Breeding, Larval Rearing and Farming of Mangrove Crab, *Scylla serrata* (Forskal, 1775)

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Introduction

'Mud crab/green crab/mangrove crab' (*Scylla serrata*) commands sustainable domestic and international market. Owing to this fact, this species is widely exploited from all along the coastal belt of India and also in many parts of the tropical/subtropical regions of the world where its natural distribution is ascertained. As such, geographically, this species is widely distributed in Indo-Asian region and also certain tropical parts of Australian continent (Hongyu et al. 2012).

Scylla serrata

Natural habitat of mangrove crab is limited to mangrove areas/mudflats adjoining to brackishwater estuarine aqua zones, bays and saltwater creeks/lagoons. During spawning, it migrates towards sea for ambient water quality conditions which facilitate spawning and hatching. Larval stages are completed in seawater, and the baby crabs migrate to brackishwater areas for further growth.

The male crab normally grows faster and attains bigger size than the female. Mangrove crabs of sizes more than 350 g only command acceptance in conventional live crab market and fetch good value depending on the weight of the individual crabs. Due to high meat content and having a pair of muscle-built claws, it fetches more than Rs. 400/kg (e.g. farm price) in India for an average 500 g crab (BOBP 1992). India exports mangrove crabs in live condition to Singapore, Malaysia, China and Taiwan. Water crabs (molted crab) of sizes varying from 90 to 100 g are having high market potential.

Identifying Features of *Scylla serrata*

1. Polygonal markings found in all legs (including the abdominal flap of female also)
2. Frontal lobe spines high, narrow and bluntly pointed with tendency to concave margins and rounded interspaces

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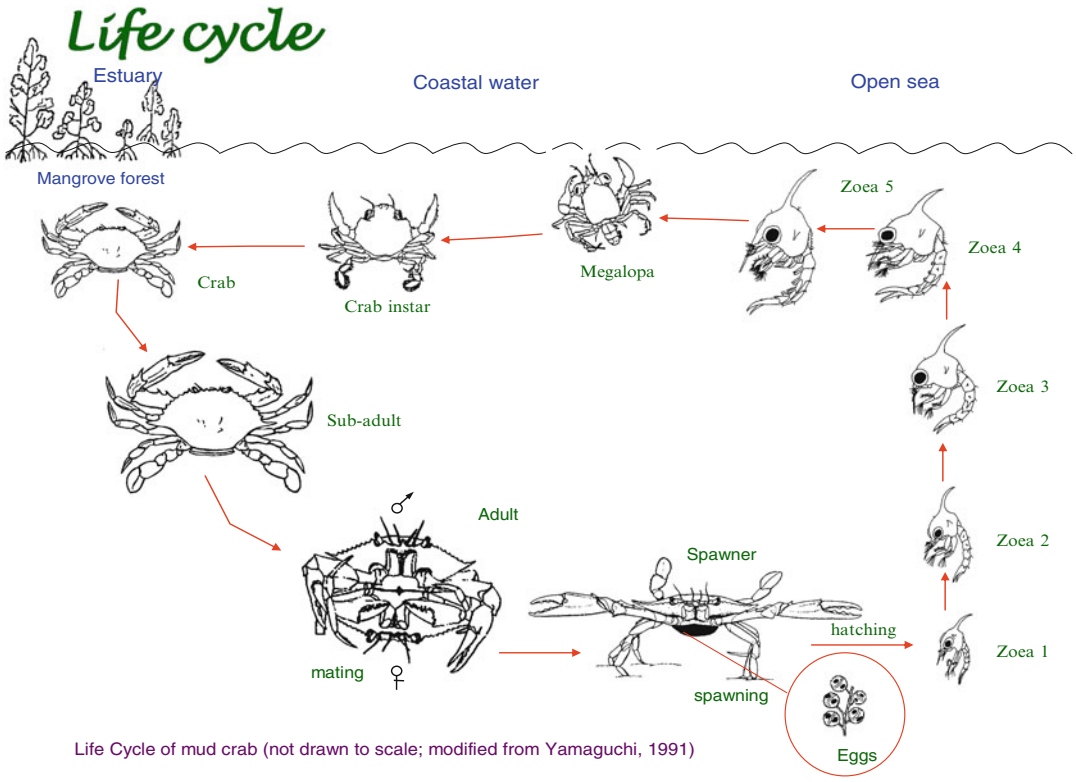
3. Wrist of claws with two prominent spines on outer margin, a pair of distinct spines on upper margin of each claw behind the movable finger

Biology of Mangrove Crab (*Scylla* spp.)

