2.1. Study area

Goa,located along the central west coast of India, has a coastline of 151 km comprising 44% of sandy beach, 21% rocky coast, and 35% muddy flats (Kumar et al., 2006). Nine intertidal rivers traverse within the state of which two rivers Chapora in the North Goa and Sal in the South Goa are selected for the present study. Both Chapora and Sal estuaries are semi-diurnal micro-tidal estuaries with tidal amplitude of around 0.25 m during neap tide to 2.0 m during the spring tide (Fernandes et al., 2018).

The Chapora river, located in the Bardez taluka with a 32 km stretch of it influenced by salinity fluctuations and harbours around 220 hectares of mangrove forest (Goa State Pollution Control Board [GSPCB], 2019a). The estuary is surrounded by some popular tourist destinations like Vagator beach (South), Morjim beach (North), and Chapora fort (estuarine mouth). Additionally, manual sand extraction activity and aquaculture ponds are common in the estuarine regions. The Sal river in the Salcete taluka is 40 km long with a 14 km stretch of it under the influence of salinity harbouring 11 hectares of mangrove vegetation (Goa State Pollution Control Board [GSPCB], 2019b). The Sal estuary runs along the coastline, featuring shallow shoreline with a narrow mouth, which hinders the transport of domestic wastes into the sea (Fernandes et al., 2018). The Cutbona jetty, located around 2 km from the estuary mouth, is close to popular beaches like Cavellosim, Mobor and Betul, which run parallel to the estuary. Additionally, the collection of bivalves, mussels, and oysters by locals is a common practice along the estuarine banks.

Due to the inflow of population and tourism, anthropogenic activities such as fishing, river cruises, shoreline constructions, sewage disposal, sand mining, extraction of oysters, disposal of fish offal and polythene waste are increasing at an alarming rate. These activities are causing significant alterations to the habitats in these regions.

2.2. Sampling Sites

A total of four mangrove-associated intertidal stations, two each along Chapora (Station C1 and C2) and Sal (Station S1 and S2) estuaries were selected for the present study (Fig. 2.1. Table 2.1). Sites were selected based on habitat diversity, mainly variation in the mangrove vegetation and accessibility. Station C1 is located almost at the mouth of the Chapora estuary (1.5 km) and harbours young and scattered mangrove vegetation (Fig. 2.2). This station is indirectly affected by anthropogenic activities such as the deposition of litter along with the incoming tide and the influence of tourist boat rides. Station C2 is situated 4 km away from

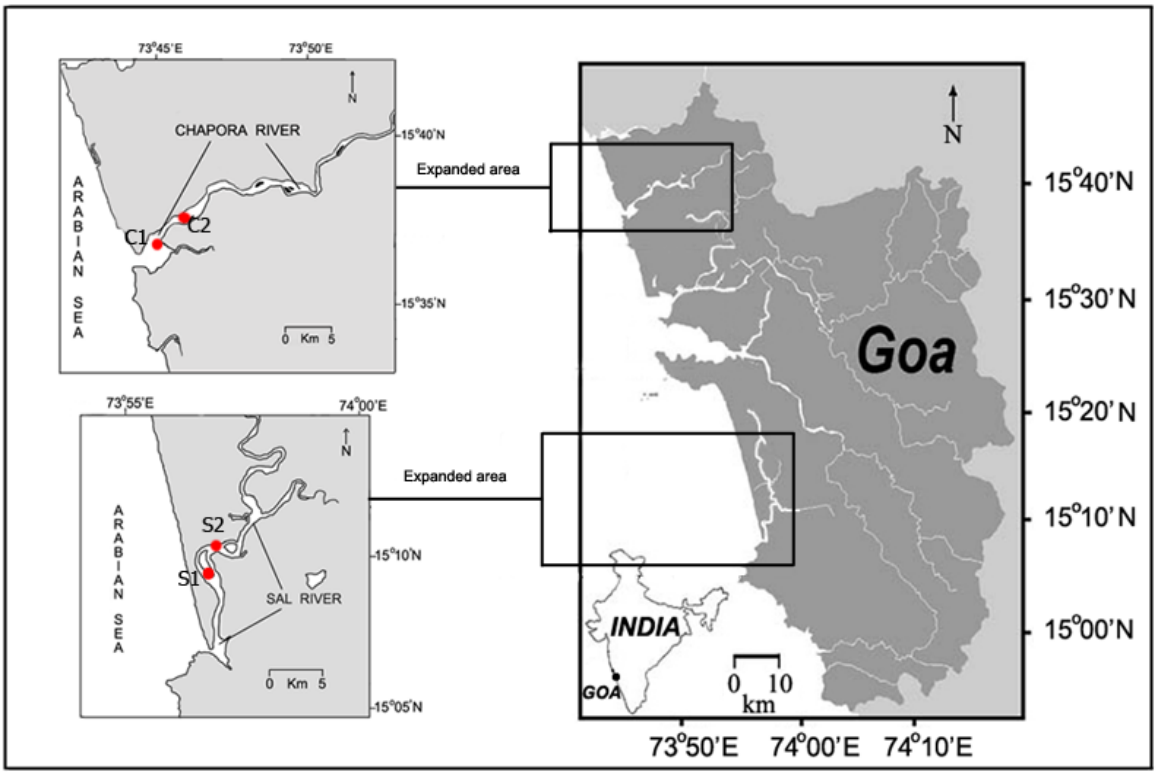

Figure 2.1. Map of the study area indicating the sampling locations.

Table 2.1. Details of sampling stations

Station no.	**Name of Estuary**	**Geographical coordinates**	**Vegetation**
C1	Chapora	15º 37.353'N, 73º 44.758'E	Sandy to muddy substratum with young, scattered *Avicennia marina* mangrove.
C2	Chapora	15º 37.953'N, 73º 45.765'E	Muddy substratum with dense, mixed mangroves (*Avicennia marina, Sonneratia alba* and *Rhizophora mucronata*) and associated shrubs (*Clerodendrum inerme* and *Acanthus ilicifolius*).
S1	Sal	15º 10.095'N, 73º 56.781'E	Muddy substratum with dense, monotypic mangrove *Avicennia marina.*
S2	Sal	15º 09.836'N, 73º 56.952'E	Sand flat lined by *Avicennia marina* mangroves.

the mouth of the estuary. This site is constantly affected by human activities such as the disposal of fish offal and polythene waste, and the movement of fishing canoes of the fisherman. Station S1 is located 3 km away from the mouth of the Sal estuary. The area around the station is surrounded by numerous hotels and resorts, along with shrimp farms. Station S2 is a sand flat located around 4.5 km away from the mouth of the estuary and is relatively pristine.

2.3 Sampling methodology

Intertidal surveys at each station were carried out during low tide at monthly intervals from April 2016 to March 2017 (Table 2.2). The sampling sites were accessed by a motorised canoe. Each survey comprised laying of 1 m^2 quadrant at low, mid and high tide levels to compute epifaunal density and record the types and numbers of brachyuran crabs and molluscs. Species abundance for burrowing fiddler and dotillid crabs was determined directly from the burrow counts; for sympatric crabs (different species occupying the same habitat) was determined with visual counts and photographs in addition to burrow counts and for sesarmids and running crabs with visual counts and photographs. Subsequently, representative subsamples of the biological specimens were picked and stored in pre-labelled containers.

The temperature of water and sediment was recorded on the field using a laboratory thermometer (±0.1°C accuracy). Additionally, samples for estimation of salinity, pH, nutrient concentration, dissolved oxygen, chlorophyll-*a*, suspended particulate matter concentration in seawater and grain size, organic carbon, soil moisture, and chlorophyll-*a* concentration in sediment were collected. For fixing the dissolved oxygen in the water sample, 1 mL Winkler's reagent was added to 125 mL water sample in glass stoppered bottles. For assessing the chlorophyll-*a* pigment concentration, water and sediment sample was collected in amber-coloured polythene bottles. Water samples for recording other environmental parameters were collected separately in plastic bottles. Sediment samples were collected using scoops in pre-labelled polythene bags and stored in ice. Additional details of mangroves and associated vegetation and microhabitats were noted at every tidal level. Sample leaves and flowers were collected from the vegetation for further identification. All the samples were transported in an ice box to the Marine Biology Laboratory at Goa University for further analysis.

Table 2.2. Details of sampling carried out in the study area

Sr. No.	Month and Year of Sampling	Estuary	Date	Time of sampling (h)	Tidal amplitude (m)
1.	April 2016	Chapora	13/04/2016	10.00-12.00	0.3
		Sal	14/04/2016	10.00-12.00	0.4
2.	May 2016	Chapora	13/05/2016	09.30-11.45	0.5
		Sal	14/05/2016	11.00-13.00	0.6
3.	June 2016	Chapora	10/06/2016	8.30-10.45	0.3
		Sal	11/06/2016	9.00-11.00	0.5
4.	July 2016	Chapora	12/07/2016	9.45-12.00	0.7
		Sal	11/07/2016	9.15-11.15	0.8
5.	August 2016	Chapora	10/08/2016	9.15-12.15	0.8
		Sal	09/08/2016	8.15-10.15	0.6
6.	September 2016	Chapora	08/09/2016	9.00-11.00	0.8
		Sal	07/09/2016	9.00-11.00	0.7
7.	October 2016	Chapora	07/10/2016	9.00-11.00	0.8
		Sal	08/10/2016	8.30-10.30	0.8
8.	November 2016	Chapora	20/11/2016	9.30-11.30	0.7
		Sal	21/11/2016	8.30-10.30	0.7
9.	December 2016	Chapora	07/12/2016	9.00-11.00	0.7
		Sal	06/12/2016	9.00-11.00	0.7
10.	January 2017	Chapora	05/01/2017	9.00-11.00	0.5
		Sal	04/01/2017	8.30-10.30	0.6
11.	February 2017	Chapora	04/02/2017	9.45-11.45	0.4
		Sal	03/02/2017	9.00-11.00	0.4
12.	March 2017	Chapora	05/03/2017	9.00-11.00	0.3
		Sal	04/03/2017	9.00-11.00	0.2

2.4. Laboratory procedure

Taxonomic identification and biomass estimation

All the collected specimens were brought to the laboratory and washed under running tap water to remove debris. The larger specimens were photographed using a Sony RX 10II camera, and smaller specimens and body parts were photographed using a DIGITAL SIGHT DS-Fi2 camera attachment for the NIKON SMZ 745T stereomicroscope. Thereafter, standard morphometric characters (Carapace length and width for brachyuran crabs; shell length and width for molluscs) were measured using INSIZE digital vernier calliper, 0-150mm. Subsequently, the specimens were subjected to biomass measurement (wet weight) g per m^2 using electronic weighing balance SHIMADZU ATX124 for weight less than 10 gm and KERN-FCB for weight more than 10 gm weight of the specimens.

The species level identification was carried out using published identification keys, monographs and taxonomic literature. For brachyuran crabs identification, the literature referred included Alcock (1896, 1898, 1899, 1900, 1901); Kemp (1917, 1919); Chhapagar (1957a, 1957b); Banerjee (1960); Serène and Soh (1970); Wee and Ng (1995); Keenan et al. (1998); Ng, (2007); Barnes (2010); Lai et al. (2010, 2013); Padate et al. (2010); Sakai and Holthuis, (2013); Kaullysing et al. (2015); Ng et al. (2017); Shih et al. (2018); Innocenti et al. (2020).

Molluscs specimens were identified following literature such as Gruneberg (1978) Cernohorsky (1984), Reid (1986, 2001); Melvill (1893); Swennen (1997); Tan and Clements (2008); Jagtap et al. (2009); Huber (2010, 2015); Claremont et al. (2013); Ramakrishna and Dey (2010); Reid and Ozawa (2016); Arathi et al. (2018); Nerurkar et al. (2020); Goulding et al. (2021); Ravinesh et al. (2021); Tudu et al. (2021), Hussain et al. (2022).

The species names were updated from the online database World Register of Marine Species (WoRMS) (http://www.marinespecies.org). Further, photographic plates were prepared using Adobe Photoshop (version CC 2019). Abbreviations used in the present study include CW, carapace width; CL, carapace length; G1: male first gonopod for brachyuran crabs and SW, shell width; SL, shell length for molluscs.

Sample preservation

Brachyuran crabs were preserved in 5 % buffered formalin (buffered with hexamethylene tetramine) and molluscs were preserved in 5 % formalin. Samples were stored in plastic bottles and deposited as reference vouchers at the Marine Biology Laboratory, Marine Science programme at the School of Earth Ocean and Atmospheric Sciences, Goa University.

Analysis of physico-chemical parameters of water and sediment

1. *Salinity* (PSU)

The salinity of the water was measured by HANNA HI96822 Seawater Refractometer, calibrated to zero with distilled water with ±0.1 PSU accuracy.

2. *pH*

A portable benchtop pH meter (Model: Thermo Orion Star A211) was used to measure the pH of water samples (Accuracy of ± 0.01). The pH meter was regularly standardised against standard buffer solutions (pH 4.0, 7.0 and 9.2).

3. *Dissolved oxygen* (mg/L)

The dissolved oxygen (D.O.) concentration of the water samples was measured following Winkler's titrimetric method (Grasshoff, 1983). The water samples fixed on field with Winkler's A and B reagents were treated with 50% HCl to dissolve the precipitate and titrated with standard sodium thiosulphate solution, where the endpoint (blue to colourless) was marked using starch as an indicator.

4. *Suspended particulate matter* (mg/L)

Suspended particulate matter (SPM) of water samples was measured by filtering 500 mL of sample through pre-weighed Millipore 0.45 µm membrane filter paper. The filter paper was then oven-dried at 100°C. Once dried, weight was recorded and subtracted from the initial weight to get the SPM value (Grasshoff, 1983). Filter papers were weighed using SHIMADZU ATX124 weighing balance with an accuracy of ±0.001mg.

5. *Nutrients (*µmol/L)

The essential dissolved nutrients (Nitrate-(NO_3-N), Nitrite (NO_2-N), Phosphate (PO_4-P), and Silicate (SiO_4-Si)) were analysed in water samples following the procedure by Grasshoff et. al. (1983). Calibrations were made using aqueous standards and results were expressed in

µmol/L. The procedure adopted for analysing each nutrient parameter is provided below briefly:

a) Nitrate and Nitrite

Nitrate and Nitrite in water were measured by colorimetric method, wherein Sulphanilamide (0.5 mL) and N (1-naphthyl)-ethylenediamine dihydrochloride (0.5 mL) were added to a 25 mL sample resulting in the formation of pink coloured azo dye. The optical density of the resultant sample was measured spectrophotometrically after 10 minutes at 543 nm in a 1cm quartz cuvette. For nitrate, the sample (50 mL) was initially passed through the reductor Cadmium column (> 95 % efficiency) where the nitrate is reduced to nitrite.

b) Phosphate

Phosphate in water was estimated by acidifying 25 mL of sample with acid molybdate reagent (0.5 mL) and further addition of ascorbic acid (0.5 mL) giving blue coloured compound, which is measured spectrophotometrically at 880 nm using 1 cm quartz cuvette in 10 minutes.

c) Silicate

Estimation of silicate in water involved acidifying the sample (25 mL) with acid molybdate reagent (1 mL), thereafter treating it with ascorbic acid (0.5 mL) and oxalic acid (1 mL). In 20 minutes, the resultant blue silico-molybdate complex was measured at 810 nm with 1 cm quartz cuvette spectrophotometrically.

6. Chlorophyll-a in water (mg/L) and sediment (mg/m^3)

Estimation of Chlorophyll-*a* in water and sediment was carried out following procedure by Strickland and Parsons (1972). 500 mL of water sample was filtered through 47 mm GF/F filter paper (Millipore, 0.7 µm pore size). The pigments were extracted by immersing the filter papers in 10 mL of 90 % acetone at 4 (±2) °C for 18 h. For sediment samples 1 gm of sediment was weighed and was similarly immersed in 10 mL of 90 % acetone. Following the extraction, filter papers were centrifuged at 1500 rpm for 5 minutes. The clear supernatant liquid was decanted and measured spectrophotometrically at Wavelengths 665 nm, 645 nm and 630 nm.

7. Texture of sediment: (Sand (%); Silt (%); Clay (%))

The grain size distribution i.e. sand (> 63 microns), silt (2.0 to 63 microns) and clay (< 2.0 microns) fractions in sediment samples were estimated by standard pipette method (Folk, 1968). The abundance of each fraction was expressed in terms of percentage of total weight.

10 gm of oven-dried sediment was weighed and 1000 mL of distilled water was added and stirred thoroughly. Upon settlement of the sediment, the supernatant water was decanted and this step was repeated thrice. The fourth time, after decanting the supernatant water, 10 mL of 10 %, sodium hexametaphosphate was added and kept overnight with occasional stirring to break the flocculated clay particles. Further, 5 mL of 30 % Hydrogen peroxide (H_2O_2) was added to oxidize the organic matter. The resultant sample was then passed through a 63-micron sieve to separate the sand fraction. The filtrate after separating the sand fraction was collected in a 1000 mL cylinder, homogenized using a stirrer and left undisturbed to settle at room temperature. At 8 ϕ, 25 mL of filtrate was pipetted out at a depth of 10 cm from the 1000 mL mark following the standard table given by Folk (1968) (Kwankam et al., 2021). Collection for both sand and clay was done in pre-weighed beakers, which were dried at 60°C and weighed again to determine the sand, silt and clay fractions.

8. Sediment Moisture (%)

Sediment moisture was estimated using a thermogravimetric method as described by Topp et al. (2008). According to this method, a moist sediment sample is weighed and oven-dried for around 24 hours at 105 °C and reweighed. The weight loss is calculated to determine the moisture content.

9. Total organic carbon (%)

To estimate total organic carbon (%), sediment was dried and finely ground using mortar and pestle. 0.2 gm of the sample was weighed and 10 mL of chromic acid was added and kept in a boiling water bath for 15 minutes to oxidise all the organic carbon compounds present in the sample. Once the contents had cooled down, 200 mL of distilled water was added with 1 drop of Ferrous-phenanthroline indicator and titrated with 0.2 N Ferrous ammonium sulphate, until the pink colour persisted (El Wakeel & Riley, 1957) (Rehitha et al., 2017).

2.5. Data Analysis

Species abundance (numbers per m^2) was computed from the burrows, visual counts and photographs of the quadrants. Subsequently, the abundance and biomass of the representative subsamples of each species were extrapolated to the total sample and used to draw inferences on the spatiotemporal variations. Monthly data collected was grouped into

seasons as Pre-monsoon (February-May), Monsoon (June-September) and Post-monsoon (October to January) following Sivadas et al. (2011).

