Overview of Crab Culture

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Aquaculture is one of the fastest growing food production sectors in the world, providing an acceptable, protein rich supplement to and substitute for, wild aquatic animals and plants. Over the time, production from aquaculture has increased steadily with the introduction of new species and many countries are venturing into it. Crab culture is popular now and good demand is there in domestic and foreign markets.Most of the edible crabs caught from marine and brackish water environments belong to the family Portunidae. In seas around India, five genera of portunid crabs have been reported by various authors, *Scylla*, *Portunus*, *Charybdis*, *Lupocyclus* and *Thalamita* and among them the first three genera are commercially important.The annual marine crab landing in India has shown increasing trend during 1975-2021 and recorded a tremendous decline during 2020 & 2021. Maximum landings registered dring 2018 (57354 t) and minimum during 1978 (14202 t). The commercially important species are *Portunus sanguinolentus, P. pelagicus, Charybdis feriata, C. lucifer, Scylla serrata* and *S. olivacea.*

Crab culture gained momentum during 1990"s due to the great demand of live crabs and crab products in the export market. In the past crabs were considered a secondary species to shrimps and finfishes. For centuries, the portunid crabs have constituted an important secondary crop in the traditional tidal ponds of Asia, the stocking of crabs was entirely passive, and it enters through the sluice gates along with young ones of other species. They were considered to be undesirable components of the typical multi species culture system, because of their "troublesome" habits of destroying pond dikes, escaping, cannibalism and damage to other species during harvest. Now the picture is changed and crabs farming picking up rapidly due to promising market and profitability.

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 for three important portunid crabs.

Portunus pelagicus (Blue Swimmer Crab)

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 blueswimmer 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.

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 presents in the sponge/ berry in *P. pelagicus* ranged between 60000 and 1976398 (Josileen, 2013).

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 aerated 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 ± 1^{o} 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 hatchery raised crablets. Five to ten ton capacity round FRP tanks can be used for the brood stock development. The colour of thetank 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% bylifting 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 5- 10% 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 28-30^{0}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 ± 1.17 mm and 120.4 ± 2.23 mm respectively (Josileen and Menon, 2005).

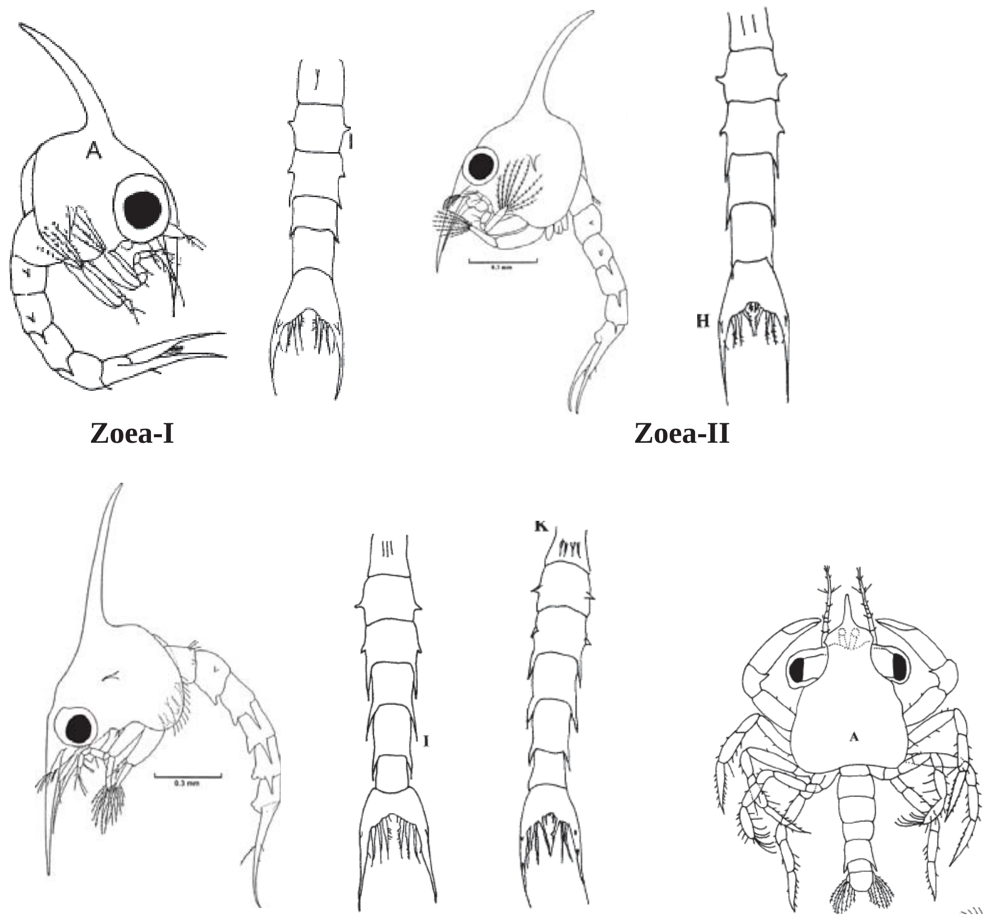
The crabs are spawned spontaneously, without using any chemicals, hormone or eye-stalk ablation. The incubation period ranged between 8-10 days mainly depending on the size of the berry and rearing water temperature. The zoeae produced from the captive broodstock are healthy and active like from the 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 introduced 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

