

COMMERCIALLY IMPORTANT CRABS (CRUSTACEA: DECAPODA) OF PAKISTAN - I: TAXONOMIC ENUMERATION

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ABSTRACT

A well-diversified crab fauna is known from Pakistan, however, only a few members of Family Portunidae are commercially exploited and supported by a substantially large fishery. Mud crabs (*Scylla olivacea* and *S. tranquebarica*) are harvested from mudflats and mangroves and exported in live form. Several other species of crabs of the genera *Portunus* and *Charybdis* are also exported from Pakistan but mainly in frozen form. *Charybdis (Archias) smithii* Macleay, 1838 is an inhabitant of the offshore waters between 50 and 500 m depth. With the extended operation area of the trawlers in Pakistan, this species is caught in small quantities and processed for export. This species is also an important component of the pelagic food chain, as it commonly occurs in most large pelagic species in the Arabian Sea. The blue swimming crab (*Portunus segnis*) used to be the most dominating crab in coastal water for about 3 decades back, however, *Portunus sanguinolentus* (Herbst, 1783) is now a dominating species which is seasonally harvested from coastal and offshore waters of Pakistan. Small quantities of *Charybdis (Charybdis) feriata* (Linnaeus, 1758) are also harvested from coastal waters and exported in frozen form whereas *Charybdis (Charybdis) lucifer* (Fabricius, 1798) is rarest among commercial crabs and exported sometimes. It was observed that in the case of all commercially important crab species males are much larger in size, as compared to females except *Portunus segnis* where females were observed to be heavier than males.

Key-words: Family Portunidae. *Scylla olivacea* and *S. tranquebarica*, *Portunus segnis*, *P. sanguinolentus*, *Charybdis (Archias) smithii*, *C. (Charybdis) feriata*, *C. (Charybdis) lucifer*, commercial fishing, export.

INTRODUCTION

Although about 251 species of crabs (Decapoda: Brachyura) are known from Pakistan only a few members of the family Portunidae are of commercial importance which support large fisheries (Kazmi *et al.*, 2022). Commercially important crabs are harvested from intertidal, mudflats, lagoons, bays, the Indus Delta, creek system, coastal waters as well as from deep oceanic waters. Small quantities of crabs are locally consumed whereas a major part of the crabs are exported in live, chilled, canned, and frozen forms mainly to Southeast Asian countries. In addition, underweight soft-shelled mud crabs (genus *Scylla*) are stocked and reared in seawater ponds mainly located in the Indus Delta for a few weeks or until they achieve a desirable size or their gonad develops as such fattened crabs fetch a price much higher than crab caught from nature.

Henderson (1893) was the first to report the occurrence of portunid crabs in Pakistan which was followed by a comprehensive taxonomic study by Alcock (1899) who provided details of the members of the Family Portunidae including the occurrence of *Portunus sanguinolentus* and *Scylla serrata* from Karachi. Hashmi (1963a, 1963b) has reported blue swimming crabs as *Neptunus (Neptunus) pelagicus*, three spot crabs- *Neptunus (Neptunus) sanguinolentus* and *Scylla serrata* from Pakistan. Hashmi (1963b) provided information about the abundance of these species in the offshore waters of Karachi. Khan (1975) and Khan and Ahmad (1975) included crabs of the family Portunidae in their checklist. Similarly, Mustaqim and Rabbani (1976) also included commercially important crab species of the family Portunidae in their checklist. In addition, Tirmizi and Kazmi (1996) provided details about the species of the family Portunidae in their monograph. Kazmi *et al.* (2000) reviewed the taxonomy of the genus *Scylla* occurring in Pakistan.

The commercial importance crab species, especially the African blue swimming crab (*Portunus segnis*), three spots swimming crab (*Portunus sanguinolentus*), and mud crab of genus *Scylla* (*S. serrata*, *S. tranquebarica* and *S. olivacea*). In addition, small quantities of Indian Ocean swimming crab - *Charybdis (Archias) smithii*, *C. (Charybdis) feriata*, and *C. (Charybdis) lucifer* are also exported mainly as frozen cut crabs. Several workers have provided information about the fisheries of members of the family Portunidae. Rasheed and Mustaqim (2010) also provided information about the swimming crab fisheries of Pakistan. They noted that *P. sanguinolentus* is mostly caught along with *Portunus pelagicus* (= *P. segnis*) as bycatch of bottom-set gill-netting or shrimp trawling. Species

of mud crab (*Scylla spp.*) are exported mainly alive while *P. sanguinolentus* and *P. segnis* are exported as frozen crab or frozen crabmeat. Separate data for these species are not available. The export of swimming crabs (*P. sanguinolentus* and *P. segnis*) from Pakistan was started in 1981 when less than one metric ton of crabs valued only ten thousand rupees (now equal to 118 US \$) were exported. The maximum quantity of 673 metric tons valued at 115 million rupees (now equal to 136,095 US \$) was exported in the year 2000. Kazmi *et al.* (2000) provided information about the mud crab fisheries of Pakistan and stressed the monitoring of the stocks of mud crab. The members of the family Portunidae have been studied by several scientists covering various aspects of biology and genetics. Naz *et al.* (2014, 2016), Khan and Mustaqim (2013), Khan *et al.* (2014), Rasheed and Mustaqim (2010; 2014), Takween and Qureshi (2001, 2005) and Tirmizi and Kazmi (1996) reported that *P. pelagicus* (= *P. segnis*), *P. sanguinolentus*, *C. feriata*, *S. olivacea*, and *S. serrata* are commercially important constituting about 63% of the total catch of the fishery. This seems to be not correct as crabs contributed a minimum of 1.1 % in 1999 and a maximum of 2.6 % in 2007, 2008, 2010, and 2012. Under no circumstances, the contribution of crabs in total landings (marine) may be higher than 2.6 %, as harvesting crab is a minor fishery of Pakistan. Imtiaz *et al.* (1998), Naz, *et al.* (2014, 2016), Khan and Mustaqim (2013), Khan *et al.* (2014), Mustaqim *et al.* (2001), Rasheed and Mustaqim (2010; 2014), and Takween and Qureshi (2001, 2005) also provided information about the fisheries and export of crab and crab products.

The present paper provides a review of the taxonomy of commercially important crab species harvested in Pakistan. In addition, some information about their biology, distribution, size distribution, and fisheries is provided.

MATERIAL AND METHODS

Published scientific literature was examined for the records of crabs from the Pakistan coast. In addition, specimens of crabs collected between 2003 and 2023 from Karachi Fish Harbour were photographed and salient features and measurements were recorded, before, their preservation in 5 % neutralized formalin. Data for landings of export was obtained from archives of the Marine Fisheries Department. Information about the fishing of crab, gears being used, and other details about fisheries obtained from fishermen living along the coast of Pakistan is also provided. Data about the size distribution of commercially important species were recorded from landings at Karachi Fish Harbour and Ibrahim Hayderi. Length frequency data about *Charybdis (Archias) smithii*, was obtained from the cruise of Dr. Fridtjof Nansen cruises of 2010 (Fanning *et al.*, 2011).

RESULTS AND DISCUSSION

Although a well-diversified crab fauna is known from Pakistan, however, only a few species of crabs belonging to three genera (*Charybdis*, *Portunus*, and *Scylla*) of Family Portunidae are commercially important which are consumed locally as well as exported. The present paper provides details about commercially important species of crabs including their taxonomy, fisheries, commercial landings, and export.

TAXONOMIC ENUMERATION

Charybdis (Archias) smithii Macleay, 1838

(Fig. 1)

Synonym:

Ng and Takeda (1999); Türkay and Spiridonov (2006); WoRMS (2024).

This crab is commonly known as the Indian Ocean swimming crab and is generally inhabits the pelagic environments in offshore waters.

Description: (Adapted after Türkay and Spiridonov, 2006): Carapace about 1.5 times as broad as long, smooth, or with a very short pile, mainly in the anterior half; areas ill-defined, mesobranchial areas somewhat swollen (Fig. 1). Usually, only the carinate epibranchial and very rarely the metagastric ridges may be recognized on the carapace. Front (excluding inner supraorbital lobe) 1.35-1.5 times shorter than a posterior border; median and submedian frontal teeth of similar shape, broadly triangular, sharpened; laterals triangular, separated from submedian by a broad U-shaped incision. The inner supraorbital lobe is triangular, at the base very little wider than lateral frontal teeth. The infraorbital margin is granular: the inner lobe is little produced with an angular tip, outer lobe is not prominent, or rounded. Anterolateral border with six teeth; first to fifth with finely granular edges, truncated, broad, subequal; sixth tooth only slightly longer than others, sharpened. Basal antennal joint with granular surface and

ridge. Chelipeds granular, anterior border of merus with two or three blunt teeth and additional tubercles, posterior and inferior borders ending in spinules; but less granular with distinctly lower granules; manus with four rather short teeth on the upper surface, one tooth near carpus articulation: two costae on the upper surface, three on outer and two costae on inner border; lower border with squamiform markings. Propodi of natatory legs with 4 to 6 very small spinules on posterior edges, dactyli distinctly compressed laterally. The abdomen of a male with an indistinct keel on the fourth tergum, that of a female with fourth tergum keeled for distinctly more than half its maximum width, penultimate tergum of the male abdomen with outer edges converging posteriorly. The distal tip of gonopod stouter and its tip are not twisted downwards and the female genital opening is nearly circular shape. Colour: Carapace brownish or red-brownish with a darker gastric area, chelipeds red or brownish, ambulatory legs dark orange.

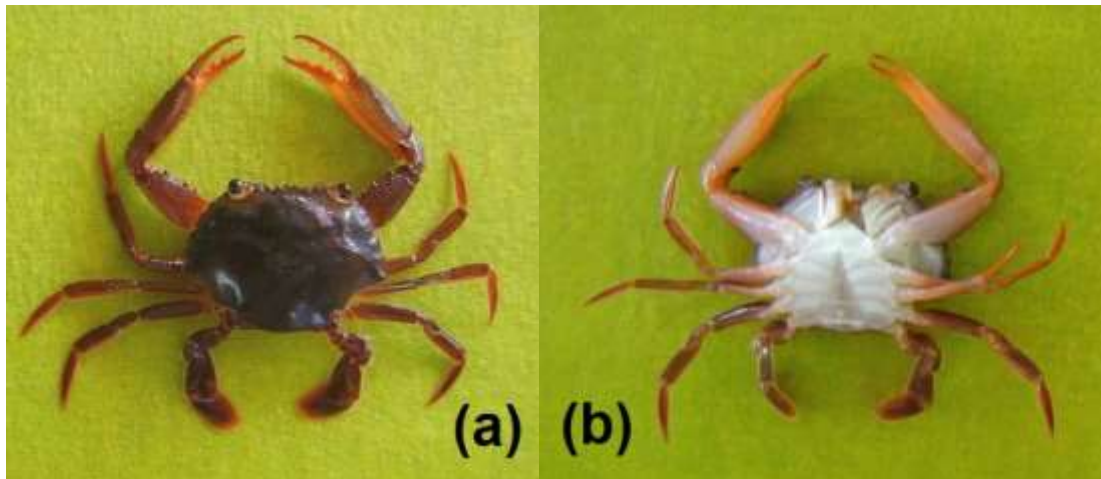


Fig. 1. *Charybdis (Archias) smithii* Macleay, 1838 collected from Dr. Fridtjof Nansen cruise 2010. (a) Dorsal view; (b) Ventral view.

This species can be distinguished from its congeners in having carapace posterior to epibranchial ridges without granular ridges or granular patches (Fig. 1). Posterior to epibranchial ridges of the carapace have granular ridges or granular patches in *(A.) omanensis septentrionalis* Türkay & Spiridonov, 2006 and *C. (A.) omanensis omanensis* Leene, 1938. *C. (A.) smithii* Macleay, 1838 is primarily a pelagic species that is found in the water column whereas the other two species are primarily benthic in nature. Considering its distribution presence of *C. (A.) omanensis omanensis* Leene, 1938 in Pakistan cannot be ruled out.