Mangrove crabs have flat, broad bodies covered with fan-shaped carapace. One pair of chelipeds, three pairs of walking legs and one pair of swimming legs are the prominent morphological features (Keenan et al. 1998; Sangthong and Jondeung 2006; Jirapunpipat et al. 2008). Walking legs are also used for clasping the female by male and for scrapping the eggs just prior to hatching by female. Under genus Scylla, *Scylla serrata*, *S. tranquebarica*, *S. olivacea* and *S. paramamosain* are the main species (Estampador 1949; Imai et al. 2004). Out of the four species, in India, only *Scylla serrata* and *S. olivacea* are available (Joel and Raj 1983; Macintosh et al. 2002; Anup Mandal et al. 2014).

Life Cycle

Burrows created in mangrove, mudflats and soft bottom shallow intertidal area are the natural habitat of *Scylla* spp. The *Scylla serrata* prefers salinity ranges of 28–35 ppt. They spawn near seawater lagoons, bays and coastal areas. The spawned eggs placed at abdominal flap of female crab would be released with the help of ciliary action of pleopods. Eggs hatch into zoeae and pass through five larval stages, after which they become megalopa. Megalopa molts into a tiny crab, viz., crab instar which is a miniature crab.



Life cycle of *Scylla serrata*

Hatchery Seed Production of Mangrove Crab

Ambient Water Quality Parameters

The ambient water quality parameters for brood stock maintenance and larval rearing are:

Salinity	28–35 ppt
Temperature	27–32 °C
pH	7.5–8.5
DO	>4 ppm
Ammonia	<0.01 ppm

At the same time, for nursery and grow out, the salinity can be 10–35 ppt. All other parameters should be same as above.

Brood Stock Collection and Maintenance

Male and female crabs can be distinguished based on the structure of the abdominal flap.

For the purpose of hatchery operation, only matured females (crabs with fully matured ovary) or berried crabs are sourced from the wild or from crab rearing ponds. Fertility percentage seems to be higher in brooders collected from the brood stock pond compared to wild collection.

Brood stocks collected from the wild/crab rearing pond are transported to hatchery in wet condition supported with oxygen supply, if necessary. On arrival at hatchery, crabs are subjected to quarantine protocols. During quarantine, crabs are screened for white spot syndrome virus (WSSV), as crab is reported to be a carrier of this virus. Once the brood stocks are qualified in screening, prophylaxis treatment and conditioning are conducted before allowing them to brood in stockholding facilities in the hatchery (FAO 2011).

Spawning and Hatching

A fully matured female weighing more than 500 g can be selected for induced spawning by eyestalk ablation. During spawning, the female crab will attach eggs to the inner portion of the abdominal flap. Hatching of egg takes place within 10–12 days. Routine observation is needed during the embryonic development stages as well as in different larval stages for ascertaining the quality of eggs and larvae.