Shannon-Weiner diversity index (H') was calculated using PAST version 4.13 statistical software (Hammer et al., 2001). H' measures the overall diversity or heterogeneity of species in a community, taking into account both species richness (the number of different species) and species evenness (relative abundance of each species) (Shannon & Wiener, 1963). Analysis of variance (ANOVA) (two-way, without replication) was carried out to assess the spatial and temporal differences in the diversity, abundance and biomass of brachyuran crabs and molluscs using the MS Excel program.

Redundancy Analysis (RDA) was performed to understand the spatial distribution of brachyuran crabs and molluscs and their relationship with environmental parameters. To know the suitability for the present study Detrended Correspondence Analysis (DCA) was carried out first and from the results obtained the choice of Canonical Correspondence Analysis (CCA) or RDA was made. The criteria for selection is based on the length of the first axis: if the length is > 2.0 CCA is performed, if it is < 2.0 RDA is performed (Pujari et al., 2021). For the present study length was < 2.0, therefore RDA was performed. To perform the above analysis CANOCO 4.5 software was used.

CHAPTER 3

Species composition of brachyuran crabs

3.1. Introduction

The estuarine shores of Goa are marked by mixed habitats comprising mangrove vegetation, rocky and sandy shores harbouring diverse brachyuran crab assemblage (Hegde et al., 2013). Preliminary faunal surveys were carried out by the Zoological Survey of India (ZSI) among these regions reporting fifty-one species (Dev Roy & Nandi, 2005; Dev Roy & Bhadra, 2008; Dev Roy, 2008, 2013). Thereafter, Vijaylaxmi (2020) in work of her doctoral thesis surveyed and provided baseline data for some rocky shore regions of the Mandovi & Zuari estuaries thereby reporting twenty-nine species of brachyura. Additionally, the studies by Padate et al. (2010, 2013, 2015), Joshi et al. (2011), Velip and Rivonker (2014) and Komarpant et al. (2018) reported new species, new records and concentrated on taxonomy and morphometry of some species of brachyuran crabs from the nearshore waters and the sandy coasts. However, the mangrove-associated estuarine regions, especially of the Chapora and Sal estuaries of Goa have largely remained unexplored. Taxonomically accurate baseline data is important not only for systematists but also for researchers from other disciplines and conservationists. Considering these lacunae in the available knowledge, the present study aims to provide baseline data of the brachyuran crab fauna from the mangrove-associated regions of the Chapora and Sal estuaries of Goa.

3.2. Results

The survey along the four study locations in the Chapora (C1, C2) and the Sal (S1, S2) estuaries revealed thirty brachyuran crab species belonging to eleven families and twenty-four genera (Table 3.1). The maximum number of species belonged to the family Sesarmidae (nine species from four genera) followed by Portunidae (four species from four genera) and Ocypodidae (four species from four genera), Macrophthalmidae (three species from one genus), Dotillidae (two species from two genera), Grapsidae and Varunidae (two species from one genus each), Matutidae, Hymenosomatidae, Xanthidae and Pilumnidae (one species each). Three species namely *Metopograpsus cannicci, Nanosesarma tweediei* and *Sarmatium crassum* were recorded for the first time from India, *Episesarma versicolor* was recorded for the first time from the west coast of India, and seven species namely *Macrophthalmus (Macrophthalmus) brevis, Macrophthalmus (Macrophthalmus) parvimanus, Metopograpsus latifrons, Parasesarma bengalense, Portunus reticulatus, Pseudosesarma glabrum*, and *Tubuca alcocki* were recorded for the first time from the state of Goa.

Table 3.1. Checklist of brachyuran crabs reported from the study area

Sr. No.	Family and species list	References/from Goa
	Order **Decapoda** Latreille, 1802	
	Infraorder **Brachyura** Latreille, 1802	
	Section **Eubrachyura** de Saint Laurent, 1980	
A.	Subsection **Heterotremat**a Guinot, 1977	
I.	**Family Matutidae De Haan, 1835**	
1.	*Matuta victor* (Fabricius, 1781)	Alcock, 1896; Dev Roy & Bhadra, 2008
II.	**Family Hymenosomatidae MacLeay, 1838**	
2.	*Neorhynchoplax demeloi* (Kemp, 1917)	Kemp, 1917; Dev Roy & Bhadra, 2008; Vijaylaxmi, 2020
III.	**Family Portunidae Rafinesque, 1815**	
3.	*Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867)	Vijaylaxmi, 2020
4.	*Portunus reticulatus* (Herbst, 1799)	Present Study
5.	*Scylla serrata* (Forskål, 1775)	Parulekar et al., 1980; Dev Roy & Bhadra, 2008; Padate et al., 2013
6.	*Thalamita crenata* Rüppell, 1830	Dev Roy & Bhadra, 2008; Dev Roy, 2013
IV.	**Family Xanthidae MacLeay, 1838**	
7.	*Leptodius exaratus* (H. Milne Edwards, 1834)	Dev Roy & Bhadra, 2008; Dev Roy, 2013; Lee et al., 2013
V.	**Family Pilumnidae Samouelle, 1819**	
8.	*Heteropanope glabra* Stimpson, 1858a	Kaullysing et al., 2015
B.	Subsection **Thoracotremata** Guinot, 1977	
VI.	**Family Grapsidae MacLeay, 1838**	
9.	*Metopograpsus cannicci* Innocenti, Schubert & Fratini, 2020	Present study
10.	*Metopograpsus latifrons* (White, 1847)	Present study

VII.	**Family Sesarmidae Dana, 1851**	
11.	*Clistocoeloma merguiense* De Man, 1888	Dev Roy & Bhadra, 2008; Dev Roy, 2013
12.	*Episesarma versicolor* (Tweedie, 1940)	Present study
13.	*Nanosesarma andersoni* (De Man, 1888)	Dev Roy & Bhadra, 2008; Dev Roy, 2013; Vijaylaxmi, 2020
14.	*Nanosesarma minutum* (De Man, 1887)	Vijaylaxmi, 2020
15.	*Nanosesarma tweediei* Serène, 1967	Present study
16.	*Parasesarma bengalense* (Davie, 2003)	Present study
17.	*Parasesarma plicatum* (Latreille, 1803)	Dev Roy & Bhadra, 2008; Dev Roy, 2013
18.	*Pseudosesarma glabrum* Ng, Rani and Bijoy Nandan, 2017	Present Study
19.	*Sarmatium crassum* Dana, 1851	Present Study
VIII.	**Family Varunidae H. Milne Edwards, 1853**	
20.	*Chhapgarus intermedius* (Chhapgar, 1957)	Vijaylaxmi, 2020
21.	*Varuna litterata* (Fabricius, 1798)	Dev Roy & Bhadra, 2008; Dev Roy, 2013
IX.	**Family Dotillidae Stimpson, 1858**	
22.	*Dotilla myctiroides* H. Milne Edwards, 1852	Kemp, 1919a; Dev Roy, 2013; Padate et al., 2015
23.	*Scopimera proxima* Kemp, 1919a	Kemp, 1919a; Dev Roy, 2013
X.	**Family Macrophthalmidae Dana, 1851**	
24.	*Macrophthalmus (Macrophthalmus) brevis* (Herbst, 1804)	Present Study
25.	*Macrophthalmus (Macrophthalmus) parvimanus* Guérin, 1834	Present Study
26.	*Macrophthalmus (Mareotis) pacificus* Dana, 1851	Kemp, 1919b; Dev Roy & Bhadra, 2008; Dev Roy, 2013
XI.	**Family Ocypodidae Rafinesque, 1815**	

27.	*Austruca annulipes* (H. Milne Edwards, 1837)	Vijaylaxmi, 2020
28.	*Gelasimus vocans* (Linnaeus, 1758)	Vijaylaxmi, 2020
29.	*Ocypode ceratophthalmus* (Pallas, 1772)	Dev Roy & Bhadra, 2008; Dev Roy, 2013; Komarpant et al., 2018
30.	*Tubuca alcocki* Shih, Chan & Ng, 2018	Present Study

Systematic accounts of all the recorded brachyuran species including their synonymy, material examined, diagnosis, and notes on their habitat and distribution, supplemented with photographic illustrations of diagnostic morphological characters are provided below.

Systematic Accounts

Order Decapoda Latreille, 1802

Infraorder Brachyura Latreille, 1802

Section Eubrachyura de Saint Laurent, 1980

Subsection Heterotremata Guinot, 1977

Family Matutidae De Haan, 1835

Genus *Matuta* Weber, 1795

***Matuta victor* (Fabricius, 1781)**

(Fig. 3.1)

Cancer lunaris Forskål, 1775: 91 (type locality: Malabar coast, India).

Cancer victor Fabricius, 1781: 502; Fabricius, 1793: 449.

Matuta victor Fabricius, 1798: 369; H. Milne Edwards, 1837: 115, pl. 20 figs. 3-6; Alcock, 1896: 158 (identification key), 160; Gravely, 1927: 142, pl. 22 fig. 28; Galil & Clark 1994: 39, fig. 7a-b, pl. 13a-b; Ng et al., 2002: 357 (identification key), 358, fig. 2G; Ng et al., 2008: 50 (list); Galil & Mendelson 2013: 69, Fig. 1,2; Trivedi et al., 2018: 53 (list).

Matuta peronii Leach, 1817: 13; pl. 127 figs. 1, 2.

Matuta lesueurii Leach, 1817: 14.

Matuta lunaris Kossmann, 1877: 64 (part); Sakai, 1936: 49, pl. 13 fig. 3; Chopra & Das, 1937: 383, fig. la; Barnard, 1950: 358, pl. 67 fig. 1; Sankarankutty, 1962: 153, fig. 2; Holthuis & Sakai, 1970: 118, pl. 10 fig. 2.

Matuta victrix Miers, 1877: 243, pl. 39 fig. 1-3 (type locality: Philippines.

Matuta crebrepunctata Ward, 1941: 1 (type locality: Gulf of Davao, Philippines).

Material examined: CW 15.32–63.00 mm; CL 9.10–39.50 mm (N=12)

Diagnosis: Carapace subcircular, smooth, as long as broad (excluding lateral spine), Front wider than orbit, trilobate, median lobe projecting, anteriorly emarginate. Anterolateral margin arcuate, tuberculate. Posterolateral margin convergent, carinate. Lateral spine massive. Orbits communicating with antennular fossa. Suborbital margin laterally interrupted by curved inhalant canal. On pterygostomial region, stridulating organ comprises rows of elongate tubercles. Chelipeds sub-equal, massive. External surface of palm with two rows of granulate low tubercles, proximal most in lower row largest. Mid-palm with a rounded ridge extending to tip of lower finger proximally with granulate tubercle followed by a prominent spine. At lower proximal angle of palm, a prominent spine. Dactylus in male bearing distinctly milled ridge on outer surface, absent in female. Pereopods natatory, with first propodus bearing triangular tooth on inferior margin; P4 carpus unicarinate; P5 propodus greatly extended. Third pleonal somite transversely carinate. Carapace pale yellow, with numerous small and evenly scattered black spots. Pereopods specially dactylus bright yellow.

Habitat and Distribution: Shallow subtidal, substrate sandy (Naderloo, 2017); Distributed from Red Sea, East coast of Africa and Madagascar through South and Southeast Asia to Japan, Australia and Western Pacific islands; invasive species in the Mediterranean region (Galil & Mendelson, 2013).

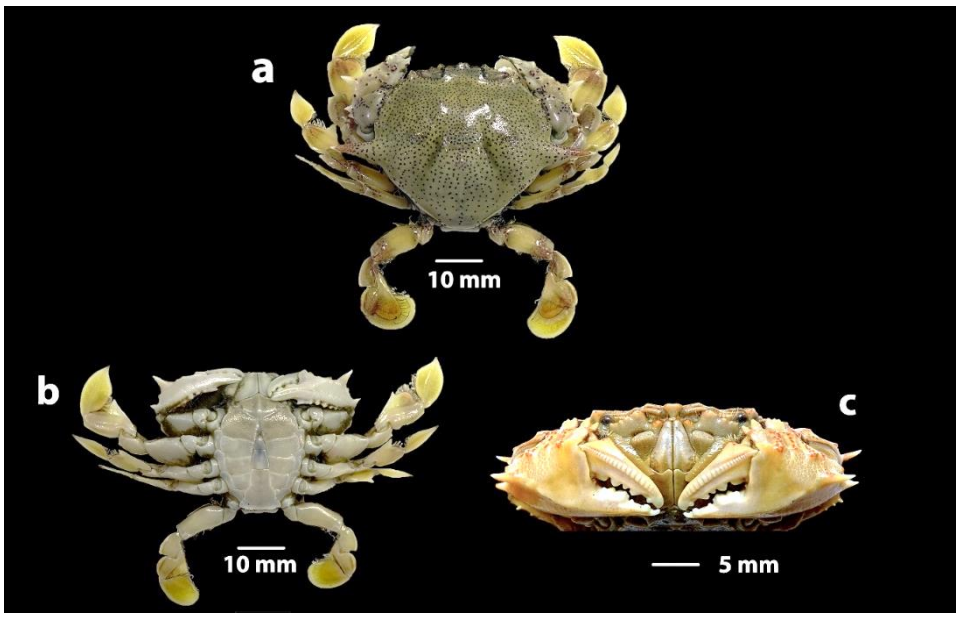

Figure 3.1. *Matuta victor* (Fabricius, 1781); CW 63.00 mm, CL 39.50 mm, male; (a) dorsal view; (b) ventral view; (c) frontal view along with chela.

Family Hymenosomatidae MacLeay, 1838

Genus *Neorhynchoplax* Sakai, 1938

***Neorhynchoplax demeloi* (Kemp, 1917)**

(Fig. 3.2)

Rhynchoplax demeloi Kemp, 1917: 258, figs. 6-9 (type locality: Goa, India).

Neorhynchoplax demeloi Sakai, 1938: 200 (list); Ng et al., 2008: 109 (list); Trivedi et al., 2018: 44 (list); Rahayu et al., 2020: 82 (identification key), 82, figs. 2b, 4a-h.

Material examined: CW 2.70–3.10 mm; CL 2.60–3.00mm (N=2)

Diagnosis: Carapace subcircular, sunken, defined by a marginal rim and the regions delimited by sharply-cut grooves. Rostrum distinctly trilobate, lobes fused, median lobe with rounded distal margin, as long as triangular lateral lobes. External maxillipeds very slender, do not close the buccal cavern. Male chelipeds elongate, subequal, stouter than the walking legs, covered with fine setae; merus long, lower margin with distal strong tooth; carpus subovate; palm slender, surfaces smooth with sparse short setae on upper half; dactylus longer than palm, cutting edge of dactylus and fixed finger with several moderately large teeth. Pereopodal articles broad, lined with bristles; dactylus broad, laterally flattened. Abdominal somites 3–5 of male fused.

Habitat and Distribution: Brackish water environments, plant debris, silty-sand substratum and submerged oyster beds; sluice gate of aquaculture farms (Rayahu et al., 2020). Distributed only along the West coast of India (Kemp, 1917; Haragi et al., 2010; Dineshbabu et al., 2011; Rayahu et al., 2020).

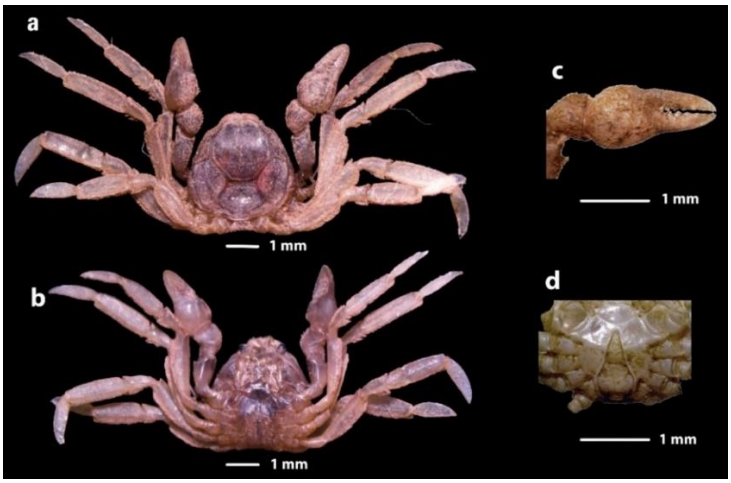

Figure 3.2. *Neorhynchoplax demeloi* (Kemp, 1917); CW 3.10 mm, CL 3.00 mm, male; (a) dorsal view; (b) ventral view; (c) chela dorsal view (d) male abdomen.

Family Portunidae Rafinesque, 1815

Genus *Charybdis* De Haan, 1833

***Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867)**

(Fig. 3.3)

Goniosoma hellerii A. Milne-Edwards 1867: 282, 283 (type locality: New Caledonia).

Goniosoma merguiense De Man 1888b: 82, pl. 5, figs. 3, 4 (type locality: Mergui archipelago).

Charybdis (Goniosoma) merguiense Alcock, 1899: 55.

Charybdis (Goniosoma) merguiensis Nobili, 1906a: 196; Chopra 1935: 484, fig. 8.

Charybdis (Charybdis) helleri Leene, 1938: 44, figs. 15, 16a-d, 17a-c, Crosnier, 1962: 77, figs. 133-135, pl. V, fig. 1; Wee & Ng, 1995: 32. Fig. 14A-G; Apel & Spiridonov 1998: 185 (in key), 194, figs. 13-15, 17; Ng et al., 2008: 153 (list); Naderloo 2017: 172 (identification key), 174, figs. 20.3d, 20.5, 20.7; Trivedi et al., 2018: 64 (list).

Charybdis (Charybdis) lucifera Stephensen, 1945: 115 (not *Portunus lucifer* Fabricius, 1798).

Charybdis helleri Guinot 1967: 255 (list); Jones 1986a: 161, pl 47.

Material examined: CW 49.63 mm, CL 32.10 mm (N=1)

Diagnosis: Carapace glabrous, with no ridges present behind epi branchial; six frontal teeth, medians elliptical, laterals acutely triangular, separated from sub medians by deep V-shaped notch; six anterolateral teeth, first and second closer and sub equal in size, last elongate and spiniform, projecting beyond preceding tooth. Basal antennal segment bearing sharp granular ridge. Chelipeds stout and unequal, surface finely pubescent; anterior border of merus with three spines and a spinule at distal end; carpus with strong spine on inner angle and three spinules at outer angle; manus with five spines on upper surface, outer surface three smooth costae, inner surface with median costa, lower surface smooth; fingers stout, deeply grooved. Propodus of natatory leg serrated on posterior border; merus and carpus with spine on posterior border. Penultimate segment of male abdomen with lateral borders parallel then converging distally. G1 distal tip slender and elongate, inner surface with short bristles, ending as tiny spinules at base of G1, outer surface with longer bristles starting from tip and ending at distal third of it.