Charybdis (Archias) smithii is a semi-pelagic species that spends a considerable part of its life in the water column (Losse 1969, Daniel and Chakrapany 1983, Zamorov *et al.* 1991, Balasubramanian and Suseelan, 1998, 2001, Türkay and Spiridonov 2006) which is extended to pelagic habitat from the mixed layer to upper mesopelagic waters between 60 and 600 m depth (Romanov *et al.* 2006, 2009). It is distributed along the western and northern Indian Ocean, from off South Africa, Madagascar, Somalia, Seychelles, Maldives, Saya de Malha, Gulf of Aden, Red Sea, and Bay of Bengal (Apel and Spiridonov 1998; Turkey and Spiridonov 2006), although most of the crabs are found in the western basin of the Indian Ocean (Romanov *et al.* 2009). Couwelaar *et al.* (1997) recorded this species in the water column as deep as in the 400-600 m layer, but most of the population was maintained between the surface and 100 (or 150) m depth.

In the Arabian Sea, the vertical distribution of *C. (A.) smithii* is limited by the oxygen minimum layer (Couwelaar *et al.* 1997). Surface swarming of large crabs was usually observed from September to March and appears to take place when the water begins to warm after the cold (winter) south-east monsoon in East Africa, while in the Gulf of Aden, it takes place when the water becomes colder after the summer south-west monsoon (Losse 1969). The juveniles of this species (Carapace Width less than 30 mm) were never found on the bottom (Balasubramanian and Suseelan 2001, Türkay and Spiridonov, 2006) and were rather common in the water column for most of the year except for the winter months (Couwelaar *et al.* 1997, Balasubramanian and Suseelan 2001). Based on the nutritive value determined for this species, Kumar *et al.* (2019) considered it to be nutritious having potential for exploitation as a commercial resource.

Along the coast of Pakistan, it is caught by exploratory and stock assessment surveys carried out by R/V Dr. Fridtjof Nansen during 1977 on-board Iranian Research Vessel R/V Firdows in 2009 and 2015 and by R/V Dr.

Fridtjof Nansen during 2010. Although *C. (A.) smithii* was not found to be abundant but occasionally encountered during offshore pelagic stations. Their highest concentration was found to be during the Research Vessel R/V Dr. Fridtjof Nansen cruise in 2010. Usually, Indian Ocean pelagic crab is not caught by local fisheries because their operations are confined to benthic areas on the continental shelf, however, since 2022, a few local fish trawlers started operations in the offshore waters beyond the continental shelf and caught large quantities of *C. (A.) smithii* during March and April. Small quantities of these crabs were exported in frozen form to Southeast Asian countries on a pilot scale. Considering the high prices offered for this species, there seems to be the prospect of starting a seasonal fishery for Indian Ocean pelagic crab in Pakistan.

Table 1.. Size of the *Charybdis (Archias) smithii* recorded from offshore waters of Pakistan coast.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	n. m.	25.0	21.0
Female (minimum)	n. m.	21.0	17.0
Male (maximum)	n. m.	69.4	38.0
Female (maximum)	n. m.	51.2	32.5

n. m. = Not measured

The size range of the Indian Ocean swimming crab observed during the present study is given in Table-I which indicates that the smallest male crab has a carapace width of 25.0 mm and weighs about 21.0 g whereas the smallest female crab has a carapace width of 21.0 mm and weight 17.0 g. The carapace lengths of the crabs were not recorded. The largest carapace width in the male Indian Ocean swimming crab was observed to be 69.4 cm (weighing 38.0 g) whereas the largest female has a carapace width of 51.2 cm (weighing about 32.5 g). Balasubramanian and Suseelan (1996) observed females to have a size range (carapace width) between 40 and 62 mm with the smallest berried female to have a carapace length of 45 mm. Balasubramanian and Suseelan (2001) reported that the carapace width of Indian Ocean swimming crabs ranged from 11 to 72 mm and 11 to 69 mm for males and females, respectively. The crabs having a carapace width less than 31 mm were not found in the benthic catches whereas juveniles of less than 20 mm (CW) were only found in the pelagic zone with a high concentration in the oceanic waters.

Couwelaar, *et al.* (1997) reported the occurrence of the smallest Indian Ocean swimming crabs having a size of 5 to 6 mm were found in the surface water samples (neuston samples) collected from the Arabian Sea. They also reported the occurrence of small crabs ranging from 15 to 25 mm off the coast of Africa together with a few larger crabs (25-40 mm) further offshore areas. The largest Indian Ocean swimming crabs were found in nearshore areas. Those trawled from the bottom off Oman ranged in size from 43 to 71.7 mm. The peaks in the size-frequency distribution at 52 and 55 mm were made up of females whereas the males showed a size peak at 59 mm. It may be noted that the sizes of crabs from Pakistan are well within the range given by Balasubramanian and Suseelan (1996, 2001) and Couwelaar, *et al.* (1997).

Charybdis (Charybdis) feriata (Linnaeus, 1758)

(Fig. 2)

Synonym:

Naderloo (2017), Wee and Ng (1995).

This species is commonly known as crucifix crab due to the presence of a cross-shaped mark present on the carapace.

Description: (modified after Tirmizi and Kazmi, 1996): The carapace is broader than long and may be glabrous, with scant hairs or covered with a thick pile of hairs. The entire surface of the carapace is covered with very small granules, those present anterolaterally are slightly larger. The regions on the carapace are ill-defined except in young specimens where the branchial regions are distinctly swollen. Three pairs of granular ridges are present. In some specimens, a pair of short ridges is present in front of the mesogastric ridges. The front is cut into six teeth, which may be distinct, the median and submedian teeth may be confluent or may appear to be arising from the common base. Of the six anterolateral teeth, the first is notched, the second is truncated with only an indication of a

notch. The teeth are acutely pointed in young individuals. The chelipeds are stout and slightly asymmetrical and are distinctly hairy only in specimens having a thick pile of hairs on the carapace. The merus is armed with three spines and granules on the inner margin, the carpus has four spines and the upper and outer surfaces are with ill-defined granular ridge; the palm has five smooth ridges and four teeth. The lower ridge of the outer side of the palm extends to the tip of the movable finger. The tip of the fingers is crossed, and the movable finger is slightly longer than the palm. The natatory leg is with a spine on the outer distal angle of the carpus, and the posterior margin of the propodus is armed with minute denticles. The second and third abdominal somites are entirely carinated while the fourth somite has a short carina only in the middle. The first gonopod is long and stout with a bulbous base, narrow neck, and an outward-directed apex, the distal part is armed with rows of spines, that on the inner margin extending to the middle, have long spines, except near the tip. The margins of the gonopod approximately to form a duct that opens at the base of the outwardly directed apex over which is a membranous flap. The second gonopod is bifid, the two lobes are equal and armed. Colour: The carapace is boldly patterned in cream and brown, mottled with red patches, and bears a characteristic yellowish cross on the gastric region of the carapace on a dark background in the centre (Fig. 2). Ventral surface is pale yellow or whitish (Fig. 3). Chelipeds and ambulatory legs mottled red.



Fig. 2. *Charybdis feriata* showing coloration including crucifix.

This species is widely distributed in Indo-West Pacific including South Africa, East Africa, Persian Gulf, Gulf of Oman, Pakistan, India, Sri Lanka, Vietnam, China, Japan, Indonesia, Singapore and Australia (Stephenson *et al.*, 1957; Stephenson, 1972; Ng, 1998; Apel and Spiridonov, 1998). It usually occurs in the sublittoral areas on muddy and sandy bottoms. It may occur on rocky and stony coasts including coral reefs, up to at depths of 3-60 m (Naderloo, 2017; Ng, 1998).



Fig. 3. *Charybdis feriata*. Ventral views. (a) Female; (b) Male

This species is considered to be of commercial importance (Fig. 4), however, only small quantities are exported from Pakistan in whole frozen and cut crab form. There is no aimed fishery for this crab in Pakistan and it is mainly caught as a bycatch of trawl nets and bottom set gillnets. Previously, it used to be locally consumed, however with the increased demand in Southeast Asian its export was started. It is also in demand in the live fish markets in these countries where this species is now maintained in aquaria (Ng, 1998). From Pakistan, its export in live form has been experimented with, however, only small quantities were exported in 2022. Because of its size, unique coloration, and meat quality, it is considered a good candidate for aquaculture (Parado-Esteva *et al.*, 2002a-b).



Fig. 4. A heap of crucifix crab (*Charybdis feriata*) awaiting auction and processing for export

Despite its frequent occurrence in commercial landings, *Charybdis feriata* is not well studied in Pakistan. During the present study, it was found to be the most widely distributed crab species which is found in all important fishing grounds along the coastline and in the offshore waters. During commercial deep sea fishing operations between 2002 and 2005, it was observed to be the most common crab species on the fishing grounds along the Sindh Coast (Great Khori Bank, around Indus Swatch) and Balochistan coasts (Sonmiani, Malan, Ormara, Astola Island and Pasni) between a depth of 23 to 121 m. According to Dineshbabu (2011), this species is caught by trawlers from a depth of 30 to 100 m along the Karnataka coast, India. Along the coast of Pakistan, this species is caught by shrimp trawlers from August and reach a peak during March and April. During June and July which close season for trawling, its landing, in small quantities, is continued by bottom-set gillnetting from coastal waters and lagoons.

Table 2. Size of the crucifix crab (*Charybdis cruciata*) observed at Karachi Fish Harbour.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	40.3	28.4	8.5
Female (minimum)	48.1	33.5	18.0
Male (maximum)	170.0	109.0	463.3
Female (maximum)	142.0	94.2	371.1

The size range of the crucifix crab observed during the present study is given in Table-II which indicates that the male crab has a smaller size (40.3 cm (carapace length) and weighs about 8.5 g whereas the smallest female crab has a carapace length of 48.1 and weight 18.0 g. Dineshbabu (2011) observed that at Mangaluru, India the size range in this crab was 26 to 170 mm and the majority of the crabs landed were in the size class 60-95 mm. During the present study, the majority of the crabs have a dominating size range between 65 and 116 cm which is slightly larger than reported by Dineshbabu (2011) from Mangaluru, India. Padayatti (1990) recorded a size range of 60-154 mm in males and 65-119 mm in females at Kochi. The maximum carapace width was recorded to be 200 mm (Ng, 1998). Its females weigh more as compared to males, which may achieve a weight of 1 kg (Parado-Esteva, *et al.*, 2002a-b, 2007).

Dash *et al.*, (2014) reported that males are heavier than females of similar size from Veraval waters, the north-west coast of India. Similar observations were made in other portended crabs (Laithadevi, 1985, Sukumaran and Neelakantan, 1997; Dineshbabu *et al.*, 2007).

Despite being large and attractive, this crab is not exported in large quantities, although there is reasonable demand for this crab in Southeast Asian countries. According to the leading crab exporters, its supplies are not reliable as compared to blue and three-spot swimming crabs, and also size composition is not uniform, therefore, it is difficult to match the demand of the importers who require dependable regular supplies and large specimens (which are only about 10 to 15 % of the total landings of this species).

Considering high demand, attractive prices, and preference over other portunid crab, this species is being considered a prime candidate for farming. Crucifix crab is listed as one of the six suitable species for stock enhancement and culture (Josileen, 2011; Parado-Esteva *et al.*, 2002a; Williams and Primavera, 2001). Successful larval development leading to the production of viable seeds for farming has already been carried out in the Philippines and India (Josileen, 2011; Parado-Esteva *et al.*, 2002a, 2002b, 2007; Soundarapandian *et al.*, 2013). The catch of the crucifix crab is decreasing in its area of distribution and to meet the future demand, its farming can be an ideal option (Josileen, 2011; Parado-Esteva *et al.*, 2002a, 2002b; Williams and Primavera, 2001). Its aquaculture may be started in Pakistan where vast land with suitable water quality is available in the Indus Delta and lagoon along the Balochistan coast.

