CHAPTER

21

Marine Crab Resources of India with Facts on Life Cycle and Biology

JOSILEEN JOSE
Crustacean Fisheries Division
ICAR-Central Marine Fisheries Research Institute

Introduction

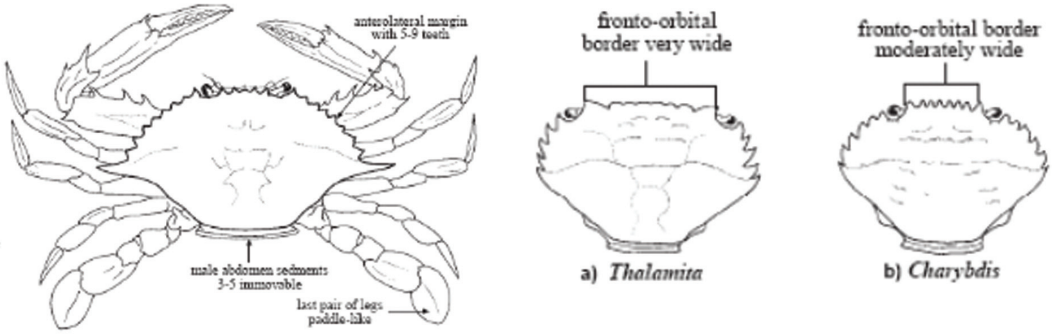
Crabs belong to the order Decapoda and they can be can be classified into two main groups, brachyuran crabs (infraorder Brachyura) and anomuran crabs (infraorder Anomura). Most species of Brachyura, or true crabs, can easily be separated from the so-called "false crabs" belonging to the infraorder Anomura by having five pairs of locomotory appendages of a crab (the pereiopods) are made up of a pair of usually powerful chelipeds (legs carrying a chela or pincer) and normally of four pairs of walking (or ambulatory) legs. The first appendage is referred to as the cheliped and the last four appendages (walking legs) as legs. The claw (or chela) itself consists of a palm (or manus) and two fingers, one of which is movable (the dactylus or movable finger), whereas the other one (Propodus/pollex) is fixed. The tips or edges of the fingers may be pectinated. In some families the last pair or all walking legs are modified for swimming or burrowing, as seen in the Portunidae (Carpenter and Niem, 1998).

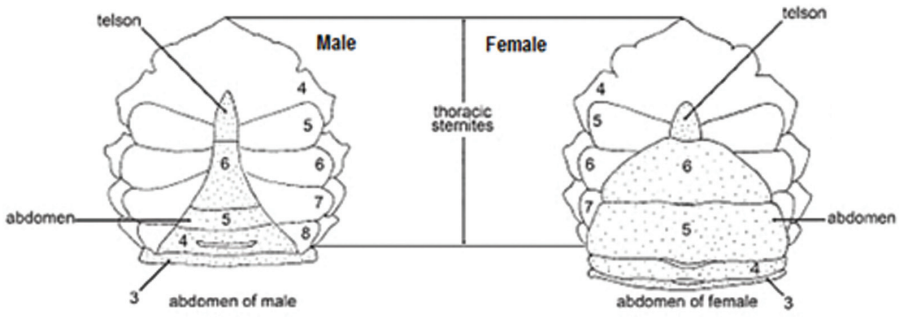
Trivedi et al., (2018) published an annotated checklist of the marine brachyuran crabs occurring in Indian waters, with a total of 910 species belonging to 361 genera and 62 families. The highest number of species were recorded from the Andaman and Nicobar Islands (588 species) while the smallest number were from Goa and Karnataka state (82 species). The records indicate that the east coast of India, with 803 species, is more diverse than the west coast, which has 446 species.

Most of the edible crabs caught from marine and brackish water environments belong to the family Portunidae. In the Indian Ocean, the crab fauna of Portunidae family is included under sub families, Podophthalmidae (Borradaile), Catoptrinae (Sakai), Portuninae (Rafinesque), Thalamitinae (Paul'son), Caphyrinae (Alcock), Carcininae (Macleay) and Polybiinae (Ortmann). In the seas around India, five genera of Portuninae have been reported by various authors. They are *Scylla, Portunus*, *Charybdis, Lupocyclus* and *Thalamita*. Among them the first three genera contribute to the commercial crab fishery Commercially important species are *Scylla* spp. (Mud crabs), *Portunus pelagicus (blue swimmer crab)*, *P. sanguinolentus (three spotted crab), Charybdis feriatus (crucifix crab), C. lucifera* (Yellowish brown crab)*, C.natator* (line crab) and *Podophthalmus vigil* (long eye-stalk crab).