Habitat and Distribution: Intertidal rocky, cobble, sandy and muddy substrates among mangroves and coral reefs (Stephenson, 1972b). Distributed from South and East Africa

through South and Southeast Asia to Australia and New Caledonia; invasive species in the Mediterranean region, the Caribbean coast of Colombia, Atlantic coasts of Florida and Brazil (Apel & Spiridonov, 1998).

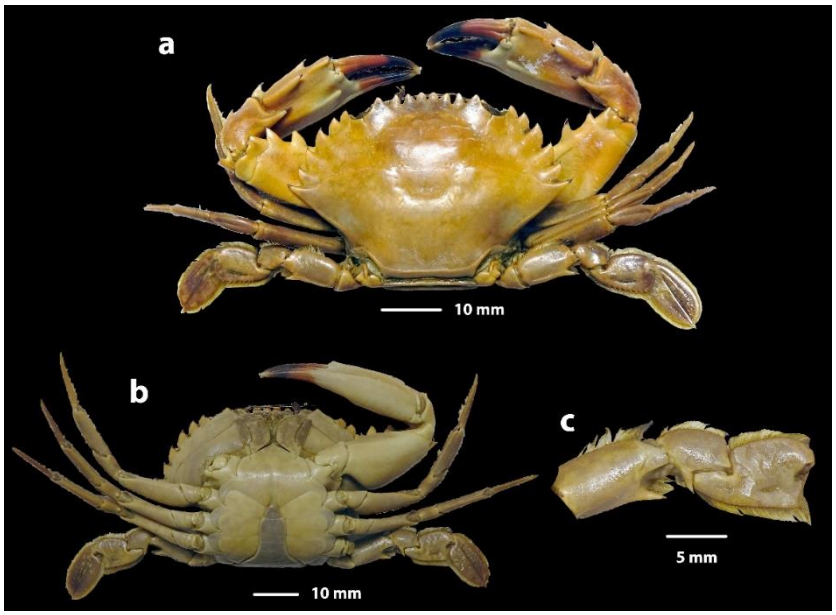

Figure 3.3. *Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867); CW 49.63 mm, CL 32.10 mm, male; (a) dorsal view; (b) ventral view; (c) spine on merus and carpus of natatory leg.

Genus *Portunus* Weber, 1795

***Portunus reticulatus* (Herbst, 1799)**

(Fig. 3.4)

Cancer pelagicus Fabricius, 1798: 367.

Cancer reticulatus Herbst, 1799: 65, pl. 50 (type locality: East Indies).

Portunus pelagicus Stephenson, 1972a: 15 (identification key); Sethuramalingam & Khan, 1991: 9 (identification key), 27, pl. 18d; Sakai, 1999: 29, pl. 15C.

Neptunus (Neptunus) pelagicus Alcock, 1899: 34; Chopra, 1935: 476, fig. 3; Chhapgar, 1957a: 418, pl. 6a-c, A6.

Neptunus pelagicus De Man, 1888: 328; Henderson, 1893: 367.

Portunus trituberculatus Stephenson & Rees, 1967a: 17

Portunus (Portunus) reticulatus Ng et al., 2008: 152 (list); Lai et al., 2010: 218, 225 (identification key), figs. 6C, 7C, 15, 16, 20C, 21C, 22C, 23C, 23G, 24C.

Portunus reticulatus Trivedi et al., 2018: 67 (list); Ahmed et al., 2021: 3, Fig. 4.

Material examined: CW 10.72–134.78 mm; CL 6.74–60.72 mm (N=48)

Diagnosis: Carapace width 2.2–2.3 times wider than long, surface finely granulated, median frontal teeth spinous, small but conspicuous. Adults with regions relatively poorly indicated. branchial regions not markedly swollen. Cheliped merus relatively short and stout, anterior margin with 3 spines. Natatorial paddle oval but less elongate. Sixth male abdominal somite relatively elongate, tapering. The base of G1 with small but conspicuous rounded basal spur. Males with greenish-blue carapace, large pale green spots with thick reticulations and variable patterns, females with green-brown carapace, tips of chelipeds marked bright red.

Habitat and Distribution: Shallow sandy lagoons (Ameer Hamsa, 1978). Distributed from Southeastern coast of India, eastern coast of Sri Lanka, southwestern Thailand (Lai et al., 2010) and Bangladesh (Ahmed et al., 2021). The present observation is the first record from Goa coast.

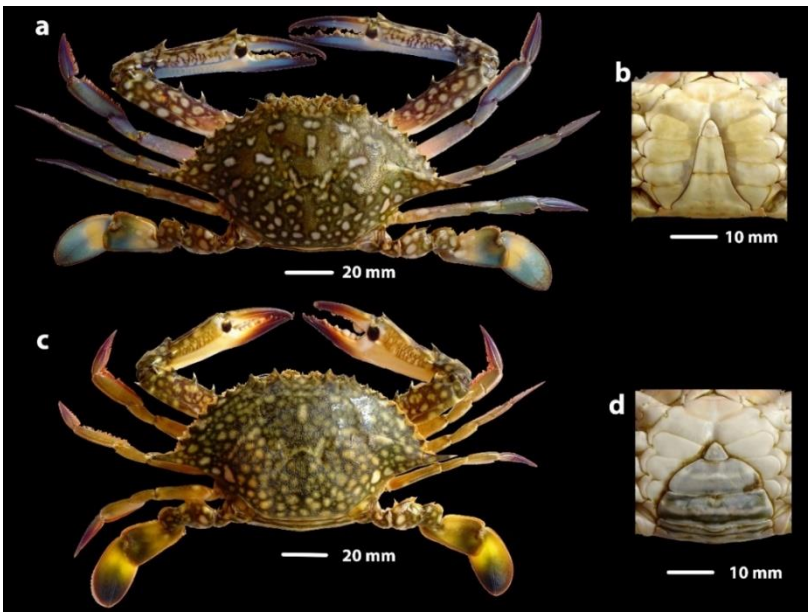

Figure 3.4. *Portunus reticulatus* (Herbst, 1799); CW 130.90 mm, CL 58.81 mm, male; CW 134.78 mm, CL 60.72 mm, female; (a) dorsal view, male; (b) male abdomen; (c) dorsal view, female; (d) female abdomen.

Genus Scylla De Haan, 1833

Scylla serrata (Forskål, 1775)

(Fig. 3.5)

Cancer serratus Forskål, 1775: 90 (type locality: Jeddah, Saudi Arabia).

Portunus serratus Rüppell, 1830: 10, pl. 2.

Achelous crassimanus MacLeay, 1838: 61 (type locality: mouth of Zwartkops River, South Africa); Stebbing, 1910: 308.

Portunus (Scylla) serrata de Haan, 1833: 44.

Scylla tranquebarica var. *oceanica* Dana, 1852a: 270 (type locality: Navigator Islands, Pacific Ocean).

Scylla oceanica (not Dana, 1852) Estampador, 1949: 101, pl. 1 fig. 2.

Scylla serrata A. Milne Edwards, 1861: 349; Barnard, 1950: 160, fig. 31b, c; Crosnier, 1962: 72, figs. 128-129; Guinot, 1966: pl. fig. 1; Apel & Spiridonov, 1998: 312 (identification key), 312; Ng et al., 2008: 153 (list); Padate et al., 2013: 83, figs. 2a, c, 3a, 4a, 5a, 6a-c; Trivedi et al., 2018: 68 (list).

Scylla tranquebarica (not Fabricius, 1798): Joel & Raj, 1980: 39, figs. 1, 3, 5, 7, 9a, b.

Material examined: CW 19.20- 152.70 mm; CL 12.82–99.49 mm (N=11)

Diagnosis: Carapace oval, convex and smooth, 'H' shape groove moderately carved in the center of the carapace; front lobe spines high, bluntly pointed with interspaces rounded. Anterolateral margin with nine narrow equivalent spines. Carpus of cheliped with two obvious spines on distal half of outer margin, palm of cheliped with a pair of distinct spines on dorsal margin behind insertion of the dactyl. Chelipeds and legs all wit polygonal patterning for both sexes and on abdomen of female only.

Habitat and Distribution: Digs large burrows among pneumatophores of mangrove forests inundated with wide range of salinity (Naderloo, 2017). Distributed from South Africa to Australia, Tahiti and Japan (Apel & Spiridonov, 1998).

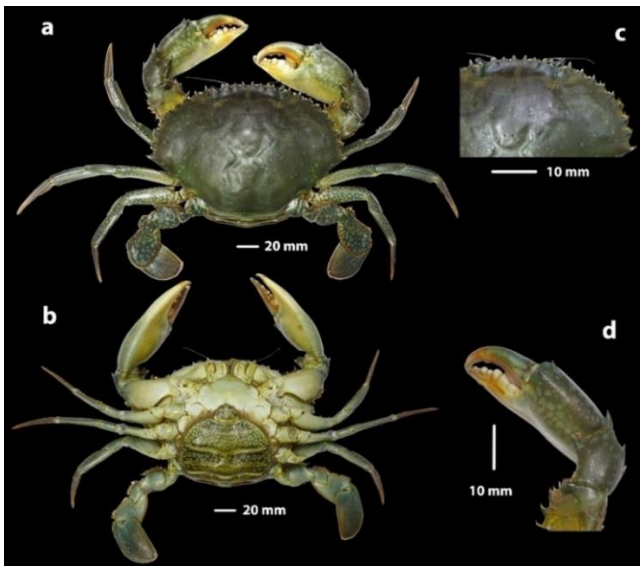

Figure 3.5. *Scylla serrata* (Forskål, 1775); CW 152.70 mm, CL 99.49 mm, female; (a) dorsal view; (b) ventral view; (c) frontal lobes and anterolateral teeth; (d) right chela, showing spines.

Genus *Thalamita* Latreille, 1829

Thalamita crenata Rüppell, 1830

(Fig. 3.6)

Thalamita crenata Rüppell, 1830: 6, pl. 1, fig. 2 (type locality: Southern Red Sea).

Portunus crenatus H. Milne Edwards, 1834: 461.

Thalamita crenata H. Milne Edwards, 1834: 461; Alcock, 1899: 73 (key), 76; Barnard, 1950: 171 (key), 172, 174, figs. 27e, 33a; Crosnier, 1962: 130, figs. 220, 226-227, 232-233; Wee & Ng, 1995: 69, figs. 34A-B, 35A-B, 36A-H; Apel & Spiridonov, 1998: 228 (identification key), 233, figs. 44, 49-50, pl. 8; Ng et al., 2008: 154 (list); Trivedi et al., 2018: 68 (list)

Thalamita prymna var. *crenata* Kossmann, 1877: 49; Laurie, 1906: 418.

Thalamita ceranata [sic] Hashmi, 1963: 17.

Material examined: CW 7.84–52.10 mm; CL 5.82–40.10 mm (N=45)

Diagnosis: Carapace surface glabrous, sparsely pilose. Six frontal lobes, broadly rounded; five anterolateral teeth subequal - decreasing slightly in size from front to rear. Chelipeds unequal; merus bearing three to four spines on anterior border; carpus armed with a strong spine at an inner angle and three spinules at an outer angle; the outer surface of manus smooth, bearing single crest running to the tip of the immovable finger, upper surface bearing five spines including spine at wrist articulation. Propodus of natatory leg with serrulations along distal half of posterior border. Penultimate segment of male abdomen with lateral borders slightly convergent distally. G1 long, gradually tapering, evenly curved along distal portion, single row of bristles line inner border, terminal cluster of bristles on the sternal surface.

Habitat and Distribution: On rocky and muddy intertidal platforms in the vicinity of mangrove-fringe and mangrove swamps (Vezzosi et al., 1995). Distributed from Red Sea, Madagascar, South and east Africa, through South and Southeast Asia to Australia, Japan and Hawaii (Apel & Spiridonov, 1998).

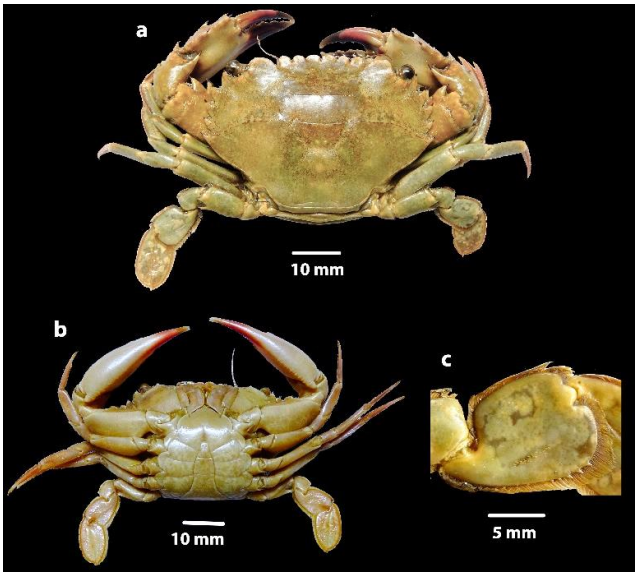

Figure 3.6. *Thalamita crenata* (Latreille, 1829); CW 44.76 mm, CL 30.33 mm, male; (a) dorsal view; (b) ventral view; (c) propodus of the natatory leg with serrulation.

Family Xanthidae MacLeay, 1838

Genus *Leptodius* A. Milne Edwards, 1863

***Leptodius exaratus* (H. Milne Edwards, 1834)**

(Fig. 3.7)

Cancer inaequalis Audouin, 1826: 86 (type locality: Egypt).

Chlorodius exaratus H. Milne Edwards, 1834: 402 (type locality: India).

Leptodius exaratus A. Milne Edwards, 1868: 71; Klunzinger, 1913: 209, pl. 3, fig. 6, pl. 5, fig. 16; Khan, 1977: 181, pl. 1D; Serène, 1984: 184, fig. 106, pl. 26 fig. A; Tirmizi & Ghani, 1996: 48, fig. 18; Ng et al., 2008: 203 (list); Trivedi et al., 2018: 80 (list).

Leptodius exaratus sensu stricto Lee et al., 2013: 190, fig. 2, 4 A-D.

Actaeodes lividus Paul'son, 1875: 35, pl. 5 fig. 2 (type locality: Red Sea).

Chlorodius (Leptodius) exaratus Kossmann, 1877: 32, pl. 2, figs. 1-6.

Xantho exaratus *var. typica* Ortmann, 1893: 445 (in part).

Xantho (Leptodius) exaratus Alcock, 1898: 118 (in part) (identification key); Stephensen, 1945: 149, fig. 37c; Guinot, 1958: 92; Michel, 1964: 32.

Xantho hydrophilus Laurie, 1915: 44, pl. 43, fig. 1 (type locality: Red Sea) (not *Cancer hydrophilus* Herbst, 1790).

Xantho exaratus Monod, 1938: 125, fig. 17b; Vatova, 1943: 19.

Xantho (Leptodius) hydrophilus Barnard, 1950: 223, g. 41c, 42c–e (not *Cancer hydrophilus* Herbst, 1790).

Material examined: CW 4.78–25.28 mm; CL 3.62–17.45 mm (N=47)

Diagnosis: Carapace transversely subovate, 1.5-1.6 times as broad as long, rugose, well defined carapace regions separated by distinct grooves. Anterolateral margin with 4 broad, triangular teeth behind exorbital angle. Chelipeds unequal with long setae on anterior and posterior margin of merus; fine granules on outer surface of carpus; wrinkled external surface, inner angle with blunt tooth; palm inflated, dorsally rugose and ventrally smooth; fingers stout, black coloured, cutting margins irregularly dentate and spoon shaped tips. Male abdomen narrow with fused 3rd and 5th somite. G1 long, slender, with 6–8 stout, curved sub distal spines and 8-10 mushroom-shaped outgrowths. Apical lobe elongate, 0.05–0.07 times total length, slightly angled with rest of gonopod.

Habitat and Distribution: On rocky or cobble substrates in intertidal waters (Naderloo, 2017). Distributed from East and South Africa to the Red Sea and India (Lee et al., 2013).

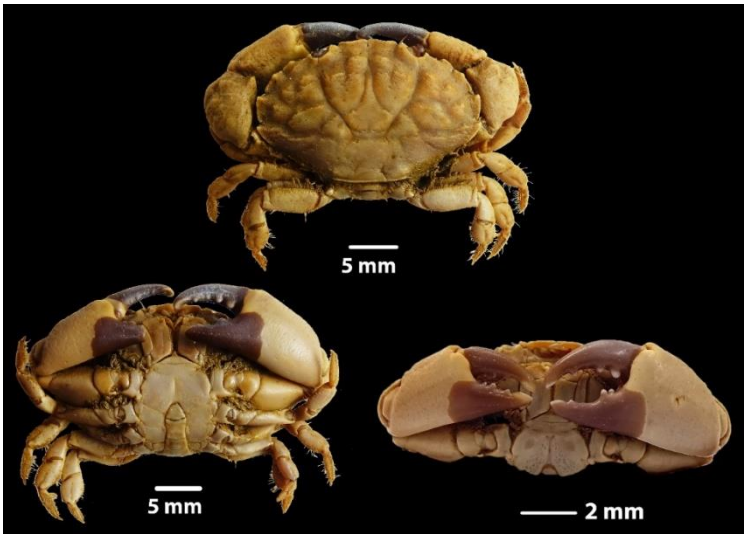

Figure 3.7. *Leptodius exaratus* (H. Milne Edwards, 1834); CW 21.92 mm, CL 14.13 mm, male; (a) dorsal view; (b) ventral view; (c) frontal view of chela.

Family Pilumnidae Samouelle, 1819

Genus *Heteropanope* Stimpson, 1858

***Heteropanope glabra* Stimpson, 1858**

(Fig. 3.8)

Heteropanope glabra Stimpson, 1858a: 35 (type locality: Hong Kong). Stimpson, 1907: 63, pl. 8, fig. 1; Ng et al., 2008: 140 (list); Kaullysing et al., 2015: 1196 (identification key), 1196, figs. 5-7; Trivedi et al., 2018: 59 (list).

Pilumnopeus maculatus A. Milne Edwards, 1867: 227; A. Milne Edwards, 1868: 82, pl. 19, figs. 17-19.

Eurycarcinus maculatus De Man, 1887: 44, pl.2, figs.2-3; Sankarankutty, 1962: 146, fig. 51.