Charybdis (Charybdis) lucifer (Fabricius, 1798)
(Fig. 5)

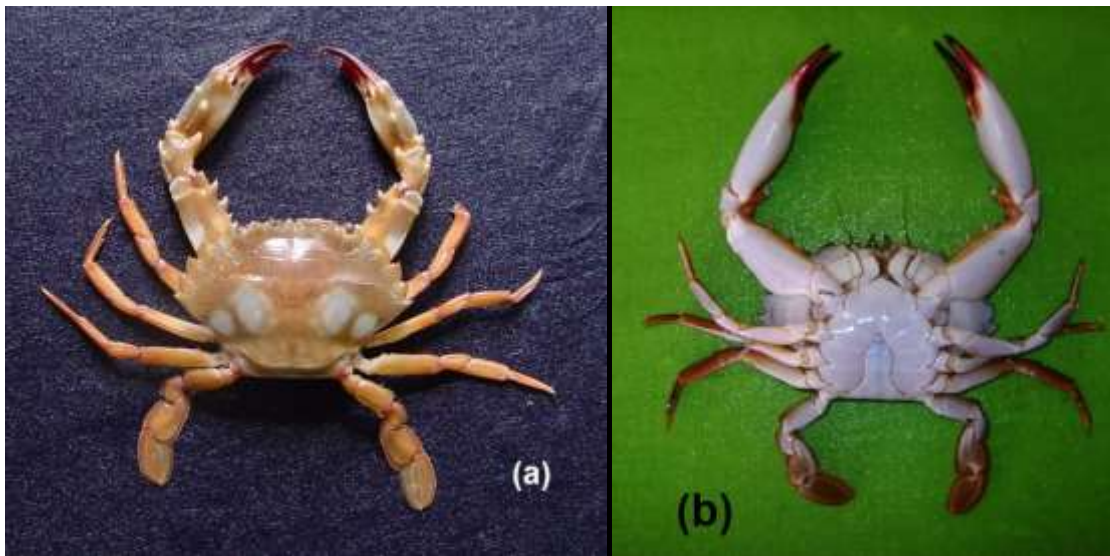


Fig. 5. *Charybdis (Charybdis) lucifer* (a) Dorsal view; (b) Ventral view (male).

Synonym:

Naderloo (2017), Wee and Ng (1995) and Hamli *et al.* (2022).

This species is commonly known as yellowish-brown swimming crab.

Description: (adapted after Wee and Ng, 1995): Carapace bare; all anterior carapace ridges present and faintly granular, none behind epibranchials; six frontal teeth, medians blunter, projecting beyond more triangular and outwardly directed submedians, laterals narrowest, separated from submedians by deep V-shaped notch and more prominent than inner supraorbital lobe; six anterolateral teeth, increasing in size from first to fifth, last smallest and spiniform. Basal antennal segment bearing low finely granular crest. Chelipeds strong and unequal; anterior border of merus with three spines; carpus with a strong spine on the inner angle and three spinules at the outer angle; manus with five short spines on the upper surface, bearing seven costae; fingers of major cheliped slightly shorter than palm. Propodus of natatory leg serrated on the posterior border; merus with the spine on the posterior border. Penultimate segment of the male abdomen with lateral borders parallel. G1 distal half narrow, inner surface bearing sparsely spaced short bristles, starting before tip and ending just proximal to the lip, abdominal surface bearing two rows of short bristles on the lip, outer surface bearing long bristles, starting at the tip and increasing in length proximally. Colour: Carapace yellowish brown with two large white spots on either of the branchial regions. Chelipeds scarlet pink, fingers light brown, extreme tips whitish.

This species is known from the Indo-West Pacific area including South Africa, East Africa, the Red Sea, the Gulf of Oman, Pakistan, India, Sri Lanka, Thailand, Vietnam, China, Japan, Indonesia, Singapore, Taiwan, and Australia (Chhapgar, 1957; Chopra and Das, 1937; Naderloo, 2017). This species is found in the coastal subtidal areas between depths of 3–60 m in the areas that have muddy, rocky, sandy, or hard substrates (Rathbun, 1910).

Table 3. Size of the yellowish-brown crab (*Charydbis lucifera*) observed at Karachi Fish Harbour.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	53.1	36.3	30.1
Female (minimum)	35.0	24.0	7.1
Male (maximum)	95.6	57.1	128.1
Female (maximum)	76.4	50.4	94.2

The size range of the yellowish-brown crab observed during the present study is given in Table-III which indicates that female crab has comparatively smaller sizes (35.0 cm carapace length) and weighs about 7.1 g whereas the smallest male crab has a carapace length of 53.1 and weight 30.1 g. The largest male has a size of 95.6 cm (57.1cm width of the carapace) and weights 128.1 g whereas the largest female has a size of 76.4 cm (50.4 cm width of the carapace) and weights 94.2 g. During the present study, the majority of the yellowish-brown crabs have a dominating size range between 60 and 96 cm.

There is no aimed fishery for this species in Pakistan, however, it is caught mainly as a bycatch of shrimp trawling and bottom-set gillnetting. Since it is not found in large quantities, therefore, there is no specific export for this species, however, sometimes large specimens are exported as cut crab form packed along with three-spot swimming crabs. Smaller specimens are usually locally consumed or dried for fish meal production. This species along with other swimming crabs is consumed in some parts of India as these crabs are considered to have high nutritional values (Ramamoorthy *et al.* 2015; Kumari *et al.* 2015).

Despite being of large and attractive, the yellowish-brown crab is not exported, although there is a reasonable demand for this crab in Southeast Asian countries. According to the leading crab exporters, its supplies are not reliable as compared to blue and three-spot swimming crabs, and also size composition is not uniform, therefore, it is difficult to match the demand of the importers who require dependable regular supplies and large specimens.

Portunus (Portunus) sanguinolentus (Herbst, 1783)
(Fig. 6-7)



Fig. 6. *Portunus (Portunus) sanguinolentus* male. (a) Dorsal view; (b) Ventral view.

Synonymy:

Naderloo (2017); WoRMS (2024), Crosnier (1962)

Because of presence of three red spots on its carapace, this species is commonly known as three-spot swimming crab, blood-spotted swimming crab, or red-spotted swimming crab.

Description: (adapted after Sakai, 1962): Carapace very broad (breadth 2.0-2.5 times length), with 3 red spots in posterior half, persisting quite long in preserved specimens; surface finely granulated anteriorly, smooth posteriorly;

with recognizable mesogastric, epibranchial, and metagastric ridges; front with 4 triangular teeth, outer pair broader and very slightly more prominent than inner ones; antero-lateral borders with 9 teeth, first clearly longer and much more pointed than following 7, last one very large and projecting straight out laterally; postero-lateral junction rounded. Cheliped merus with postero-distal border smooth, anterior border with 3-4 sharp spines; carpus with inner and outer spines; lower surface of palm smooth. Posterior border of swimming leg without spines or spinules. Postero-lateral junction of carapace rounded; external surface of the merus of third maxilliped densely hirsute, antero-external angle not produced laterally. Colour: Posterior of carapace with three large red spots; carapace plain, without meshwork pattern background colour.



Fig. 7. *Portunus (Portunus) sanguinolentus*. Female. (a) Dorsal view; (b) Ventral view.

According to Crosnier (1962), *Portunus sanguinolentus* can be distinguished from other species of the genus *Portunus* in having a carapace which is smooth at its posterior part and finely granulated at its anterior part; the presence of a transverse line of metagastric granules in addition mesogastric and epibranchial lines, the more developed middle teeth of the forehead, teeth 2-7 (sometimes only 2-5) of the anterolateral edges of the carapace with a blunt apex, the lobe between the cracks on the upper edge of the orbits devoid of teeth, the posterior edge of the merus of spineless chelipeds, the propodus of chelipeds with smooth sides, the sixth segment of the abdomen is longer and narrower and the end of the internal, external edges of the pleopod is lined with bristles subequal and most importantly the posterior of carapace with three large red spots. Its carapace is plain and lacks meshwork pattern background colour.

This species is known to be widely distributed in the Indo-West Pacific area including Red Sea, Persian Gulf, Gulf of Oman, Mozambique, South Africa Madagascar, Mauritius, Karachi, Pakistan India, Maldives, Sri Lanka, Nicobar Islands, Myanmar, Malaysia, Thailand, Japan, Taiwan, China, Singapore, the Philippines, Indonesia, Australia, New Caledonia Hawaiian Islands (Naderloo, 2017; Sakai, 1976; Alcock, 1899, Stephenson, 1972). It is widely distributed subtidally between a depth of 3–40 m in areas that have sandy bottoms (Naderloo, 2017; Sakai, 1976, Stephenson, 1972). During the present study, it was reported from a maximum depth of 105 m.

Three-spot swimming crab is the most important commercial crab species which is exported as whole frozen and in the form of frozen cut crabs to Southeast Asian countries. It is mainly harvested from fishing grounds located off Indus Delta (mainly off Ghorabari area), off Sonmiani Bay (between Phor, Sapat, Wad Bundar, Kund Malir and Malan) off Ormara, Off Shumal Bundar and Jiwani. During commercial deep sea fishing operations between 2002 and 2005, it was observed to be the most common crab species in the fishing grounds along Sindh Coast (Great Khori Bank, off Ghorabari) and Balochistan coasts (Malan, Ormara, Astola Island and Pasni) between a depth of 23 to 105m.

There is an aimed bottom-set gillnet fishery for three-spot swimming crabs in some areas along Sindh and Balochistan coast. Off Indus Delta (between Khori Great Bank, Wari Creek, Hajamro Creeek, Khuddi Creek and Phitti Creek) and off Sonmiani Bay (between Phor, Sapat, Wad Bundar, Kund Malir and Malan) are its main fishing grounds. Bottom-set gillnets are used to harvest this crab species for six months (during December and May). Sukumaran *et al.* (1986) observed the peak fishing season along South Kanara Coast, India during December and May or early June. However, according to Dash *et al.* (2013) its peak fishing season is March and April followed by October in Veraval, Gujarat, India.

Landings of this crab are being done at all major landing centres (Fig. 8) whereas a major part of the crabs from small landing centres is directly delivered to the seafood processing plants. Shrimp/fish trawling on the main fishing ground undertaken during October and November yields large quantities of small and immature crab. Since there is no market for such small crabs (> 30-40 mm), therefore, it are discarded in large quantities (Fig. 9). Dumping of juvenile three-spot swimming crabs is a recurring event every year and has to be controlled as it must be seriously affecting the stocks of this crab in subsequent months (December to May).



Fig. 8. Commercial landings of *Portunus (Portunus) sanguinolentus*

Table 4. Size of the three-spot swimming crab *Portunus (Portunus) sanguinolentus* recorded at Karachi Fish Harbour.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	34.1	15.7	20.3
Female (minimum)	15.4	7.3	5.3
Male (maximum)	150.2	67.4	191.5
Female (maximum)	144.2	52.1	70.3

The size range of the three-spot swimming crab observed during the present study is given in Table-IV which indicates that the female crab has a smaller size carapace length of 15.4 mm, a breadth of 7.3 mm weighing about 5.3 g whereas the smallest male crab has a carapace length of 34.1 mm, breadth 15.7 mm and weighing 20.3 g. The male, however, attains a larger size than the female. During the present study, the largest crab has a size of 150.2 mm, breadth of 67.4 mm, and weighs 191.5 g whereas the largest female has a size of 144.2 mm, breadth 52.1 mm and weighs 70.3 g.

Vidhya, *et al.*, (2019) studied the sizes of *P. sanguinolentus* from the Gulf of Mannar coast, India which revealed that the carapace width of males and females ranged from 39 mm to 191.0 mm, the carapace length 19 mm to 103 mm and the weight ranged from 15 to 328 g. The size range of males and females of *P. sanguinolentus* ranged from 124.1 to 112.5 mm and 103 to 88 mm was recorded from Karnataka (Sukumaran and Neelakantan, 1997). In the same area, the size range of males and females was observed to range between 56 and 160 mm and 61 and 170 mm respectively (Dineshbabu, *et al.*, 2007). The male and female sizes ranged from 36 to 155 mm and 26 to 175 mm at Calicut (Sarada, 1998) and in Chennai, the male and female of *P. sanguinolentus* was reported to be between 41 and 165 mm and 41 and 155 mm respectively (Pillai and Thirumilu, 2012).

This is the most dominating crab which is exported in frozen forms because of demand for this crab in Southeast Asian countries including South Korea. According to the leading crab exporters, its supplies are reliable

during December and May, thus, it is an important export commodity during this period. The export of this species, at times, continues beyond June to September, as small quantities of three-spot swimming crab are landed by gillnet vessels from the offshore Sindh area.



Fig. 9. Discard and dumping of juvenile three-spot swimming crabs by trawlers in the offshore waters of Sindh.