Portunidae

Carapace hexagonal, transversely ovate to transversely hexagonal, sometimes circular; dorsal surface relatively flat to gently convex, usually ridged or granulose; front broad, margin usually multidentate; usually 5 to 9 teeth on each anterolateral margin, posterolateral margins usually distinctly converging. Endopodite of second maxillipeds with strongly developed lobe on inner margin. Legs laterally flattened to varying degrees, last 2 segments of last pair paddle-like. Male abdominal segments 3 to 5 completely fused, immovable.





thoracic sternum and abdomen (ventral view)

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

Key to species of interest to fisheries occurring in the area

1a. Carapace with 2 anterolateral teeth; eyes very long, reaching lateral edge of carapace (Fig. 1) . . . . . ***Podophthalmus vigil***

1b. Carapace with more than 2 anterolateral teeth; eyes normal in size **2**

2a. Carapace rounded; ventral surface of palm with stridulatory (sound-producing) ridges (Fig. 2a) . . . . . ***Ovalipes punctatus***

2b. Carapace transversely ovate; palm without any stridulatory (sound-producing) ridges (Fig. 2b) ***3***

Fig. 1 *Podophthalmus vigil*

Fig. 2 chela in ventral view

3a. Five to 7 teeth on each anterolateral margin (Fig. 3a-c) **4**

3b. Nine teeth on each anterolateral margin (Fig. 3d) **12**

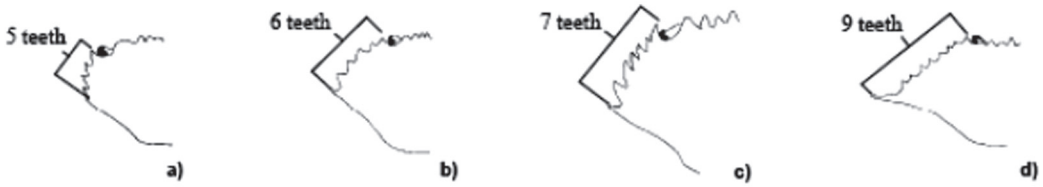


Fig. 3 lateral margin of carapace (dorsal view)

4a. Width of frontal-orbital border not much less than greatest width of carapace; 5 teeth on each anterolateral margin (first tooth sometimes with accessory denticle) (Fig. 4a) . . . . . ?***5***

4b. Width of frontal-orbital border distinctly less than greatest width of carapace; 6 or 7 teeth on each anterolateral margin (Fig. 4b) ***6***

5a. Basal antennal segment with a smooth or granulated ridge (Fig. 5a) . . . . . ***Thalamita crenata***

5b. Basal antennal segment with several sharp spines (Fig. 5b) . . . . . ***Thalamita spinimana***

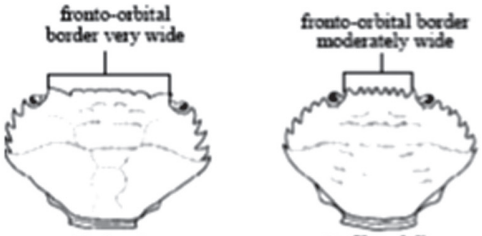


Fig. 4 carapace (dorsal view)

Fig. 5 basal antennal segment

6a. Posterior border of carapace forming an angular junction with posterolateral border (Fig. 6a); merus of cheliped without distal spine on posterior border . . . . . ***Charybdis truncate***

6b. Posterior border of carapace forming a curve with posterolateral border (Fig. 6b);merus of cheliped with distal spine on posterior border ***7***

7a. Carapace with distinct ridges or granular patches behind level of last pair of anterolateral teeth (Fig. 7a) . . . . . ***Charybdis natator***

7b. Carapace without distinct ridges or granular patches behind level of last pair of anterolateral teeth (Fig. 7b) ***8***

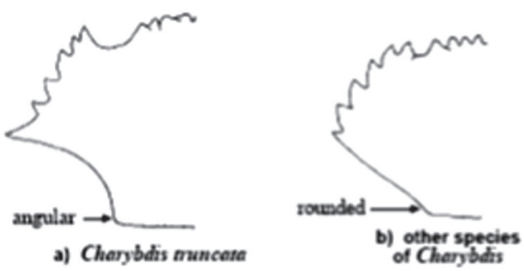


Fig. 6 left side of carapace (dorsal view)

