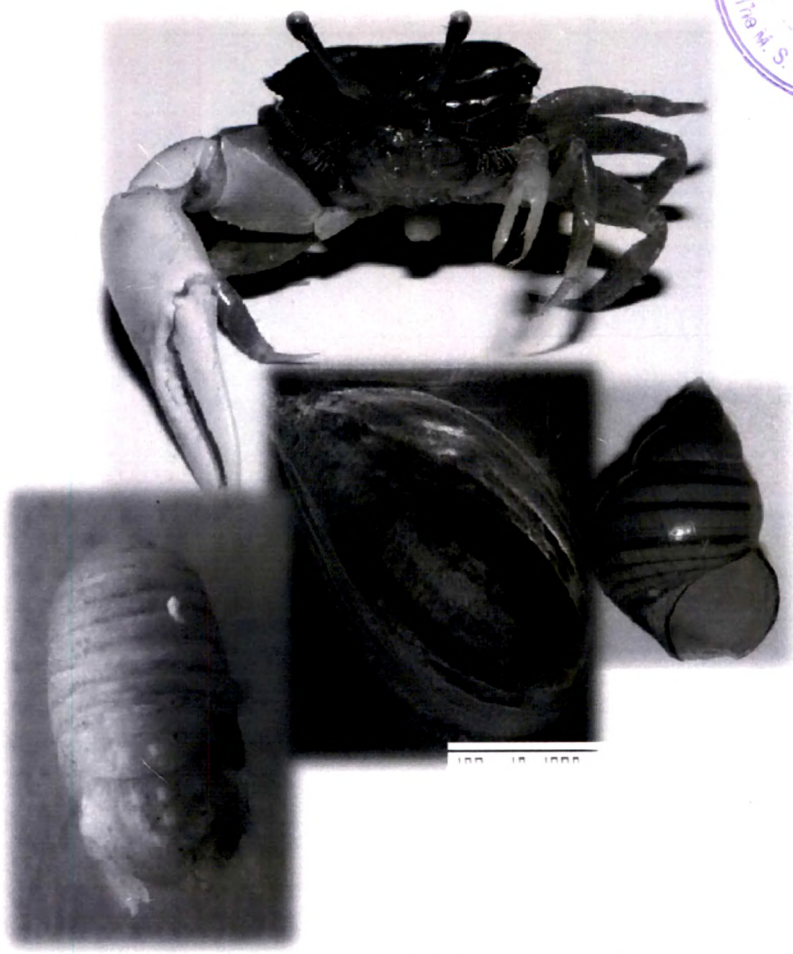


CHAPTER 2

Diversity of Benthic Fauna

There has been no detailed record of benthic animals of Mahi river estuary. Moreover, Gulf of khambhat is known for its poor benthic diversity as compared to Gulf of Kutch due to higher amount of turbidity and extreme hydrodynamic conditions. During the tenure of research, overall 292 faunal species were recorded (Table 2.1). The animals encountered were categorized into microbenthic, macrobenthic and associated fauna. Out of the total 292 benthic faunal species obtained, 241 species were identified while 51 were unidentified species with few of the species were identified to family or genus level. Table 2.2 shows tabular representation of different groups encountered and total number of identified and unidentified animals.

1. BENTHIC MACROFAUNA DIVERSITY

1.1. Molluscan Diversity

A total of 24 molluscan species belonging to 13 genera and 10 families were obtained during the study period (Table 2.3). Out of this, 16 species belonged to class Gastropoda while 8 belonged to class Bivalvia. Upstream (Vasad) showed maximum diversity with 14 species 52%) followed by Downstream (Kamboi) with 11 species (30%) and Midstream (Dabka) with only 5 species (18%). Family Thiaridae dominated with 6 species (25%) and was mostly confined to the fresh water zone (Table 2.4). The heterogeneity in distribution pattern at different habitats were confirmed by various indices. Family Thiaridae dominated with 25 % of the overall diversity followed by family Amblemidae (16.6%), Planorbidae and Corbiculidae (12.5%) (Table 4).

Calss: Gastropoda

Subclass: Prosobranchia

Order: Mesogastropoda

Family: Viviparidae

Subfamily: Bithyniidae

Genus: *Bellamya Jousseaume*, 1886

i. ***Bellamya bengalensis*** , Lamarck, 1882

Paludina bengalensis Lamarck, 1822, *Hist. nat. Anim. Sans Vert.*, 6(2):174

Vivipara bengalensis: Annandale, 1921, *Rec. Indian Mus.*, 22:267

Shell thin, more or less smooth, with three or more colour bands, embryonic shell delicate and thin with three primary rows of chaetae, low ridges, the lower most well developed, sometimes developing into a keel. The shell features may vary in 3 forms due to the physical factors of the environment.

ii. ***Bellamya crassa*** Benson, 1836 (Plate 1a)

Paludina crassa (Hutton Ms.) Benson, 1836, *J. Asiat. Soc. Beng.*, 5: 745.

Shell olive brown, globose, without colour bands, spire small and blunt, shell surface sculptured with fine wavy spiral lines; aperture suboval, columella arched, anterior margin almost straight, outerlip arched, umbilicus rimately perforate.

Family: Bithyniidae

Subfamily: Bithyniinae (Buliminae)

Genus: *Digoniostoma* Annandale, 1920

iii. ***Digoniostoma textum*** Annandale, 1921

Digoniostoma textum Annandale, 1921, *Rec. Indian Mus.*, 22: 541, figs. 1, 2. Type locality: Manipur.

Whorls 4.5, spire shorter than the body whorl in dorsal view, suture oblique, not very much impressed, aperture narrowly oval, posteriorly the outerlip meets the columellar callus at an angle slightly greater than a right angle, columellar margin arched, prominent and thick, umbilicus almost closed. Operculum large, moderately thick, internally convex and granular.

Genus: *Gabbia* Tryon, 1865

iv. ***Gabbia alticola*** Annandale, 1918 (Plate 1g)

Amnicola alticola Anandale, 1918, *Rec. Indian Mus.*, 14:122, pl.xiv, figs. 6, 6a. Type locality: Inle Lake, S. Shan states.