***Portunus (Portunus) pelagicus* (Linnaeus, 1758)**

Synonymy:

Given in detail by Lai *et al.* (2010)

Lai *et al.* (2010) revised *Portunus pelagicus* (Linnaeus, 1758) species complex using morphological and genetic data. They recognized four species within broadly distributed *Portunus pelagicus* *sensu lato*, which are relatively geographically distinct. According to Lai *et al.* (2010), *Portunus segnis* (Forskål, 1775) is a species distributed in the western Indian Ocean including the Persian Gulf, the Gulf of Oman, and the Pakistan coast whereas *P. pelagicus* is restricted to Southeast and East Asia. The detailed taxonomic description is given by Lai *et al.* (2010).

Its main characters are the presence of median teeth frontal teeth conspicuous, either small or prominent. It also has three spines on the anterior margin of the cheliped merus whereas the sixth segment of the male abdomen is relatively shorter and broader. It has white spots on the carapace, often merging into broad almost banded reticulations, in particular on the posterior and branchial regions. *P. pelagicus* is known from Southeast Asia to north-western Australia, the western Pacific to Japan whereas *Portunus segnis* (Forskål, 1775) is known from in the western Indian Ocean including Pakistan.

This species was widely reported from the Pakistan coast and is part of the checklist of crabs from Pakistan including Henderson (1893), Khan (1975 as *Neptunus pelagicus*), Mustaqim and Rabbani (1976) and Tirmizi and Kazmi (1996 as *Portunus pelagicus*). *Portunus pelagicus* does not occur in Pakistan where it is replaced by *P. segnis* (Psomadakis, *et al.*, 2015, however, still several scientists in Pakistan are using *Portunus pelagicus* for blue swimming crabs. Naz *et al.* (2014) reported that *Portunus pelagicus* is widely distributed throughout the Indo-West Pacific region and found as a complex of four morpho type. Based on morphological, morphometrical and genetic analysis they concluded that two species *P. pelagicus* and *P. segnis* occur in the coastal waters of Pakistan. However, the occurrence of *P. pelagicus* is not authenticated in their future studies. All records of *Portunus pelagicus* from Pakistan, may, therefore, be referred to as *P. segnis*. No further details about *Portunus pelagicus* is provided in the paper and all publications about *P. pelagicus* from Pakistan may be considered to be detailing with *P. segnis*.

***Portunus (Portunus) segnis* (Forskål, 1775)**

(Fig. 10)

Synonymy:

Lai *et al.* (2010), Naderloo (2017)

This species is commonly known as African swimming crab

Description: (adapted after Lai *et al.*, 2010): Carapace width 2.2–2.3 times wider than long, median frontal teeth minute or obsolete, usually inconspicuous, appearing confluent or with wide gap between lateral median teeth, except sometimes in larger individuals (carapace width more than 140 mm). Carapace regions poorly defined, branchial regions not as swollen. Chelipeds narrow, elongated, merus length of adult males maximum 4.5 times longer than wide; most specimens with short, stout chelipeds; anterior margin of merus of cheliped usually with 3 spines. Ambulatory legs relatively elongated, slender, merus of 4th pereopod 3.3–4.4 (median 3.6) longer than wide. Natatorial paddle elongate oval, obtusely angled distally (Fig. 14b). Sixth male abdominal somite relatively shorter, less tapering. Base of G1 with slight basal spur. Colour: Males with dark olive green blue carapace with many pale white spots on surface particularly posteriorly and anterolaterally; spots do not tend to merge to form thin bands, however. Females similar in pattern to male except that tips of chelipeds are red tinged with a brownish red instead of blue tinged with deep rust red.



Fig. 10. *Portunus segnis* (Forskål, 1775) Male. (a) Dorsal View; (b) Ventral View.



Fig. 11. *Portunus segnis* (Forskål, 1775) Female. (a) Dorsal View; (b) Ventral View.

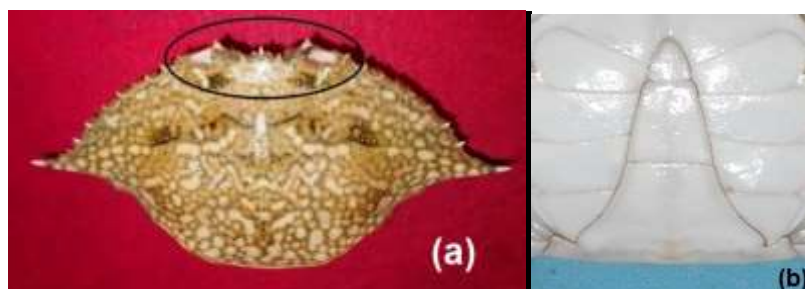


Fig. 12. (a) Frontal teeth minute and inconspicuous in *P. (P). segnis*; (b) Sixth segment of the male abdomen relatively shorter and broader in *P. segnis*.

Species of the *P. pelagicus* complex can also be readily differentiated from *P. (P.) sanguinolentus* by different life colour patterns (three blood-red spots posteriorly in *P. (P.) sanguinolentus* which is lacking other species of *Portunus*). Medium teeth (frontal teeth) are minute and inconspicuous (Fig. 12a), almost obsolete if present always small in *P. (P.) segnis* (small and conspicuous in *P. pelagicus*). The branchial region of the carapace is convex (Fig. 13a) but less prominently swollen (Fig. 14a) in *P. (P.) segnis* (prominently swollen in *P. pelagicus*). Three spines on the anterior margin of the cheliped merus (Fig. 13b) and the sixth segment of the male abdomen are relatively shorter and broader (Fig. 12b). Male with dark blue-green carapace *P. (P.) segnis* (dark blue-green with purple-blue cheliped in *P. pelagicus*); with discrete white spots on the carapace (Fig. 10a) sometimes merging into thin reticulated bands and female similar to male; spotting on the posterior third of carapace (Fig. 11a) in *P. (P.) segnis* (both male and females possess white spots on the carapace, often merging into broad, almost banded reticulations, in particular on the posterior and branchial regions in *P. pelagicus*).

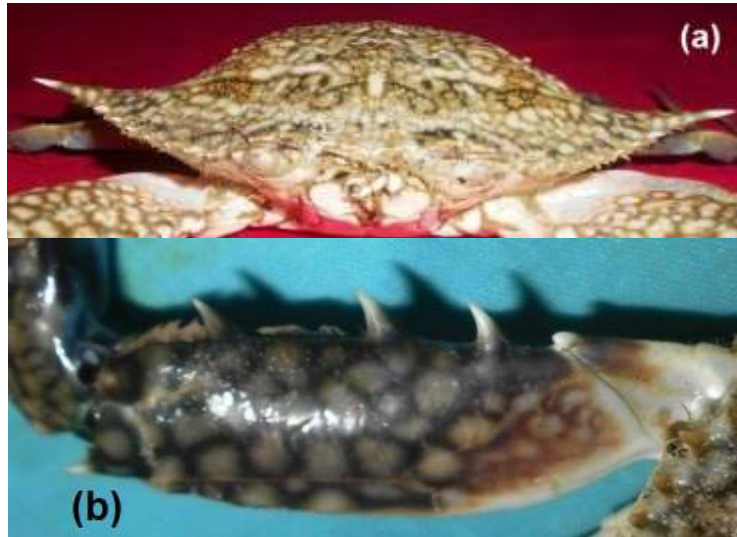


Fig. 13. (a) Branchial region of carapace convex and less swollen in *P. segnis*; (b) 3 spines on anterior margin of left cheliped merus of *P. segnis*.



Fig. 14. (a) Frontal view showing branchial swelling in *P. segnis*. (b) Dactylus of fifth pereiopod ovate and relatively elongate in *P. segnis*.

Four species of *Portunus (Portunus)* including *P. pelagicus*, *P. segnis*, *P. reticulatus* and *P. armatus* can be separated based on various combinations of morphological characters, primarily on the prominence of the frontal teeth, the length and armature of the cheliped merus, live colour patterns, male sixth abdominal segment shape, paddle shape of fifth pereiopod, and other character (Lai *et al.*, 2010). Three species including *P. (P.) pelagicus*, *P. (P.) reticulatus* and *P. (P.) armatus* are extralimital and no confirmed report from Pakistan coast. However, despite confirmation of presence of one species of the complex *P. (P.) segnis*, many authors are still using *Portunus (P.) pelagicus* for blue swimming crab from Pakistan.

Blue swimming crab (*P. (P.) segnis*) is widely distributed in the Western Indian Ocean, from Pakistan westwards to the Red Sea, Gulf of Aden, Socotra, Persian Gulf, South Africa, Mozambique, Madagascar and Mauritius, East Africa and west of Indian sub-continent (Lai *et al.*, 2010, Naderloo, 2017). It has also entered and established in the Mediterranean Sea, as a Lessepsian migrant through the Suez Canal (Castriota *et al.*, 2022; Ekman, 1967; Naderloo, 2017; Ozcan *et al.*, 2005; Yokes *et al.*, 2007) and become established as far north as the northern Tyrrhenian Sea (Crocetta, 2006).

This species is distributed between 3 m to a maximum depth of 65 m in various soft bottom substrates including mangroves, sandy, mudflats, and soft bottoms along the coastline. Although rocky shores are not an ideal habitat for this crab those that venture for feeding on rocky shores cannot find their way back when tides recede can also be found in the rocky/cobble beaches mainly under rocks and in rock pools. Juveniles are commonly found in the intertidal pools in the sandy and muddy areas along the coast.

Blue swimming crab (*P. (P.) segnis*) is one of the most important crab species which is exported whole frozen and in the form of frozen cut to Southeast Asian countries. It is mainly harvested from fishing grounds located within and off the Indus Delta (mainly in near shore waters Ghorabari, Waddi Khuddi, Wari, Khai, Hajamaro and Khajar Creek areas), Sonmiani Bay (between Phor, Sapat, Wad Bundar, Kund Malir and Malan) and other parts of Balochistan coast. During commercial deep sea fishing operations between 2002 and 2005, it was observed to be one of the rarest crab species that is found only in the coastal area along Sindh Coast (Great Khori Bank, off Ghorabari) between depths of 15 to 30 m.



Fig. 15. *Portunus (P.) segnis* displayed for auction at Karachi Fish Harbour.

There is an aimed bottom-set gillnet fishery for blue swimming crabs (*P. (P.) segnis*) along the Sindh coast including in the creek areas of the Indus Delta and the open ocean along the creek system (between Khori Great Bank, Wari Creek, Hajamro Creeek, Khuddi Creek and Phitti Creek). Small quantities are also caught off Sonmiani Bay (between Phor, Sapat, Wad Bundar, Kund Malir, and Malan). Bottom-set gillnets are used to harvest crabs for five months (during May and September). In addition to gillnet, blue swimming crab (*P. (P.) segnis*) is also caught as a bycatch of trawl fisheries throughout the year except June and July which are close seasons. In shrimp trawl fisheries peak seasons for this species is from August to October. Peak landings of blue swimming crab (as *P. (P.) pelagicus*) from trawl grounds off the Gulf of Kutch, India are in March-May while gillnet landings are maximum in June and September (Kizhakudan, 2002), similar to landings by gillnet fleet in Pakistan.

Dineshababu *et al.* (2008) studied *P. (P.) segnis* (as *P. portunus*) from south Karnataka coast, India which reveals that the peak fishing season for crabs was during December-June. Sukumaran *et al.* (1986) observed the peak fishing season along the South Kanara Coast, India during December and May or early June. However, according to Dash *et al.* (2013), the peak fishing season for this species is March and April followed by October in the area off Veraval, Gujarat, India. This crab is landed at all major fisheries centres (Fig. 15), especially at the Ibrahim Hayderi Landing Centre, however, a major part of the crabs from small landing centres is directly delivered to the seafood processing plants.

Table 4. Size of the blue swimming crab *Portunus (Portunus) segnis* recorded at Karachi Fish Harbour.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	37.2	18.4	45.1

Female (minimum)	35.8	18.1	30.3
Male (maximum)	158.4	53.0	264.4
Female (maximum)	167.2	50.3	309.1

The size range of the blue swimming crab observed during the present study is given in Table-IV which indicates that the female crab has a smaller size carapace length of 35.8 mm, a breadth of 18.1 mm weighing about 30.3 g whereas the smallest male crab has a carapace length of 37.2 mm, breadth 18.4 mm and weighing 45.1 g. The female, however, attains a larger size than the male. During the present study, the largest female crab has a size of 167.2 mm, a breadth of 50.3 mm, and weighs 309.1 g whereas the largest male has a size of 158.4 mm, a breadth of 53.0 and weighing 264.4 g.