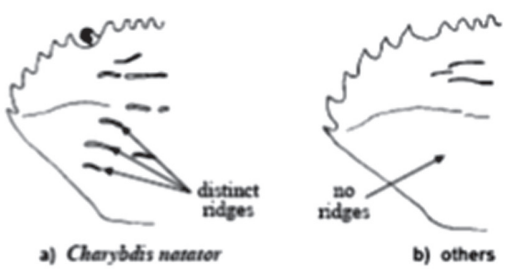


Fig. 7 left side of carapace (dorsal view)

8a. Merus of cheliped with 2 spines on anterior border; palm with 2 spines on upper surface (Fig. 8a) . . . . . ***Charybdis anisodon***

8b. Merus of cheliped with 3 or 4 spines on anterior border; palm with more than 2 spines on upper surface (Fig. 8b) ***9***

9a. First anterolateral tooth not truncate or notched (Fig. 9a) . . . . . ***Charybdis annulata***

9b. First anterolateral tooth truncate or notched (Fig. 9b) ***10***

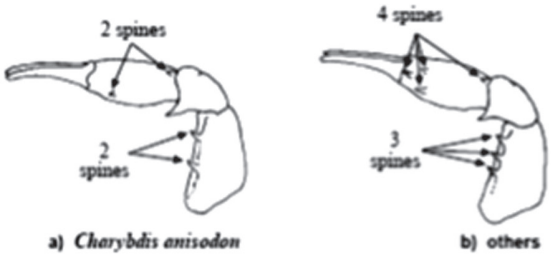


Fig. 8 right cheliped (dorsal view)

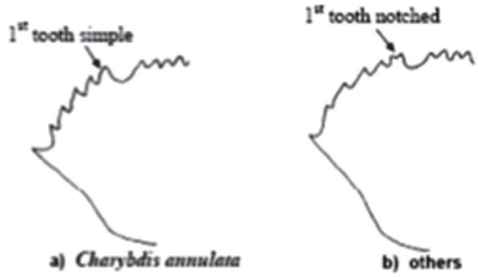


Fig. 9 lateral margin of carapace (dorsal view)

10a. Palm of cheliped with 4 spines on upper surface (Fig. 10a); male abdominal segment 4 keeled (Fig. 11a) . . . . . ***.Charybdis feriatus***

10b. Palm of cheliped with 5 spines on upper surface (Fig. 10b); male abdominal segment 4 not keeled (Fig. 11b) ***11***

Fig. 10 right cheliped (dorsal view)

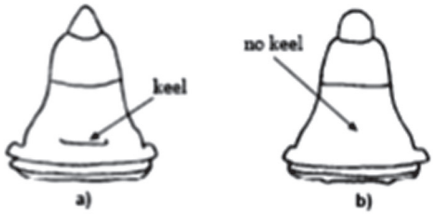


Fig. 11 male abdomen

11a. Palm with well-developed spines (Fig. 12a); male abdominal segment 6 with convex lateral borders (Fig. 13a); last anterolateral tooth smallest and spiniform, not projecting beyond preceding tooth (Fig. 14a) . . . . . ***.Charybdis japonica***

11b. Palm with poorly developed spines (Fig. 12b); male abdominal segment 6 with lateral borders parallel in proximal half (Fig. 13b); last anterolateral tooth elongate, projecting laterally beyond preceding tooth (Fig. 14b) . . . . . ***.Charybdis affinis***

12a. Last anterolateral tooth subequal in size to others (Fig. 15a) . . . . . ?***13***

12b. Last anterolateral tooth at least 2 times larger than others (Fig. 15b) ***16***

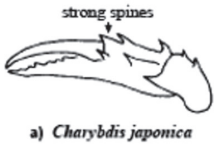


Fig. 12 right cheliped

Fig. 13 male abdomen

Fig. 14 anterolateral teeth

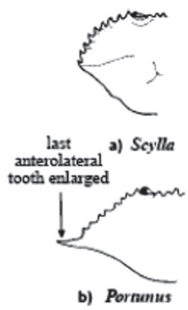


Fig. 15 anterolateral teeth

13a. Carpus of cheliped with only 1 low to very low granule on outer surface, never spiniform (Fig. 16a); colour of palm usually with at least some patches of orange or yellow in life **. . . . *14***

13b. Carpus of cheliped with 2 distinct spiniform or sharp granules or spines on outer surface (Fig. 16b); colour of palm in life green to purple **. *15***

14a. Frontal margin usually with sharp teeth (Fig. 17a); palm usually with distinct, sharp spines (Fig. 18a) **. . . . . *Scylla paramamosain***