Shell ovately fusiform, sculptured with close-set longitudinal stiare, whorls swollen, suture impressed, narrowly unbilicate, aperture large, strongly rimate and projecting, columella arched, operculum testaceous, with 4 distinct whorls.

Family: Thiaridae

Subfamily: Thiarinae

Genus: *Thiara* Roeding, 1786

v. ***Thiara (Melanoides) tuberculata*** Mueller, 1774 (Plate 1f)

Nerita tuberculata Mueller, 1774, *Hist. Verm. Terr. Fluv.*, 2:191. Type locality: Coromandel Coast.

Melania pyramis Benson, 1836, *J. Asiat. Soc. Beng.*, 5:354. Type locality: Ganges

Melanoides(Melanoides) tuberculatus: Starmuehlner, 1976, Ann. Natur Hist. Mus. Wien., 80:591

It has a wide- range of distribution and variation. Shell with a high spire and moderately large body whorl, whorls evenly rounded, dark red- brown dots and flames, either irregularly distributed or longitudinally arranged on the shell surface, sculptured with vertical ribs and spiral striae, distinct and raised on the upper whorls, but flatter on the lower ones.

vi. ***Thiara (Melanoides) tuberculata crebra*** Lea, 1850

Melania crebra Lea, 1850, *Proc. Zool. Soc. Lond.,* 1850: 193. Type locality: Philippines

It differs from the typical form in being broader, width usually more than 1/3 of the total height, whorls comparatively less rounded, sculptured with broad equidistant spiral ridges, raised axial ridges present only on the apical whorls often continuing on the body whorl.

vii. ***Thiara (Tarebia) lineate*** Gray, 1828. (Plate 1c)

Helix lineate Gray, 1828, in *Wood's Index Test. Suppl.*, p. 24, fig.68. Type locality: Ganges

Tiara (Tarebia) lineate: Preston, 1915, *Fauna Brit. India,* Mollusca (Freshwater Gastropoda and Pelecypoda), p.34,

The species was often synonymised with *T. granifera* (Lamarck) or treated as its variety (Van Benthem Jutting, 1956). But it is readily distinguished from the former by the absence of rows of nodules and presence of distinct dark spiral lines.

viii. ***Thiara (Tarebia) granifera*** Lamarck, 1822

Melania (Tarebia) granifera; Pace, 1973. *Mal. Review Supplement* 1:62, pl.12, fig.3, pl.13, fig.4.

Tarebia granifera: Starmuehlner, 1976, *Ann. Naturhist. Mus. Wien*, 80: 569, figs. 72-75, pl. 16, figs. 17-179.

Shell elongate conical, sculptured with distinct spiral rows of nodules, spires sharp with flat whorls, height of body whorl more than half the total height of the shell.

ix. ***Thiara (Thiara) scabra*** Muller, 1774

Buccinum scabrum Mueller, 1774. *Hist. Verm. Terr. Fluv.,* 2:136. Type locality: Tranquebar.

Melania acanthica Lea, 1850, *Proc. Zool. Soc. Lond.*, p.194

Thiara (Thiara) scabra: Pace, 1973. *Malac. Riview Suppl.* 1:52, pl. 21, figs. 1, 2 pl.13, fig. 3.

Whorls regularly increasing in size, sutures distinct, whorls often shouldered above and rounded below the row of spines, shell sculptured with characteristic vertical ribs bearing prominent spines directed obliquely outward, surface with rough spiral striations, on the body whorl near the umbilical region striations from strong ridges.

x. ***Thiara (Sermyla) riqueti*** Grateloup, 1840

Melania riqueti Grateloup, 1840, Act. Soc. Linn. Bordeaux, 11:433, pl. 3, fig. 28. Type locality: Bombay

Thiara(*Melanoides*)riqueti: Pace, 1973, Mal. Review, Supplement 1:64, pl.12, fig.4, pl.13, fig. 5.

Shell small, moderately elongated, sculpture of undulating axial ridges and spiral ridges, axial rodges dominant above the periphery and the spiral ridges below it on the body whorl. Whorls about 8, regularly increasing, suture distinct.

Family: Hydrobidae

Subfamily: Triculinae Annandale, 1924

Genus: *Tricula* Benson, 1843

xi. ***Tricula Montana*** Benson, 1843

Tricula montana Benson, 1843, *Calcutta J. nat. Hist.,* 3:467. Type locality: Bhimtal, Nainatal, Uttar Pradesh. Prasad, B. 1921. *Rec. Indian Mus.*, 22:67. Figs. 1a, 1b

Shell conically ovate, twice as long as broad, apex obtuse, whorls $5^{1}/2$ – 6, increase irregularly, sutures oblique, curved and somewhat canaliculated.

Family: Planorbidae
Subfamily: Bulininae
Genus: Indoplanorbis Annandale and Prasad, 1921

xii. ***Indoplanorbis exustus*** Deshayes, 1834 (Plate 2 I)

Planorbis exustus Deshayes, 1834, in Belanger, *Voy. Indes-Orientales,* p.417, pl. 1, figs. 11-13. Type locality: Malabar Coast.

Indoplanorbis exustus: Benthem Jutting, 1956, Treubia, 23(2):471. Rajagopal and Subba Rao, 1968. *Proc. Symposium on Mollusca,* pt. 1, p. 110.

Shell large and thick, sutures deeply impressed, aperture ear shaped. Animal sinistral, foot relatively broad and short, leaf-shaped, broadly rounded anteriorly and pointed posteriorly, branchial process lobed.

Subfamily: Segmentininae
Genus: *Segmentina* Fleming, 1817

xiii. ***Segmentina spp.***

Shell small and glossy, thin, whorls convex above and flattened below, deeply embracing the previous one, body whorl very large and carinate or angular, internal cavity divided by opaque, white, transverse laminae of enamel like substance, aperture lunate or subtriangular.

Subfamily: Planorbinae

Genus*: Gyralus* Charpentier, 1837.

xiv. ***Gyralus spp.*** (Plate 2k)

Shell small, always less than 1 cm in diameter, thin, greatly depressed, pale translucent or transparent, with three to five rapidly increasing whorls, without strong transverse ribs, with or without peripheral keel, body whorl at aperture slightly deflected.