Afzaal, *et al.* (2017) studied the carapace length-weight and carapace width-weight relationship of *Portunus (P.) pelagicus* (= *P. segnis*) from the Pakistan coast and they observed that the carapace width and weight in this crab range from 7 to 17 cm and 30 to 409 g respectively whereas according to Afzaal, *et al.* (2016) the length in *Portunus (P.) pelagicus* (= *P. segnis*) ranged were from 7 to 17 cm (CW) with the dominant length range were from 8 to 12 cm. Rasheed and Mustaqim (2014) have reported that the size (short carapace width-SCW) of male and female crabs *Portunus (P.) pelagicus* (= *P. segnis*) from coastal waters of Pakistan ranged from 23 -135 mm (mean 73.87 mm) and from 26-148 mm (mean 72.97 mm) respectively. The weight of crabs varied from 2 – 380 g for males and from 2- 397g for females.

The mean size of *P. (P.) pelagicus* (= *P. segnis*) in Gujarat waters, India was observed to vary with the types of fishing (Kizhakudan, 2002). Trawl net operation at Jakhau yielded males to have a maximum size of 141.3 cm and females to be 141.7 cm whereas males were 64.25 cm and females were 63.67 cm with gillnet operation at Patanbara and males were 33.59 cm and females were 35.33 cm with gillnet operation at Vanakbara. No such variations were noticed during the present study. Dineshbabu, *et al.* (2008) studied *P. (P.) segnis* (as *P. portunus*) from the south Karnataka coast, India which revealed that the size range was 56 to 165 mm in males and 61 to 170 mm in females.

Josileen and Menon (2007) reported from a size range between 70 and 195 mm at Mandapam (Palk Bay), India. At Devipattinam, the fishery was contributed by a size range of 81-182 mm. The maximum recorded sizes for males and females were 182 and 176 mm respectively. In Thoppukadu, India the landed crabs were in the size range of 81-160 mm. The maximum sizes recorded for males and females were 156 and 159 mm respectively. No such variation was noticed during the present study.

This is the second most dominating crab which is exported in frozen forms to Southeast Asian countries including South Korea. According to the leading crab exporters, its supplies are reliable during June and October, thus, it is an important export commodity during this period.

Scylla serrata Complex

Mud crabs (*Scylla serrata* complex) are found in the Indo-West Pacific region from East and South Africa to Southeast and east Asia (from Southeast China and Sri Lanka), and Northeast Australia. These are also found in the eastern Pacific around the Marianas, Fiji, and the Samoa Islands. It was introduced in Hawaii. Mud crabs are typically associated with mangroves in estuaries and sheltered coastal habitats in soft muddy bottoms where they dig deep burrows. It was generally considered that *Scylla* is a monospecific genus with *S. serrata* with only species occurring in the Indo-West Pacific region. Keenan *et al.* (1998) revised the taxonomy of the genus *Scylla* considering morphology, morphometric ratios, and allozyme variability and classified this genus into four distinct species: *S. serrata* (Forskål, 1775), *S. olivacea* (Herbst, 1796), *S. tranquebarica* (Fabricius, 1798) and *S. paramamosain* Estampador 1950. Since then several studies on the taxonomy of mud crabs have been done that used either of the morphological characteristics.

Kazmi *et al.* (2000) revised the taxonomy of mud crabs and reported the occurrence of three species *Scylla serrata*, *S. olivacea* and *S. tranquebarica* in Pakistan. Psomadakis *et al.* (2015) reported only two species (*S. olivacea* and *S. tranquebarica*) from Pakistan. However, almost all research papers from Pakistan are still using *Scylla serrata* for mud crab species from Pakistan. The details of species occurring in Pakistan are provided in this paper which indicates that only two species (*S. olivacea* and *S. tranquebarica*) are from Pakistan. It may be noted that unambiguous identification of mud crab belonging to the genus *Scylla* is based on external morphology and it is extremely difficult to distinguish between the species because these are closely related and have overlapping

morphological traits (Kazmi *et al.*, 2000). Table-V. Present characters and other features that can be used for distinguishing four species of the genus *Scylla*.

Although a bit complicated but three species of mud crabs can be identified based on morphological characters. The orange mud crab (*Scylla olivacea*) from two species of genus *Scylla* in having chelipeds of carpus without two obvious spines on distal half of the outer margin (two distinct spines on the distal half of outer margin of carpus of chelipeds of *S. serrata* and *S. tranquebarica*). The two remaining species of the genus *Scylla* (*S. serrata* and *S. tranquebarica*) can be distinguished as *S. serrata* have high frontal lobe spines (moderately high in *S. tranquebarica*), bluntly pointed with a tendency to concave margins and rounded interspaces (blunted with rounded interspaces in *S. tranquebarica*). Anterolateral carapace spines narrow with outer margin straight or slightly concave (anterolateral carapace spines broad with outer margin convex in *S. tranquebarica*). Chelipeds and legs all with polygonal patterning for both sexes and on the abdomen of the female only (polygonal pattern weak on chelipeds and first two pairs of legs, last two pairs of legs with stronger patterning for both sexes; pattern variable on abdomen of female, absent in male in *S. tranquebarica*).

Table 5. Morphology and characteristics of four species of genus *Scylla*.

Characteristics/Morphology	<i>Scylla tranquebarica</i>	<i>Scylla olivacea</i>	<i>Scylla serrata</i>	<i>Scylla paramamosain</i>
Frontal lobe spines				
Shape	Blunt	Rounded	Blunt pointed	Triangular
height	Moderately high in males; high in females	Low in males; moderate in females	High in males; moderately high in females	High in both sexes
Cheliped				
Carpus spines	Both spines obvious	Inner spine absent; outer spine obvious	Both spines obvious	Inner spine absent; outer spine obvious
Propodus spines	Obvious	Reduced	Obvious	Obvious
Polygonal pattern	Present on the third, fourth and fifth legs	Absent on all chelipeds and legs	Present on all chelipeds and legs	Weak patterns only present on fifth leg
Cheliped colouration	Mostly purple, rarely green or blue	Orange or red through brown to black	Blue, purple or green	Green to bright yellow with black spot or stripe patterns unlike polygonal pattern
Habitat	Associated with mangrove forests and coastlines inundated with reduced salinity Seawater for part of year.	Associated with mangrove forests and coastlines inundated with reduced salinity Seawater during the wet season.	Associated with mangrove forests inundated with full salinity oceanic water for the greater part of the year. Can tolerate reduced salinity	Associated with various habitats including shallow coral rubble; shallow subtidal flats and estuarine ponds; mangrove forests
Geographical Distribution	South China Sea, Pacific Ocean, Indian Ocean including Pakistan– a widespread species, often associated with <i>S. olivacea</i> .	South China Sea, Indian Ocean, Pacific Ocean – moderately widespread, often associated with <i>S.</i>	Indian Ocean including Pakistan, Red Sea, Pacific Ocean – the most widespread <i>Scylla</i> species.	South China Sea, Java Sea – an abundant species where it occurs

		<i>tranquebarica.</i>		
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Based on Keenan *et al.* (1998), Kazmi *et al.* (2000), Naim *et al.*, (2020) and Shelley and Lovatelli (2011).

The presence of mud crab *S. tranquebarica* in Indian coastal waters was reported by several researchers (Joel and Raj 1983; Pillai *et al.* 2002; Gopikrishna and Shekhar 2003; Mohanty *et al.* 2006; Vartak *et al.* 2008; Trivedi and Vachhrajani 2013; Ramalingam *et al.* 2015). The results obtained using multiple molecular markers indicate that all four mud crab species (genus *Scylla*) could be identified accurately and reconfirmed that there are only two species *S. serrata* and *S. olivacea* found along coastal waters of India. Mandal *et al.* (2014a, 2014b, 2021) carried out detailed molecular work and advocated that only two species of mud crabs (*S. serrata* and *S. olivacea*) are commonly available in Indian coastal waters. According to them the species mentioned as *S. tranquebarica* (green morph) in most of the publications from India may be treated as *S. serrata* and the species named *S. serrata* (brown morph) should be considered to be *S. olivacea*. A similar situation may be occurring in the case of species of *Scylla* occurring in Pakistan which warrants a detailed molecular investigation of the mud crab species that are found in coastal waters of Pakistan.

Scylla serrata (Forskål, 1775)

Synonymy:

Keenan *et al.* (1998), Kazmi *et al.* (2000), Naderloo (2017)

This species is commonly known as the Indo-Pacific swamp crab or mud crab.

Description: (adapted after Trivedi and Vachhrajani (2013): and Keenan *et al.* (1998)'. Carapace oval and convex in shape; carapace surface smooth and glabrous; granular lines present on the gastric region and epibranchial region, line originates from last teeth of the anterolateral region and ends at branchial region; 'H shape groove moderately carved in the centre of the carapace front ornamented with 4 subequal and equally spaced teeth; tips of the front teeth high in height and rounded in shape; the interspaces between front teeth rounded; anterolateral borders ornamented with 9 subequal teeth; last teeth is smallest; anterolateral tooth narrow with curved or straight outer margin; Basal antennal joint short and broad with lobules on antero-external angle. Chelipeds massive and unequal in size; merus ornamented with 3 spines and 2 spines on the anterior and posterior region respectively; carpus with a strong spine on the inner part and small spine on the outer part; two distinct spines present on the distal upper part near the insertion of the finger; carapace green to almost black; legs may be marbled. Cheliped colour ranging from dark green to blue-green; polygonal markings present on the chelipeds and female abdomen; fingers straight with slightly rounded claw shape tip; Walking legs strong and slightly compressed, polygonal markings present on the walking legs.

Khan *et al.* (2014) studied some biological aspects of the *Scylla serrata* from coastal waters of Karachi and reported the carapace width varied from 50 to 170 mm in males and 40 to 169 mm in females respectively. They also observed that at early stages the females are comparatively larger than males but in larger size groups females are larger than males. The carapace width of mud crab from Karachi varied from 50 to 170 mm in males and 40 to 169 in females averaging to 103.8 mm and 100.8 mm, respectively. The size of the first maturity was observed to be 75 and 70 mm CL for male and female crabs, respectively. They also observed that, carapace width varied 17.22% in males and 18.2% in females. Maximum variation was observed in the fresh weight of left and right claws of males. Such a variation was comparatively low in females left and right claws fresh weight. They also observe that other body parts of mud crab had low variation in size around 15-24% in males and 17-21% in females. Carapace length was shorter than carapace width in both sexes.

The species has widespread distribution ranging from Madagascar to Japan. The species is reported from Yemen, Mozambique, South Africa, Mauritius, Myanmar, Korea, Taiwan, China, Vietnam, Singapore, the Philippines, India, and Japan (Keenan *et al.*, 1998; Naderlo, 2017). Although it is reported from Pakistan by several authors no specimen of this species was observed during the present study. Its presence in Pakistan requires further studies and verification.

Scylla tranquebarica (Fabricius, 1798)

(Fig. 16)

Synonymy:

Keenan *et al.* (1998), Kazmi *et al.* (2000; 2022)

This species is commonly known as purple mud crab.

Description: (adapted after Trivedi and Vachhrajani (2013) and Keenan *et al.* (1998). Carapace oval and convex in shape; carapace surface smooth and glabrous; granular lines present on the gastric region and epibranchial region, line originates from last teeth of the anterolateral region and ends at branchial region; H-shaped groove moderately carved in the centre of the carapace front ornamented with 4 subequal and equally spaced teeth; front teeth moderately high in height and rounded in shape; the interspaces between front teeth rounded; anterolateral borders ornamented with 9 subequal teeth; last teeth is smallest; anterolateral tooth broad with convex outer margin; Basal antennal joint short and broad with lobules on antero-external angle. Chelipeds massive and unequal in size; merus ornamented with 3 spines and 2 spines on the anterior and posterior region respectively; carpus with strong spine on the inner part and small spine on the outer part (smaller than *Scylla serrata*); two distinct spines present on the distal upper part near the insertion of finger (Size of the spine smaller than *Scylla serrata*); cheliped colour ranging from purple to dark orange; polygonal markings weak on chelae and first two pair of walking legs; Strong patterning observed on female abdomen and last two pairs of walking legs; fingers straight with slightly rounded claw shape tip.

