily given. Usually, the berried crabs do not feed and hence feeding is not required.

Broodstock Development in Captivity

Brood stock crabs can be raised in captivity using either juvenile crabs collected from the wild or using reared crablets. produced. Five to ten ton capacity round FRP tanks can be used for the brood stock development. The colour of the tank is preferably black to minimize the algal growth and to provide suitable natural environment to the growing crabs. An in-situ biological filter bed of 5-10 cm height was set on a perforated false bottom erected at about 15 cm height over the entire bottom of the maturation pool. 8-12 numbers of PVC tubes of 1 m height and each with 50 mm dia. are fixed vertically in the peripheral region of the sand bed at equal distances. Water column in the pool above the sand bed must be maintained at 0.5 -0.75 m depth, depending on the size and height of the broodstock tank. The crabs above the size of 60mm carapace width (CW) are transferred into the pool. Water recirculation was maintained at the rate of 300% by lifting the filtered seawater from below the sand bed through PVC pipes with a lid to reduce light intensity. Air water lifting system is arranged in the tank through air dispersing stones. Daily 15-20% water exchange is given and once in a week 100% exchange was given. If possible it is better to provide a running water facility of slow speed to ensure the best water quality. Water pH must be maintained at 8.0-8.2 by addition of sodium carbonate whenever necessary. Crabs should be tagged individually by sticking labels on middle of the dorsal carapace. Daily the animals are fed ad libitum with clam meat/ shrimp/ squid meat in the morning and evening hours. Faecal matter and unused feed are siphoned out in the morning hours before the water exchange. Animals are observed regularly especially the female crabs for spawning and its frequency in each moult cycle. After each moult and sufficient hardening of the exoskeleton of the crab, new stickers are attached to the dorsal side of the carapace.

Water quality was maintained in the ideal range as those factors play important role in successful growth and maturation in captivity. Salinity, temperature, pH, dissolved oxygen, total ammonia and nitrate are monitored and kept optimal regularly. Tank water temperature is maintained between 28-300 C and dissolved oxygen between 5-7 mg/l. In such a maturation system with good management practices, crabs will attain maturity within few weeks / months depending on the initial size of the crab. The male crab attains maturity by its 12th moult and female crab by 14th moult. The average size (CW) of the mature male and female crab was 82.3 $\pm$ 1.17 mm and 120.4 $\pm$ 2.23 mm respectively (Josileen and Menon, 2005).

The crabs are spawned spontaneously, with out using any chemicals, hormone or eye-stalk ablation. The incubation period ranged between 8-10 days mainly depending on the size of the berry and rearing water temperature. The zoeae produced from the cative broodstock are healthy and active like from the wild berried mothers. The duration of the larval cycle also similar to those collected from the wild. For best results it is better to use the mother for a single spawning or at the maximum two.

Hatching of zoeae: The changes in the egg colour must be observed daily and when the egg mass changes to deep grey that particular female crab is transferred into a separate tank with known volume of seawater (around 500 liters) during evening hours. Only one berried mother is intro-

duced in a single hatching tank. The total weight and carapace width are measured. The tank must be cleaned and water exchange should be given till of hatching. Anticipating the hatching during the following night mixed phytoplankton dominated with Chaetoceros spp. (10000 cell/ml) and rotifers (5no. /ml) are added in the hatching tank.

Hatching takes place during early morning hours. After full hatching mother crab is removed from the tank and weight of the crab has to be taken. In hatching tank aeration is stopped for few minutes allowing the empty eggshells and un-hatched eggs to settle at the bottom. These are removed carefully without disturbing the live zoeae in the water column and surface. Samples are taken from the tank and zoeae are counted and total zoeal estimate is recorded.

Larval rearing: 1-5 ton capacity round/oval fibre glass tanks are generally used for rearing larvae. Filtered seawater (through 1 mesh filter bag) is used for larval rearing. The newly hatched active zoeae are stocked in the larval rearing tanks at a stocking density of 50,000 no/t. Stocking is normally done during morning hours.

During the entire larval rearing period, every morning 30-40% of the culture tank water is exchanged. During the process tank bottom is cleaned, excess feed and dead larvae must be removed using suitable filter after stopping the aeration. For all the zoeal stages vigorous aeration is given, while for megalopa stage it is marginally reduced. The desired range of various parameters in LRT's are shown in the following table.

Parameter	Range
Salinity	30 - 33ppt
Temperature	27 - 31°C
PH	8.0 - 8.5
Dissolved oxygen	4 - 8 ml/l
Total ammonia	< 0.1 ppm
Nitrite	< 0.05 ppm

A combination of algae + rotifer can be given for the first zoeal stage. Among the different phytoplankton feeds used Chaetoceros found to be the best for the first zoeal stage (Josileen, 2001). For the rest of the zoeal stages a combination of rotifer + Artemia and for megalopa, Moina/Artemia +prawn-egg custard will give the best results. From Zoea- II onwards Chaetoceros is not supplied to the larvae. Mortality was recorded throughout the rearing period and mortality was more in the 1st to 2nd stage, 4th to megalopa and megalopa to crab stage.

Feeding Schedule: Based on the results of various mass rearing trials on different larval foods and their combinations, feeding protocol for Portunus pelagicus has been standardized. Larval food for different stages and their feeding concentration in the rearing water is given in the table.

Stage	Food	Concentration
Zoea I	Chaetoceros + rotifer	25,000/ml + 40/ml
Zoea II	Rotifer + Artemia	20/ml + 5/ml
Zoea III	Artemia	5-10/ml
Zoea IV	Artemia	5-10/ml
Megalopa	Moina/Artemia + prawn-egg custard	3-5/ml + 20-25mg/l
Crab 1 -3	Prawn-egg custard	20% of the biomass

Harvesting

During the time of baby crab harvest, water in the larval rearing tank is reduced to 1/4th. Then the ball valve is opened gently and baby crabs are collected, transferred to another tank of known volume of water. Based on this, the survival is estimated.

Nursery phase

The baby crabs are stocked either in rectangular, open outdoor tanks (provided with sand bed and additional substrata) or in earthen ponds, at the rate of 400-500/ m2. The depth of the water column must be maintained at 80-100cm. For the first week, feeding rate and schedule are followed as in the case of first crab instar. In the second

week of nursery phase, cooked clam meat / small shrimp can be given @ 20% of their body weight /day, in addition to the egg custard. 20% water exchange is given on every alternative days by removing water from the bottom layers. Care is taken to prevent the escape of crabs through the outlet by keeping proper mesh. The baby crabs attain an average size of 10mm carapace width at the end of the nursery phase and are ready to stock in a crab farm.

Farming

Earthen ponds are preferred for the grow-out culture of Blue Swimmer Crab. Pond preparation must be carried out as in shrimp farming to ensure the best environmental conditions for the growth and survival of the growing crabs. For best growth and survival salinity between 25-35 ppt is good. Presently no commercial feed is available in the country for using for grow-out culture of marine crabs. However it can be grown with appropriate sizes of commercial shrimp feeds and rate of feeding can be adjusted using check trays. Sampling for growth must be done once in a fortnight using dragging the bag. About 25-30 crabs for each sampling must be collected, segregated sex-wise and carapace width in mm and weight must be recorded. Within a period of 120 days crabs attain marketable size of 100g size and can be sold in live condition by individually tying them without damaging/breaking their appendages. (For the details refer Maheswarudu et al., 2008).

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