Photo: fully matured female crab

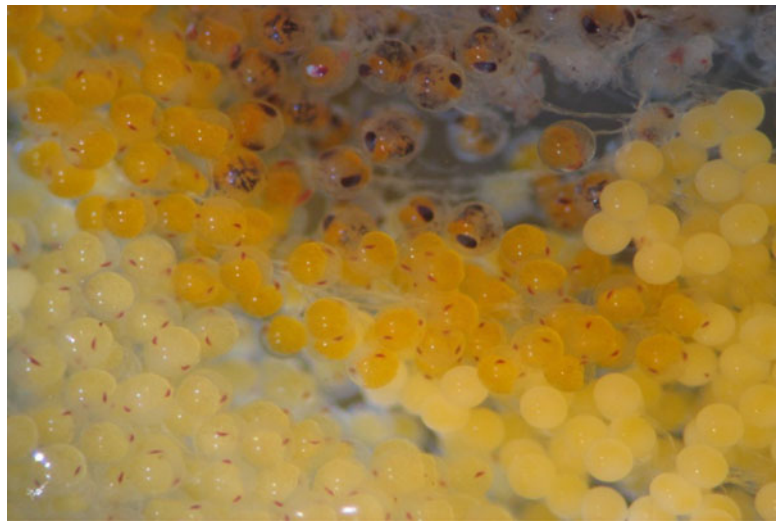


Photo showing different eye stages of developing crab embryo

Larval Rearing

In mangrove crab, there are three larval stages, viz., zoea (1–5), megalopa and crab instar. Generally 27–30 days are required to complete the larval stages so as to get a baby crab (crab instar). Similarly, *Artemia* nauplii and *Artemia* biomass production is also to be maintained as these are the exclusive feed for the later part of the larval stages (Table 1). No artificial or supplementary diets in commercial scale are available at present for mangrove crab larval rearing (Shaji et al 2006).

Zoea – 4 stage

Megalopa stage

Success of larval rearing relies on the live feed production and supply in a timely manner as per the demand, based on the feeding efficiency of larvae. This should be a synchronised activity, and therefore, any lag in synchronisation attributes to poor survival. The main live feeds are rotifers and *Artemia* nauplii for the entire larval rearing period. In order to sustain the production of rotifers, initially microalgal species, viz., *Nannochloropsis salina*, *N. oculata*, *Chlorella marina*, etc., are cultured in large scale for feeding the marine rotifer, *Brachionus plicatilis*.

Nursery Rearing

Nursery Rearing of Crab Instars

Nursery phase covers rearing megalopae/crab instars into crablets (in brackishwater ponds/creeks of ambient salinity range of 15–35 ppt.) within a period of 30–40 days, i.e. rearing a megalopae/crab instar of 0.3–0.4 cm carapace width (*CW*) to crablet of 2.5 cm or above *CW*, commonly called as *matchbox size*. It is noticed

Table 1 Food and feeding schedule for mud crab larval rearing

	Natural feed (live feed)			Wet feed
Larval stage	*Nannochloropsis* sp. (feed for rotifer)	*Brachionus* sp. (rotifer)	*Artemia* nauplii	(fish, mussel, killed Artemia biomass)
Zoea 1	50,000 cells/ml	10–20 ind./ml	-	-
Zoea 2	50,000 cells/ml	10–20 ind./ml	-	-
Zoea 3	-	-	0.5–1 ind./ml	-
Zoea 4	-	-	0.5–1 ind./ml	-
Zoea 5	-	-	0.5–1 ind./ml	-
Megalopa	-	-	Adult Artemia (1 ind./ml)	Based on consumption
Crab instar	-	-	-	Based on consumption

that cannibalism is a serious issue in obtaining good survival in indoor nursery facilities. Hence, nursery rearing is recommended only by using nylon/HDPE happas lined with Silpaulin sheet installed in brackishwater ponds or brackishwater creeks. Hideouts are provided to minimise cannibalism during the nursery rearing period. PVC pipes, garden nets, seaweeds (*Gracilaria*), etc. can be used as hideouts in nursery happa. If sufficient hideouts are provided and if grading is practised to maintain even-sized crab instars in happas, a minimum of 60 % survival can be achieved from crab instars to crablets.

HDPE/nylon happas with a total area of 20 m^3 (5 m × 4 m × 1 m) are recommended as ideal size for nursery rearing. Recently, the technology of rearing megalopae stage to crablet in nursery happa is also being practised with a survival of 30–40 %. 25–30 nos/m^2 of crab instars is the ideal stocking density in the nursery happas.

regular intervals at 50–20 % body weight. The average growth rate in terms of carapace width (*CW*) in 30 days of rearing period is 2.5 cm. Sixty-percent survival can be attained in nursery phase. Crablets of >2.5 cm *CW* are suitable for grow-out farming (Quinitio et al. 2009).