Actumnus nudus (not Milne Edwards, 1867) Grant and McCulloch, 1906: 17.

Not *Heteropanope glabra* Sakai, 1976: 503, fig. 269.

Heteropanape longipedes Davie, 1989.

Material examined: CW 4.62–14.48 mm; CL 3.22–9.75 mm (N=145)

Diagnosis: Carapace smooth, wider than long (1.4 –1.5 times), convex on the mid line, carapace region poorly defined. Front broadly bilobed, each lobe being convex; no lateral lobule distinct from supraorbital angle. Antero-lateral margin cut into four teeth or lobes, which may be pointed but not spinous, first tooth a broad lobe confluent with the outer orbital angle. Chelipeds unequal in size with smooth surface, carpus with strong blunt tooth on the inner side. Walking legs moderate in length; slender in shape; with serrated setae, thicker setae on propodus and dactylus. Male abdomen triangular in shape and seven segmented; first to third segments similar in width; four to seven similar in length; telson bluntly rounded distally and base as broad as wide; G1 slender and elongated; S-shaped with a downward tapering tip.

Habitat and Distribution: Among rock or cobble on muddy substrates in the vicinity of mangroves in intertidal waters (Naderloo, 2017). Distributed from East coast of Africa through South and Southeast Asia to Northern Australia and Solomon Islands (Trivedi et al., 2015).

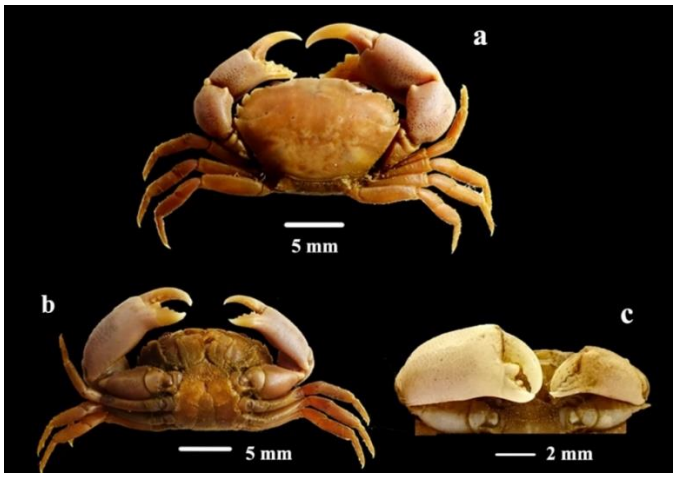

Figure 3.8 *Heteropanope glabra* Stimpson, 1858; CW 12.88 mm, CL 8.33 mm, male; (a) dorsal view; (b) ventral view; (c) frontal view of chela.

Family Grapsidae MacLeay, 1838

Genus *Metopograpsus* H. Milne Edwards, 1853

***Metopograpsus cannicci* Innocenti, Schubart & Fratini, 2020**

(Fig. 3.9)

Metopograpsus thukuhar Crosnier, 1965: 25, Fig. 20-22, 27; Vannini & Valmori, 1981a: 73, Fig. 8B, 9B; Naderloo, 2011: 11, Figs. 4a–g, 5f; Trivedi et al., 2018: 42 (list).

Metopograpsus cannicci Innocenti et al., 2020: 621 Figs. 1A, 2A, 3A, 4A, 5A, 6.

Material examined: CW 3.88–22.00 mm; CL 5.23–28.66 mm (N=156)

Diagnosis: Carapace flat, broader than long and smooth. Lateral margins entire. Regions weakly defined, urogastric region with groove distinct, branchial region having distinct oblique ridges, cardiac and intestinal regions smooth, with no ridge or tubercles. Front broad, deflexed with rugose surface and free margin crenulated, with some concavity, 4 depressed post-frontal lobes along the line of frontal deflexion. Suborbital tooth triangular, suborbital border denticulate. The exposed surface of the base of the antenna densely pubescent. Chelipeds subequal, with no certain handedness, fingers stout with spatulated tip, slight gape visible when closed. The cutting edge of both fingers with series of inconspicuous teeth. Ambulatory legs compressed, merus broad and longest, third and fourth pereiopod longest, first shortest. Male abdomen with 6 distinct segments, basal one as broad as thoracic sternum, somite 6 almost rectangular, telson triangular. Female pleon fringed with long setae, broad, evenly rounded, telson half-moon shaped. In males, G1 slender, with twisted shaft along the longitudinal axis, apical corneous process elongate, bearing long setae at the base.

Habitat and Distribution: On pneumatophores of *Avicennia marina* shrubs, in creeks and fringing mangroves, wooden and concrete vertical surfaces in harbours and vertical jetties (Innocenti et al., 2020). Distributed from East coast of Africa, Madagascar, Mauritius and Iran (Innocenti et al., 2020). The present observation constitutes the first record from India.

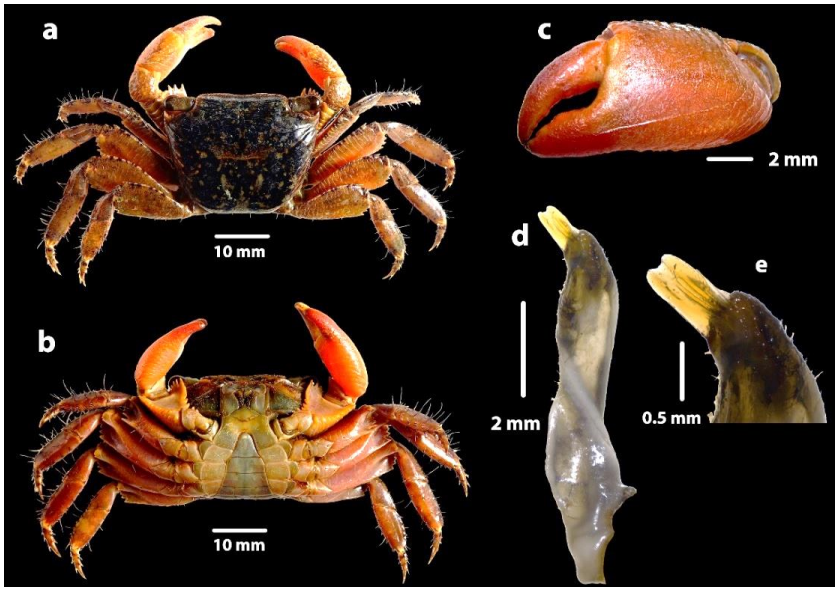

Figure 3.9. *Metopograpsus cannicci* Innocenti, Schubart, and Fratini 2020; CW 25.35 mm, CL 20.61 mm, male; (a) dorsal view; (b) ventral view, (c) left chela showing inconspicuous teeth; (d) left pleopod - G1, dorsal view; (e) G1 apical chitinous process.

Metopograpsus latifrons (White, 1847)

(Figs. 3.10)

Grapsus latifrons White, 1847a: 337, pl. 2 fig. 2 (type locality: Eastern Seas, Singapore).

Metopograpsus maculatus H. Milne Edwards, 1853: 165; 7b: 517, pl. 15.

Metopograpsus latifrons H. Milne Edwards, 1853: 166; Tweedie, 1949: 468, pl. 1; Banerjee, 1960: 12, fig. 4j, 5d, 6a; Ng et al., 2008: 217 (list); Trivedi et al., 2018: 42 (list).

Grapsus (Grapsus) dilatatus Herklots, 1861: 129.

Metopograpsus pictus A. Milne Edwards, 1867: 283.

Grapsus dilatatus De Man, 1879: 68.

Material examined: CW 9.78–23.95 mm, CL 8.04–9.51 mm (N=7)

Diagnosis: Carapace trapezoidal, flat, slightly convex, glabrous, glossy, broader than long. Lateral margin entire, very convergent posteriorly. Front broad, more than half the greatest width of the carapace, sharp, distinct, almost straight, beaded. Post frontal region with 4 distinct lobes separated by furrow, outer lobes broader than the median with tendency to split into two. Orbits are markedly oblique, infraorbital margin slightly serrated, lined with setae. Suborbital tooth obtuse, keeled. Chelipeds sub-equal. Ambulatory legs flattened, long and broad merus. Second pereiopod shortest and fourth longest. Ischium and merus end with a spine, merus, and carpus with distinct squamiform markings. Propodus of every walking

leg with unique pattern of setae. Dactylus of all the pereiopod with chitinous spines. The sixth segment of the male abdomen distinctly rectangular in shape, outer border auriculate. G1 slender, coiled, apical chitinous process obliquely T shaped, petal like, the base of the chitinous projection soft with setae. Gonopore on 6th segment, shallow, inverted 'U' shaped.

Habitat and Distribution: on trunks, prop roots and crevices of mangrove trees during low tides, sluice gates of fish ponds (Masagca, 2011). Distributed from southwest coast of India through southeast Asia to the Philippines (Fratini et al., 2018). In India, it is known from Tamil Nadu and Kerala (Kurian & Apreshgi, 2020); the present observation is the first record from the Goa coast.

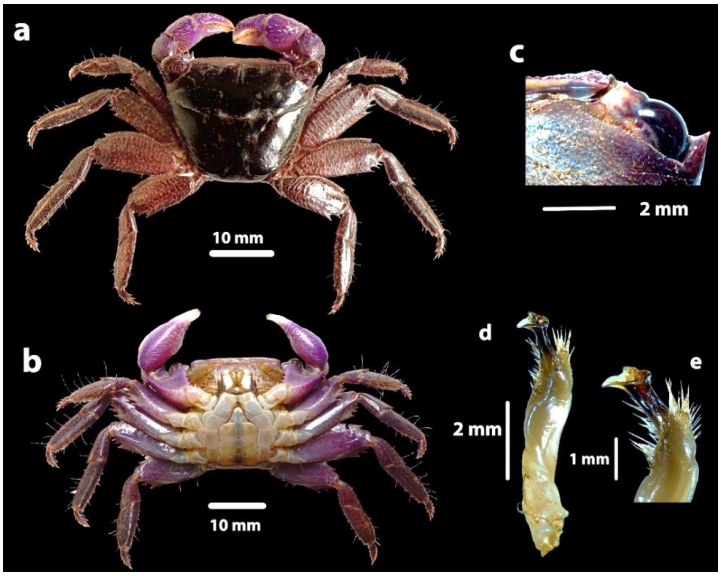

Figure 3.10. *Metopograpsus latifrons* (White, 1847); CW 23.95 mm, CL 19.51 mm, male; (a) dorsal view; (b) ventral view; (c) suborbital tooth and margin; (d) left G1, sternal view; (e) G1 chitinous projection.

Family Sesarmidae Dana, 1851

Genus *Clistocoeloma* A. Milne-Edwards, 1873

***Clistocoeloma merguiense* de Man, 1888 [in de Man, 1887-1888]**

(Figs. 3.11)

Clistocoeloma merguiensis de Man, 1888 (in de Man, 1887-1888): 195, pl. 13, fig. 10 (type locality: Kisseraing Island).

Clistocoeloma merguiense Alcock, 1900: 429; Chopra and Das, 1937: 431, fig. 21; Hsueh and Huang, 1996: 67, Fig. 3C, D; Fig. 4B, D; Ng et al., 2008: 220 (list); Lee et al., 2014: 967, fig. A-F; Trivedi et al., 2018: 71 (list).

Material Examined: CW: 17.71 mm, CL 14.64 mm (N=1)

Diagnosis: Carapace quadrangular, a little more than three-fourths as long as broad; the dorsal surface is convex and the regions well-demarcated, covered with numerous small patches of blackish tomentum. The front slightly sinuate, the epigastric lobes thick. The anterior half of the lateral border cristate and is indistinctly divided into three lobes, the middle lobe shortest; the posterior half of the border depressed and not crested or tomentose. The chelipeds are also fringed with short piles and furnished with small patches of tomentum, the dorsal margin of the dactylus with 15 to 16 granules. The ambulatory legs are compressed and thickly fringed with short, blackish tomentum as in other parts of the body; the merus is rather slender, being about 2.5 times as broad as long, and its dorsal surface marked with several patches of tomentum. G1 short and stumpy with broadly truncate tip which is densely hairy.

Habitat and Distribution: Burrowing in wet mud (Kemp, 1918), and dead and rotten wood (Hutchings & Recher, 1982). Distributed from India through Southeast Asia to Japan (Ghosh, 1995).

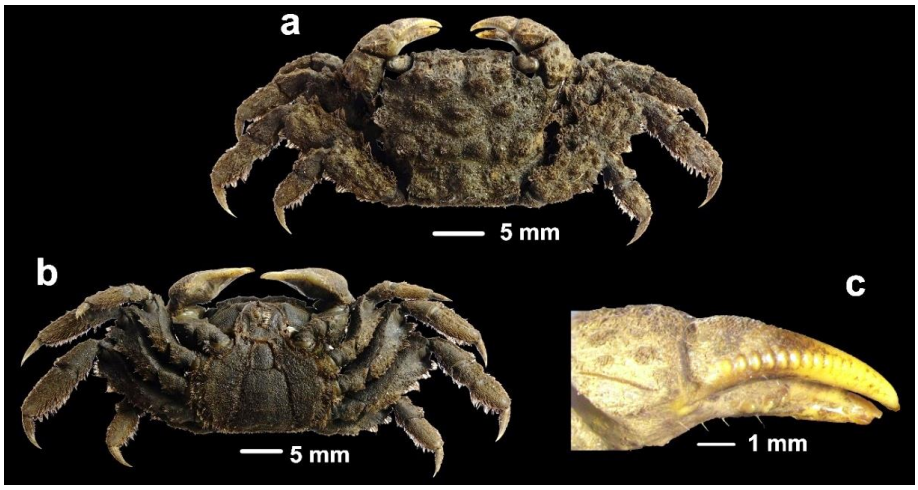

Figure 3.11. *Clistocoeloma merguiense* de Man, 1888; CW 17.71 mm, CL 14.64 mm, male; (a) dorsal view; (b) ventral view; (c) dactylus of the left chela with granules.

Genus *Episesarma* De Man, 1895

Episesarma versicolor (Tweedie, 1940)

(Figs. 3.12)

Sesarma (Sesarma) palawanensis Tweedie, 1936: 54-58, text fig. 1a, pl. 14 (not Sesarma *(Sesarma) palawanense Rathbun, 1914).*

Sesarma versicolor Tweedie, 1940: 98, fig. 7 (type locality: Singapore).

Sesarma (Episesarma) versicolor Soh, 1969: 11 (list), 21 (key), 58, 92 (list), 94, 96, 97, 101 (list), figs. 10, 21, table 13.

Sesarma (Sesarma) versicolor Serène and Soh, 1967: 27, pl. 3, 4.

Neoepisesarma (Neoepisesarma) versicolor Serène & Soh, 1970: 396, 405 (list); Dai et al., 1986: 495, fig. 279 (2), pl. 70 fig. 1.

Episesarma versicolor Ng, 1998: 1140 (key), 1143, figs. 10, 11; Ng et al., 2008: 220 (list).

Material Examined: CW 15.83–29.65 mm; CL 14.46–27.72 mm (N=3)

Diagnosis: Carapace quadrate, slightly wider than long, covered with tufts of setae on the entire carapace, posterior region with inverted 'V' shaped row of setae. Regions well marked, with four distinct frontal lobes. Lateral margin subparallel with one lateral tooth behind the external orbital angle. Adult male cheliped with the dorsal surface of palm sparsely granulated; dorsal margin of the dactylar finger of chela with 46 tubercles increasing in size towards the distal end of dactylus. Single longitudinal pectinated ridge on dorsal margin with 70 fine tubercles. The palm of chela violet with fingers white; juveniles with delicate chela without ridge or dactylar tubercles and with whitish to violet colouration. Ambulatory legs long and slender with violet and black colouration and chitinous dactylus tips. Male abdomen narrow, telson tip oval. Abdomen and sternum white coloured; G1 with a single row of setae on the exterior margin, tip of G1 with dense tufts of setae, single peak with chitinous crest relatively narrow.

Habitat and Distribution: Arboreal species on mangrove vegetation, also digs burrows at mud base of mangrove trees (Sivasothi, 2000). Distributed from India through Southeast Asia to China, Philippines and Australia (Lee et al., 2015; Manikantan et al., 2016). In India, known from Tamil Nadu (Manikantan et al., 2016). The present observation is the first record from the west coast of India.

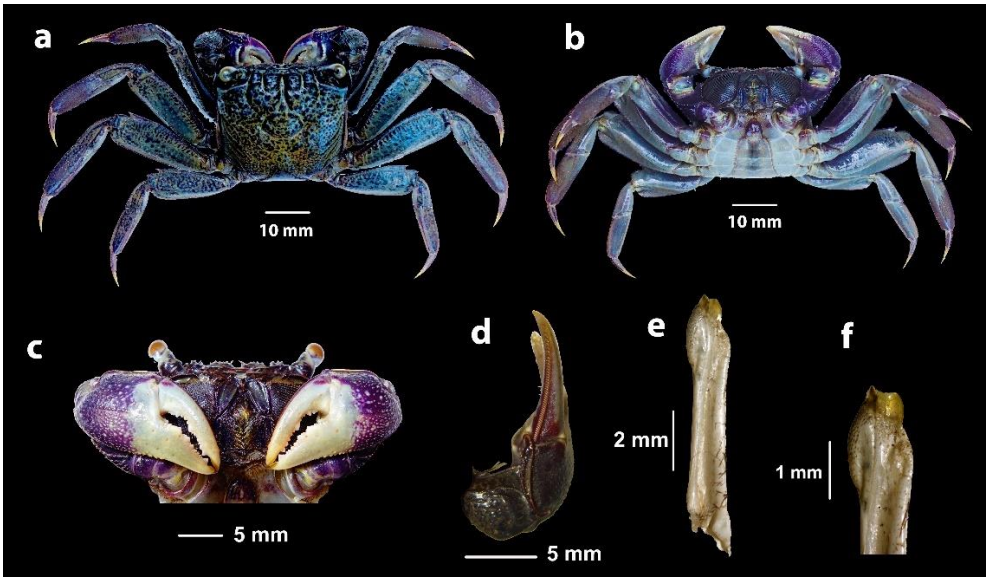

Figure 3.12. *Episesarma versicolor* (Tweedie, 1940); CW 29.65 mm, CL 27.72 mm, male; (a) dorsal view; (b) ventral view; (c) chelae, outer view; (d) upper surface of chela; (e) G1, dorsal view; (f) tip of G1, dorsal view.

Genus *Nanosesarma* Tweedie, 1951

***Nanosesarma andersoni* (de Man 1888)**

(Fig. 3.13)

Sesarma andersoni de Man, 1888a: 172, pl. XII, figs. 1-4; Alcock, 1900: 411 (key), 418.