Parameter	Range
Salinity	28 - 33ppt
Temperature	27 - 31ºC
pH	8.0 - 8.5
Dissolved oxygen	4 - 8 ml/l
Total ammonia	< 0.1 ppm
Nitrite	< 0.05 ppm

aeration is given, while for megalopa stage it is marginally reduced. The desired range of various parameters in LRT‟s are shown in the table.

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.



A- Carapace, I- Abdominal segment, H- Telson,
K- First abdominal segment with spines

*****Larval stages of the marine crab, *Portunus pelagicus* (Linnaeus, 1758)
* For details refer Josileen, J. and N. G. Menon. 2004. Larval stages of the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura). Crustaceana 77 (7): 785-803.

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/ m^2. 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 weekof 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 byremoving 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 environmentalconditions 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 mmand 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).

Mud Crab, *Scylla* Spp.

The taxonomy of the genus *Scylla* has been terribly confused and is still difficult. Keenan *et al*., (1998) confirmed that there are 4 species of *Scylla* using morphological, DNA, and allozyme data.

***Scylla serrata* (Forsskål, 1775) (Giant mud crab)**

Carapace smooth, with strong transverse ridges; H-shaped gastric groove deep; relatively broad frontal lobes, all more or less in line with each other; broad anterolateral teeth, projecting obliquely outwards, colour green to greenish black; legs may be marbled. Well- developed spines present on outer surface of chelipedal carpus and anterior and posterior dorsal parts of palm.

Scylla serrata

***Scylla tranquebarica* (Fabricius, 1798) (Purple mud crab)**

Colour varies from brown to almost black in coloration, and has very well-developed spines on the outer surfaces of the chelipedal carpus and the palm (as seen in *S. serrata*). It differs from *S. serrata*, however, by having the frontal teeth more acutely triangular, the median pair projecting slightly forwards of the lateral pair, and the anterolateral teeth gently curving anteriorly, giving the carapace a less transverse appearance.

Scylla tranquebarica

***Scylla olivacea* (Herbst, 1796) (Orange mud crab)**

Carapace brownish to brownish green in colour (sometimes orangish), palm orange to yellow. It has a smoother, more evenly convex carapace with very low transverse ridges, a shallow H-shaped gastric groove, the median pair of the frontal lobes more rounded and projecting slightly forwards of the lateral ones, the anterolateral teeth gently curving anteriorly, giving the carapace a less transverse appearance. It also has very low spines on both the outer surface of the chelipedal carpus and the dorsal surface of palm.