Nursery Pond Preparation

Prior to stocking of megalopae, it is necessary for pond conditioning and natural food production. Pond conditioning refers to the following management measures:

1. Draining/flushing of pond bottom.
2. Drying of pond bottom till cracks are developed.
3. Control of pests and competitors by using inorganic/organic eradicators such as ammonium sulphate + CaO combination, Mahua oil cake (MOC)/tea seed cake, etc.

5 mm crab instar

Crablets of match box size

Food and Feeding

Megalopae are fed with either *Artemia* biomass or with chopped fish meat at 50–30 % of biomass/day. Succeeding weeks feeding rate has to be reduced to 20 %. Two times of feeding (40 % morning and 60 % evening) is recommended. The rearing period from megalopa to crab instars is 35–40 days.

The crab instars are fed with low-valued minced fish having good flesh (trash fish) at

4. Induce the natural food production by the application of inorganic/organic fertilisers such as urea/DAP/superphosphate or manure.
5. If properly fertilised, there will be abundant food for megalopa, which will help to control cannibalism and hence improve survival.
6. The salinity range should be 22–32 ppt, and water depth is maintained at 100 cm.
7. Install happas (1.5 mm mesh size having a dimension of 4 m × 5 m = 20 m^2) with support of casuarinas or bamboo poles.

8. Happa nets are installed prior to filling of water in pond.
9. Catwalk of 0.6 m width is constructed for monitoring and feeding of crab instars.

Market Potential for Crab Instars

The conventional crab fattening farmers procure juvenile crabs (100–200 g) or large-sized adult water crabs (350 g and above) for further rearing as per the market requirements. Therefore, no scientific farming techniques are applied in this sort of crab fattening practice. Presently 50–300 g crab (which doesn't have much export demand) is taken to Andhra Pradesh state for further rearing into marketable size. Thousands of acres of farms are operating where crab rearing is exclusively based on wild collected juvenile crabs. Similarly, some entrepreneurs in India started rearing 80–150 g of juvenile mangrove crabs collected from the wild and stocked in individual plastic boxes till molting stage for soft-shell crab export business. But the overdependence on the wild crabs for export, fattening and soft-shell crab production attributes excess pressure on wild population. Hence, farming with hatchery-produced mangrove crab seed reduces the pressure on the natural mangrove crab population, which is presently the only source of mangrove crab for export (Quinitio and Samaj 2007).

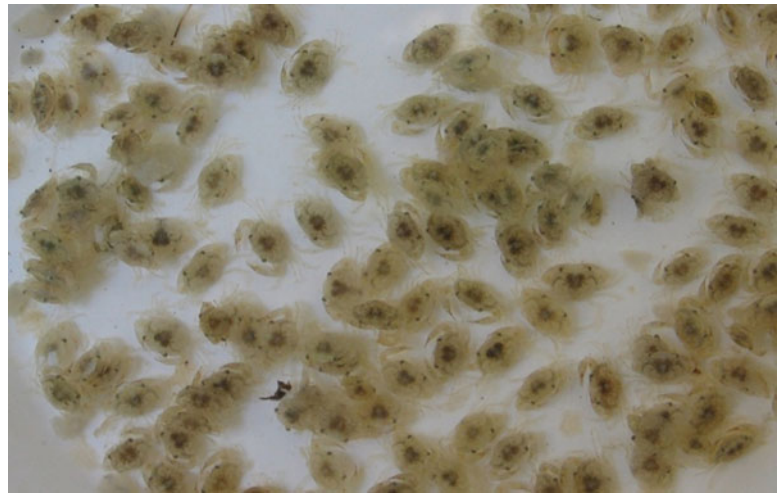
Grow-Out Technology

Grow-Out Culture in Earthen Pond

Mangrove crabs are generally tolerant to a wide range of temperature and salinity. They can withstand water temperature from 12 to 35 °C, but their feeding efficiency falls rapidly when the temperature is below 20 °C. They are able to tolerate salinity range of 5–34 ppt. but the optimum salinity range is 15–30 ppt. Pond eradication and water culture are to be done similar to shrimp farm preparation.