The distribution of the species ranges from Pakistan to Vietnam including India, Taiwan, the Philippines, and Malaysia (Serene, 1952).

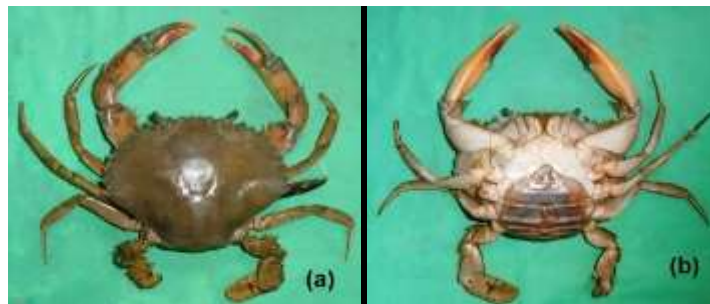


Fig. 16. *Scylla tranquebarica* (Fabricius, 1798) Female. (a) Dorsal view; (b) Ventral view.



Fig. 17. *Scylla tranquebarica* (Fabricius, 1798) Male. (a) Dorsal view; (b) Ventral view

The size range of the purple mud crab observed during the present study is given in Table-VI which indicates that the female crab has a smaller size carapace length of 39.1 mm, a breadth of 27.4 mm weighing about 47.4 g whereas the smallest male crab has a carapace length of 42.3 mm, breadth 36.1 mm and weighing 49.3 g. The male attains a larger size than the female. During the present study, the largest female crab has a size of 194.3 mm, a breadth of 183.2 mm, and weighs 1,232.8 g whereas the largest male has a size of 210.3 mm, a breadth of 196.4 mm, and weighs 2,121.4 g.

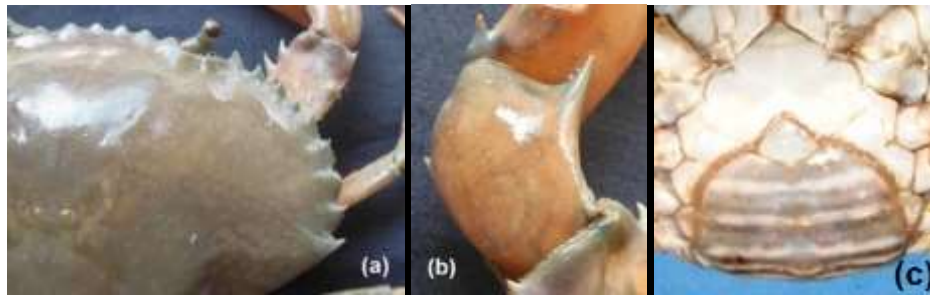


Fig. 18. *Scylla tranquebarica*. (a) Frontal lobe and anterolateral margin of carapace; (b) Left propodus showing spines; (c) Female sternum.



Fig. 19. (a) Last legs marbled in males (b) Large specimen of purple mud crab (*Scylla tranquebarica*) from Miani Hor.

Table 6. Size of the purple mud crab (*Scylla tranquebarica*) recorded from Pakistan coast.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	42.3	36.1	49.3
Female (minimum)	39.1	27.4	47.4
Male (maximum)	210.3	196.4	2,121.4
Female (maximum)	194.3	183.2	1,232.8

The size range of the purple mud crab observed during the present study is given in Table-VI which indicates that the female crab has a smaller size carapace length of 39.1 mm, a breadth of 27.4 mm weighing about 47.4 g whereas the smallest male crab has a carapace length of 42.3 mm, breadth 36.1 mm and weighing 49.3 g. The male attains a larger size than the female. During the present study, the largest female crab has a size of 194.3 mm, a breadth of 183.2 mm, and weighs 1,232.8 g whereas the largest male has a size of 210.3 mm, a breadth of 196.4 mm, and weighs 2,121.4 g.

Redjeki *et al.* (2020) studied purple mud crab (*Scylla transquebarica*) from three villages Klaces, Panikel and Sapuregel in the Segara Anakan area in Cilacap, Central Java, Indonesia. They observed that In the Klaces area, the average total weight of *Scylla transquebarica* was 223 g, the average carapace length was 71.3 mm and the average carapace width was 99.8 mm. In the Panikel area, the average total weight of *Scylla transquebarica* was 205 g, the average carapace length was 71.1 mm and average carapace width was 99.5 mm whereas, at Sapuregel area, the average total weight was 168 g, the average carapace length was 63.6 mm and the average carapace width was 88.0 mm. These results indicate that *Scylla transquebarica* caught in Sapuregel (6.36) have smaller carapace lengths than Klaces and Panikel. Additionally, mangrove crabs caught in Sapuregel have smaller carapace width than Klaces and Panikel whereas crabs caught in Sapuregel have smaller carapace width than Klaces and Panikel. Size at first maturation was observed in male crabs with 110 mm carapace width and in female crabs with 100 mm was observed in *Scylla transquebarica* by Naik *et al.* (2015) from Ratnagiri coast, Maharashtra, India.

Because of its large size and relative abundance, *Scylla transquebarica* is the most common mud crab species being exported from Pakistan. It is also the most common crab which is kept in ponds and crab boxes for fattening

and production of soft crab. It may be noted that the identification of mud crab species still has some controversies and careful identification is warranted, at least, in scientific studies.

Scylla olivacea (Herbst, 1796)
(Fig. 20)

Synonymy:

Keenan *et al.* (1998), Kazmi *et al.* (2000)

This species is commonly known as orange mud crab.



Fig. 20. *Scylla olivacea* (Herbst, 1796). (a) Dorsal view; (b) Frontal and anterolateral carapace and right propodus showing absence of spines

Description: (adapted after Trivedi and Vachhrajani, 2013 and Keenan *et al.*, 1998). Carapace oval and convex in shape; carapace surface smooth and glabrous; H-shaped groove prominently carved in the centre of the carapace front ornamented with 4 subequal and equally spaced teeth; front teeth low in height and rounded in shape; the interspaces between front teeth shallow; anterolateral borders ornamented with 9 subequal teeth; last teeth is smallest; anterolateral tooth broad with convex outer margin; Basal antennal joint short and broad with lobules on antero external angle. Chelipeds massive and unequal in size; merus ornamented with 3 spines and 2 spines on the anterior and posterior region respectively; no spines present on the inner and outer margin of the carpus; two blunt spines present on the distal upper part near the insertion of finger (Size of the spine smaller than *Scylla serrata*); cheliped color ranging from red brown to dark brown; polygonal markings not present on any chelipeds, walking legs and female abdomen.

The distribution of the species ranges from Asia to Australia. The species is reported from Karachi, Thailand, China, Taiwan, Malaysia, Philippines, Indonesia, and Australia (Kazmi *et al.*, 2020, 2022; Keenan *et al.*, 1998).

Table 7. Size of the orange mud crab (*Scylla olivacea*) recorded from Pakistan coast.

Sex	Length of Carapace (mm)	Breadth of carapace (mm)	Weight (g)
Male (minimum)	65.9	64.7	68.3
Female (minimum)	67.2	66.3	73.9

Male (maximum)	128.9	123.5	491.5
Female (maximum)	121.3	114.3	316.7

The orange mud crab was observed to be smaller than purple mud crab collected from Pakistan coast. The size range of the orange mud crab observed during the present study is given in Table-VII which indicates that the unlike purple mud crab, male orange crab has a smaller size carapace length of 65.9 mm, a breadth of 64.7 mm weighing about 68.3 g whereas the smallest female crab has a carapace length of 67.2 mm, breadth 66.3 mm and weighing 73.9 g. The male attains a larger size than the female. During the present study, the largest female crab has a size of 121.3 mm, a breadth of 114.3 mm, and weighs 316.7 g whereas the largest male has a size of 128.9 mm, a breadth of 123.5 mm, and weighs 491.5 g.

Shahriar and Rouf (2018) reported that the smallest orange mud crabs (*S. olivacea*) from Sundarbans, Bangladesh have a carapace length of 46 mm in males and 45 mm in females weighting 24 and 22 g respectively whereas the largest crabs have a carapace length of 122 mm in male and 119 mm in female weighting 173.15 and 97.15 g respectively. This tends to suggest that male crabs grow to larger size and weight as compared to females. Ismail *et al.* (2017) also reported that *S. olivacea* has larger males than females from Terengganu, Malaysia. According to them smallest orange mud crabs have a carapace length of 66 mm in males and 73 mm in females whereas the largest crabs have a carapace length of 128 mm in males and 126 mm in females. Ikhwanuddin *et al.* (2019) studied the growth in females of *S. olivacea* from Terengganu, Malaysia, and observed that the smallest females have a length of 55.3 mm weighing 59.60 g whereas the largest female was 91.5 mm weighing 96.60 g.

Rouf *et al.* (2021) studied orange mud crabs (*S. olivacea*) from Sunderban, Bangladesh, and observed that males have a minimum carapace width of 54.18 mm (weigh 36.25 g) whereas the female has a minimum carapace width of 54.17 mm (weighs 36.16 g). Males can achieve a maximum carapace width of 130.71 mm (weighs 487.21g) whereas the carapace in large females is almost the same (130.94 mm) which weighs only 389.0 g. Similar observations were noted in Pakistan.

Despite having issues with the identification of the genus *Scylla*, orange mud crab (*S. olivacea*) is being exported from Pakistan and adjacent areas. It is not a common crab but is still kept in ponds and crab boxes for fattening and production of soft crabs.

Since the identification of mud crabs still has some issues especially the use of molecular and genetic tools have created more doubts and complications in the identification of mud crabs of the genus *Scylla* in Pakistan and other Indo-Pacific areas. Mud crabs have been studied in detail in Pakistan which provides information about their distribution, size, and other aspects of biology. Khan and Mustaqim (2013) have studied the size and weight attained by mud crabs (*Scylla serrata*) from the Karachi coast which reveals that in the small size groups, males are comparatively larger than females. The male crabs achieve a minimum length of 50 mm (weighing 39 g) whereas male crabs achieve a maximum size of 170 mm (weighing 500 g). Female mud crabs have a maximum length of 200 mm (weight of 150 g).

Alam *et al.* (2018) studied mud crab (*Scylla serrata*) from Kakapir (Karachi) and Khararo Creek (Sindh Coast) and observed that at Kakapir minimum and maximum sizes of male crabs are higher than female crabs. The minimum size of male crabs was found to be 67.32 mm (weighing 72.29 g) whereas the maximum size of males was recorded to be 118.2 mm (400.02 g). In the case of females, the minimum size was found to be 65.32 mm (weighing 72.4 g) whereas the maximum size of females was recorded to be 116.6 mm (335.15 g). At Khararo Creek, the minimum size of male crabs was found to be 70.12 mm (weighing 76.32 g) whereas the maximum size of males was recorded to be 126.81 mm (369.4 g). In the case of females, the minimum size was found to be 71.24 mm (weighing 80.01g) whereas the maximum size of females was recorded to be 125.72 mm (326.97 g).

Khaksari, *et al.* (2023) reported that in the Persian Gulf, the range of carapace width in male *Scylla serrata* varied between 62–212 mm and in females between 82–187 mm which showed that the males are larger compared to females. Similarly, Rezaie-Atagholipour *et al.* (2013) reported range of carapace width in this species on the northwest coast of the Sea of Oman in the Iranian waters was recorded to be 89.7–196.5 mm and 91.7–170.1 mm (122.6-1,989.6 g and 135.6-810.0 g) for males and females, respectively. This indicates that male mud crabs attain large size and weight as compared to female crabs. Khaksari, *et al.* (2023) also reported that the changes in average carapace width in different months showed that adult crabs were predominant from winter to mid-spring (December to May), for both sexes whereas the juvenile crabs were dominant from late spring to mid-summer (May to August), in the region. The difference in the size of male and female crabs of genus *Scylla* and the family Portunidae is well known. In many species of portunid crabs, the males have a larger size than the females (La Sara, 2010, Rezaie-Atagholipour *et al.*, 2013, Safaie *et al.*, 2015, Widigdo *et al.*, 2017, Rouf *et al.*, 2021, Sakib *et al.*, 2022, Khaksari, *et al.*, 2023).