Sesarma (Parasesarma) andersoni Tesch, 1917: 129.

Nanosesarma andersonii Tweedie, 1950: 312, fig. 1d, e; Ng et al., 2008: 221 (list); Trivedi et al., 2018: 72 (list).

Nanosesarma (Beanium) andersoni Serène & Soh, 1970: 394.

Beanium andersonii Tan & Ng, 1994: 82 (list).

Nanosesarma andersoni Komai et al., 2004: 45, fig. 5A-P; Padate et al., 2022: 2, Figs. 1A, 2, 7A, B)

Material Examined: CW 3.40–8.22 mm, CL 2.54–6.30 mm (N=9)

Diagnosis: Carapace, wider than long, slightly convex, covered with scattered pits, indistinct setal tufts. Exorbital tooth followed by rudimentary epibranchial tooth. Frontal margin wide, bilobed, strongly deflexed, depressed frontal lobes separated by shallow depression. Chelipeds subequal, massive; inner surface of merus with four teeth on lower margin; Manus massive, surfaces rugose, dorsal surface with one oblique pectinated crest and 4–5 oblique granular ridges. Male cheliped dactylus short, with row of 13 -14 small

smooth transverse tubercles and proximal granules on dorsal surface; inner surface with proximal granular patch. Ambulatory legs compressed, shorter than chelipeds; P4 merus anterior margin terminates in blunt angle followed by sub-distal spine, postero-distal margin with 3-4 teeth followed by 4 spinules; P5 merus anterior margin with sub-distal prominence, postero-distal margin with progressively increasing 5 teeth followed by alternately arranged 2 teeth and 2 spinules, lower surface smooth; lower posterior margin granulated. G1 long, almost straight, distal tip pectinated, flattened, slightly twisted, medially notched, covered with long, stiff setae, groove at base of tip extends along ventral surface up to G1.

Habitat and Distribution: In cavities made by wood-boring isopods on rotten wood in mangrove swamps (Komai et al., 2004). Distributed from India through Southeast Asia to Japan (Komai et al., 2004; Padate et al., 2022).

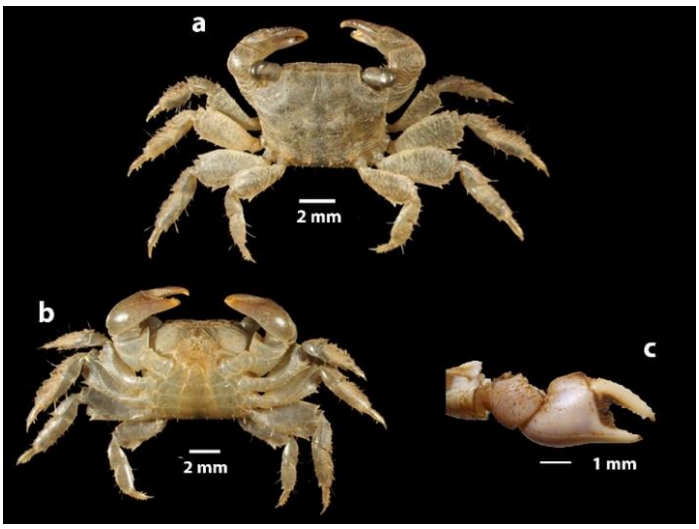

Figure 3.13. *Nanosesarma andersoni* (de Man 1888); CW 6.54 mm, CL 4.90 mm, male; (a) dorsal view; (b) ventral view; (c) outer view of chela.

Nanosesarma minutum (de Man, 1887)

(Figs. 3.14)

Sesarma minuta de Man, 1887: 650 (type locality: Edam Island, Batavia).

Sesarma (Sesarma) minutum Rathbun, 1910a: 327.

Sesarma (Sesarma) minuta Tesch, 1917: 174; Chhapgar, 1957b: 522, pl. 16, figs. k–m.

Nanosesarma minuta Tweedie, 1950: 311.

Nanosesarma cf. *minutum* Crosnier, 1965: 70, text-figs. 89, 109-115, pl. 6, fig. 1.

Nanosesarma minutum Serène & Soh, 1970: 393; Ng et al., 2008: 221 (list); Trivedi et al., 2018: 72 (list); Padate et al., 2022: 8, Figs. 1C, 4, 7E, F).

Material Examined: CW 3.08–6.50 mm; CL 2.64–4.40 mm (N=14)

Diagnosis: Carapace quadrangular, wider than long, epibranchial tooth posterior to external orbital angle sharp. Several oblique, low, setose granulated ridges across branchial regions. Third maxilliped ischium length less than 1.5 times merus length. Male chelipeds less than 2.0 times longer than CL, propodus lacking pectinated crest, dactylus with proximal granules on dorsal surface, transverse ridges lacking. Pereiopod merus postero-lateral margin with minute spinules followed by two to three large spinules. G1 distal tip curved, scoop-shaped, flanked by thick bristles, groove at base of tip extends along ventral surface up to G1 base. Gonopore at junction of thoracic sternites 5 and 6, gonopore with long oval operculum on inner side and small semi-circular process on outer side.

Habitat and Distribution: On Rhizophora and Avicennia mangroves, rock crevices and oyster shells (Ravichandran et al., 2007). Distributed from the East coast of Africa and Madagascar to the South China Sea (Padate et al., 2022).

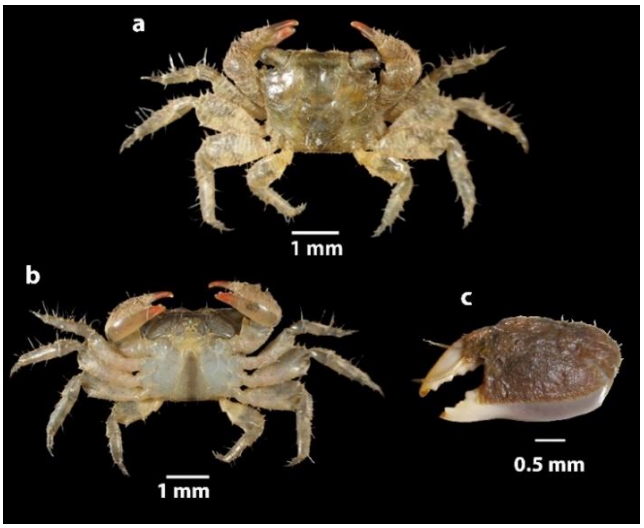

Figure 3.14. *Nanosesarma minutum* (De Man, 1887); CW 5.12 mm, CL 4.10 mm, male; (a) dorsal view; (b) ventral view; (c) densely setose outer surface of palm.

Nanosesarma tweediei Serène, 1967

(Figs. 3.15)

Nanosesarma tweediei Serène, 1967: 818, figs. 1-2, pl. 1A, B; Ng et al., 2008: 221 (list).

Material Examined: CW 3.00–5.48 mm; CL 3.32–5.91 mm (N=26)

Diagnosis: Carapace vase-shaped, longer than wide, thickly setose, epibranchial tooth posterior to external orbital angle rudimentary. No oblique ridges across branchial regions.

Third maxilliped ischium length lesser than 1.5 times merus length. Male chelipeds less than 2.0 times longer than CL, propodus lacking pectinated crest, dactylus with smooth median longitudinal ridge and proximal granules on dorsal surface, outer surface with strong proximal spine. Pereiopod merus postero-lateral margin lacking distinct spinules. Thoracic sternum wide in both sexes, with smooth finely pitted ventral surface. G1 distal tip curved, long scoop-shaped, flanked by thick bristles, groove at base of tip extends along ventral surface up to G1 base. Gonopore on thoracic sternite 6, gonopore with semi-circular operculum on inner side and small semi-circular process on outer side.

Habitat and Distribution: Under and between crevices of dead wooden logs, oyster colonies, rocks and pebbles (present study). Distributed from India to Malaysia, Singapore, Vietnam and the Philippines (Serène, 1967; present study).

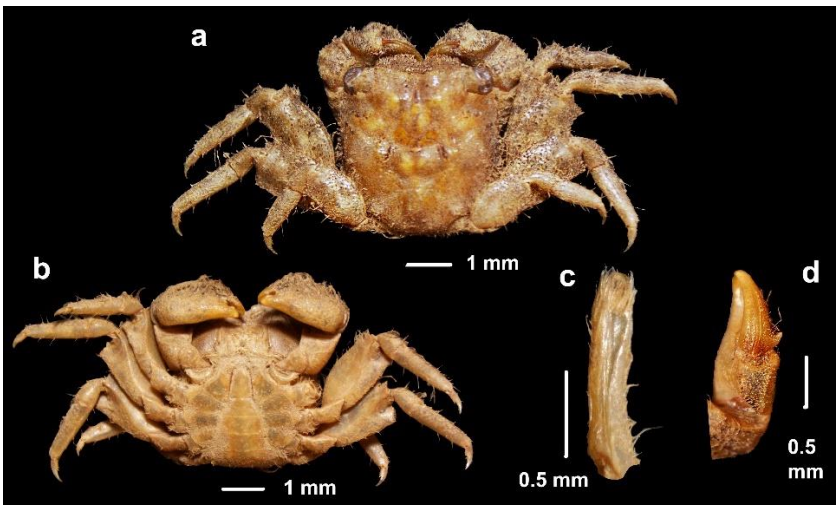

Figure 3.15. *Nanosesarma tweediei* Serène, 1967; CW 5.48 mm, CL 5.91 mm, male; (a) dorsal view; (b) ventral view; (c) right G1 ventral view; (d) right male cheliped dactylus showing smooth longitudinal ridge and proximal spine.

Genus *Parasesarma* De Man, 1895

***Parasesarma bengalense* (Davie, 2003)**

(Fig. 3.16)

Perisesarma bengalense Davie, 2003: 388 (type locality: Colombo, Sri Lanka).

Perisesarma bengalensis Bouillon et al., 2004: 83 (list).

Perisesarma bengalense Ng et al., 2008: 222 (list); Davie, 2010: 197 (list).

Parasesarma bengalense Shahdadi & Schubart, 2018: 525, figs. 3C, 4C, 5C, 6C, 7C, 8C, 9C, 10C; Pati et al., 2019: 3, Fig. 2.

Material Examined: CW 5.32-19.60 mm; CL 4.00–18.95 mm (N=143)

Diagnosis: Carapace sub rectangular, slightly broader than long (CW/CL 1.2–1.5); regions well defined. Postfrontal region with 4 prominent, rounded lobes. Frontal margin sinuous, deflexed downwards. Anterolateral margin with small acutely triangular tooth separated by a distinct notch from large, acutely triangular external orbital tooth. Cheliped subequal, upper surface of palm in males with 2 transverse pectinate crests; 14–18 tall, broad corneous teeth on primary and 13–15 relatively shorter corneous teeth on secondary pectinate crest. Cutting margins of the fingers serrated; strong subdistal tooth along cutting margin of fixed finger. Dactylus displays prominent subdistal tooth and medial tooth along the cutting margin with 16–18 nearly symmetrical tubercles on upper surface and 1–10 closely spaced tubercles proximally. In males, 6th pleonal somite around 2.1 times broader than long. Male G1 gently curved, moderately stout with corneous apical process.

Habitat and Distribution: In the vicinity of intertidal mangroves (Davie, 2003). Distributed in India, Sri Lanka and Thailand (Pati et al., 2019); the present observation is the first record from Goa.

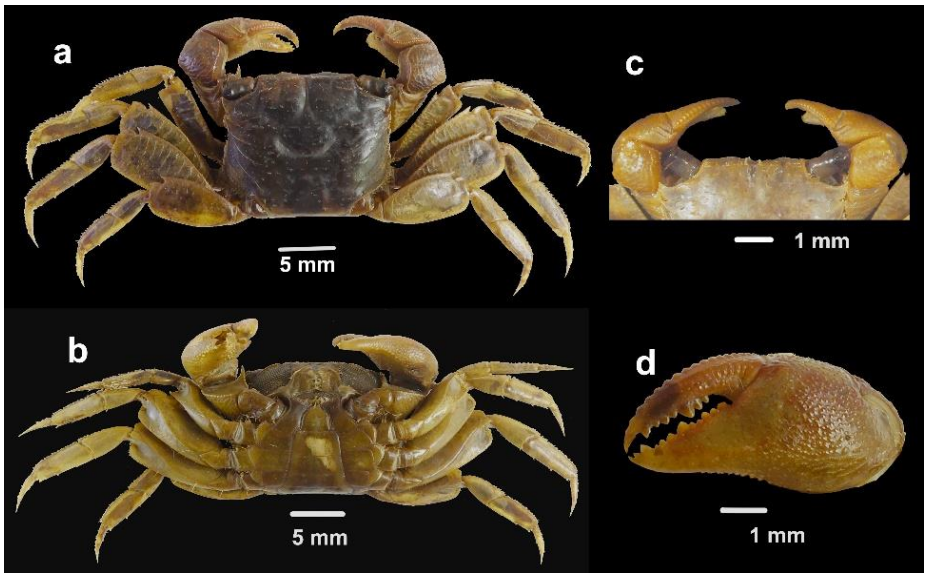

Figure 3.16. *Parasesarma bengalense* (Davie, 2003); CW 14.29 mm, CL 12.15 mm, male; (a) dorsal view; (b) ventral view; (c) front along with chelipeds; (d) chela showing serrations on fingers of cutting margin.

***Parasesarma plicatum* (Latreille, 1803)**

(Fig. 3.17)

Cancer quadratus Fabricius, 1798: 341 (type locality: East India); Zimsen, 1964: 650.

Ocypode quadrata Bosc, 1802: 198.

Ocypoda plicata Latreille, 1803: 47.

Sesarma quadrata H. Milne Edwards, 1837: 75.

Sesarma (Parasesarma) plicata Tesch, 1917: 187.

Parasesarma plicatum Naiyanetr, 2007: 114; Ng et al., 2008: 222 (list); Rahayu & Ng, 2010: 2, figs. 1-4; Trivedi et al., 2018: 73 (list).

Sesarma aspera Heller, 1865: 63, pl. 6, fig. 1.

Sesarma quadratum Alcock, 1900: 411 (identification key), 413.

Sesarma aspera Müller, 1887: 476 (not Sesarma aspera Heller, 1865).

Sesarma (Parasesarma) plicatum Serène, 1968: 107.

Material Examined: CW: 3.12–22.10 mm; CL: 2.60–18.80 mm (N=32)

Diagnosis: Carapace 1.35 times broader than long, mesogastric, cardiac regions well defined. Postfrontal margin with 4 distinct, similar lobes, separated by narrow grooves. External orbital tooth triangular, directed upward. Chelipeds subequal, large, robust. The upper surface of the palm with 2 transverse pectinated crests; primary crest composed of 8–12 broad teeth; secondary crest well developed, shorter than the primary, with 5–9 broad teeth. Fixed finger rounded, granular on the outer surface. The dorsal surface of the dactylus with 11–14 tubercles, small proximally, becoming larger distally; tubercles distinct, and subcircular. Walking legs robust, flattened, broad. The male abdomen relatively broad; telson semicircular, evenly rounded. G1 slender, an apical process long, produced, corneous part long, slightly sinuous, tip rounded. Female with chelipeds smaller than in male, pectinated crests on palm replaced by 2 transverse rows of tubercles, dactylar tubercles indistinct.

Habitat and Distribution: In marshy intertidal areas of mangrove habitats (Rahayu & Ng, 2010). Distributed from Thailand and Indonesia (Rahayu & Ng, 2010); India (Trivedi et al., 2018).

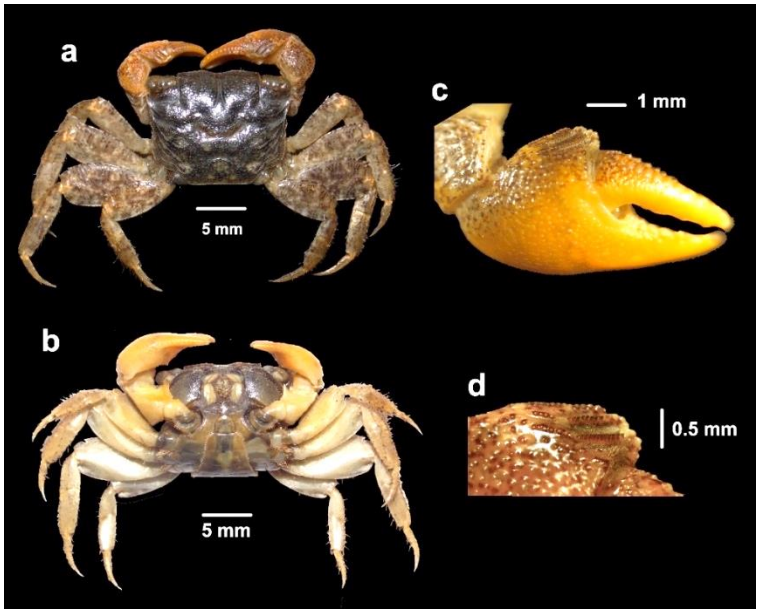

Figure 3.17. *Parasesarma plicatum* (Latreille, 1803); CW 18.21 mm, CL 14.87 mm, male; (a) dorsal view; (b) ventral view; (c) right chela showing pectinated crests and dactylar tubercles; (d) pectinated crests.

Genus *Pseudosesarma* Serène & Soh, 1970

***Pseudosesarma glabrum* Ng, Rani & Bijoy Nandan, 2017**

(Fig. 3.18)

Pseudosesarma edwardsii Shet et al., 2016: 8, 12, fig. 2 (not *Sesarma edwardsii* De Man, 1887).

Pseudosesarma glabrum Ng et al., 2017: 265, fig. 2–5 (type locality: Cochin estuary, India); Trivedi et al., 2018: 73 (list); Pati et al., 2020: 144, fig 2-4.

Material examined: CW 11.34 -15.21mm; CL 9.88-13.68 mm (N=6)

Diagnosis: Carapace 1.1–1.3 times broader than long; frontal margin broad, with relatively shallow median concavity; prominent postfrontal lobes, all at the same level. Anterolateral margin with short external orbital tooth, anteriorly directed with deep, V-shaped cleft separating it from the rest of the margin; one low, distinct, epibranchial tooth, separated by small U-shaped notch from rest of margin. Chelipeds short, stout with almost straight ventral margin of fixed finger and distal half of palm; palm gently convex on the outer surface, with numerous small, rounded granules. Ambulatory legs with relatively short and stout meri. Male thoracic sternites 3 and 4 with distinct groove. Male pleon broad, triangular; 6th somite broad, and distinct convex lateral margins. Male sternopleonal cavity with press-button of pleonal locking mechanism on anterior edge of thoracic sternite 5. G1 long, stout; distal part

dilated forming bulbous structure; median part constricted; chitinous tip relatively short, broad, appearing bifurcated. Vulvae large, orbicular, situated on submedian part of thoracic sternite 6 and occupying nearly half of its length.