Scylla olivacea

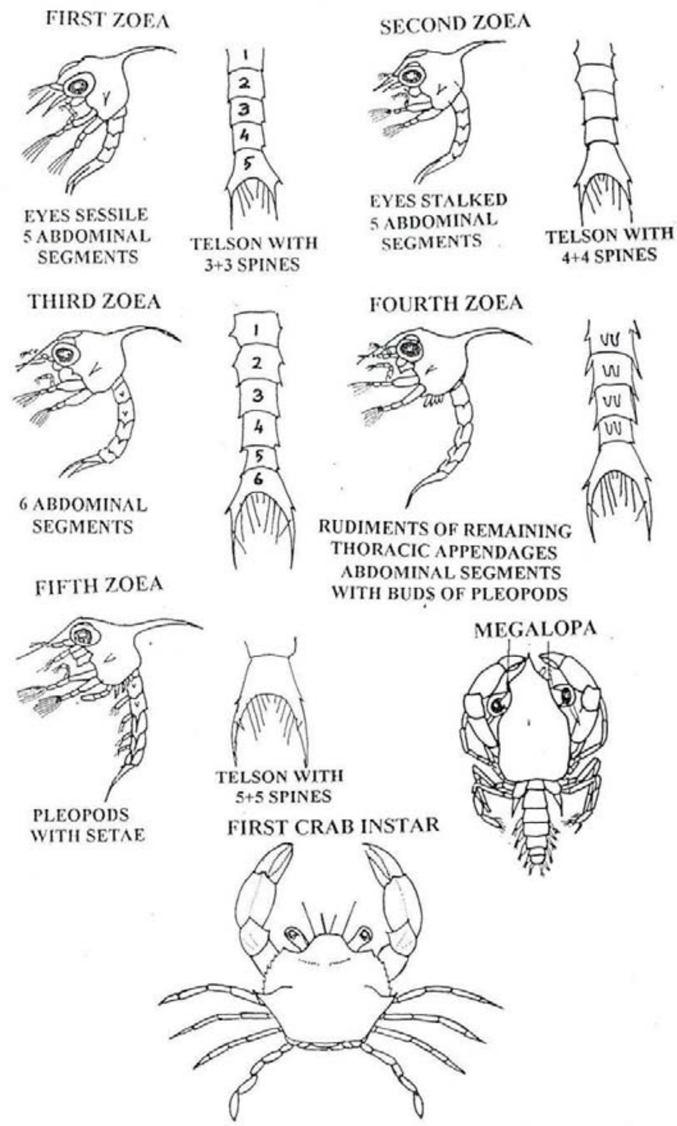
***Scylla paramamosain* Estampador, 1949 (Green mud crab)**

Carapace usually green to light green, palm green to greenish blue with lower surface and base of fingers usually pale yellow to yellowish orange. Frontal margin usually with sharp teeth, palm usually with distinct, sharp spines.

Scylla paramamosain

Larval development

The different *Scylla* spp. pass through 5 zoeal stages and a megalopa stage before it moults tothe crab stage, taking 21-25 days for the entire cycle.



Larval Stages of *Scylla serrata*

Culture Methods

Mud crab farming is done by two methods. The first methos id by growing young crabs for a period of 3-6 months till attain desirable size, commonly known as **grow-out** culture. In the second method of **fattening**, soft shelled crabs are reared for a period of 1-3 weeks till their exoskeleton gets hardened. These „hard" crabs fetch three to four times better price than the soft crabs. Between these two methods, the latter is more advantageous since the culture period is short and profitable.

Grow-out: This is not a common practice but some traditional prawn farming ponds are used in certain locations. Mud crab grow-out systems are generally pond based, with or without mangroves, their size varying between 0.5-2 ha, with proper bunds and tidal water exchange.