Subclass: Pulmonata
Order: Basommatophora
Family Lymnaeidae
Genus: *Lumnaea* Lamarck, 1799

xv. ***Lymnaea spp.***

Shell generally thin, body whorl large, spire always excreted, columella spirally twisted.

Family: Assimineidae

Genus: *Assiminea* Fleming 1828

xvi. ***Assiminea spp.*** (Plate 1e)

These are very small to medium large snails, ranging between 2 to 13 mm. Shells are brightly orange with brownish apex. Shells are thin and ovately triangular. The margin of the aperture is simple. The operculum is in most cases horny.

Class: Bivalvia

Subclass: Plaleoheterodonta

Order: Unionoida

Family: Amblemidae

Subfamily: Parreysiinae

Genus: Parreysia Conard, 1853

xvii. ***Parreysia (Parreysia) favidens*** Preston, 1912

Parreysia faivdens var. *assamensis* Preston, 1912, *Rec. Indian Mus.*, 7:299. Type locality: Digong, Assam.

Shell convex, anterior side more rounded and posterior slightly naruate, dorsal margin rather less posteriorly angled.

xviii. ***Parreysia (Radiatula) chaudhurii*** Preston, 1912

Nodularia(N) chaudhurii Preston, 1912, *Rec. Indian Mus.*, 7: 290. Type locality: Burma.

Very confusing with other speices other than few specific characters. Shell shorter, more ovate, less inflated with more pronounced sculpture.

xix. ***Parreysia (Radiatula) lima*** Simpson, 1900

Nodularia(Radiatula) lima, Simpson, 1900, *Proc, U. S. natn. Mus.*, 22:820. Preston, 1915,

Fauna Brit. India, Mollusca (Freshwater Gastropoda and Pelecypoda), p. 147.

Indonaia lima: Prashad, 1921, Rec. Indian Mus., 22:604.

xx. ***Parreysia (Radiatula) pachysoma*** Benson, 1862

Unio pachysoma.Benson, 1862, *Ann. Mag. Nat. Hist.*, (3) 10: 186. Type locality: Brahmaputra River, Assam.

Nodularia (N) pachysoma: Preston, 1915, *Fauna Brit. India*, Mollusca (Freshwater Gastropoda and Pelecypoda), p. 139

Can be distinguished from similar species by more elongated, more inflated, but less deep shells, more pronounced umbones and much stronger hinge. Lack radial sculpture on the sides.

Subclass: Heterodonta

Order: Veeroida

Family: Coriculidae

Genus: *Corbicula* Megerle von Muehfeld, 1811

xxi. ***Crobicula krishnaea*** Ray, 1967

Corbicula krishnaea Ray, 1967, *Arch. Moll.*, 96:191, figs. 1, 2. Type locality: Krishna River, Maharashtra.

Shell thin, small, triangularly ovate, inequilateral, anterior side narrow and more produced, posterior side broader and shorter, umbones prominent slightly tumid, striae regular and distinct hinge plate well developed.

xxii. ***Corbicula peninsularis*** Prasad, 1928 (Plate 2i)

Corbicula peninsularis Prasad, 1928, *Mem. Indian Mus.*, 9:21, pl. iv. Figs. 13-16. Type locality: Bombay

Shell thick, large (30 mm), ovately triangular, dorsal margin very convex posteriorly drawn out into a regular beak-like structure, umbones prominent, tumid, periostracum glossy, chocolate brown colour, concentric, regular, broad and shallow ribs, pallial line distinctly notched, hinge strongly developed, anterior lateral shorter than posterior ones.

xxiii. ***Crobicula sylhetica*** Preston, 1908

Corbicula sylhetica Preston, 1908, *Rec. Indian Mus.* 2: 47. Type locality: Phenchooaganj, Sylhet, Bangladesh. Prasad, 1928, *Mem. Indian Mus.*, 9:24, pl.iv, figs. 5, 6.

Shell tumid, subtrigonal, dorsal margin sloping, ventral margin rounded, umbones slightly prominent, striae fine and irregular.

Family: Donacidae

Genus: *Donax*

xxiv. ***Donax incarnates*** Chernnitz (Plate 2j)

Shell small 12-20mm, sharply triangular, inequilateral shell. Posterior side steeply sloping. Lunule narrow, elongated and depressed. Area marked by keel bears undulating concentric ridges. Surface finely and radially grooved. Umbonal area smooth and glossy. Pallial sinus wide, dee,p, U-shaped. Colour: Outer surface pale flesh pink or whitish tinged with pink and banded with dark pinkish concentric bands. Umbonal area deep pink. Muscle impressions on inner side pale flesh pink or deep purple.

1.2. Sipuncula Diversity (Plate 6b)

Kingdom: Animalia

Subkingdom: Metazoa

Superphylum: Lophotrochozoa

Phylum: Sipuncula Rafinesque, 1814

A single species of sipuncula was noted from Mahi river estuary during the study period. The species was not identified in detail.

1.3. Polychete Diversity (Plate 6c)

Phylum: Annelida
Class: Polycheta
Subclass: Palpata
Order: Phyllodocida
Family: Nereidae
Genus: Nereis Linnaeus, 1758

Two polychetes were reported from Kamboi (downstream) during the study period.

1.4. Brachyuran Crab Diversity

A total of 11 species of brachyuran crabs belonging to 8 families and 8 genus were reported throughout the study period (Table 2.5). Few of the crab species were partially identified to family or genus level either due to their single sighting or unavailability of specimen for detailed study. Family Ocypodidae dominated the overall brachyuran count followed by family macrophthalminae.

1.4.1. Taxonomic Identification of Crabs (Classification as per Ng, 2007)

Phylum: Arthropoda

Class: Crustacea

Order: Decapoda

Sub Order: Brachyura

Family: Ocypodidae Rafinesque, 1815

Subfamily: Ucinae Dana, 1851

Genus: *Uca* Leach, 1814

Subgenus: *Uca (Gelasimus)* Latreille, 1817

i. ***Uca vocans*** Linnaeus, 1758 (Plate 3c)

Cancer vocans LINNAEUS 1758 (fide HOLTHUIS 1959, p. 116).

