14 Life Cycle and Biology of Portunid Crabs

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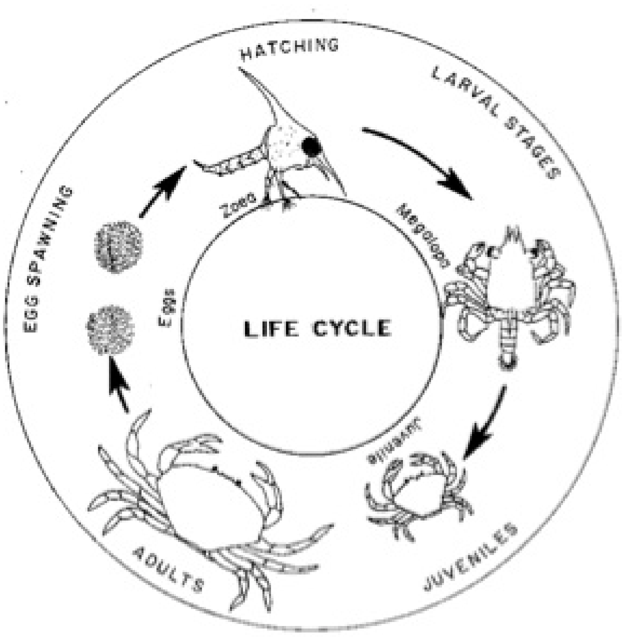
Growth

In crustaceans, as growth progresses, certain dimensions of the animal's body may grow much more than others, resulting in the phenomenon known as relative growth (Hartnoll, 1974). Studies of relative growth are often used to determine changes in the form and size of the abdomen, pleopods, or chelipeds during ontogeny. Knowledge of these distinguishing characters and size relationships in sexually mature individuals is of particular importance in the study of commercially valuable crustaceans. Such knowledge can be useful for further studies on the life history of the species and in the development of its fishery, resource management, and culture. The mathematical length-weight relationship thus yields information on the general well-being of individuals, variation in growth according to sex, size at first maturity, gonadal development, and breeding season. Study of the length-weight relationship in aquatic animals has wide application in delineating the growth patterns during their developmental pathways (Bagenal, 1978). In population studies, morphometric analysis provides a powerful complement to genetic and environmental stock identification approaches (Cadrin, 2000) and length-weight relationships allow the conversion of growth-in-length equations to growth-in-weight for use in a stock assessment model (Moutopolos & Stergiou, 2002). Information about individual body weight-length/width relationships in populations is important for estimating the population size of a stock, specifically for the purpose of its exploitation. The length-width/weight relationships are regarded as more suitable for evaluating crustacean populations (Prasad & Neelakantan, 1988; Prasad et al., 1989; Sukumaran & Neelakantan, 1997). The interrelationships between various morphometric characters will be useful in comparing the different stocks of the same species at different geographical locations (Josileen,2011a).

Crustaceans are equipped with a hard exoskeleton that must be shed in order to grow, i.e., through moulting or ecdysis. Quantifying patterns of crustacean growth is difficult. Although there have been many studies, there is no generally accepted or convincing model describing crustacean growth, which is comparable to the models widely applied to fish growth. Among the reasons for this are the complications of incremental, discontinuous growth by moulting and the variety of life history strategies expressed by crustaceans. The best way of describing the growth of many crustacean species is by observing their moulting pattern. Crustacean growth is dependent upon the duration of the intermoult (moult interval) and size increase at each moult (moult increment). The processes of the moulting cycle have been adequately described by Skinner (1985). The growth of *Portunus pelagicus* from the first instar to stage 16 was studied by rearing the crabs in the laboratory (Josileen and Menon, 2005). The males have grown from an initial average carapace width of 2.38 ± 0.18 mm to 159.86 ± 3.52 mm;



i.e. from first instar to sixteenth instar within a mean period of 272 days and further reared to a maximum of 455 days. The average total weight gained was 275.00 ± 25.41 g from an initial weight of 0.008 g. Females have grown from an initial average carapace width of 2.43 ± 0.34 to 154.31 ± 2.73 mm, reached sixteenth instar within a mean period of 332 days. The average weight gain during the same period was 0.006 g to 210.33 ± 18.39 g.