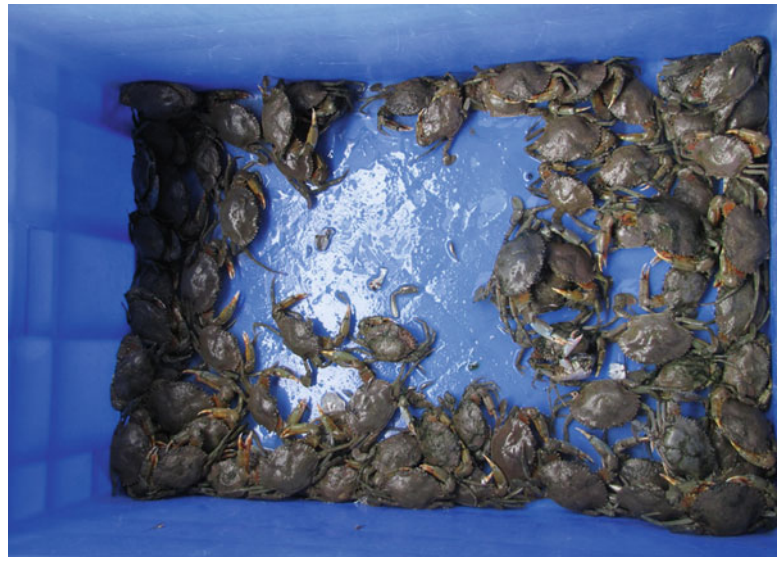
Existing or abandoned shrimp culture ponds/ponds in and around mangrove area can be utilised for culturing mangrove crab. However, ponds situated in isolated zones/area are recommended. Net enclosures should be installed along the inner side of the pond dike to prevent the escape of stock.

Nursery reared crablets are used for grow-out culture. Normally 6–7-month period is required to attain the marketable size of 500 g (average). Another way of grow-out culture can be attempted by growing juvenile sizes in small brackishwater earthen ponds for 2 months to attain an average size of 50–75 g. These juveniles can be further grown in grow-out ponds up to marketable size of >500 g within 4–5 months of culture. The second method mentioned facilitates to select even-sized juvenile crabs for grow-out,



Hatchery-produced crab instars

and as such it would yield successful crop with less differential growth. The size of grow-out pond can vary from 0.25 to 1 ha with proper inlet and outlet for water management. Soil texture with high percentage of silt is not suitable for crab farming. Earthen bund of the pond is to be fenced with HDPE net to avoid escape of crab. Minimum of 1 m water depth is required, and the recommended stocking density is 0.5–0.7 juvenile crab/m^2. Stocking with uniform-sized crablets can yield an average survival of 60 %, whereas stocking with juveniles can provide more than >70 % survival. However, if stocking density is maintained at 0.5 No./m^2, the survival rate can be increased further.



Juvenile crab ready for stocking

In grow-out culture, the cannibalism can be minimised by the use of macrophytes (viz., *Gracilaria* sp.), mangrove twigs and shelters such as sand heaps, old tiles, earthen/cement/PVC pipes, hollow blocks, etc., which will help to attain normal growth and good survival with reduced cannibalism.

Transport, Acclimation and Stocking of Mangrove Crab Juveniles

Mangrove crab juveniles are transported in ventilated bamboo baskets, plastic trays, straw bags and carton boxes. Each container is provided with wet *Gracilaria*/mangrove leaves/some material which can hold water. This would help to minimise fighting among crabs and keep the temperature cool in the container during transport.

Crabs are acclimatised before being released into ponds to prevent thermal and salinity shock that leads to sudden mortality. Avoid stocking in hot sunny time.

Water Management

Daily monitoring of water quality parameters such as temperature, salinity, DO, pH, water colour and transparency is important as a tool for the management of good water conditions in pond. Water exchange can be done according to the need, followed by application of probiotics which will save pumping cost.