Gelasimus marionis DESMAREST 1823, Consid. Gen. Crust., p. 124, pl. 13, fig. 1 (not seen); DE MAN 1880, p. 67; ALCOCK 1900, p. 359; LENZ 1910, p. 559; TWEEDIE 1937, p. 143.

Gelasimus marionis nitidus, ALCOCK 1900, p. 360; TWEEDIE 1937, p. 143, figs. 1d-e; SAKAI 1939, p. 622, pl. 71, fig. 3, text-fig. 95b.

Uca marionis nitidus SAKAI 1935, p. 213, pl. 58, fig. 3.

Uca vocans, HOLTHUIS 1959, p. 115; SERENE 1973, p. 337, pl. 1, figs. 1-4.

Uca (Thalassuca) vocans vocans CRANE 1975, p. 92, pl. 14 E-H, Figs. 38I-L, 56B, 60C-E, 64F.

Subgenus: *Celuca* CRANE, 1975

ii. ***Uca (celucs) lactea annulipes*** H. Milne Edwards, 1837 (Plate 3b, Fig. 2.1))

Gelasimus annulipes H. MILNE EDWARDS 1837, p. 55, pl. 18, figs. 10, 13; ORTMANN 1897, p. 354;

ALCOCK 1900, p. 353; GORDON 1934, p. 10; TWEEDIE 1937, p. 141,text-fig. Ia; SAKAI 1939, p. 616.

Uca annulipes, BALSS 1922, p. 142; SAKAI 1936a, p. 170; BARNARD 1950, p. 97, figs. 18f-i, 19a; FOREST et GUINOT 1961, p. 141, figs. 150-151; 155, 158a-b; CROSNIER 1965, p. 117, figs. 204; 206-207; 212-213.

Uca (Celuca) lactea annulipes CRANE 1975, p. 299, pl. 39A-D; 45A; 47C; 50A; and Figures.

Sam.1: CW = 14mm, CL = 10mm

Sam. 2: CW= 15mm, CL=10mm

Average: CW=14.5mm, CL= 10mm

Characters:

- Dark/choclate brown coloured fiddler crab
- One chela larger and pink in colour
- Carapace slightly rectangular (fig. 2.1).
- External orbital angles projecting almost anteriorly.
- Eyestalk long upto carapace end, interorbital distance 0.3cm
- Light purple design seen on the carapace.
- Carapace slightly narrowed posteriorly.
- Finger of major cheliped of male compressed and broad with wide gaping. Major chelipeds usually plain with no nodes or sculpture (fig. 2.1. c, d, e).

Subgenus Deltuca CRANE, 1975

iii. *Uca (Deltuca) dussumieri* H. Milne Edwards, 1852 (Plate 3a)

Gelasimus dussumieri MILNE EDWARDS 1852, p. 148, pl. 4, fig. 12; DE MAN 1887, p. 108, pl. 7,figs. 2-7; ALCOCK 1900, p. 361; GORDON 1934, p. 12, figs. 5a-c; TWEEDIE 1937, p. 141, fig. 2b.

Uca dussumieri, ORTMANN 1897, p. 348; TESCH 1918, p. 39; MIYAKE 1963, p. 70 (part.); CROSNIER 1965, p. 112.

Uca (Deltuca) dussumieri dussumieri CRANE 1975, p. 37, pl. 2E-F, 3A-D; and Figs. 5, 8A, 9A, 34A, 36A.

Characters:

- External orbital angles sharply projecting anterio laterally.
- Carapace convex, quadrangular, with anterio-lateral tips projecting outward.
- Outer surface of palm of major cheliped of male shows deep orangish colour on lower parts while upper one third is pale yellowish white.

Family: Macrophthalmidae Dana, 1851

Subfamily: Macrophthalminae Dana, 1851

Genus: *Macrophthalmus (Mareotis)*, Barnes 1967

iv. ***Macrophthalmus (Mareotis) depressus*** R□ppell, 1983 (Plate 4a, Fig. 2.2)

Characters:

- Carapace usually very broad and qudralateral. The anteriolateral sides of carapace marked with 2 to 3 small notches (fig. 2.2a).
- Eye stalks long and slender, not extending from the orbits.
- Anterio lateral borders marked with 1-2 teeth.
- Chela equal, slender and not too much sculptured. Fingers well modified for sediment scraping and feeding (fig 2.2c).

v. ***Macrophthalmus dilatatus*** Lanchester,1900 (Plate 4b, Fig. 2.3)

Ocypode (Macrophthalmus) dilatata DE HAAN 1835, p. 55, pl. 15, fig. 3.

Macrophthalmus dilatatus ORTMANN 1894, p. 744; TESCH 1915, p. 168, pl. 6, fig. 4 (lit.); BALSS 1922,p. 145; URITA 1926, p. 26; SHEN 1932, p. 220, pl. 9, fig. 6, text-figs. 135-137; SAKAI 1934, p.320; 1935, p. 216, text-fig. 114; 1939, p. 624, pl. 105, fig. 3; 1995, p. 190, pl. 90, fig. 3; KAMITA 1941, p. 164, text-figs. 90a-d.

Sam.1: CW= 15mm, CL= 7mm

Sam.2: CW=18mm, CL= 8mm

Sam.3: CW= 22mm, CL= 10mm

Sam.4 CW= 15mm, CL= 7mm

Sam.5: CW = 19mm, CL=9mm

Sam.6: CW = 1.8cm, CL= 0.8cm

Average: CW = 17.8 mm, CL = 8.1 mm

Characters:

- Carapace dark greyish in colour.
- Body dorsoventrally depressed and broad.Carapace more broad as compared to length and rectangular in shape.
- Anterio lateral border spined.
- Two bluish large spots seen on the carapace on two halves. (fig.2.3a)
- Two small spines present on the anterio-lateral ends.
- Eyestalk slender and longer than carapace extending out of the orbital gap (fig. 2.3 a & b).
- Hairs seen on the either sides of the carapace.
- Interorbital distance 2mm – 3mm.
- Immovable finger almost rectangularly deflected (fig. 2.3c).