14b. Frontal margin usually with rounded teeth (Fig. 17b); palm usually with reduced, blunt spines (Fig. 18b) **. . . . . *Scylla olivacea***

15a. Frontal margin usually with rounded teeth (Fig. 19a); sharp granules on palm and carpus never spiniform; colour in life: carapace usually very dark green to black, outer surface of palm purple and never with marbled pattern, last legs marbled only in males . . . . . **. . . . . *.Scylla tranquebarica***

15b. Frontal margin usually with sharp teeth (Fig. 19b); sharp granules on palm and carpus often spiniform; colour in life: carapace usually green to olive-green, outer surface of palm green and often with marbled pattern, last legs marbled both in males and females **. . . . . *Scylla serrata***

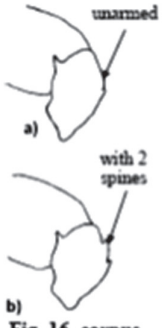


Fig. 16 carpus of cheliped

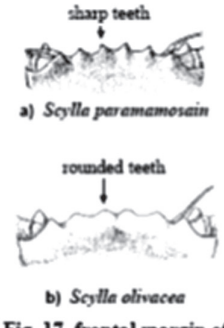


Fig. 17 frontal margin of carapace (dorsal view)

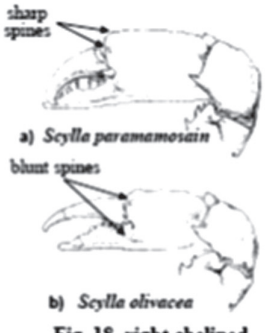


Fig. 18 right cheliped

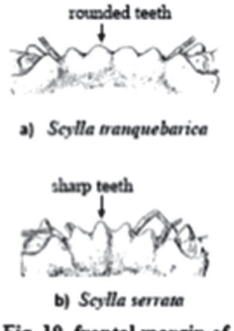


Fig. 19 frontal margin of carapace (dorsal view)

16a. Carapace with 3 purple to red spots on posterior half*. . . . . .Portunus sanguinolentus*

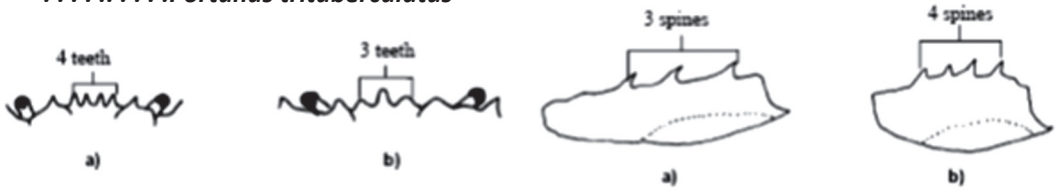
16b. Carapace marbled or with uniform coloration . . . . . .?***17***

17a. Front with 4 teeth (Fig. 21a); inner margin of merus of cheliped with 3 spines (Fig. 22a)

. . . . . ***Portunus pelagicus***

17b. Front with 3 teeth (Fig. 21b); inner margin of merus of cheliped with 4 spines (Fig. 22b)

. . . . .Portunus trituberculatus



Key – P.K.L.Ng .1998. FAO species identification guide for fishery purposes – Crabs –Portunidae .

Portunus pelagicus (Linnaeus, 1758) (Flower crab/ Blue Swimming Crab).

Carapace rough to granulose, front with 4 acutely triangular teeth; 9 teeth on each anterolateral margin, the last tooth 2 to 4 times larger than preceding teeth. Chelae elongate in males; larger chela with conical tooth at base of fingers.

Colour: males with blue markings, females dull green/greenish brown.

Portunus sanguinolentus (Herbst, 1783) (Three-spot swimming crab).

Carapace finely granulose, regions just discernible; 9 teeth on each anterolateral margin, the last tooth 2 to 3 times larger than preceding teeth. Chelae elongated in males; larger chela with conical tooth at base of fingers; pollex ridged.

Colour**:** olive to dark green, with 3 prominent maroon to red spots on posterior 1/3 of carapace.

Charybdis feriatus(Linnaeus, 1758) (Crucifix crab)

Carapace ovate; 5 distinct teeth on each anterolateral margin.

Colour: distinctive pattern of longitudinal stripes of maroon and white, usually with distinct white cross on median part of gastric region; legs and pincers with numerous scattered white spots.