Food and Feeding: Grow-Out Culture

Feed comprises 50–60 % of the total cost of production. The use of cost-effective feeds and the right amount will prevent feed wastage and water pollution. General thumb rule for feed calculation based on the carapace width is given

below. Also providing feed in several feed trays will help to monitor the crab daily.

Carapace width (cm)	% of feed
<6	10
>6–15	8
>15	6–4

1. Facilitate stocking of different sizes of crab in different pens which may ultimately increase the survival and yield.
2. This type of culture can be practised even in mangrove areas.
3. Easy growth monitoring and harvesting.

Mangrove crab pen culture pond at RGCA farm, Karaikal, India

Feed is given twice, 40 % in the morning and 60 % in the evening. Generally while using trash fish, the FCR varies from 6 to 7 per kg of biomass. Though artificial diets are available for crab farming, its standardisation is under progress.

Pen Culture

Crablets/juveniles can also be reared successfully in pens (e.g. 20 m × 10 m × 1.2 m of HDPE net with mesh size of 10 mm). The stocking density of crablet in a pen can be 0.5–1 No/m^2. The advantages of the pen culture are:

Harvest and Marketing

Selective harvesting can be practised to remove the harvestable-sized, hard crabs continuously during the culture period. This also allows smaller crabs to grow faster, thus helping to shorten the culture period. This type of harvest is done with lift net or scoop net.

Complete harvest can be done by the end of 120–150 days by lift net/scoop net and hand-picking after draining the pond.

Conclusion

Presently, mangrove crabs are exploited from the wild and marketed for export and domestic

Photo: Hatchery-produced crab instars reared up to 700 g of marketable-sized crabs

consumption. Most of the wild-caught mangrove crabs are exported in live form. The fishers collect mangrove crabs of different sizes starting from juvenile to adult from mangrove mudflats and estuarine areas. Hard-shell crabs of sizes more than 350 g are sold to the exporters directly, and soft-shell crabs of different sizes and juvenile crabs are sold to mangrove crab fattening groups by the fishers. But as the natural stock is depleting due to the overdependence on wild stock, most of the fattening centres are not getting sufficient quantity of crab for their routine operation. As such there is no organised farming prevailing in India to grow mangrove crabs in land-based earthen ponds/pens/cages using hatchery-produced crab seeds. Now MPEDA-RGCA has taken up this challenge to popularise crab farming using hatchery-produced crab larvae, and as a result, a state-of-the-art hatchery facility is built up at Thoduvai, Nagapattinam District, Tamil Nadu, India, for the large-scale production of disease-free crab instars. Meanwhile several trials are progressing at the Aquaculture Demonstration Farm of RGCA at Karaikal for increasing the survival during farm operation while feeding with low-value fish as well as artificial diets.

Photo: The mangrove crab hatchery of RGCA, MPEDA, Thoduvai, Tamil Nadu

Indicative Economics Based on Recurring Expenditure for a Crab Grow-Out Farm

Basic assumptions	
Pond area	0.5 ha
No. of seed stocked (at 0.5 pcs/m^2)	2,500 nos
Period of culture	7 months
Survival (at 50 %)	1,250
ABW at harvest	500 g
Total biomass at harvest	625 kg
Selling price for 500 g crabs	Rs. 400/kg
Feed used (trash fish) at 1:6 FCR	3,750 kg
Recurring expenditure	**(Rupees)**
Pond lease amount for 1 year	20,000
Sluice net and fencing net	10,000
Cost of crablet at Rs. 5 for 2,500 (0.5/m^2)	12,500
Feed -FCR 6:1 at Rs. 15 for trash fish (50 % survival at 500 g)	56,250
Labour salary at 7,000 per month for 8 months – 1 person	56,000
Chemicals, lime/probiotics, etc.	10,000
Power/diesel for pumping and lighting	25,000
Miscellaneous expenses	10,000
Total	**1,99,750**
Revenue	
Sale price of 1,250 nos at 500 g with sale price at 400/kg	**2,50,000**
Profits	
Gross profit per crop	**50,250**

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