According to Paital and Chainy (2012), Srinivasagam and Angell (1992) and Mohanty *et al.* (2006) *S. tranquebarica* is comparatively larger than *S. serrata*. Oshiro (1941) reported that in Taiwan, *S. oceanica* has 2.5 kg body weight and 200 mm carapace width whereas *S. serrata* has a 0.9 kg body weight and 180 mm carapace width whereas Mohanty *et al.* (2006) reported that in India, *S. tranquebarica* has 2.8 kg body weight and 240 mm carapace width whereas *S. serrata* has 0.83 kg body weight and 181 mm carapace.

Widigdo *et al.* (2017) studied mud crab (*Scylla serrata*) from North Kalimantan, Indonesia and they observed that the males can achieve larger sizes than females (128 mm vs 122 mm). They also observed that the growth pattern is faster and larger in the male. According to them, it is a common phenomenon since the claws of males grow significantly larger than females in mud crabs. Pinheiro and Fiscarelli (2009) pointed out that bigger claws in males enable them to protect the females successfully during and after copulation whereas Pinheiro and Hattori (2006) mentioned that females tend to reduce their chelae growth as they grow bigger, while males tend to do the opposite. This is mainly because mature females utilize much of their energy in egg production cause reducing their somatic growth (Pinheiro and Fransozo 2002).

Tetelepta *et al.* (2018) studied orange mud crab (*Scylla olivacea*) from Kotania Bay, western Seram District, Indonesia, and found that the size distribution of male mud crabs ranged from 88 to 178 mm (weight about 12.7 g to 165.0 g) with the average size caught being 136 mm carapace width. For females, sizes ranged from 98 to 172 ((weight about 12.5 g to 145.0 g) mm with an average size of 135 mm carapace width. The study indicates that at smaller sizes males and females are of almost equal weight but at the maximum size, males are much heavier than females. Tetelepta, *et al.* (2018) studied from Kotania Bay, Western Seram District, Indonesia, and noted that the size distribution of male and female mud crabs range from 78.0 to 235.0 mm carapace width. For male mud crabs size ranges from 82.0 to 235.0 mm. whilst the size of female mud crabs ranges from 78.0 to 201.0 mm. The size distribution for both sexes was no different.

Suryandari *et al.* (2002) studies the length-weight relationship, sex ratio, and condition factors of mud crabs (*Scylla paramamosain* Estampador, 1950) from Brantas Estuary, East Java, Indonesia and observed that smallest female and male have a size of 53.6 mm and 70.8 mm and weights of 65.90 g and 61.5- g respectively whereas largest female and male have a size of 132.0 mm and 112.3 mm and weights of 356.89 g and 270.11 g respectively. This indicates that female body size is larger than males. They attributed this to differences in growth patterns, the environment, food availability, and the size of maturity.

Iromo, *et al.* (2022) studied species of *Scylla* from North Kalimantan Province, Indonesia, and noted that the carapace length of *Scylla* has an average length of 81.7 mm, an average width of 118.5 mm and an average weight of 397.41 g. *Scylla serrata* has a carapace length of 69.0 mm to 99.0 mm a carapace width of 97.0 mm to 172.0 mm and a weight ranging from 207.0 g to 839.3 g. For *Scylla tranquebarica*, the carapace length was 62.0 mm to 93.0 mm, and for the carapace width, 92.0 mm to 132.0 mm and the weight ranged from 202.0 g to 701.0 g. In general, the size and weight of *Scylla serrata* is greater than that of *Scylla tranquebarica* (Iromo, *et al.*, 2022).

Ahmadoon (2019) studied *Scylla serrata* from the Sundanese Red Sea and recorded that the carapace width of males ranged from 11.64 to 19.95 mm (carapace length 7.80 to 12.7 mm), while in females ranged from 12.73 to 20.86 mm (carapace length 8.64 to 13.92 mm). The weight of males ranged from 216.0 to 1,352.0 g, while females ranged from 315.0 to 1,287.0 g. Thirunavukkarasu and Shanmugam (2011) observed that males grow to larger size and weight in purple mud crabs (*Scylla tranquebarica*) at Chennai, Tamil Nadu, India.

CRAB FISHERIES OF PAKISTAN

Background of Crab Fisheries

Crab is not a general part of food items consumed by the local population in Pakistan. Only some minorities living in Karachi and some fishermen communities consume crabs as a regular part of their diet. Because of this reason, no aimed crab fisheries could be established in Pakistan till the early 1980's. Before that crabs that were caught as bycatch of trawling and coastal gillnetting used to be sold mainly in the Empress Market, Karachi. A small recreational fishery for crabs was established in Karachi, where families used to hire local harbour or fishing boats and to catch crabs from Manora Channel, Karachi Port, and Korangi Creek mainly using handlines. Crabs used to be cooked on the boat during such excursions. This recreational crab fishery practically died down in in early 2000's mainly because of pollution in Karachi Harbour and Korangi Creek areas. The crabs were obtained from bycatch of trawling, handlining, and gillnetting in the coastal waters. used to be either discarded or destined for the fish meal industry (Fig. 21).

Harvesting of Crab

Crabs are harvested as bycatch of trawling and gillnetting in the coastal and offshore waters. Aimed gillnetting and baited longlining is also used for catching swimming crab. Mud crabs are mainly harvested manually from mudflats along Sindh and Balochistan coast.

Trawling

Blue swimming crab, three spot swimming crab and crucifex crabs are caught as bycatch of shrimp trawling along the coast of Pakistan. During daily fishing operations (“hella” fishing) crabs are separated from the catch and landed in fish markets for auction (Fig. 4, 8, 15). In case of multi-day fishing trips, crabs caught during first few days are discarded whereas crabs harvested during last 3 to 8 days are kept with ice and landed in fish market and exported. Smaller crabs from both “hella” and multiday fishing are discarded (Fig. 9, 22) which is considered to be serious impact on population of crabs in the trawling grounds. Recently some trawlers that operated in comparatively deeper waters along continental margin (more than 200 m) also caught Indian Ocean pelagic crabs (*Charybdis smithii*) which were exported as trial shipment and fetched good prices in Thailand.



Fig. 21. In the absence of crab processing for export and limited local consumption, crabs used to dried and used as raw material for fish meal production.

Gillnetting:

Gillnetting is an important gear being used for catching crabs in coastal and offshore waters of Pakistan. Blue swimming crab is mainly caught with bottom-set gillnet (locally known as “Thukri”) in coastal waters and creeks of the Indus Delta and lagoon along the Balochistan coast whereas “Thukri” as well as other bottom-set gillnets are used along open coastline in Sindh (off Indus Delta), along Sonmiani Bay, and other bays along Balochistan coast (Pasni Bay, Shumal Bundar, Gwadar West Bay and off Jiwani) for catching three spot swimming crab. There are no specific gillnet fisheries for crucifix crabs and it is rarely caught in gillnet operations. In daily trip, the crabs are not removed from gillnets and it is usually done at the landing centers. The catch of gillnet operations is landed in wicker baskets, plastic boxes as well as in fish crates (Fig. 23).



Fig. 22. Small-sized crabs (three spot swimming crabs) being discarded in the sea (a) three spot swimming crabs, (b) three spot swimming crabs being discarded from shrimp trawler.



Fig. 23. Catch of crab is landed in fish harbors in (a) fish baskets; (b) wicker baskets.



Fig. 24. Manual harvesting and tying of crab for dispatch for processing and export

Manual Harvesting

Mud crab is manually harvested from mudflats and from among the roots of mangroves during low tides along Sindh and Balochistan coast. Mud crab forms holes in the mud in which they take shelter during low tides; upon locating such a hole, the crab is forced to come out and picked up. Some time wooden stick or iron rods are used to probing and forcing the crabs to come out of the hole. Manual picking of mud crabs is also done for harvesting of mud crab from crab fattening ponds (Fig. 24).

Trap Fishing:

Simple trap made of a circular iron ring with netting was used for catching mud crabs from shallow waters along the Indus Delta (Fig. 25a). The traps were baited with rotten or dried fish. This method is still being used in some areas, however, its use is now limited. Traps were also used extensively for harvesting mud crabs by large crab-fattening facilities.

Handline and Longlining:

Longlines and handlines baited with fresh fish, dried fish or poultry offal were used for catching blue swimming crabs in shallow coastal waters. The main-line of about 100 to 200 m with 1 m branch-lines which are attached about 5 m on the mainline apart to which a piece of bait is tied. The line is laid and after a while line is picked. Blue swimming crabs keep on holding the bait when the line is heaved. The crab is picked up using a scoop net. Handline is also operated in the same manner which is usually used by both adults and children in shallow coastal waters (Fig. 25b).

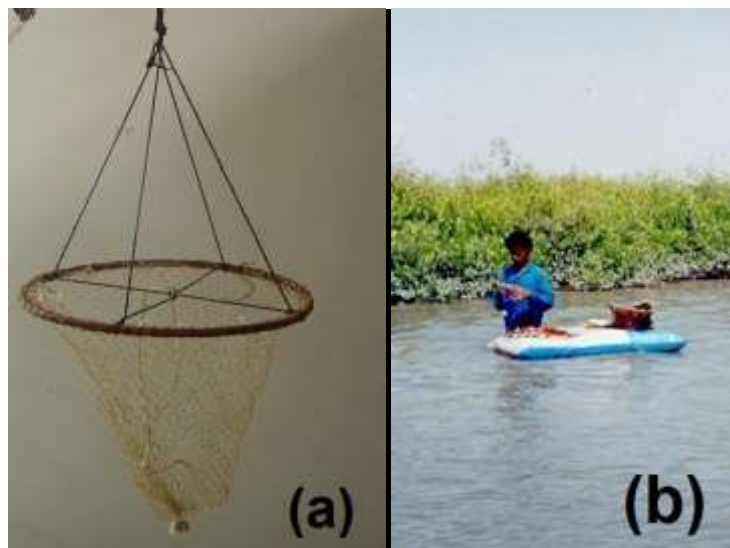


Fig. 25. (a) Simple traps were used for catching mud crabs in shallow waters, (b) handline being use for cacthing blue crab is shallow coastal waters.

Commodities of Crabs

Crabs are not part of the diet in Pakistan and only small quantities are locally marketed. Chilled crab (mainly blue swimming crab) is, therefore, sold in some fish markets. However, bulk of the crabs caught by local fishermen are exported in many forms and commodities including live, chilled, frozen (whole and cut crabs), or meat (in canned forms). Mud crab (genus *Scylla*) is exported mainly in live form whereas all other species are exported in either chilled, frozen or canned meat.

Live Crab

Mud crab belonging to the genus *Scylla* is exported in live form. Keeping other crab species of crab in live form is difficult as these cannot survive outside the sea for long periods. The export of crabs was started in Pakistan in live crabs to Singapore in 1987. Presently, live crabs are exported to mainland China whereas small quantities are also exported to the Persian Gulf countries (mainly to Dubai, UAE). Live crabs are categorized according to the sizes of both males and females (Table-VIII) whereas females with eggs (within the body) are separately categorized, as it fetches higher prices. Recently export of soft crabs, in chilled form, has also started. These soft mud crabs are produced in crab-fattening farms. Mud crabs are highly cannibalistic and aggressive, therefore, soon after their harvesting, chelipeds of mud crabs are tied mainly with plastic cords ensuring that crabs may not fight and damage each other (Fig. 26-27). Mud crabs are generally packaged in small sheds established in some of the coastal settlements around the coast of Karachi. Previously a large facility for fattening and packaging was operative in Gharo, District Thatta which is now not fully operational.



Fig. 26. Live crabs for export are tied with cord to avoid fighting and loss of appendanges



Fig. 27. To keep the live crabs cool during export, ice in the form of frozen PET bottle is placed in the package.