In crabs there are certain morphological features which are present in full expression at sexual maturity. These changes in morphological characters are otherwise known as secondary sexual characters, are prominent in both sexes of the crabs. In males, pubertal changes include the colour of the chelae and other pereiopods, length and depth of the pereiopods, and length of the first pleopods relative to the sternites in the sternal depression. In *P. pelagicus* it was noticed that there is a drastic change in the length of chelae in males by their 12th moult. The total increment was 24.23 mm from the previous moult registering 97.51% increase in chelar propodus length. Chelar propodus depth also increased, 3.68 mm (45.71%), but it was more prominent in the subsequent mature moultings. Male has pleopods modified as copulatory organ on the first and second abdominal somites.

Onset of sexual maturity was explicit in female crabs too. In contrast to males, passage of a female through pubertal moult was indicated by gross morphological changes particularly of the abdomen and accessory reproductive structures. The most evident change in the female was the change of the triangular abdomen to oval shaped one and in later moultings it almost attained a semicircular shape. In juveniles, abdomen was held tightly against the sternum and by the puberty moult the abdominal flap become free. All the abdominal segments become freely articulated and bordered by small setae. If the abdomen of the female was lifted, round oviduct openings can be seen which was a slit like in a juvenile crab. There are four pairs of biramous pleopods on the second to fifth abdominal segments and these pleopodal endopodites bear clusters of long and silky setae to which eggs are attached during spawning.

Food & feeding

Knowledge of the dietary habits of a species is essential for understanding its nutritional requirements and thus its interactions with other groups of animals. Crabs include filter feeders, sand cleansers, mud, plant, and carrion feeders, predators, commensals, and parasites (Dall & Moriarty, 1983). Crabs occupy many different niches and inhabit many different habitats in a variety of geographical areas, and this is reflected in the variety of food consumed by them.

The crab uses its mouthparts to chop the food into small pieces and then the gastric mill ossicles further reduce the food to unidentifiable fragments. The majority of researchers use the foregut contents to study the quantity and nature of the different food items the crab has consumed (Sukumaran & Neelakandan, 1997; Chande & Mgaya, 2004 and Josileen, 2011b). They are all opportunistic omnivores with a preference for animal prey, but within that framework only rarely feed on more mobile prey such as fish and prawns. Josileen (2011b) observed that crustaceans constitute the most favoured item in *Portunus pelagicus* diet, followed by molluscs and fish. Also recorded the presence of detritus (80%) in the stomachs, which suggests that these crabs are also detritivorous, consuming both fresh and decaying flesh of all kinds of animals. It was found that the stomachs of juveniles and sub-adults are predominated by debris. Grapsid, xanthid, majid, potamid, and portunid crabs (in portunids particularly juveniles) have also been reported to consume plant material.

Fecundity

Fecundity is an index of reproductive capacity, expressed in terms of the number of eggs produced by an organism. Among decapod crustaceans, fecundity varies widely within families and genera, and in crabs it varies from species to species. There is also variation within the same species, due to factors such as age, size, nourishment, ecological conditions of the habitat, etc. (Giese & Pearse, 1974; Shields, 1991). In general, fecundity in crabs is measured as the number of eggs produced in each clutch, and it is usually described as a function of body size (Corey & Reid, 1991). Fecundity allows a better understanding of the reproductive potential, dynamics and evolution of a given population (García-Montes et al.,1987).Variation in fecundity was primarily a reflection of variation in the size of the crab at maturity. Brachyuran crabs show a great diversity in embryonic development, especially owing to a significant variation in egg size. Fecundity, expressed as average number of eggs in ovigerous females, was positively correlated with the size of the egg-bearing females in all species. The relationship between female size and egg number is usually described as an allometric function equivalent to that between size and weight (Hines, 1988; Josileen 2013). The increase in fecundity is here explained by positive allometric relationship (increase in egg number with the increase in total width). For brachyuran crabs correlation is often high and body size is the prime determinant in fecundity per brood and reproductive output. For example, Josileen (2013) reported that in *Portunus pelagicus* the fecundity measured ranged between 60,000 and 19,76,398 in crabs with carapace widths of 100 to 190 mm from Indian waters. In same species from Malaysia, fecundity estimates ranged from 1,48,897 to 8,35,401 eggs within a carapace width of 102-140 mm (Arshad et al., 2006).