Family: Dotillidae

Genus: *Dotilla* Stimpson, 1858

vi. ***Dotilla clepsydrodactyla*** Alcock, 1900 (Plate 4c, Fig. 2.4)

Sam.1: CW= 8mm, CL=7mm

Sam.2: CW= 7mm, CL= 7mm

Sam. 3: CW=5mm,CL=4mm

Sam.4: CW= 6mm, CL= 5mm

Sam.5: CW= 6mm, CL=5mm

Average: CW: 6.4mm, CL=5.6mm

Characters:

- Small sized crabs found in sandy lower intertidal area.
- Colour yellowish brown. Same like substratum.
- Carapace slightly oval. Crabs look like small balls in natural habitat.
- Chelipeds larger, equal and bulky compared to carapace and other appendages (fig. 2.4 b & c).
- Tympanum seen on the merus of fifth walking leg (fig. 2.4d).
- Palm dull pinkish orange coloured.
- Eyestalks short and slender.
- Forms chimney like burrow walls and leaves small feeding pellets.

Carapace characters:

- Carapace slightly oval/triangular, with some pattern seen (fig. 2.4 a).
- Small spine present at the anterio lateral end.
- Small groove seen from spine to posterior part.
- 3 pairs of nodules like structures seen at the centre of the carapace.

Super family: Portunoidea Rafinesque, 1815

Family: Portunidae Rafinesque, 1815

Subfamily: Portuninae Rafunesque, 1815

Genus: *Scylla* De Haan, 1833

vii. ***Scylla serrata*** Forskal, 1775 (Plate 5, Fig. 2.5)

Samp. 1: CW = 64mm, CL = 42mm

Samp. 2: CW = 64mm, CL = 42 mm

Average: CW = 64mm, CL = 42mm

Characters:

- Carapace buff yellowish coloured.
- Antherilateral half of the carapace cut into 9 anterior lateral spines on the starting from the upper centre half (fig.2.5a).
- 1st median spine prominent showing outgrowth on the carapace.
- 3 frontal spines (between eyestalks).
- Eyestalk short and stout.
- The inner margins of fingers marked prominently with nodule like structures (fig.2.5c)
- Cheleped bulky with a prominent spine near the juncture of fingers and palm specially near movable finger (fig.2.5d).
- 5th leg adapted to swimming.

Family: Gecarcinidae Macleay, 1838

Genus: *Cardisoma* Latreille, 1828

viii. ***Cardisoma carnifex*** Herbst, 1796 (Plate 5b)

Sam.1 : CW= 34mm, CL= 23mm

Sam.2: CW=33mm, CL= 22mm

Sam.3: CW= 34mm, CL= 24mm

Average: CW=33.6, CL = 23mm

Characters:

- Colour light/buff pinkish with light violet marking at centre.
- Front orbital border more than half of maximum breadth of carapace
- Carapace somewhat oval.
- Anteriolateral border divided/cut into 3 parts by notches.
- 3 pair of white spots seen on the either side of carapace.
- Eyestalk short, broad orbital part (inter orbital distance = 0.9 cm).
- Legs adapted for walking.

Family: Matutidae De Haan 1835

Genus Matuta VEBER, 1795

ix. ***Matuta lunaris*** Forskal, 1775 (Plate 5d, Fig. 2.6)

Sam. 1: CW = 3.5cm (excluding spiens) , CL = 3.4 cm

Sam 2: CW= 2.7cm, CL=2.7cm

Sam. 3: CW = 2.7, CL = 2.6

Sam.4 : CW = 2.2cm, CL= 2.2cm

Samp.5: CW = 2.0cm, CL= 2.0cm

Average: CW= 26.2mm, CL= 25.8mm

Characters:

- Carapace somewhat triangular more or less oval (fig. 2.6a)
- Carapace yellowish brown with dense red spots entirely
- A single heavy spine at the junction of the anteriolateral and posteriolateral borders.
- Chela heavily armoured with small stout spines
- Eyestalk short and stout
- The chelipeds are ponderous, greatly enlarged and symmetrical (fig. 2.6 c & d).
- The hands are bulky and curved so as to shut closely against the pterygostomian regions of the carapace, acting as shield.
- Longitudinal ridge of dactylus of chelipeds is well striated.
- Prominent spine at outer angle of palm.
- Carapace uniformly covered with red spots.
- All legs adapted for swimming (fig. 2.6e).
- Successful predators.

Family: Sesarmidae Dana, 1851

Genus: *Parasesarma* De Man, 1895

x. ***Parasesarma pictum*** De Haan, 1835 (Plate 5c)

Grapsus (Pachysoma)pictus DE HAAN 1835,p. 61, pl. 16,.fig. 6.

Sesarmapieta, KRAUSS 1843, p. 45; ALCOCK 1900. p. 414 (earlier lit.); STIMPSON *1907,* p. 135.

Sesarma(Parasesarmri) pieta, DE MAN 1895,p. i83; TESCR 1917, p. 186; BALSS 1922, p. 156; SHEN 1932,p. 186, text-figs. 117, 1113, pl. 7, fig. 7. SAKAI:1935, p.236, pl. 65, fig. 2; 1939, p. 682, pl. 78,fig. 2; ,1965, p•.,201, pl. ,96, .fig. 5; KAMITA 1941, p.219, text-figs. 121a-c.

Sesarma rupicola 'STIMPSON 1858, p. 106; 1907, p.1'35, pl. 17, figs. 1, lb. (Amami Ohshima).

Sam.1: CW=1.8cm, CL=1.4cm

Sam.2: CW=1.3cm, CL= 0.9cm

Sam.3: CW= 1cm, CL=0.7cm

Sam.4: CW= 1.4cm, CL= 1cm

Average: 13.7mm, L= 10mm

Characters:

- Carapace brown in colour
- Carapace rectangular-squarish with single spine at anterior lateral end. Carapace width slightly more than length
- Medium sized bulky crab
- Eyestalk short and stout (inter orbital distance 0.9cm)
- Chela bulky and equal
- Palm orange coloured at tips
- Merus of parapodia with hairy edge and spine on carpus.