Habitat and Distribution: Distributed restricted to the west coast of India- Kerala, Karnataka, Maharashtra and Gujarat (Ng et al., 2017; Pati et al., 2020). The present observation is the first record from Goa.

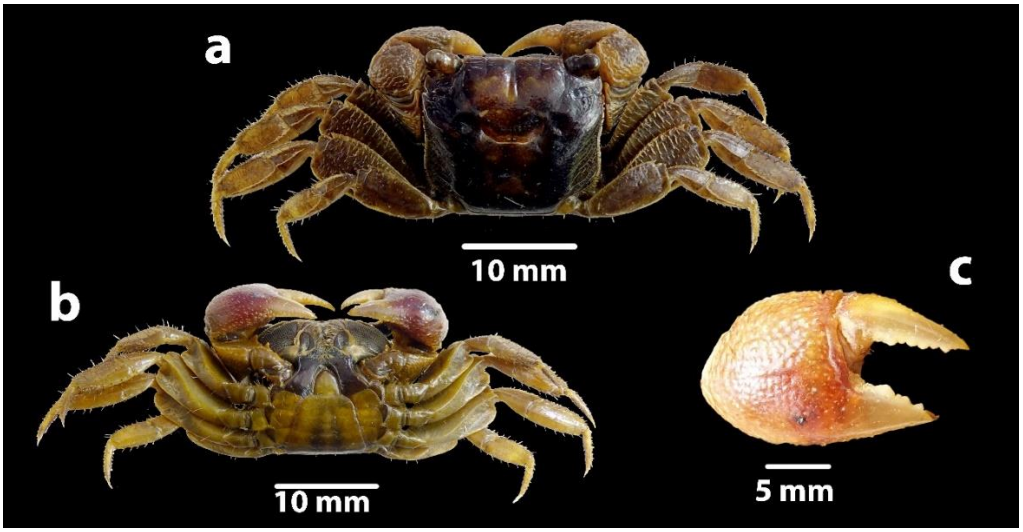

Figure 3.18. *Pseudosesarma glabrum* Ng, Rani and Bijoy Nandan, 2017; CW 15.21 mm, CL 13.68 mm, male; (a) dorsal view; (b) ventral view; (c) major male chela.

Genus *Sarmatium* Dana, 1851

***Sarmatium crassum* Dana, 1851**

(Fig. 3.19)

Sarmatium crassum Dana, 1851: 251 (type locality: Samoa); Barnard, 1955: 28, fig. 9; Crosnier, 1965: 74, figs. 121-124, pl. 5, fig. 1; Davie, 1992: 80 (identification key), 81, figs. 1A, 2A-C; Ng et al., 2008: 223 (list); Trivedi et al., 2018: 73 (list).

?Sarmatium crassum Nobili, 1899: 505 (list); Trivedi et al., 2018: 73 (list).

not *Sarmatium crassum* Serène & Soh, 1970: pl. 4C, D; Serène and Soh, 1971; 237, fig. 2, pl. 2 (= *S. striaticarpus*).

Material Examined: CW 10.6 mm; CL 9.6 mm (N=1)

Diagnosis: Carapace slightly broader than long, glabrous, deeply vaulted, punctate with setae arranged sparsely on branchial lines. Regions moderately defined with mesogastric distinct. Anterolateral margins regularly convex with two blunt teeth behind the exorbital

angle. Front bilobed. Branchial ridges prominent forming a series of short broken granular striations. Inner orbital tooth well developed; ocular peduncle swollen basally, cornea constricted and reduced. Chelipeds subequal, large, robust. Merus posterior border with minutely granular striations; distinct subdistal spine; carpus with a small spine at an inner angle. Palm upper surface with a series of transverse grooves separating swollen ridges, distal margin of ridges granular with a row of 8 pectinated comb-like teeth. Dactylus dorsal surface of males bearing 4 large, broad, chitinous tubercles proximally; first proximal tooth placed distally from articulation. Male pleon relatively narrow, third somite widest, telson subequal to the sixth somite in length, longer than wide. G1 moderately stout; slightly curved, dorsal surface of shaft flattened with poorly developed protuberance on the distal end; apical process corneous; strongly produced; straight.

Habitat and Distribution: In mangrove-fringed creeks, river mouths in mudbank at low water (Davie, 1992). Distributed from South Africa, Madagascar and Red Sea to Philippines, Australia Western Pacific Islands (Davie, 1992). According to Davie (1992), the record of *S. crassum* from Nicobar Island (Alcock, 1900) is doubtful, and therefore the present observation is the first confirmed record from India.

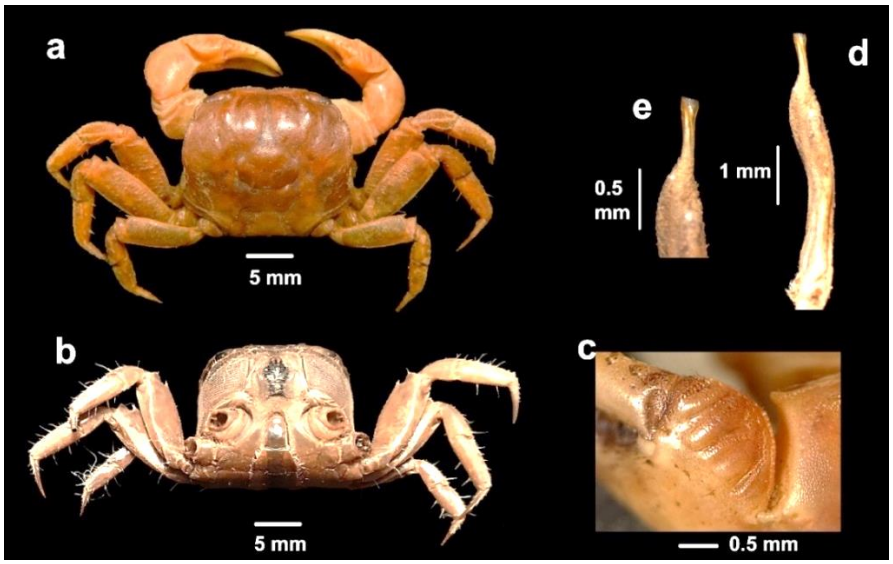

Figure 3.19. *Sarmatium crassum* Dana, 1851; CW 10.6 mm, CL 9.6 mm, male; (a) dorsal view; (b) ventral view; (c) upper surface of palm of left chela; (d) left G1, dorsal view; (e) distal tip of G1, dorsal view.

Family Varunidae H. Milne Edwards, 1853

Genus *Chhapgarus* Ng, Trivedi & Bhat, 2022

***Chhapgarus intermedius* (Chhapgar, 1957)**

(Figs. 3.20)

Pseudograpsus intermedius Chhapgar, 1955: 257 (type locality: Bombay); Tirmizi & Ghani, 1996: 170, fig. 65; Ng et al., 2008: 228 (list); Dineshbabu et al., 2011: 23 (list); Trivedi et al., 2018: 75 (list).

Chhapgarus intermedius Ng et al., 2022: 131, figs. 1-6.

Material Examined: CW 4.60 – 11.82 mm; CL 4.80 – 12.90 mm (N=26)

Diagnosis: Carapace squarish in shape, dorsal surface covered with short brown setae; regions well defined, convex. The frontal margin is slightly convex, and straight. Anterolateral margin sub-cristate with three teeth including the first orbital tooth. Posterolateral margins not sharply demarcated from the anterolateral margin, concave at the branchial region, distinctly subparallel Orbits small, eyes filling orbit. Third maxillipeds are short, and stout. Small, distinct rhomboidal gape when closed, palp short, with short setae. Exopod with the short flagellum. Epistome broad, flat, posterior margin entire. The inner surface of chela with granules; setose. Ambulatory legs with short setae, stout dactyl. Lateral margins of thoracic sternites 4-5 finely granulated; anterior sternal plates without any medial grooves. Male abdomen triangular in shape with seven moveable segments.

Habitat and Distribution: Under dead logs, rock boulders and mud burrows among mid-intertidal mangroves (Ng et al., 2022). Distributed in Pakistan and India (Ng et al., 2022).

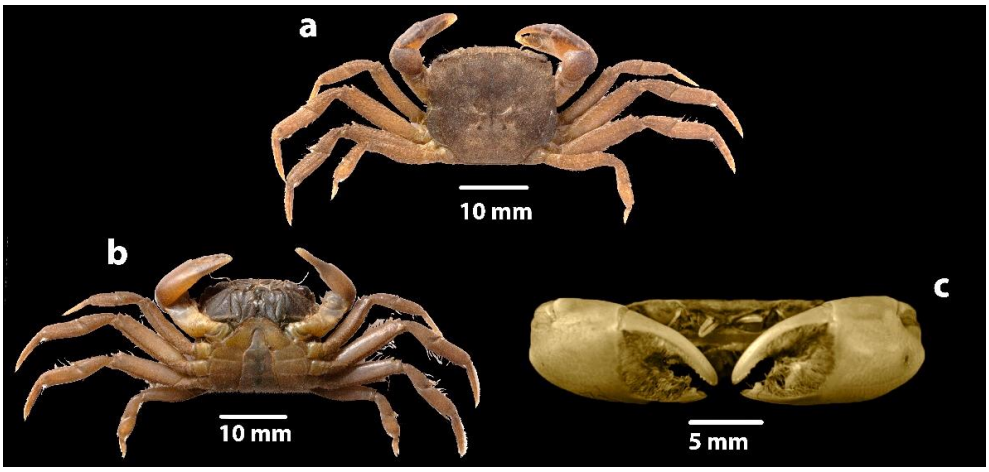

Figure 3.20. *Chhapgarus intermedius* (Chhapgar, 1957); CW 10.1 mm, CL 9.0 mm, male; (a) dorsal view; (b) ventral view; (c) frontal view along with chela.

Genus *Varuna* H. Milne Edwards, 1830

***Varuna litterata* (Fabricius, 1798)**

(Fig. 3.21)

Cancer litteratus Fabricius, 1798: 342 (type locality: east coast of India).

Grapsus litteratus Bosc, 1802: 203.

Varuna litterata H. Milne Edwards, 1830: 511; Barnard, 1950: 122, figs. 22c, 23f, 24d; Chhapgar, 1957b: 518, pl. 15; Crosnier, 1965: 34, figs. 40, 41a-b; 46, pl. 6, fig. 1; Ng et al., 2008: 229 (list); Trivedi et al., 2018: 76 (list).

Trichopus litteratus De Haan, 1835: 33; Dana, 1852: 336, pl. 20, fig. 8.

Varuna tomemtosa Pfeffer, 1889: 30.

Material Examined: CW 30.00 mm, CL 29.20 mm (N=1)

Diagnosis: Carapace quadrangular. Dorsal surface punctate, regions well defined. Front broad, anterior margin almost straight, slightly produced, sloping downwards. Anterolateral margins arched upwards, with three teeth including an orbital tooth. Third maxillipeds closed with a narrow gap. Chelipeds are symmetrical and larger in males. Fingers closed without any gap. Ambulatory legs are long, slender, merus with a small sub-distal spine on the anterior margin, densely setose on anterior, and posterior margins, last ambulatory very flattened. G1 long, stout, distal end with a single lobe, length-to-width ratio 6.9. Female gonopore operculate, with an oval protruding button.

Habitat and Distribution: Slow-moving and stagnant freshwater bodies as well as intertidal areas, on floating clumps of brown algae (Ng, 1998). Distributed from East Africa to New Zealand, Australia and Japan (Chhapgar, 1957b; Ng, 2006).

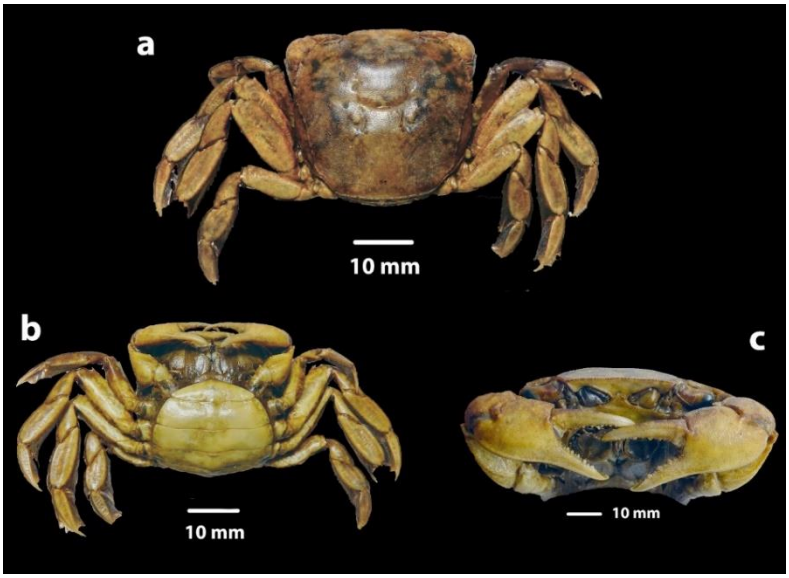

Figure 3.21. *Varuna litterata* (Fabricius, 1798); CW 30.00 mm, CL 29.20 mm, female; (a) dorsal view; (b) ventral view; (c) frontal view along with chela.

Family Dotillidae Stimpson, 1858

Genus *Dotilla* Stimpson, 1858

***Dotilla myctiroides* (H. Milne Edwards, 1852)**

(Figs. 3.22)

Dotilla myctiroides Henderson, 1893: 390; Alcock, 1900: 364 (identification key), 368; Kemp, 1915: 227, fig. 8; Sankarankutty 1961: 102 (list), 114, Figs. 3D-E, 4A; Ng et al., 2008: 235 (list); Padate et al., 2015: 7, Figs. 2-5; Trivedi et al., 2018: 34 (list).

Material Examined: CW 1.75–8.42 mm; CL 1.70–8.40 mm (N=89)

Diagnosis: Carapace oval, as long as broad, with rugose dorsal surface (except cardiac regions). Dorsal surface of the carapace longitudinally and transversely convex, with scattered microscopic granules except for the lateral grooves practically devoid of sculpture. Orbits wide, occupy approximately three-fourths of the anterior carapace margin. Eyes (cornea) elongated, ocular peduncle slightly longer than the cornea. Buccal cavern broader than long, rounded anterolaterally, wider posteriorly. Epistome narrow. Third maxillipeds are large, oval-shaped, and do not leave a gape when closed. Chelipeds are slender, compressed, subequal, and at least three times CL. Ambulatory legs are slender and shorter than chelipeds. Pereiopod meri with characteristic elongated tympana. Margin of tympanic membrane marked with depressed granules. Thoracic sternum with tympana on all segments. Male abdomen narrow comprised of seven distinct, narrow segments the fourth

segment overlapping the fifth, with a thick brush of hairs at the distal end. G1 slightly sinuous, distal tip blunt, covered with a tuft of numerous long unbranched setae at the outer margin. Colouration varies from a grey body with pinkish legs to a sand brown colour

Habitat and Distribution: Constructs igloo-shaped and vertical burrows along lower parts of tropical sandy shores (Takeda et al., 1996). Distributed in India, Thailand, Malaysia and Indonesia (Darmarini et al., 2019).

Figure 3.22. *Dotilla myctiroides* H. Milne Edwards, 1852; CW 8.42 mm, CL 8.40 mm, male; (a) dorsal view; (b) ventral view; (c) male abdomen.

Genus *Scopimera* De Haan, 1833

***Scopimera proxima* Kemp, 1919**

(Figs. 3.23)

Scopimera proxima Kemp, 1919a: 317, pl. 12 fig. 3; Silas & Sankarankutty, 1967: 1008; Ng et al., 2008: 235 (list); Trivedi et al., 2018: 35 (list).

Material Examined: CW 3.30–5.00 mm; CL 2.30–3.90 mm (N=15)

Diagnosis: The carapace is smooth, inflated, broader than long, and depth about equal to its length. Lower orbital border sinuous, facet at the inner end sharply defined. Third maxilliped with shallow furrow parallel with the outer border of the merus. Chelipeds are short, and subequal, edges of the merus sharp and serrated. The anterior and posterior borders of the palm are rounded with coarse granules, cutting the edge of the fingers sharp. Male abdomen with deep constriction at the junction of fourth and fifth segments, the fifth segment not channelled, the sixth segment broader than long with straight, slightly divergent sides. The

female abdomen is proportionately narrower, with the sides a trifle concave and the seventh segment broader

Habitat and Distribution: Constructs burrows at high-tide level along sandy shores (Silas & Sankarankutty, 1967). Distributed in India (Trivedi et al., 2018) and Thailand (Wada, 2020).

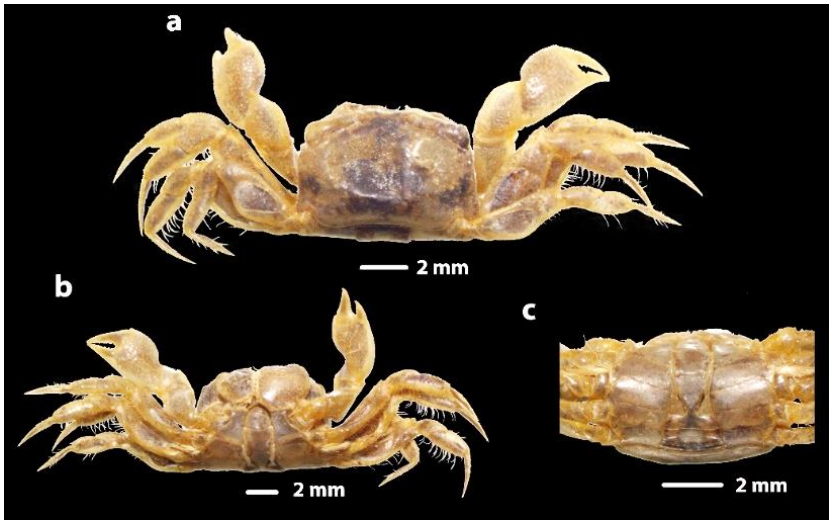

Figure 3.23. *Scopimera proxima* Kemp, 1919; CW 4.06 mm, CL 3.20 mm, male; (a) dorsal view; (b) ventral view; (c) male abdomen.