Fencing is advisable if the pond is small and large ponds where natural conditions are prevailing, strengthening is necessary along the outlet area. Wild collected juveniles of 10- 100 g size are used for stocking. The duration of the culture varies between 3-6 months and stocking rates are commonly between 1-3 crabs/m^2 with supplementary feeding. Feeding is usually with trash fish (wet weight feeding rate 5% per day of the biomass), along with other locally available items like bivalves. Regular sampling is necessary to monitor the growth & general health, and to adjust the feeding rate. Partial harvesting of marketable sized crabs can be started from 3rd month onwards; this "stock-thinning" provides chances for better survival by reducing the mutual attacks and cannibalism. In India grow-out culture is not popular mainly due to non-availability of crab seeds and commercial feed.

Fattening in ponds: fattening can be done in small tidal ponds between 0.025-0.2 ha with a water depth of 1to 1.5 m. Before stocking the soft crabs in the pond, the bottom is preparedby draining the pond water, sun-drying and adding sufficient quantity of lime. Care is taken in strengthening the pond bunds without any holes and crevices. Special care is taken in the sluice area as these crabs have a tendency to escape through nearby areas of sluice gate. The inlet areas should be reinforced with bamboo matting inside the bund. The ponds are fenced properly using bamboo poles and nets along the side of the bund, which incline towards the pond to prevent the escape of crabs. Soft crabs collected from local fishermen/crab merchants are stocked in the ponds preferably in the morning hours @0.5-2 crabs/m^2 according to the size of the crabs. For crabs of 550g and above, market demand is more. Hence it is ideal to stock crabs belonging to this size group and then stocking density should not be more than 1 crab/m^2. Depending upon the location and availability of water crabs, 6-8 cycles of "fattening" can be carried out in a pond during one year by repetitive stocking and harvesting. If the pond is big, it is better to divide the pond into different compartments of suitable sizes for stocking crabs of uniform sizes in the same compartment. This is good for manipulating the feeding and is easy to monitor and harvest. Sex-wise stocking in compartments is advantageous to reduce the attacks from more aggressive male crabs. It‟s better to provide shelters like bamboo baskets, old tyres, tiles etc. to minimize mutual attacks and cannibalism. Crabs are fed daily with trash fish, brackish water clams or boiled chicken waste @5-8% of their body weight. If the feeding is twice a day, major share must be given during evening hours. Water quality must be maintained in a range of; salinity-15-25 ‰, Temperaure-26-30 ^{0}C, Oxygen-> 3 ppm and pH- 7.8-8.5.

Crab fattening pond

Harvesting and marketing:

Periodically crabs are to be checked for their hardening. Harvesting should be done in the early morning hours or evening hours. The harvested crabs should be washed in good brackish water to remove the dirt and mud and carefully tied without breaking its legs. The harvested crabs have to be kept in moist and cool conditions, away from sunlight which has a negative effect on survival. Crab fattening is getting more importance and many farmers are attracted, due to frequent failures in shrimp farming and short culture period. It is an ideal livelihood option for coastal people those who own/can lease suitable water bodies with good tidal water exchange.

Vertical farming

Vertical Crab farming is an emerging area a land based system, in which crabs are grown in individual boxes which are interconnected and entire unit is functioning on recirculatory mode maintaining the desired water quality. The system is cleaned regularly and parameters are monitored daily. This system is beneficial for the fattening of crabs with minimal usage of sea water in short span of time. It is cent percent natural farming and without the usage of chemicals. It is advantageous that farmer can closely monitor the crabs individually and hardened crabs can be harvested without much difficulty. Initial invest is quite high, hence farmers are little hesitant to take up this method.

Soft shell crab production

Soft-shell crab farming has become popular because it is a profitable business providing employment and fetches more income. Moreover, the whole soft-shell crab can be eaten when cooked. However, procurement of soft-shell crab is very labour intensive compared to other culture methods. The crabs must be inspected every 3-4 hours around the clock to ensure that newly moulted crab taken out of the individual box in which they are reared and shifted to fresh water before the hardening of the shell. The number of crabs may vary according the holding capacity of the farm. In Thailand the typical farm will contain an array of 10,000 to 50,000 boxes, in order to have a consistent number moulting on each day for fresh sales. The rearing ponds usually are tidal ponds, at high tide the pond is filled and then sluice gates are adjusted to hold the water.