Genus: Metopograpsus H. MILNE EDWARDS, 1853

xi. ***Metopograpsus messor*** **Forskal, 1775** (Plate 5e)

Cancer messor FORSKAL 1775, Descrip. Anim. in itin. Orient. p. 88 (not seen).

Grapsus messor H. MILNE EDWARDS 1837, p. 88; HOFFMANN 1874, Rech. Faune Madagascar, Crust., p.23.

Grapsus gaimardi AUDOUIN 1826, p. 82.

Grapsus (Pachygrapsus).aethwpicus HILGENDORF 1869, p: 88, pl. 4, fig. 2.

Metopograpsus messor, ALCOCK 1900, p. 397 (earlier lit. and syn.); RATHBUN 1906, p. 839; BALSS 1922, p. 147; SAKAI 1936a, p. 172; BALSS 1935, p. 77; SAKAI 1939, p. 654, pl. 107, fig. 3; BANERJEE 1960, p. 174, figs. 4h,i, 5c; FOREST et GUINOT 1961, p. 156, fig. 166; CROSNIER 1965, p. 23, figs. 19, 26.

Characters:

- Carapace quadrangular
- Anterior carapace broader than lower part.
- Single spine of the external orbital end directing on upper side.
- Carapace colour olive dark with light green scattered patches.
- Carpus of ambulatory legs hairy.
- Anterio lateral borders of carapace marked with transverse ridges, with posterio lateral ridges convergent to posterior end.
- Internal orbital front of carapace deflected into 4 lobes.
- Eyestalk short and stout.

2. Other Arthropods

Phylum: Arthropoda

i. ***Amphipod sp.*** (Plate 6d)

Phylum: Arthropoda

Subphylum: Crustacea

Class: Malacostraca

Superorder: Peracarida

Order: Amphipoda, Latreille, 1816

The species ranges from 5-10mm in size and semi transparent body. Inhabits older sediments and are active burrowers.

ii. ***Spheroma sp.*** (Isopod) (Plate 6e)

Subclass: Eumalacostraca

Superorder: Peracarida

Order: Isopoda Latreille, 1817

The species is tinny, with dull brownish body colour and size ranging from 8 to 15 mm. The species is mostly seen in zone 5 in hard substratum. The species is active burrower feeding on the organic detritus within as co-dweller with *amphipod spp.*

iii. **Insect Larvae (Cicindela spp./ Megacephala spp)** (Plate 6f)

Class: Insecta

Order: Coleoptera

Suborder: Adephaga

Family: Carabidae

Subfamily: Cicindelinae, Latreille, 1802

Larvae are S-shaped, with dorsal abdominal hooks (on segment 5) which are used to hold position in their vertical burrows. The burrows are made mostly towards the high tide line on the estuarine mudflat. Burrows are shallow and superficially formed with horizontal curvature.

iv. **Spider** (Plate 6g)

Class: Arachnida

Order: Araneae

Superfamily: Lycosoidea

Family: Lycosidae Sundevall, 1833

The species body size ranged from 1-1.5cm with dull brownish colour. They were mostly seen in the upper intertidal mudflats and are active burrowers.

v. **Ant sp.**

Class: Insecta
Order: Hymenoptera
Family: Formicidae
Subfamily: Formicinae
Genus: *Formica* Linnaeus, 1758

The species size ranged from 1-1.5cm with black abdominal part and reddish brown head and trunk. Formica nests are of many different types from simple shaft-and-chamber excavations in soil with a small crater or turret of soil above to large mounds.

3. Avifauna

Total of 118 species were reported belonging to 42 families during the study period (Table 2.8). Although, some of the families were represented by one or two species, family Scolopidae dominated with 10 representatives (Table 2.6) and was mainly confined to the lower reaches of estuary. Species richness was higher at upstream with 68 species contributing 37% of the total number followed by midstream 63 species (33%) and downstream 57 species

(30%). However, no significant difference in diversities among the three zones was noted (Table 2.7). Jaccard's and Sorenson's similarity indices depicted higher similarity between upstream and midstream followed by midstream and downstream. The higher diversity in upstream and midstream can be probably attributed to the appropriate feeding landscape available for aquatic birds and the adjacent bushy habitat in the gorges and ravines for terrestrial birds. Conclusively, it can be stated that Mahi estuary and the adjacent ravines/gorges and bushy habitat within provides excellent environment for variety of birds. As the present investigation did not include the detailed study of interior ravines, further surveys in the ravines and adjacent terrestrial region can certainly make good addition to the present checklist.

4. BENTHIC MICROFAUNA DIVERSITY

4.1. Foraminiferans (Table 2.9; Plate 7& 8)

Kingdom: Protozoa (Goldfuss, 1818) R. Owen, 1858

Subkingdom: Biciliata

Infrakingdom: Rhizaria Cavalier-Smith, 2002

Phylum: Foraminifera (Eichwald, 1830)

Class: Foraminifera Lee, 1990

Order: Miliolida Delage & Herouard, 1896

Family: Hauerinidae, Schwager, 1876

Genus: *Quinqueloculina* d'Orbigny, 1826

i. ***Quinqueloculina spp.*** (Plate 7)

Test typically coiled about an elongated axis in various planes. Aperture simple with a simple tooth.

ii. ***Quinqueloculina seminulum*, Linnè, 1758** (Plate 7)

Family Miliolodae

Genus TRILOCULINA d'Orbigny, 1826

iii. ***Triloculina oblonga*** (Plate 7)

Triloculina D'ORBIGNY, Ann, Sci, Nat., vol. 7, 1826, p. 299

Test typically coiled about an elongated axis in various planes. Aperture simple with a simple tooth. Interior simple, aperture with a simple or bifid tooth. Tests with the early chambers quinqueloculine, at least in the microscopic form, later ones added in planes 120o from one another, third of each series added in the plane of the third preceding and covering it so that the surface of the test is composed of three visible chambers.

iv. ***Triloculina spp. 1***

Triloculina D'ORBIGNY, Ann, Sci, Nat., vol. 7, 1826, p. 299

v. ***Triloculina spp. 2***

Triloculina D'ORBIGNY, Ann, Sci, Nat., vol. 7, 1826, p. 299

Genus: Miliolinella

vi. ***Miliolinella subrotunda* Lendenfeld, 1888** (Plate 7)

vii. ***Miliolinella sp.*** (Plate 7)