Family Macrophthalmidae Dana, 1851

Genus *Macrophthalmus* Desmarest, 1823

Subgenus *Macrophthalmus (Macrophthalmus)* Desmarest, 1823

***Macrophthalmus (Macrophthalmus) brevis* (Herbst, 1804)**

(Figs. 3.24)

Cancer brevis Herbst, 1804: 9, pl. 60, fig. 4 (type locality: East India).

Macrophthalmus carinimanus H. Milne Edwards, 1837: 65.

Macrophthalmus dilatatus carens Lanchester, 1900: 759.

Macrophthalmus crassipes Lanchester, 1900: 759 (not H. Milne Edwards, 1852).

Macrophthalmus brevis Tesch, 1915: 169, pl. 6, fig. 5; Barnes, 1977:276 (identification key).

Macrophthalmus simdentatus Shen, 1936: 70, text-figs. 2-3;

Macrophthalmus cf. *crassipes* Tweedie, 1937: 164.

Macrophthalmus tranvancorensis Pillai, 1951: 30, text-fig. 5.

Macrophthalmus (Macrophthalmus) brevis Barnes, 1970: 207; 1971: 4, fig. 1; Dai et al., 1986: 432, pl. 60 fig. 1, fig. 240(2); Komai et al., 1995: 107, fig. 2; Ng et al., 2008: 237 (list); Barnes, 2010: 40, fig. 2; Trivedi et al., 2018: 50 (list).

Not *Macrophthalmus (Macrophthalmus) brevis* Pandya & Vachhrajani, 2013: 243, fig. 3 *(=Macrophthalmus (Macrophthalmus) sulcatus*)

not *Macrophthalmus brevis* Hilgendorf, 1869: 86; Nobili, 1906a: 318 (=*M. grandidieri* A. Milne Edwards, 1867).

not *Macrophthalmus carinimanus* Hilgendorf, 1879: 806 (=*M. grandidieri*); Haswell, 1882: 88 (=*M. crassipes* H. Milne Edwards, 1852); McNeill, 1962: 41, pl. 2, fig. 2 (=*M. crassipes*).

Material Examined: CW 6.00 – 20.82 mm; CL 3.22 – 9.42 mm (N=16)

Diagnosis: Carapace wide, maximum width across 2nd anterolateral teeth, almost 2.0 times as broad as long, covered with granules. Border of the upper orbits strongly granulated (stronger in males in comparison to females). Anterolateral margins with three anterolateral teeth along with narrow, triangular external orbital tooth separated by deep V-shaped incision; 2nd anterolateral tooth triangular, slightly wider than preceding tooth; 3rd anterolateral tooth small but distinct, separated by shallow U-shaped incision from preceding tooth. Male chelipeds with dactylus fairly longer than palm. Outer surface of the proximal half of the palm with central row of granules; the fingers bear small, tuberculate teeth on the proximal half of the cutting edge; Both male and female abdomen very wide. Colour sandy grey.

Habitat and Distribution: Constructs burrows in open mudflats (Komai et al., 1995), intertidal and fine sand dominated areas (Pandya & Vacchrajani, 2013). Distributed from Bay of Bengal through Southeast Asia to Japan (Barnes, 2010).

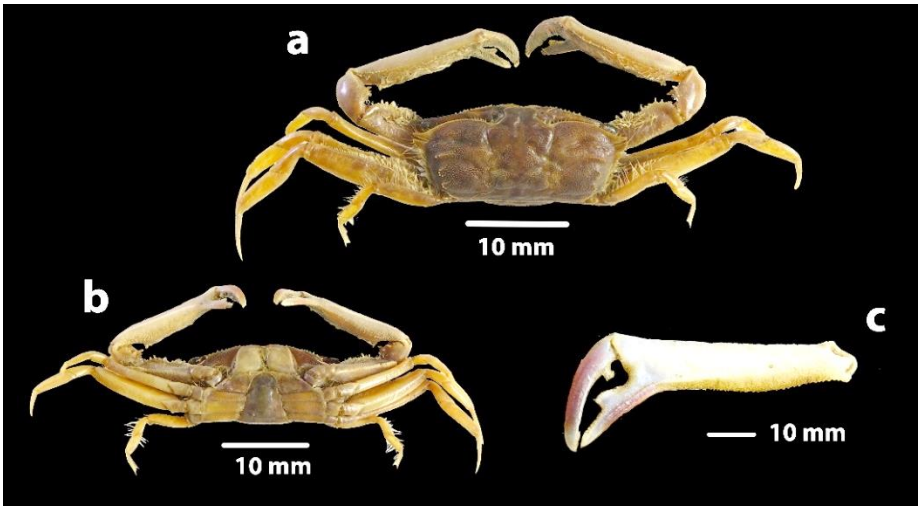

Figure 3.24. *Macrophthalmus (Macrophthalmus) brevis* (Herbst, 1804); CW 13.74 mm, CL 6.32 mm, male; (a) dorsal view; (b) ventral view; (c) outer view of left chela.

Macrophthalmus (Macrophthalmus) parvimanus Guérin, 1834

(Fig. 3.25)

Macrophthalmus parvimanus Guerin-Meneville, 1834: 7, pl. 4, fig. 1 (type locality: Seychelles); Barnes, 1977: 277 (key).

Macrophthalmus convexus Kemp, 1919b: 389, pl. 24, fig. 2 (in part).

Macrophthalmus convexus kempi Gravely, 1927: 150 (type locality: Gulf of Mannar).

?*Macrophthalmus consobrinus* Nobili, 1906c: 265 (type-locality: Rikitea, Tuamotu Archipelago); Crosnier, 1965: 129, figs. 232-234, 237, 238.

Macrophthalmus (Macrophthalmus) parvimanus Barnes, 1970: 211, fig. 2; Vannini & Valmori, 1981b: 216, figs. 9B, 10A; Komai et al, 1995: 119, figs. 7-8; Ng et al., 2008: 237 (list); Trivedi et al., 2018: 50 (list).

Material Examined: CW 15.72–30.22 mm; CL 11.28–21.38 mm (N=2)

Diagnosis: The carapace surface is smooth, naked, lateral areas covered with small granules, 1.74-1.86 times as wide as long with maximum width across external orbital teeth. Border of the upper orbits somewhat oblique and minutely granulate. Anterolateral margins with two or three anterolateral teeth including external orbital tooth. Lateral margin convergent posteriorly from dorsal aspect, armed, with a third tooth, if present, poorly defined. The external orbital tooth narrow, triangular, longer than 2nd anterolateral tooth, separated by V-shaped narrow incision; 2nd anterolateral tooth almost as wide as preceding tooth, triangular from the dorsal aspect. Male chelipeds with dactylus 0.85-0.88 longer than palm. Outer

surface of the proximal half of the palm without central row of granules; superior surface with two rows of granules; cutting margin of the fingers with small tuberculate teeth on proximal half. Abdomen, moderately narrow in males. Colour sandy grey.

Habitat and Distribution: On sandy flats at the lowest high tidal level (Komai et al., 1995). Distributed from East coast of Africa to Malaysia and Solomon Islands (Komai et al., 1995).

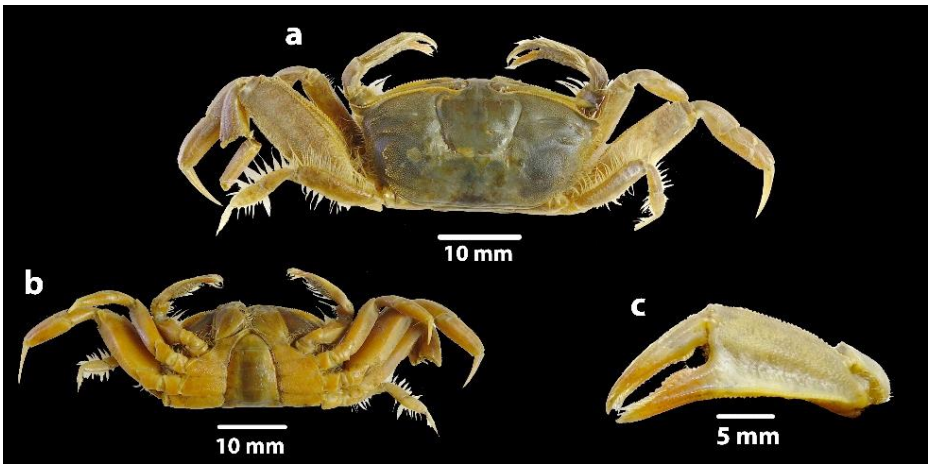

Figure 3.25. *Macrophthalmus (Macrophthalmus) parvimanus* Guérin, 1834; CW 30.22 mm, CL 15.72 mm, male; (a) dorsal view; (b) ventral view; (c) outer view of left chela.

Subgenus *Macrophthalmus (Mareotis)* Barnes, 1967

***Macrophthalmus (Mareotis) pacificus* Dana, 1851**

(Fig. 3.26)

Macrophthalmus pacificus Dana, 1851: 248 (type locality: Samoa); Dana, 1852: 314, pl. 19, fig. 4 a-c; De Man, 1895: 579; Tesch, 1915: 155 (key), 190, pl. 8, fig. 11; Chhapgar 1957b: 514, pl. 15, a-d; Barnes, 1977: 278 (identification key).

Macrophthalmus (Mareotis) pacificus Barnes, 1967: 218, pl. 2b, Fig. 6; Sakai, 1976: 614, text-fig. 337; Dai et al., 1986: 435, pl. 60(5), fig. 242 (3-4); Komai et al., 1995: 128, Fig. 11; Ng et al., 2008: 237 (list); Rahayu & Setyadi 2009: 119, Fig. 1; Barnes, 2010: 37; Davie, 2012: 187, Fig. 27; Trivedi et al., 2018: 51 (list).

? *Macrophthalmus bicarinatus* Heller, 1865: 36, pl. 4, figs. 2, 3 (type-locality: Nicobars).

Macrophthalmus depressus Lanchester, 1900: 259 (not *M. depressus* Rüppell, 1830).

not *Macrophthalmus pacificus* Rathbun, 1910b: 307, pl. 1, fig. 3 (= *M. crinitus* Rathbun, 1913).

Material Examined: CW 2.20–12.00 mm; CL 1.60–8.40 mm (N=16)

Diagnosis: Carapace smooth, shiny with long, slightly oblique rows of granules on branchial regions; 1.30 times as broad as long, maximum width across third anterolateral tooth. Border of the upper orbits nearly transverse, minutely granulate. Anterolateral margins with three anterolateral teeth along with wide, square external orbital tooth separated by deep U-shaped incision, 2nd anterolateral tooth wider than preceding tooth, 3rd anterolateral tooth small but distinct, marked by V-shaped incision. Lateral margins behind third anterolateral teeth fairly convergent posteriorly. Male chelipeds with dactylus equal to that of palm; palm with distinct inferior ridge, extending proximally to level of articulate knob of palm; inferior row of setae absent; superior surface rounded; cutting margin of fingers with small, tuberculate teeth. Abdomen narrow in males and wide in females. Colour sandy grey.

Habitat and Distribution: Muddy substrate along seaward fringe of mangrove forests and river mouths (Rahayu & Nugroho, 2012). Distributed from India through Southeast Asia to Solomon Islands, Papua New Guinea, Japan, and Australia (Komai et al. 1995; Rahayu & Nugroho, 2012).

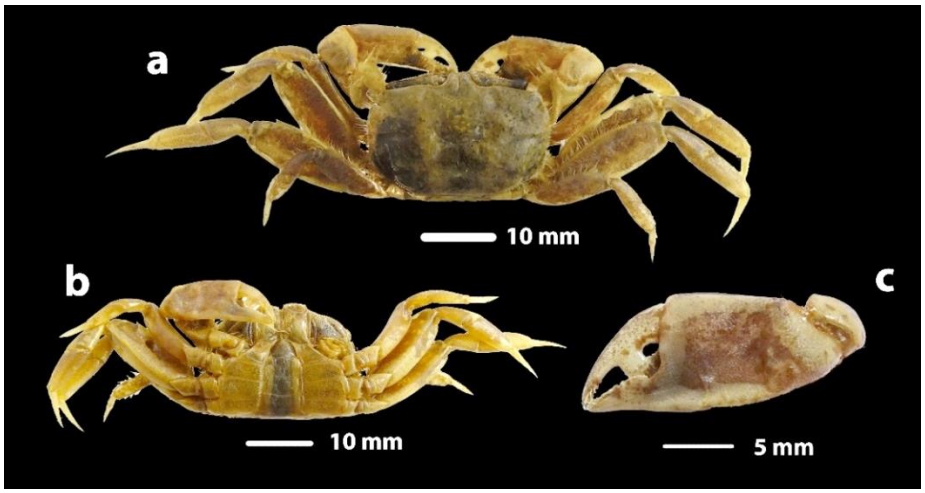

Figure 3.26. *Macrophthalmus (Mareotis) pacificus* Dana, 1851; CW 6.40 mm, CL 4.32 mm, male; (a) dorsal view; (b) ventral view; (c) outer view of left chela.

Family Ocypodidae Rafinesque, 1815

Genus *Austruca* Bott, 1973

***Austruca annulipes* (H. Milne Edwards, 1837)**

(Fig. 3.27)

Gelasimus annulipes H. Milne Edwards, 1837: 55 (type locality: India).

Gelasimus lacteus Krauss, 1843: 14, 39; Alcock, 1900: 352 (identification key), 355.

Gelasimus annulipes White, 1847b: 36; Tweedie, 1937: 141, fig. 1a; Chhapgar, 1957b: 508, pl. 13, figs. i-o.

Gelasimus annulipes var. lacteus Ortmann, 1894: 759.

Uca annulipes Nobili, 1899: 518; Barnard, 1950: 97, 98, figs. 18g-i, 19e; Crosnier, 1965: 117, figs. 204, 206, 207, 212, 213; Shih et al., 2016b: 77 (identification key).

Uca lactea Pesta, 1911: 22; Tesch, 1918: 39; Maccagno, 1928: 29, fig. 15; Barnard, 1950: 96, 97 (not *Ocypode (Gelasimus) lactea* De Haan, 1835).

Uca lacteus Stebbing, 1917: 16, pl. 4 (not *Ocypode (Gelasimus) lactea* De Haan, 1835).

Austruca annulipes Bott, 1973: 322, fig. 13; Trivedi et al., 2018: 53 (list).

Uca (Celuca) annulipes Dai and Yang, 1991: 467, pl. 3, fig. 362 (2).

Uca (Celuca) lactea annulipes Crane, 1975: 299, 301, 611. figs. 18A-C, 19I-N, 20D-K, 24.

Uca (Paraleptuca) annulipes Ng et al., 2008: 241 (list).

Uca (Austruca) annulipes Naderloo et al., 2010: 3 (identification key), 6, Figs. 2a-h, 3a-e, 4b, 12a-c.

Material Examined: CW 4.60–25.20 mm; CL 3.30–1.81 mm (N=740)

Diagnosis: Carapace smooth, about three-fifths of the greatest breadth. The supraorbital border well arcuate and fairly oblique, the external orbital angles pointed obliquely outward. Anterolateral borders of carapace moderately convergent. Front wide, the width of front, measured between the bases of the eyestalks, is nearly one seventh that of the carapace. The major cheliped unarmed, the outer surface of palm smooth and the lower border marked with a faint ridge, which extends toward the base of the immovable finger, just above which is found a small depressed and rough surface; the inner surface of palm has two salient granular crests, one of which is deeply grooved and nearly vertical and becomes continuous with the dentary edge of the immovable finger; the other, which is very prominent is oblique and runs toward the lower border of the same finger. The fingers widely gaping, the movable finger being curved inward at the tip. Distinct variation in the colouration with a reddish-brown carapace and white stripes with light pink major chela as the most common colouration pattern to the white, blue carapace.

Habitat and Distribution: On intertidal mudflats, sandy habitats in lagoonal beaches (Mokhlesi et al., 2011; Bom et al., 2020). Distributed from Pakistan through Southeast Asia to China (Shih et al., 2022).

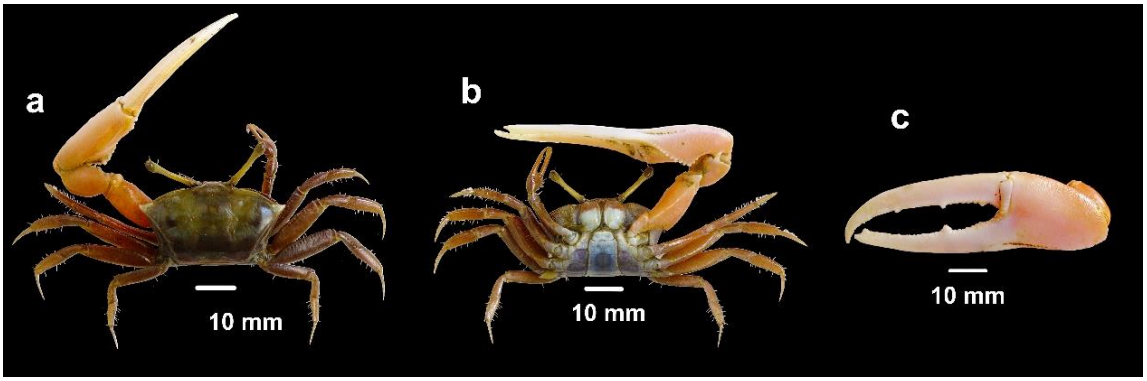

Figure 3.27. *Austruca annulipes* (H. Milne Edwards, 1837); CW 15.61 mm, CL 8.90 mm, male; (a) dorsal view; (b) ventral view; (c) major male chela.

Genus *Gelasimus* Latreille, 1817

***Gelasimus vocans* (Linnaeus, 1758)**

(Fig. 3.28)

Cancer vocans Linnaeus, 1758: 626 (type locality: India).

Ocypode vocans Bosc, 1802: 198.

Gelasimus vocans Desmarest, 1825: 123; Milne Edwards H., 1852: 145, pl. 3, fig. 4a; Trivedi et al., 2018: 54 (list).

Gelasimus marionis Desmarest, 1825: 124; pl. 13, Fig. 1; Alcock, 1900: 353 (identification key), 359; Chhapgar, 1957b: 47, pl. 13p-q, t.

Gelasimus marionis nitidus Alcock, 1900: 353 (identification key), 360; Chhapgar, 1957b: 510, pl. 13.

Uca (Thalassuca) vocans vocans Crane 1975: 92, figs. 38I, L, 56B, 60C-E, 64F, FF, pl. 14E-H; Sakai, 1976: 605, pl. 208(3) (part); Miyake, 1983: 163, pl. 55(2); Dai & Yang 1991: 463, fig. 234, pl. 58 fig. 7.