Fig. 28. Holes are made in the styrofoam boxes for flow of fresh air, so that mud crab may breath during export

Chilled Crab:

Small quantities of whole crabs including three spot swimming crabs and blue swimming crabs are exported to Persian Gulf countries. These crabs are categorized according to the same classification as used for frozen crabs (Table-VIII). Prior to packaging such crabs are kept in the slurry of ice and water to cool them to the temperature of melting ice. These are packed in styrofoam (Thermopore) boxes and small quantities of normal ice is placed in the boxes which is holes so that live crab may have supply of air for breathing (Fig. 28). Sometimes small quantities of dried ice are also kept to ensure that normal ice is not melted and to keep it cool till it reaches the destination market.

Frozen Crab

All major seafood processing plants established in Pakistan are engaged in the processing of swimming crabs in frozen form. Upon receipt of crabs from landing centers are graded according to species and size (Table-VIII). It is ensured that during cleaning and grading no appendages are lost or the shell is not damaged as such crabs are rejected or fetch very low prices. The appendanges of crabs are tied with rubber band so that during freezing, packaging and exports legs are not lost (Fig. 29-30). Crabs are packaged in 10 kg cartons and frozen at -30°C and stored at a minimum of -18°C . Cut crab is prepared by removing the carapace, gills, and viscera and split in two from the middle with the help of knife. After washing, these are categorized into sizes (Table-VIII). Major market for whole swimming crabs in frozen form (Fig. 30-31) is South Korea and Thailand whereas cut swimming crabs

(Fig. 31) are exported to South Korea. Berried swimming crab (Fig. 32) are also frozen and exported to South Korea.

Table 8. Weight categories of exported various crab commodities.

Swimming Crab			Mud Crab		
Frozen (pieces/kg)			Live		
Three-spot crab	Blue Crab	Cut Crab	Female with eggs	Female without eggs	Mlae
40/60	40/60	>8	AA1 (>200 g)	A5 (400-500g)	AAA5 (>1000g)
60.80	60.80	8/12	A1 (150-200 g)	A6 (300-400g)	AA5 (500-1000g)
80/100	80/100	12/15	A2 (150 g>)	A7 (200-300 g)	A5 (400-500g)
100/150	100/150	15/19		A8 (110-200 g)	A6 (300-400g)
150/200	150/200	21/25		A9 (90/110 g)	A7 (200-300 g)
200/250	200/250	Broken (large)			A8 (110-200 g)
250/300	250/300	Broken (medium)			A9 (90/110 g)
	300/400	Broken (small)			
	400<				



Fig. 29. Three spot swimming crab whole is exported to southeast Asian countries mainly South Korea and Thailand.



Fig. 30. Blue swimming crab whole is exported mainly to South Korea and Thailand



Fig.31. Frozen cut-swimming crab is exported to South Korea



Fig. 32. Berried swimming crabs also exported to South Korea

Canned Crab:

Canned swimming crab meat used to be exported mainly to USA from Pakistan from 1985 to 2000. Swimming crabs used to be boiled in large containers and after cooling meat of the crab was extracted and categorized as jumbo lump, lump, claw, and cocktail claw (cocktail fingers). The categories may have different names according to size and type in different countries. Each category is, however, separately canned. The process of canning involves placement of meat in cleaned cans, sealing, degassing for 12min at 75 to 90°C, and sterilizing at 80 to 90°C. The

canned crabs are kept in refrigerated conditions at 5°C and transported in refrigerated reefer containers. In addition, crab meat in frozen form is exported to Korea and China in small quantities in 2000's whereas presently crab meat, in small quantities, is also to Sri Lanka for onward processing and export to USA.

EXPORT OF CRABS



Fig. 33. Landings and Export of Crabs in Pakistan

Till 1990s, there was no organized crab fisheries in the country (Fig. 33). By 1995, the demand for crabs increased substantially which led to the establishment of crab fishing using bottom-set gillnetting. Handlining and trawling also used to supplement the landings of crabs which reached a level of 1,877 m. tons in 1995. A major increase in the annual crab landings was observed since then but again it started to decline because of shifting a part of the crab fishing fleet to the harvesting of Indian mackerel which was getting high returns during that period and this trend continued till 2006. Since 2007, a major increase in the crab landings was observed as annual landings of crabs were observed to be about 9,178 m. tons which coincided with the increase in the export of cut-crab from Pakistan mainly to South Korea. This trend continued till 2012 except in 2009 when annual landings of crabs decreased to a level of 7,652 m. tons (Fig. 33).

The annual landings of crabs reached a level of 9,321 m. tons in 2013 and continue to be above 9,000 tons till 2015. There was a decrease in the landings of crabs was observed in 2016 when it reached a level of 5,436 m. tons. This decrease during this period (2016-2022) is attributed to the shifting of the fleet engaged in crab fishing to other fisheries including sole and babylon shells harvesting. An increase in crab annual landings was observed in 2022 when it reached a level of about 6,941 m. tons, because of unprecedented catches of three spot swimming crabs (*Portunus sanguinolentus*) along Phor to Malan areas (Balochistan).

The export of crabs from Pakistan started in 1981 when small quantities of frozen blue crab were exported for the first time to Singapore (Fig. 33-34). This trend continued till 1987, when the export of live mud crab to Singapore was started (Fig. 34-35). The export of pasteurized canned crab from Pakistan to the USA was started in 1989 (Fig. 34-35). Till 1995, only small quantities (collectively less than 500 m. tons annually) of chilled, frozen and canned products used to be exported from Pakistan. The export of live mud crab was the main commodity that was exported between 1995 and 2022. The highest level of export of mud crabs in live form achieved maxima in 2007 when a total of 7,621 m. tons was exported. The annual export of live crab remained to be high (around 6,000 m. tons) between 2008 and 2015. Presently around 3,000 m. tons of live mud crabs are annually exported from Pakistan (Fig.33-34).

The export of frozen crab is an important fishery of Pakistan. Three crab species *Portunus segnis*, *P. sanguinolentus* and *Charybdis feriata* which are mainly harvested from the Indus Delta, lagoons, and coastal waters along the coast are mainly exported to Southeast Asian countries including Thailand, China, Malaysia, and Korea. These are exported as whole frozen and in the form of cut crabs. *Portunus sanguinolentus* seems to be most

dominating among swimming crabs followed by *P. segnis*. Small quantities of crucifix crab (*Charybdis feriata*). Rarely yellowish-brown crab (*C. lucifer*) is also exported whereas recently small quantities of deepwater pelagic swimming crab (*C. smithii*) are also exported to Southeast Asian countries.



Fig. 34. Exports of Crabs from Pakistan (Quantity and Value)

The export of pasteurized canned crab to the USA was started in 1989 when about 20 m. tons of canned crabs were exported to the USA. According to available information, the export of canned crab continued to 2005 when 114 m. tons was exported. Recently (2023), the export of pasteurized crab to the USA via Sri Lanka was again started and it is estimated that about 120 tons of crab meat was exported to Sri Lanka for onward export to the USA.

It may be pointed out that live mud crabs fetch high prices in the local as well as export markets. It may be noted that between 2016 and 2021, the export quantities of both live and frozen crabs were almost the same (Fig. 35-36), however, in terms of value the chilled crab fetches have extremely high prices (Fig. 35-36). Pasteurized canned crabs used to fetch the highest prices among different crab commodities, however, their exports stopped in 2005 (Fig. 35-36). There is still potential for further increase in the local consumption and export of crab which can be achieved by the establishing aimed crab fisheries in offshore waters of Pakistan and promotion of aquaculture of lucrative species such as crucifix crab, blue swimming crab, and three-spot swimming crab as well as strengthening and expanding mud crab fattening in coastal waters.

DISCUSSION

Crabs of Family Portunidae support a substantially large fishery in Pakistan which involved thousands of fishermen as well as an important source of foreign exchange earnings for Pakistan. This fishery supports the livelihood of coastal communities, especially in some areas where seasonal crab fishing is the sole economic activity. Albeit, issues with the taxonomy of most of the commercially important species, crabs are harvested, processed, and exported to many countries. There are issues with the identification of two important crabs occurring in Pakistan. There are issues with the identification of *Portunus (Portunus) segnis* as several scientists are still using *Portunus (Portunus) pelagicus*. Mud crabs in the Indo-Pacific area are now considered to be four distinct species: *S. serrata*, *S. olivacea*, *S. tranquebarica* and *S. paramamosain*, however, most studies in Pakistan referred mud crabs to *Scylla serrata*.

Lai *et al.* (2010) studied in detail the taxonomy of *Portunus (P.) pelagicus* and concluded that it does not occur in Pakistan where it is replaced by *P. (P.) segnis* (Psomadakis, *et al.*, 2015). Similarly Keenan *et al.* (1998) and Kazmi *et al.* (2020) have tried to resolve the taxonomy of the genus *Scylla* but still most of the publications referred to mud crabs as *Scylla serrata*. The use of molecular and genetic studies on the genus *Scylla* has further complicated the identification of the species based on morphological features. Studies by Mandal *et al.* (2014a, 2014b, 2021) using molecular technology revealed that only two species of mud crabs (*S. serrata* and *S. olivacea*) are commonly available in Indian coastal waters. Their studies further indicated *S. tranquebarica* (green morph) reported from India is *S. serrata* and the species named *S. serrata* (brown morph) is *S. olivacea*. According to Psomadakis, *et al.* (2015), only two species *S. tranquebarica* and *S. olivacea* occur in Pakistan. Mandal *et al.* (2021) doubted the

presence of *S. tranquebarica* in Indian waters. A similar situation may be found in Pakistan. There is a need to resolve this issue for which a detailed molecular investigation of the mud crab species that are found in the coastal waters of Pakistan has to be carried out.

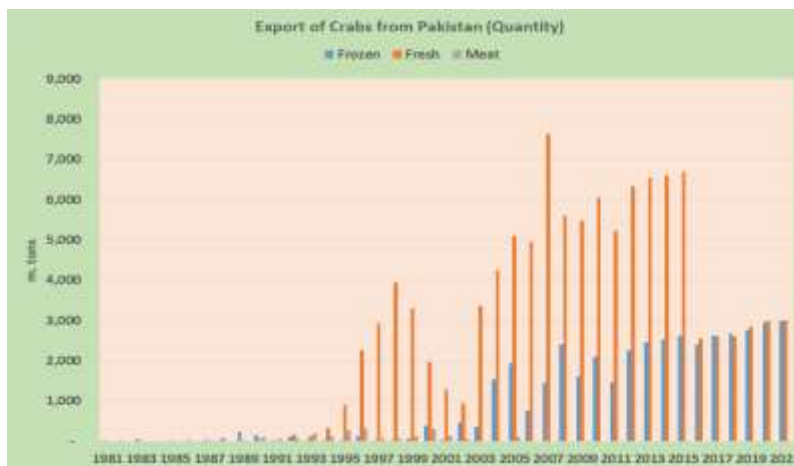


Fig. 35. Exports of Crabs Commodities from Pakistan (Quantity)

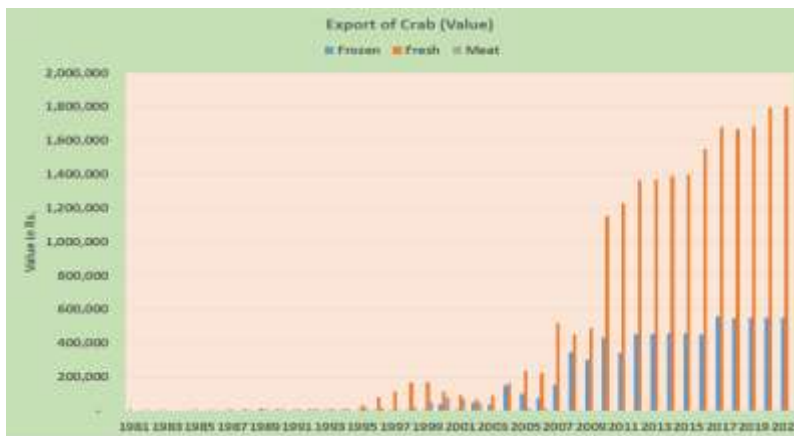


Fig. 36. Exports of Crabs Commodities from Pakistan (Value)

Commercial exploitation of crab is continued without any management measures in Pakistan, therefore, even juveniles are being caught in large quantities which are either discarded in the sea or dried and used for fish meal production. There is a need to develop regulations banning the catching and discarding of juveniles of commercially important crab species, or else the stocks of these species will be seriously affected.

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