Family: Spiroloculinidae Wiesner, 1920

Genus: *Spiroloculina*

viii. ***Spiroloculina spp.*** D' Orbigny, 1826 (Plate 7)

Spiroloculina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 298

Test with the early chambers in the microspheric form quinqueloculine, later ones in a single plane, chambers a half coil in length; apertural end usually witha neck and lip, simple, with a simple of bifid tooth.

ix. ***Spiroloculina spp. 2*** D' Orbigny, 1826

Spiroloculina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 298

Family: Soritidae

Genus: *Peneroplis*

x. ***Peneroplis spp.*** (Plate 8g)

Order: Lagenida Delage & Herouard

Family: Lagenidae Reuss, 1862

Genus: Procerolagena Puri, 1953

xi. ***Procerolagena spp.*** (Plate 8d)

Test free, unilocular, big, amphora-shaped, elongate, tapering into long, slender neck; wall calcareous, hyaline, finely perforate, surface ornamented with thick, longitudinal, plate-like costae that extend onto neck; aperture simple, terminal, rounded, with phialine lip.

Family: Vaginulinidae Reuss, 1860

Genus: *Lenticulina* Lamarck, 1804

xii. ***Lenticulina spp. Lamarck, 1804*** (Plate 7)

Lenticulina LAMARCK, Ann. Mus., vol. 5, 1804, p. 186

Test planispiral, bilaterally symmetrical, typically close coiled or in many species uncoiled; wall very finely perforate, glassy, smooth or variously ornamented; aperture radiate, typically with a small chamberlet below with a simple rounded aperture opening into the larger cavity of the chamber.

Family: Nodosariidae - Ehrenberg, 1838

Genus: *Lagena* Walker and Jacob, 1798

xiii. ***Lagena maccullochae*** (Plate 8a)

Order: Rotaliida Delag & Herouard,1896

Superfamily: Rotaliacea Ehrenberg,1839

Family: Elphidiidae Galloway, 1933

Genus: *Elphidium*

xiv. ***Elphidium spp. Montfort, 1808***

Elphidium MONTFORT, Conch. Syst., vol.1, 1801, p. 15.

Test typically planispiral, bilaterally symmetrical, mostly involute; chambers numerous with distinct sutures either depressed or raised and limbate, with septal bridges and depressions; wall calcareous, perforate; apertures one or more at the base of the apertural face.

Genus: *Cribrononion* Thalmann, 1947

xv. ***Cribrononion simplex***

xvi. ***Ammonia beccarri*** **Linné, 1758** (Plate 7)

Test low trochospiral, biconvex, spiral side evolute, umbilical side involute, periphery rounded to carinate, wall calcareous; aperture an interiomarginal extraumbilical arch.

Super family: Bolivininacea Glaessner, 1937

Family: Bolivinidae Glaessner, 1937

Genus: *Bolivina* d'Orbigny, 1839

xvii. ***Bolivina striatula*** **Cushman, 1922** (Plate 8c)

Carnegie Inst. Washington, vol. 17, p. 27, pl.3, fig. 10

xviii. ***Bolivina spp. 1*** (Plate 8e)

Test typically an elongate spiral, divided into chambers, Test biserial in the adult; wall calcareous, perforate; aperture loop-like or rounded and terminal. Aperture in the median line, reaching the base of the chamber.

xix. ***Bolivina spp. 2***

Discription: -----As above-----

Order: Rotaliida: Delage & Herouard, 1896

Superfamily: Rosalinacea Reiss,1963

Family: Rosalinidae Reiss,1963

Genus: *Rosalina* d'Orbigny, 1926

xx. ***Rosalina spp.*** **d'Orbigny, 1926** (Plate 8b)

Test free or attached, plano-convex, trochospiral; wall calcareous, hyaline, smooth, finely perforate; chambers irregular in shape and gradually increase in size as added, all visible on spiral side, and only 6 to 7 visible on final whorl around open umbilicus on partially evolute umbilical side; sutures depressed and slightly curved; aperture an interiomarginal arch at base of final chamber, near periphery on umbilical side extending into umbilicus.

Order: Foraminiferida Delage & Herouard, 1896

Superfamily: Rotaliacea Ehrenberg, 1839

Family: Discorbidae Ehrenberg, 1838

Genus: *Cancris*

xxi. ***Cancris oblonga*** **Thiele, 1905** (Plate 7)

Order: Textulariida Delage & Herouard, 1896

Family: Valvulinidae Berthekin, 1880

Genus: Eggerella Cushman, 1933b

xxii. ***Eggerella spp.*** **Cushman, 1933b**

Test free, elongate, sharply tapering, early portion with 4 to 5 chambers in a whorl, later portion triserial; wall finely agglutinated with occasional larger grains; chambers numerous, low and broad in early portion, increase in relative height as added, those of final whorl approximately equal in height and breadth; sutures distinct and depressed; aperture small, central, low arch at base of final chamber.

Table 2.1: Numerical presentation of overall benthic groups found during the study period.

Fauna	Identified	Unidentified	Total
Micro benthic animals	16	25	41
Macro benthic animals	37	14	51
Total Benthic animals	**53**	**39**	**92**
Associated animals of Mahi river	185	15	200
Total	241	51	292

Table 2.2: General and taxonomic categorization of obtained benthic species

Category	Sub category		No. identified species	No. of unidentified species	Total no. of species
Benthic microfauna	Foraminiferans		22	09	31
	Ostracods		-	05	05
	Mollusca		-	05	05
	Total		22	25	41
Benthic macrofauna	Nemaotda		-	02	02
	Mollusca		24	-	24
	Sipuncula		-	01	01
	Annelida		-	03	03
	Arthropoda	Spider	-	01	01
		Crab	11	03	13
		Amphipod	01	00	01
		Isopod	-	01	01
		Barnacle	-	01	01
		Insect larvae	01	01	02
		Ant	01	-	01
	Chordata: Mudskipper		01	-	01
	Total		38	14	51
Associated fauna	Planktonic		60	15	65
	Avifauna		118	-	118
	Fishes		15	-	15
	Reptiles		01	-	01
	Mammals(Dolphin)		01	-	01
	Total		185	15	200
Grand Total			238	54	292