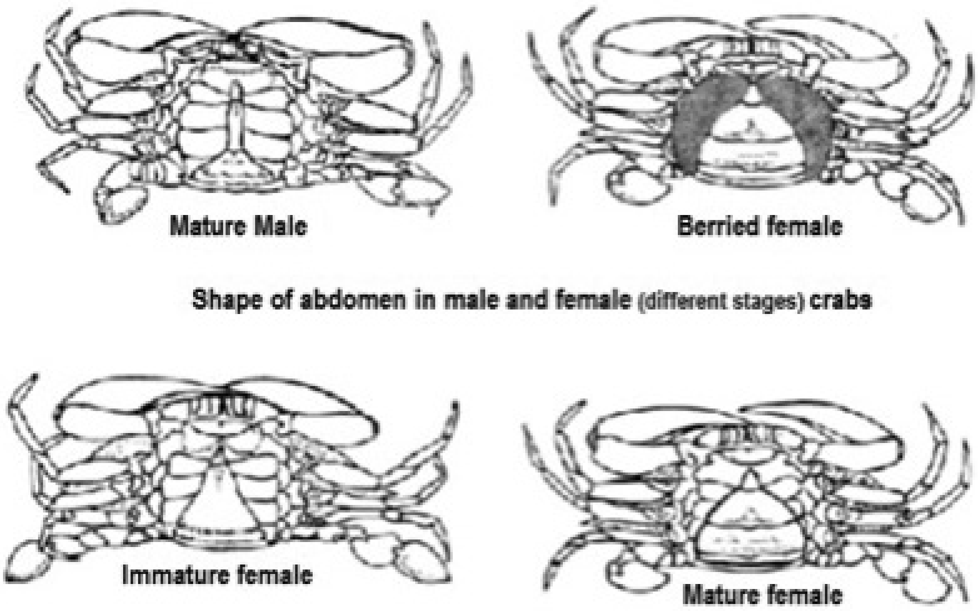
Sexual dimorphism and sexual characters

In crabs sexes are separate and sexes can be distinguished from the shape of the abdomen. In males the abdomen is narrow, inverted ‘T’ shaped and in addition mature males have larger and broader chelae. The first and second abdominal appendages (pleopods) are highly modified to form an intromittant copulatory organ. Females possess a broad abdomen, conical/oval in shape (according to the stage of maturity) and bear four pairs of pleopods.

Many species of crabs show sexual dimorphism, with males being larger, smaller, or possessing special or enlarged structures. In some species the females are the larger. Most commonly, males have proportionately much larger chelipeds or chelae. In some heterochelous crabs, males have one of their chelipeds extremely enlarged to be used for courtship. Males always have only two pairs of gonopods (uniramous swimmerets or pleopods) which are specially modified for copulation (most crabs practice internal fertilisation). The first gonopod (G1) is basically a highly modified pleopod which has been folded or rolled longitudinally to form a cylindrical tube. The degree of this folding varies; from incomplete, leaving a prominent longitudinal gap between the two margins, to having the folds overlapping several times. The channel thus formed can vary from very wide to extremely narrow and almost capillary-like. The form of the G1 varies from broad to very slender, straight to sinuous, and even strongly recurved.

Reproductive system

The male reproductive system of is bilaterally symmetrical creamy to whitish in colour,