Charybdis natator (Herbst, 1789) (Ridged swimmimg crab)

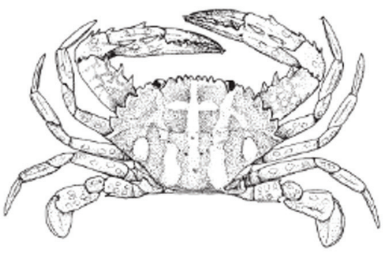
Carapace with densely covered with very short pubescence which is absent on several distinct transverse granulated ridges in anterior half.

Colour: orangish red overall, with ridges on carapace and legs dark reddish brown.

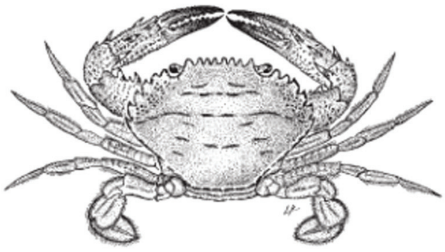
Podophthalmus vigil (Fabricius, 1798)

Carapace distinctly broader than long; anterior margin much broader than posterior margin, with posterolateral margins converging strongly towards narrow posterior carapace margin; orbits very broad. Eyes very long, reaching to or extending beyond edge of carapace.

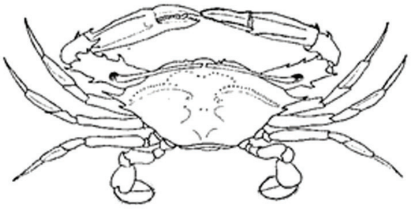
Colour: carapace green; chelipeds and parts of legs violet to maroon in adults.

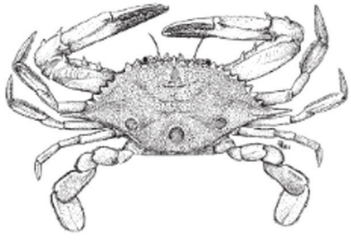


Podophthalmus vigil (Fabricius, 1798)



Portunus sanguinolentus (Herbst, 1783)





Portunus pelagicus (Linnaeus, 1758)

***Scylla* spp.**

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

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 tranquebarica (Fabricius, 1798) (Purple mud crab)

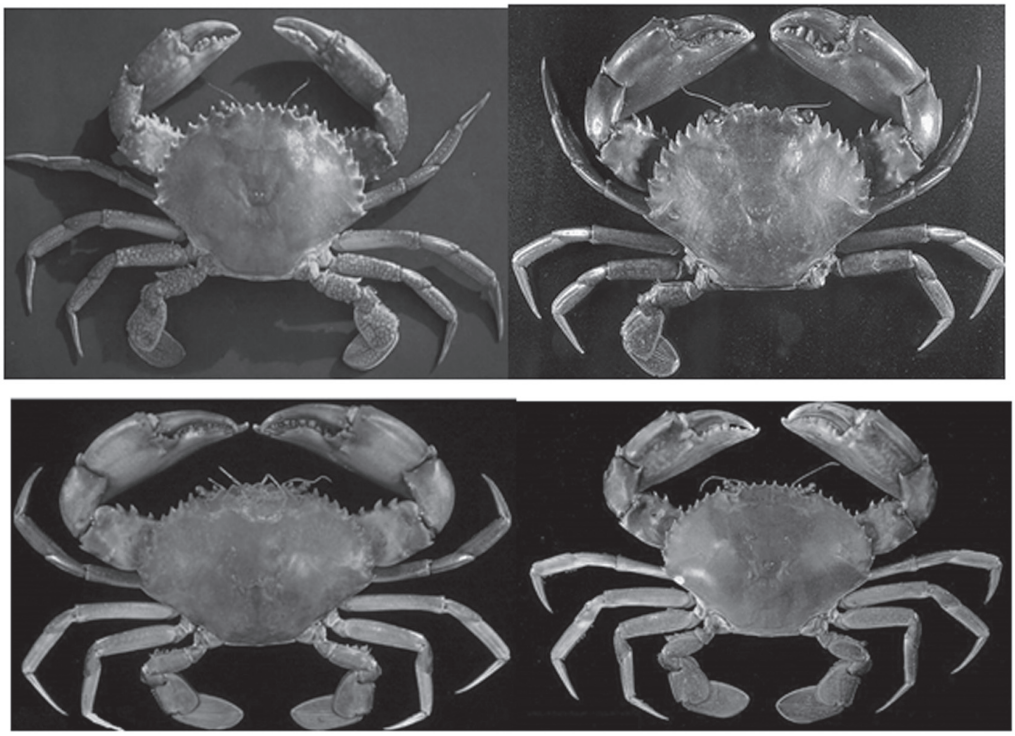
Colour varies from brown to almost black in coloration, and has very well-developed spines on the outer surfaces of the chelipedal carpus and the palm (as seen in *S. serrata*). It differs from *S. serrata*, however, by having the frontal teeth more acutely triangular, the median pair projecting slightly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