Uca vocans Lanchester, 1900: 754; Takeda, 1982: 207, 1 unnumbered fig.

Uca borealis Hung, 2000: 140-1, figs. 428–429, 1 unnumbered fig. (part) (not *Uca borealis* Crane, 1975).

Uca vocans vocans Nakasone and Irei, 2003: 269, fig. 31E.

Uca (Gelasimus) vocans Ng et al., 2008: 240 (list); Shih et al, 2016b: 66, fig. 3G, H.

Material Examined: CW 3.20 -23.70 mm, CL 1.80-19.22 mm (N=428)

Diagnosis: Carapace with orbits moderately oblique; front narrow, narrowest between eyestalk bases, frontal groove moderately wide, with sides diverging rapidly posteriorly; anterolateral margins short, sometimes absent, converging, exorbital tooth little produced,

acute; suborbital crenellations strong, distinct, no tubercles on the floor of the orbit. Major pollex and dactyl flattened, the dactyl especially notably broad, without furrows except for basal traces sub dorsally; pollex with a deep outer furrow in basal two-thirds; ridge inside palm high, its tubercles strong; tubercles on the outer margin of palm large, particularly near depression at pollex base; major merus with a large, sharp tooth at the distal end of its anterodorsal margin. Gonopods usually with entire tip, or some of its elements, twisted; in subspecies without twisting anterior flange is wider than the posterior. Minor cheliped with gape much longer than manus. Merus of all ambulatories slender. Female gonopore with marginal tubercle or other structures; no pile on postero-lateral part of carapace; dorsolateral margin strongly beaded. Displays distinct variation in the colouration with a greyish brown carapace with yellow major chela being the most common pattern.

Habitat and Distribution: Burrows in muddy and sandy substrates, at the fringe of mangrove vegetation in the lower intertidal zones (Crane, 1975). Distributed from East Africa to Samoa, from the Red Sea to Natal, and from Okinawa to subtropical Australia (Crane, 1975).

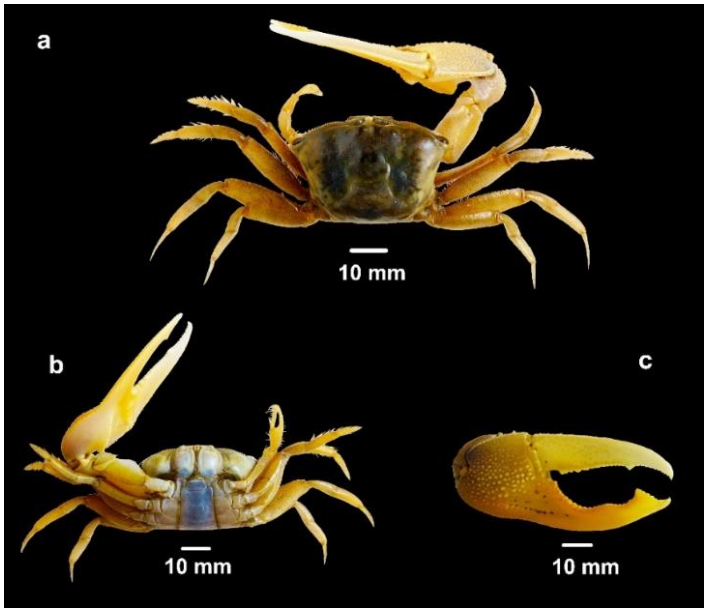

Figure 3.28. *Gelasimus vocans* (Linnaeus, 1758); CW 15.45 mm, CL 12.81 mm, male; (a) dorsal view; (b) ventral view; (c) major male chela.

Genus *Ocypode* Weber, 1795

***Ocypode ceratophthalmus* (Pallas, 1772)**

(Figs. 3.29)

Cancer cursor Linnaeus, 1758: 625 (in part).

Cancer ceratophthalmus Pallas, 1772: 83, pl. 5, fig. 17 (type locality: unknown).

Ocypode (Ocypode) ceratophthalmus de Haan, 1835: pl. C.

Cancer caninus Herbst, 1782: 78.

Ocypode ceratophthalma Weber, 1795: 92; Fabricius, 1798: 347.

Ocypode rhombea Weber, 1795: 92 (nomen nudum).

Ocypode rhombea Fabricius, 1798: 348.

Ocypode cursor Olivier, 1811: 416 (not *Cancer cursor* Linnaeus 1758).

Ocypode ceratophthalma Barnard, 1950: 86, fig. 17c-d; Crosnier, 1965: 93, figs 152, 160, 167–168, pl. 8, fig. 1, pl. 10, fig. 3; Dai & Yang, 1991: 458, text-fig. 231, pl. 58 (4); Ng et al., 2008: 240 (list); Sakai &Türkay, 2013: 685, figs. 1D-I, 10, 32; Komarpant et al., 2018: 73, Fig. 2-4; Trivedi et al., 2018: 55 (list).

Ocypode Urvillei Guérin-Méneville, 1829: pl. 1, fig. 1

Ocypoda (Ocypode) ceratophthalma Voigt, in Cuvier, 1836: 119.

Ocypoda ceratophthalma Milne Edwards H., 1837: 48; Alcock, 1900: 345 (identification key), 345; Chopra and Das, 1937: 418, fig. 17a-a'; Sakai, 1939: 614, fig. 91a, pl. 104, fig. 5; Chhapgar, 1957b: 4, pl. B, fig. 1, pl. 13 a-c.

Ceratophthalma cursor MacLeay, 1838: 64.

Ocypode urvillei Stebbing, 1917: 11.

Ocypoda urvillei Bouvier, 1915: 122.

Ocypode cursor White, 1847b: 35 (in part).

Ocypoda pallidula Dana, 1852: 324, pl. 20, fig. 1.

Ocypoda Urvillii Dana, 1852: 328.

Ocypoda brevicornis var. longicornuta Dana, 1852: 327.

Ocypoda brevicornis Dana, 1852: 326.

Ocypode cordimanus Jacquinot & Lucas, 1853: 64; Heller, 1865: 42.

Ocypoda Macleayana Hess, 1865: 143, pl. 4, fig. 8; Haswell, 1882: 95.

Ocypode Fabricii Hilgendorf, 1869: 82.

Ocypode aegyptiaca Hoffmann, 1874: 13.

Parocypoda ceratophthalma Neumann, 1878: 26.

Ocypoda cordimanus Kingsley, 1880: 185 (in part).

Ocypoda fabricii Kingsley, 1880: 182.

Ocypoda macleayana De Man, 1887: 696.

Ocypoda Kuhlii Pfeffer, 1889: 30.

? Ocypoda ceratophthalma: Matsuura, 1894: 55;

Ocypoda Urvillei Nobili, 1907: 407.

Ocypode gaudichaudii Estampador, 1937: 542.

Cancer francisci Curtiss, 1938: 175.

? Ocypode longicornuta Ng et al., 2008: 240 (list).

Material Examined: CW 4.62 -28.78 mm, CL 3.10-24.34 mm (N=24).

Diagnosis: The carapace is squarish, broader than long, external orbital angles are broadly triangular, front narrow, deflexed; eyestalks are large, elongated, and prolonged beyond the cornea, Chelipeds stout, unequal, fingers with truncate ends, Stridulating ridge of male cheliped with 7 interspaced round tubercles, 12 thick striae and 25-27 closely spaced striae; in females, it consists of 4 interspaced round tubercles, 8-12 thick striae and 29 closely spaced striae. P2–P3 propodi with setae. G1 slender, bears sub-distal palp. Gonopore surrounded by sunken sternite.

Habitat and Distribution: Burrowing in intertidal sandy shores in tropical and temperate regions (Lucrezi & Schlacher, 2014). Distributed from East coast of Africa (except Red Sea) to Japan, Micronesia, and eastwards to Polynesia and Clipperton Island (Sakai &Türkay, 2013).

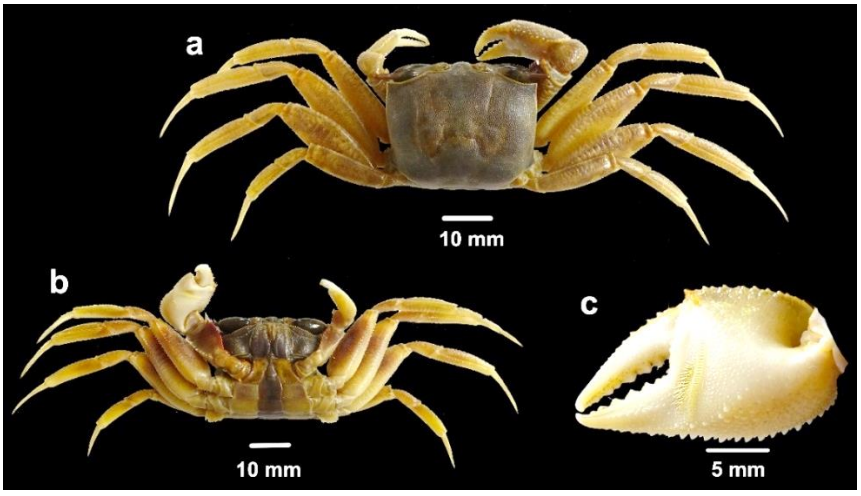

Figure 3.29. *Ocypode ceratophthalmus* (Pallas, 1772); CW 28.78 mm, CL 24.34 mm, male; (a) dorsal view; (b) ventral view; (c) major male chela.

Genus *Tubuca* Bott, 1973

***Tubuca alcocki* (Shih, Chan, and Ng 2018)**

(Figs. 3.30)

Gelasimus dussumieri H. Milne Edwards, 1852: 148, pl. 4(12) (type locality: Malabar, India); Chandy 1973: 402.

Gelasimus acutus Alcock, 1900: 360 (not G. acutus Stimpson, 1858).

Gelasimus urvillei Alcock, 1900: 362 (not G. urvillei H. Milne Edwards, 1852).

Uca angustifrons Lundoer, 1974 (type locality: Phuket, Thailand): 8;

Uca (Deltuca) [coarctata] urvillei Crane, 1975: 35, 58-61, figs. 8B, 9E, pl. 9C, D.

Uca urvillei Tirmizi & Ghani, 1996: 103, fig. 39; Odhano et al., 2015: 170, figs. 1-2.

Uca (Deltuca) urvillei Hogarth 1986: 222; Krishnan, 1992: 471.

Uca (Deltuca) dussumieri Krishnan, 1992: 471.

Uca (Tubuca) urvillei Beinlich & von Hagen, 2006: 10, 14, 25, fig. 7f, k

Uca (Tubuca) acuta Trivedi et al., 2015: 27.

Tubuca urvillei Shih et al., 2016: 159, 174 (part), fig. 12A.

Tubuca alcocki Shih et al., 2018: 49, figs. 3, 4A, C, 5A–D, 6, 7A, C, E, G (type locality: Ranong, Thailand); Trivedi et al., 2018: 55 (list).

Material Examined: CW 5.74–25.72 mm, 3.16–15.38 mm (N=59)

Diagnosis: Diagnosis: Carapace smooth, trapezoidal. Front narrow, with narrow median groove. The floor of the orbit with a row of 5–11 tubercles, sometimes with a blunt ridge in males and with a row of 17–19 tubercles in females. Anterolateral angle acutely triangular, directed obliquely anteriorly; anterolateral margin short to moderately long. Major cheliped with dactylus longer than palm; One long groove on the outer surface of dactylus and pollex each proximally extending beyond midlength. Fingers of minor cheliped without conspicuous tooth in males and with conspicuous tooth on occlusal margin in females. Male G1 with slender distal tube, straight to slightly curved, width of proximal and distal parts subequal; moderate length thumb, extending beyond the base of the distal tube.

Habitat and Distribution: In muddy banks of mangroves (Shih et al., 2018). Distributed from Red Sea to India and Western Thailand (Shih et al., 2018).

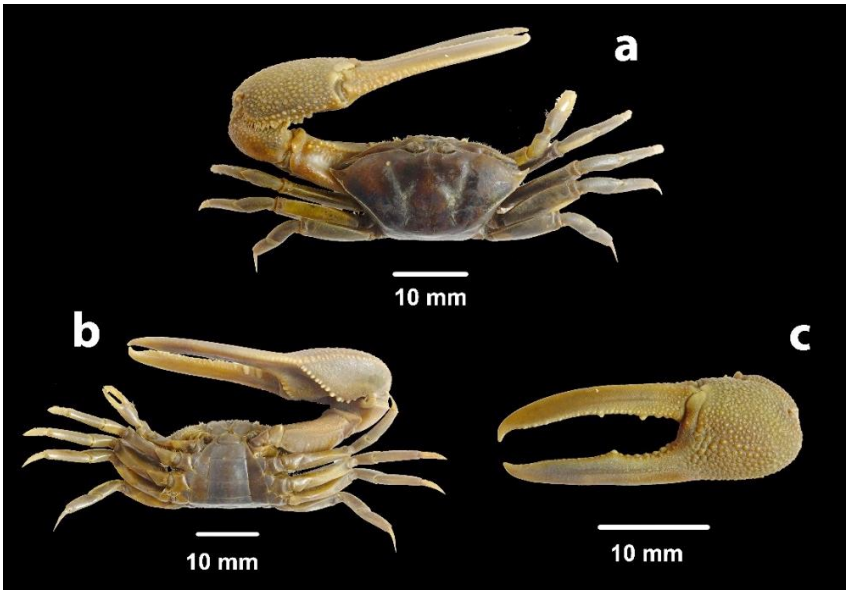

Figure 3.30. *Tubuca alcocki* (Shih, Chan, & Ng, 2018); CW 22.72 mm, CL 14.22 mm, male; (a) dorsal view; (b) ventral view; (c) major male chela.

3.3. Discussion

The present study is the first systematic attempt to document the occurrence of brachyuran crabs from the mangrove-associated regions of Chapora and Sal rivers of Goa. A review of the mangrove-associated crabs of the Indian wetlands revealed the lowest number of brachyuran crab species from Goa (sixteen species) and Karnataka (fourteen species) in comparison to the other coastal states (Chennuri et al., 2023). In view of this, the current study documents thirty species of brachyuran crabs from eleven families and twenty-two genera and thus helps to fill the existing lacunae in species distribution data of the mangrove-associated regions.

Out of the eleven families recorded during this study, the maximum number of species belonged to the family Sesarmidae (nine species from four genera) followed by Portunidae (four species from four genera) and Ocypodidae (four species from four genera). Family Sesarmidae belongs to the superfamily Grapsoidea, which along with the superfamily Ocypodoidea, is known to dominate mangroves all over the world (Hogarth, 2015; Hajializadeh et al., 2022). Most of the sesarmids are herbivorous in nature and therefore show a preference for the mangrove-associated regions (Colpo & Fransozo, 2011; Ferreira et al., 2019) whereas ocypodids are deposit feeders and are known to show their preference for the mangrove-associated regions (Colpo & Fransozo, 2011; Ferreira et al., 2019).

Metopograpsus cannicci is reported for the first time from India indicating its eastward extension. The taxonomy of the genus *Metopograpsus* is difficult owing to the subtle differences in the morphological features between species (Fratini et al., 2018; Innocenti et al., 2020). Recently Innocenti et al. (2020) examined specimens identified as *M. thukuhar* and on the basis of their morphological and genetic investigations described a new species, *M. cannicci*, referring to it as a pseudo-cryptic taxon. Fratini et al. (2018), through molecular phylogenetic investigation, found that the hitherto widely distributed *M. thukuhar* comprised two species with different distributions. *M. thukuhar* is confined to Southeast Asia and Pacific islands, while populations from the East African coast, Red Sea and Seychelles were described as distinct species, *M. cannicci* by Innocenti et al. (2020).

A sesarmid crab *Sarmatium crassum* recorded in the present study has so far been recorded from Eritrea (Red Sea) to Tanzania, South Africa, Madagascar, Philippines, eastern Australia, New Caledonia, Tahiti and Samoa. The taxonomy of the genus *Sarmatium* Dana, 1851, has a very confused history and has been revised on several occasions (Tesch, 1917; Serène and Soh, 1970; 1971; Davie, 1992) and is currently represented by five species which are distributed in the Indo-Pacific region (Davie, 1992): Alcock (1900) recorded *S. crassum* from India on the basis of a single female specimen from Nicobar Island. Davie (1992) commented that this record from India by Alcock (1900) is doubtful, as the diagnostic characters of *S. crassum* are present on male individuals only; the identification of a female specimen may not be precise. Since the specimen was not traceable in the crustacean collection of the Zoological Survey of India, Kolkata, the identity of the *S. crassum* female specimen collected by Alcock (1900) could not be confirmed. The present study confirms the occurrence of the sesarmid crab *Sarmatium crassum* in India.

The genus *Nanosesarma* Tweedie, 1950 comprises ten valid species of intertidal crabs (Ng et al. 2008) inhabiting mixed intertidal habitats across the Indo-Pacific region (Serène & Soh, 1970). *Nanosesarma tweediei* is recorded for the first time from the Indian coasts, indicating a westward extension of geographical range i.e. Malaysia, Singapore, Vietnam and Philippines (Serène, 1967).

The sesarmid genus *Episesarma* (De Man, 1895) contains some of the largest sesarmid crabs. Currently, *Episesarma* is represented by seven species out of which three species *E. chentongense, E. mederi* and *E. versicolor* are reported from India (Manikantan et al., 2016; Trivedi et al., 2018). *E. versicolor* (Tweedie, 1940) also known as violet vinegar crab is a widely distributed species in south-east Asian countries. However, its presence in India is

restricted, with just one record from Pichavaram and Vellar mangroves of Tamil Nadu state located on the east coast of India. The present study records the occurrence of *E. versicolor* for the first on the west coast of India.

Large-scale baseline studies of the brachyuran crabs of the estuaries and coasts of Goa by the Zoological Survey of India (Dev Roy and Bhadra, 2008) revealed fifty-one species, out of which thirty species were reported from various estuaries in the region. Subsequently, Vijaylaxmi (2020) reported twenty-nine species from the Mandovi and Zuari estuaries. It is noteworthy, that despite the earlier attempts to document the brachyuran crab communities of the estuarine regions, the present study yielded the first records of *M. latifrons, P. bengalense*; *P. glabrum*, *M. brevis*, *M. parvimanus* and *T. alcocki* from Goa.

It is apparent from the present study and comparison with published literature that the brachyuran crab assemblages of this region are substantially diverse, and long-term systematic studies encompassing all the estuaries of the state would yield several records of rare and possibly new species.