Shape of abdomen in male and female (different stages) **crabs**

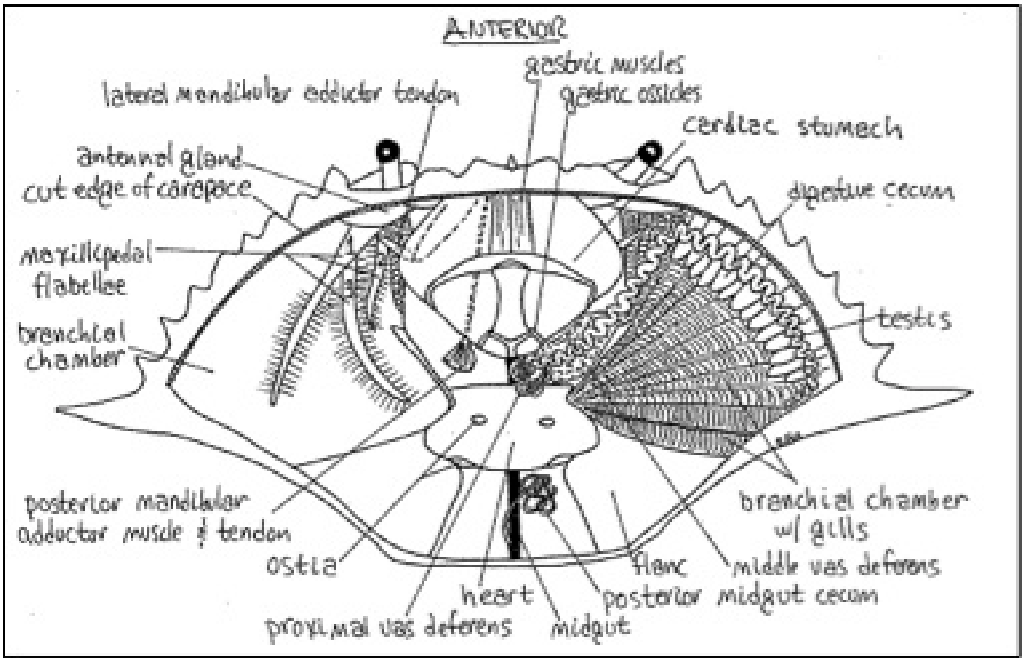
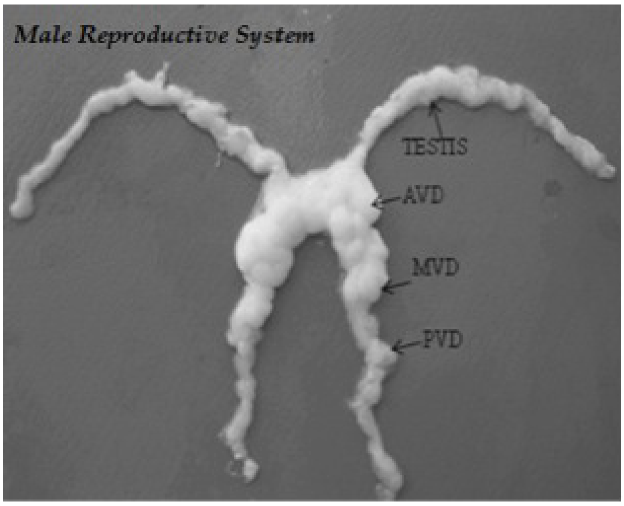
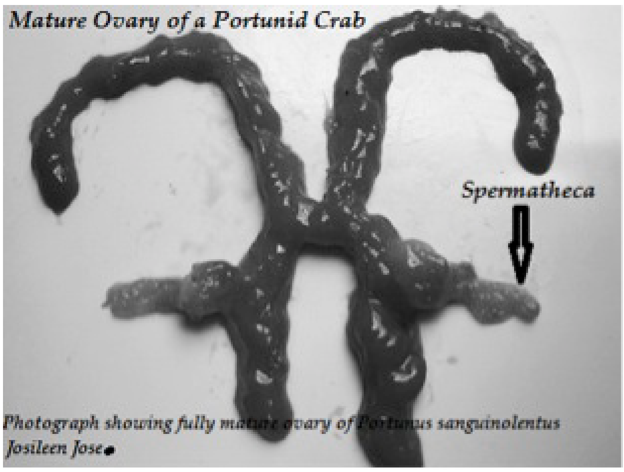


Diagram showing the internal organs of the Portunid crab composed of a pair of testes, a pair of vas differentia, and a pair of ejaculatory ducts internally, and a pair of pleopods externally as accessory reproductive organs, present on the inner side of the abdominal flab. The vas differentia has been divided into three distinct regions, based on the morphological and functional criteria: Anterior (AVD), Median (MVD) and Posterior (PVD) vas deferens. The female reproductive system composed of a pair of ovaries, a pair of seminal receptacles (or) spermatheca, and a pair of oviducts open to the exterior through the female genital opening situated on the left and right sternites of sixth thoracic segment. The ovaries are categorized into five stages, according to the size, colour and external morphology of the ovaries; immature, early maturing, late maturing, ripe and spent. In general males mature earlier than females and the size at first maturity varies from species to species.