Soft shell crab farm in Myanmar A vertical crab culture nit

Charybdis feriata

Larval stages: The larval development of *Charybdis feriata* 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). 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). 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). 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). 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). Duration: 3-4 days.

General Constraints

Hatchery

(a) Water quality is still a problem at all sites and water treatment, e.g. ozone, carbon filtration, protein fractionation and removal, and better biofiltration require systematic evaluation.

(b) Bacterial problems still require antibiotic intervention. Finding ways to eliminate or reduce antibiotic use, e.g. through better water treatment, improved hygiene or probiotic use requires systematic investigation.

(c) Live food is still a major constraint. The cultures are difficult /expensive to maintain and live food is a disease vector. Research to eliminate live food for all or some stages is needed.

(d) Mortality at moulting is a problem. The inability to moult may be due to nutritional deficiencies and requires investigation.

(e) Asynchronous moulting

(f) Differential growth

(g) Cannibalism from Megalopa stage

(h) Nutritional adequacy of feed is unknown. Nutritionally optimal feeding regimes need tobe developed.

(i) Very low survival

(j) Transfer of technology has been excellent (under Leading Centres project) but will need tobe maintained and expanded as new technology is developed.

Grow-out

Similar constraints to grow-out development apply to mud crabs and blue swimmers.

(a) Replacement diets for trash fish needed in Southeast Asia. Existing high quality feed for *Penaeus* spp. is effective, but prohibitive economically and physically: it is too small and the wrong texture.

(b) Diseases not a major problem yet but will be in future.

(c) Regular harvesting to remove larger most aggressive animals difficult logistically and too expensive.

(d) Moult synchrony a key priority.

(e) Differential growth rate.

(f) Cannibalism

(g) Possibility of selective breeding for „increased survival‟ (reduced aggression).

(h) Better techniques for harvesting, especially with a view to reducing labour

(i) High densities during transportation lead to significant limb loss and sometimes death.

References

Jose Josileen. 2001. On the fishery, biology and the hatchery technology of the portunid crab *Portunus pelagicus*. Ph.D thesis, Cochin University of Science and Technology, Cochin.

Jose Josileen. 2011a. Food and feeding of the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, brachyura) along the Coast of Mandapam, Tamil Nadu, India. Crustaceana, 84 (10): 1169-1180.

Jose Josileen. 2011b. Captive spawning, hatching and larval development of crucifix crab, *Charybdis feriata* (Linnaeus, 1758). Journal of the Marine Biological Association of India, 53(1): 35-40.

Jose Josileen. 2013. Fecundity of the Blue Swimmer Crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura, Portunidae) along the coast of Mandapam, Tamil Nadu, India. Crustaceana, 86 (1):48-55.

Jose Josileen and Menon, N. G. 2005.Growth of the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura) in captivity. Crustaceana, 78 (1): 1-18.

Jose Josileen and Menon N. G. 2004. Larval stages of the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura). Crustaceana, 77 (7): 785-803.

Lai, J.C.Y., P.K.L.Ng and P.J.F. Davie. 2010. A revision of the *Portunus pelagicus* (Linnaeus, 1758) species complex (Crustacea: Brachyura: Portunidae),with the recognition of four species. The Raffles Bulletin of Zoology 58(2): 199–237.

Maheswarudu, G, Jose Josileen, Nair, K R Manmadhan and Arputharaj, M R. 2008. Evaluation of the seed production and grow out culture of blue swimming crab *Portunus pelagicus* (Linnaeus, 1758) in India. Indian Journal of Marine Sciences, 37 (3): 313-321.

Shelley, C.and A. Lovatelli. 2011. Mud crab aquaculture – A practical manual. FAO Fisheries and Aquaculture Technical paper. No. 567. Rome, FAO.78 pp.

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