Scylla 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 paramamosain Estampador, 1949 (Green mud crab)

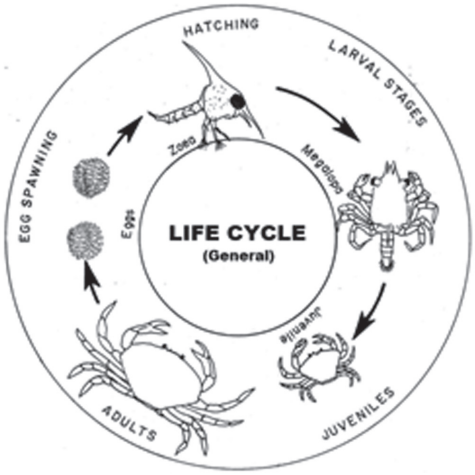
Carapace usually green to light green, palm green to greenish blue with lower surface and base of fingers usually pale yellow to yellowish orange. Frontal margin usually with sharp teeth, palm usually with distinct, sharp spines.

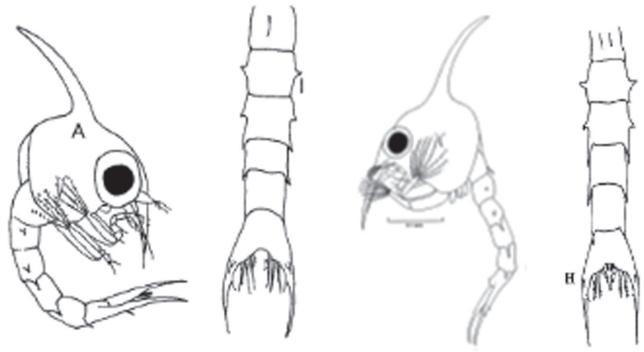


Life cycle & Biology of Portunid crabs

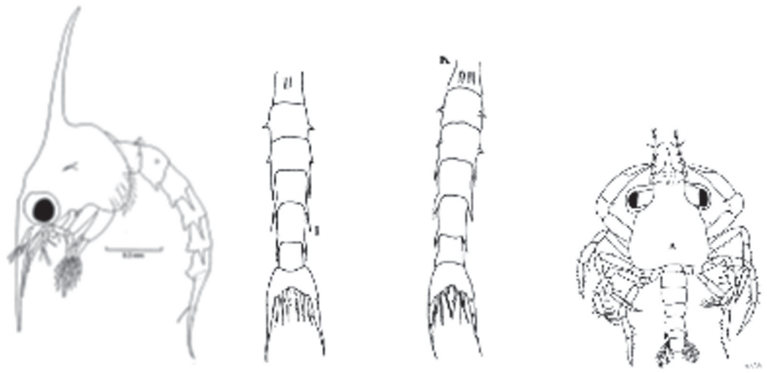
Larval stages

In general, development in almost all crabs is via zoeae. The eggs hatch into first zoeae which typically go through 1–7 instars before becoming a megalopa. The number of zoeal stages varies from species to species.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



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.

Growth

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.

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, 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

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.

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).

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.

Fishery and Management

Crabs are mainly landed by as a by-catch in trawls all along the coastal states and especially by gillnets in Tamil Nadu which is the major contributor for the crabs in India. From the growth studies conducted in different species of the commercial crabs it is estimated that the life span of these crabs may be around three years, although majority of the crabs is fished in the early part of their life (0-year class), leaving only a few to reach their maximum age. At present there is no separate management guidelines for crabs other than the general trawl ban for the respective states. Minimum Legal Size has been implemented in Kerala (Mohamed et al., 2014) and likely to implement other southern states very soon.

At present, there is no ban on fishing the berried crabs and other than CMFRI is proposing a management plan for Blue Swimming Crab in Palk Bay region of Tamil Nadu. As a conservation measure, fishermen must be educated to release the berried and soft crabs to the sea while they are alive. The state governments should take steps to implement ban during peak spawning seasons to prevent indiscriminate fishing. The best method to ensure a sustainable fishery throughout the year as well as to improve the quality of the yield is to ban fishing and marketing of berried crabs.

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