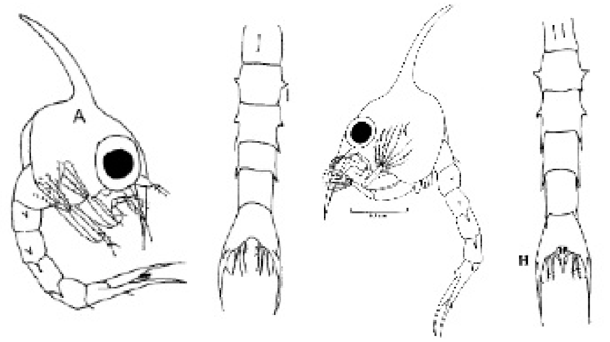


Mating and spawning

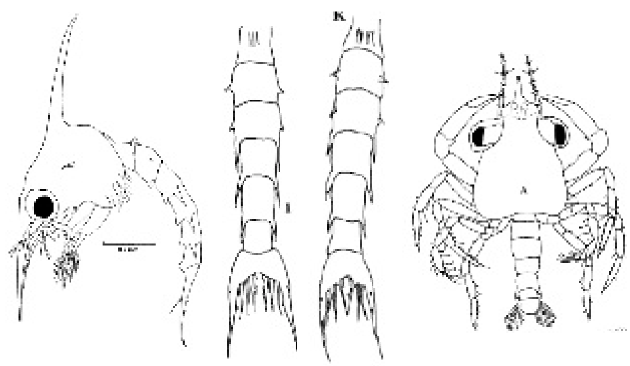
Like in shrimps, mating takes place as soon as the female crab moults with a hard male. The sperms are transferred and stored in the spermathecal of the female crab. After the spawning the eggs are attached to the endopodites of the pleopods and females carry the 'berry' till hatching and release the planktonic larvae (zoeae). The embryonic development takes 8-12 days in tropical species and the period is considerably long in other species. Hatching generally takes place during early morning hours.

Life cycle & Larval stages of Portunid crabs

In general, development in almost all crabs is via zoeae. The eggs hatch into first zoeae which typically go through 1–6 instars before becoming a megalopa. Some species have larger eggs and fewer zoeal stages. Majids in particular, typically have only two zoeal stages. Some groups have species in which the typical number of zoeal stages is reduced, with their zoeae more advanced in form, and having fewer stages. This is termed semi-abbreviated development. In extreme cases, there may only be one zoeal stage that may not even need to feed, relying entirely on stored yolk inside the body. In a few species, the larval development is even more truncated, with no free swimming zoeal stages, and the eggs hatch directly into megalopae, or even the first crab stage. This is abbreviated development. Few marine crabs practice abbreviated development, notable being some species of pilumnids, dromiids, homolodromiids, freshwater sesarmids and all true freshwater crab families.



Zoea-I Zoea-II



Zoea-III Zoea-IV Megalopa

A- Carapace, I- Abdominal segment, H- Telson,

K- First abdominal segment with spines

*Larval stages of the marine crab, *Portunus pelagicus* (Linnaeus, 1758)

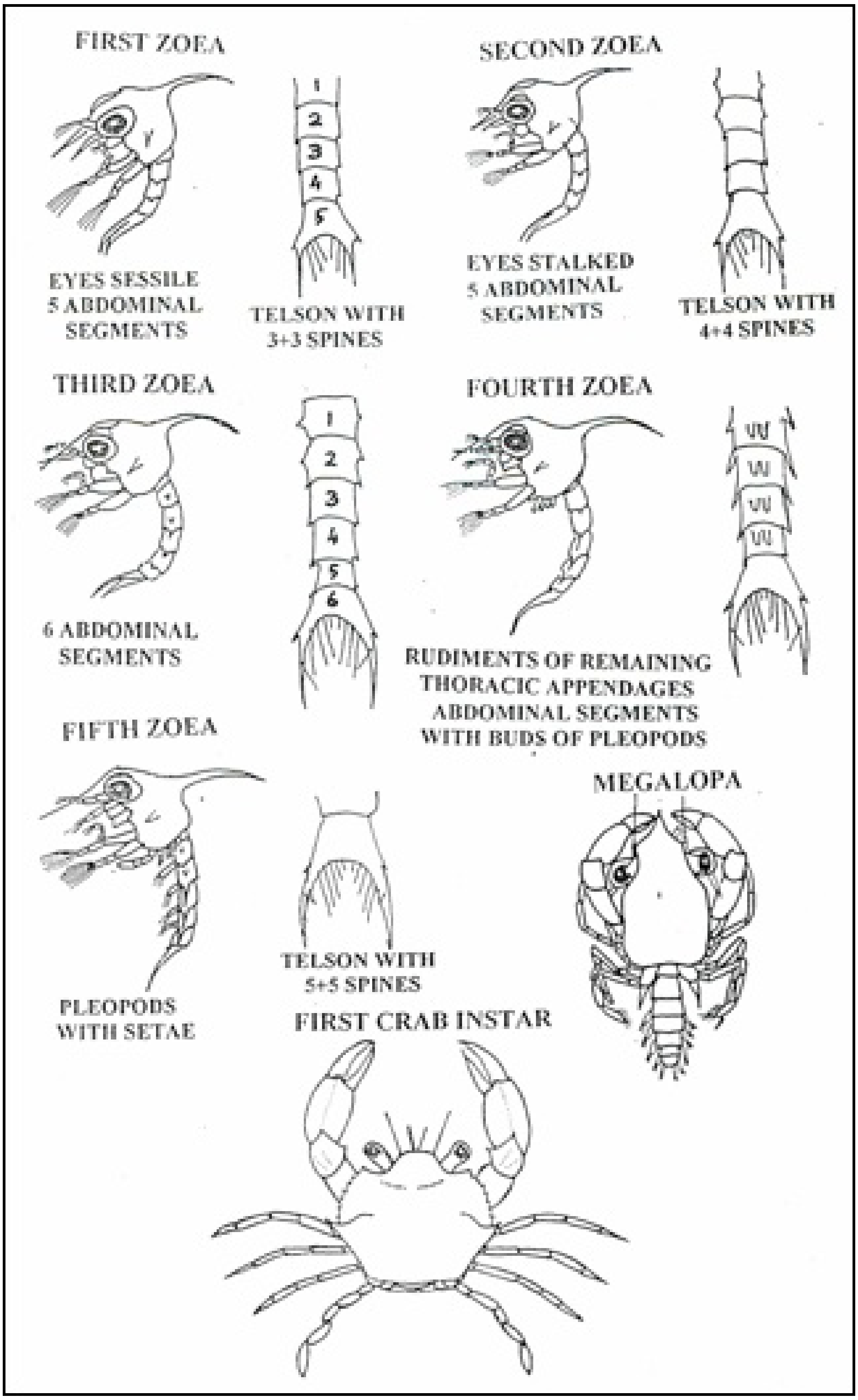
* For details refer Josileen, J. and N. G. Menon. 2004.

The larva passes through zoea (no. vary according to the species) and megalopa stages and moult to crab instar. For example *P. pelagicus* has four zoeae & a megalopa stage and *Scylla* spp. have five zoeae & a megalopa stage.

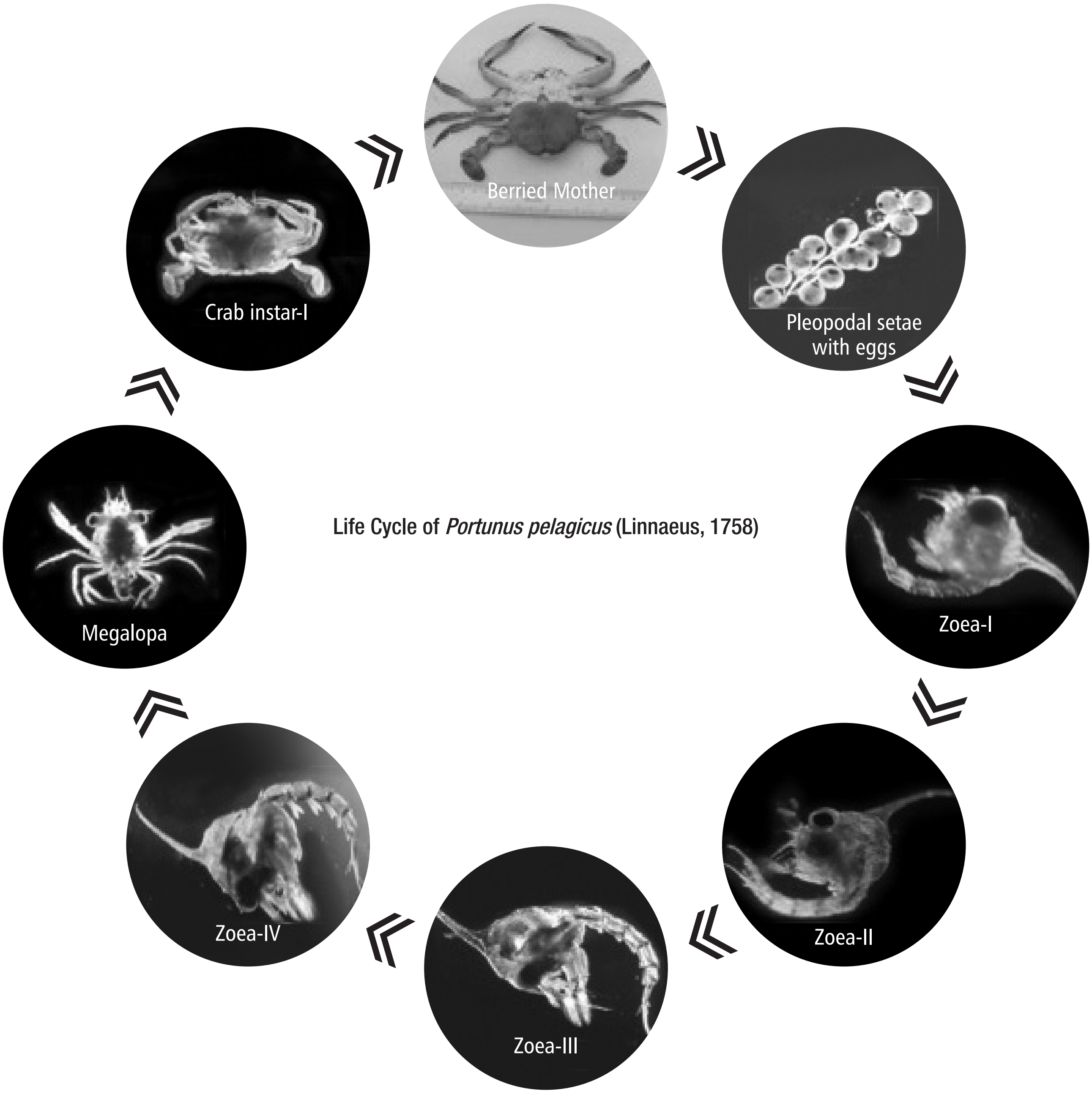
Mud Crab, *Scylla* Spp.

Larval development

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

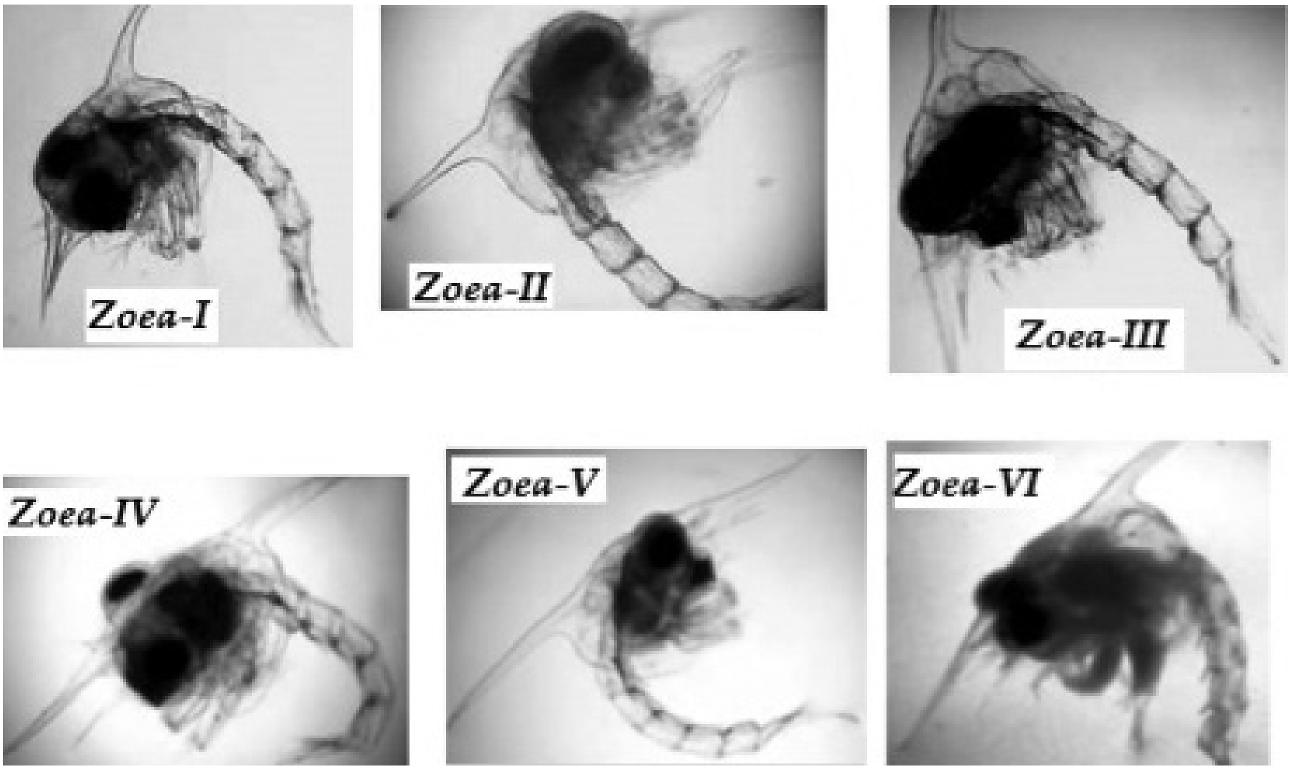


Scylla Larval stages (Zoea 1- 5 & megalopa)



Charybdis feriatus

Crucifix crab has six zoeal stages, the maximum number recorded for a portunid crab in the Indo- Pacific region. The larval stages recorded for the species are found to be similar to the larval stages of *C. feriatus*, reported from other regions (Josileen, 2011c).



Zoeal stages of *Charybdis feriatus* (Crucufix Crab)

American blue crab, *Callinectes sapidus*

The blue crab, *Callinectes sapidus*, represents the most valuable fishery in the Chesapeake Bay and the mid-Atlantic states of Mary land, Virginia and North Carolina. Recently, due to fishing pressure and destruction of coastal nursery habitats has driven the crab populations to a crisis situation. In 2005, researchers from Maryland University succeeded in the mass larval rearing of the species with scope of further upgradation of the technology. It passes through 8 zoeal stages and a megalopa stage taking a minimum period of 50 days to reach the first crab stage.

Suggested reading

Arshad, A., Efrizal, M.S. Kamarudin and C.R. Saad. 2006. Study on Fecundity, Embryology and Larval Development of Blue Swimming Crab *Portunus pelagicus* (Linnaeus, 1758) under Laboratory Conditions. Research Journal of Fisheries and Hydrobiology,1 (1) : 35-44.

Bagenal, T.,1978. Method for assessment of fish production in fresh waters (3rd ed.): 1-365. (IBP Handbook, 3. Blackwell Scientific Publications, Oxford).

Cadrin, S. X., 2000. Advances in morphometric identification of fishery stocks. Reviews in Fish Biology and Fisheries, 10: 91-112.

Chande, A. I. and Y. D. Mgaya. 2004. Food habits of blue swimming crab *Portunus pelagicus*, along the coast of Dar es Salaam. Western Indian Ocean Journal of Marine Science, 3(1): 37-42.

García-montes, J. F., A. García and L. A. Soto, 1987. Morphometry, relative growth and fecundity of the Gulf crab, *Callinectes similis* Williams, 1966. Ciencias Marinas, 13: 137-161.

Giese, A. C. and J. S. Pearse, 1974. Introduction. In: A. C. GIESE & J. S. PEARSE (eds.), Reproduction of marine invertebrates, 1, Acoelomate and pseudocoelomate metazoans: 1-49. (Academic Press, New York, NY).

Hartnoll, R. G., 1974. Variation in growth pattern between some secondary sexual characteres in crabs (Decapoda, Brachyura). *Crustaceana*, 27: 131-136.

Hines, A. 1982. Allometric constraints and variables of reproductive effort in brachyuran crabs. Marine Biology 69: 309-320.

Hines, A. 1988. Fecundity and reproductive output in two species of deep-sea crabs, *Geryon fenneri* and *G. quinquedens*. Journal of Crustacean Biology, 8(4): 557-562.

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

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

Josileen Jose. 2011a. Morphometrics and Length-Weight Relationship in the Blue Swimmer Crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura) from the Mandapam Coast, India. *Crustaceana*, 84 (14): 1665-1681.

Josileen Jose. 2011b. 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.

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

Josileen, Jose. 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). pp. 48-55.

Moutopoulos, D. K. and Stergiou, K. I. 2002. Weight-length and length-length relationships for 40 fish species of the Aegean Sea (Hellas). *Journ. appl. Ichthyol.*, 18: 200-203.

Prasad, P. N. & Neelakantan, B. 1988. Morphometry of the mud crab — *Scylla serrata*. Seafood Export Journ., 20(7): 19-22.

Prasad, P. N., Reeby, J., Kusuma N.and B. Neelakantan, 1989. Width-weight and length-weight relationship in three portunid crab species. Uttar Pradesh Journ. Zool., 9(1): 116-120.

Sukumaran, K. K. and Neelakantan, B. 1997. Length-weight relationship in two marine portunid crabs, *Portunus (Portunus) sanguinolentus* (Herbst) and *Portunus (Portunus) pelagicus* (Linnaeus) from the Karnataka coast. Indian Journ. mar. Sci., 26(1): 39-42.

Sukumaran, K. K. and B. Neelakantan, 1997. Food and feeding of *Portunus (Portunus) sanguinolentus* (Herbst) and *Portunus (Portunus) pelagicus* (Linnaeus) (Brachyura: Portunidae) along the Karnataka coast. Indian Journal of Marine Science, 26(1): 35-38.