Class	Sub Class	Order	Family	Subfamily	Genus	Sub genus	Species
Gastropoda	Prosobranchia	Mesogastropoda	Viviparidae	Bellamyinae	*Bellamya* Jousseaume	--	*B.bengalensis*
							B.crassa
			Bithyniidae	Bithyniinae	*Digoniostoma*	--	*D.textum*
					Gabbia	--	*G.alticola*
			Thiaridae	Thiarinae	*Thiara* (Roding)	*Melanoides* Olivier	*Thiara (Mel.) tuberculata*
							Thiara.(M.) tuberculata crebra
						Tarebia	*T. lineate*
							T. granifera
						Thiara	*T.scabra*
						Sermyla	*T.riqueti*
			Hydrobiidae	Triculinae	*Tricula*	--	*Tricula montana*
			Planorbidae	Bulininae	*Indoplanorbis*	--	*Indoplanorbis exustus*
				Segmentininae	?	?	*Segmentina spp.*
				Planorbinae	*Gyralus*	--	*Gyralus spp.*
			Lymnaeidae	--	*Lymnaea*	?	*Lymnea spp.*
			Assimineidae		*Assiminea*	?	*Assiminea spp.*
Bivalvia	Palaeoheterodonta	Unionoida	Amblemidae	Parreysiinae	*Parreysia* Conard	*Parreysia s.*	*P.(P.) favidens*
						Radiatula Simpson	*P. (R.) chaudhurii*
							P.(R.) lima
							P.(R.) pachysoma
	Heterodonta	Veneroida	Corbiculidae	--	*Corbicula* Megerle	--	*Corbicula krishnae*
							C.penninsularis
							C.sylhetica
			Donacidae	--	*Donax*	--	*Donax incarnatus*

Table 2.3: General classification of obtained molluscan speices.

Table 2.4: Family wise percentage contribution of molluscan fauna.

Family	Subfamily	Genus	Species	% Species Contribution
Viviparidae	*01*	*01*	*02*	*8.33*
Bithyniidae	*01*	*02*	*02*	*8.33*
Thiaridae	*01*	*01*	*06*	*25.00*
Hydrobiidae	*01*	*01*	*01*	*4.17*
Planorbidae	*03*	*03*	*03*	*12.50*
Lymnaeidae	-	*01*	*01*	*4.17*
Assimineidae	-	*01*	*01*	*4.17*
Amblemidae	*01*	*01*	*04*	*16.66*
Corbiculidae	-	*01*	*03*	*12.5*
Donacidae	-	*01*	*01*	*4.17*
	08	*13*	*24*	100

Table 2.5: Outline classification of brachyuran crab taxa obtained from Mahi estuary.

Sr. No.	Family	Sub family	Genus	Species
1	Ocypodidae	Ucinae	Uca	Uca vocans
2				Uca lacteal annulipes
3				Uca dussumieri
4	Macrophthalmidae	Macrophthalminae	Macrophthalmus	Macrophthalmus depressus
5				Macrophthalmus dilatatus
6	Dotillidae	-	Dotilla	Dotilla clepsydrodactyla
7	Portunidae	Portuninae	Scylla	Scylla serrata
8	Gecarcinidae	-	Cardisoma	Cardisoma carnifex
9	Matutidae	-	Matuta	Matuta lunaris
10	Sesarmidae	-	Parasesarma	Parasesarma pictum
11	Grapsidae	Grapsinae	Metapograpsus	Metopograpsus messor

Table 2.6: Species richness of the reported avian families from the study area.

Sr. No	Family	No. of Species	Sr. No	Family	No. of Species
1	Phasianidae	2	22	Podicipedidae	1
2	Anatidae	5	23	Ardeidae	9
3	Upupidae	1	24	Phoenicopteridae	1
4	Alcedinidae	2	25	Threskiornithidae	4
5	Meropidae	2	26	Pelecanidae	1
6	Cuculidae	3	27	Ciconiidae	3
7	Psittacidae	1	28	Laniidae	1
8	Apodidae	1	29	Corvidae	3
9	Strigidae	1	30	Oriolidae	1
10	Columbidae	5	31	Dicruridae	1
11	Gruidae	1	32	Thurdinae	4
12	Rallidae	3	33	Sturnidae	3
13	Rostratulidae	1	34	Hirundinidae	4
14	Scolopacidae	10	35	Pycnonotidae	2
15	Burhinidae	1	36	Cisticolidae	2
16	Recurvirostridae	1	37	Sylviidae	7
17	Charadriidae	3	38	Alaudidae	1
18	Jacanidae	2	39	Nectariniidae	1
19	Dromadidae	1	40	Passeridae	1
20	Laridae	8	41	Montacillidae	7
21	Accipitridae	6	42	Phalacrocoracidae	1

Table 2.7: Similarity and diversity index of avifaunal records at different sites.

Study Site	**Similarity Index**		**Study Site**	**Diversity Index**		
	Jaccards Index SCJ	**Sorrenson Index SCs**		**Shannon Index**	**Simpson Index**	**Berger-Parker Index**
Upstream-Midstream	0.28	0.56	Upstream	4.22	0.985	0.01
Upstream - Downstream	0.17	0.35	Midstream	4.14	0.984	0.01
Midstream - Downstream	0.26	0.53	Downstrea m	4.06	0.982	0.01

Table 2.8: Checklist of birds with their location and distribution status.

	Family/Common name	Scientific name	Status	Up stream	Mid stream	Down stream
	Family: Phasianidae					
1	Grey Francolin R	*Francolinus pondicerianus*	RB	-	-	+
2	Indian Peafowl R	*Pavo cristatus*	RB	-	-	+
	Family: Anatidae					
3	Lesser Whistling-duck	*Dendrocygna javanica*	RB	+	+	-
4	Greylag Goose	*Anser anser*	M	+	+	-
5	Brahminy duck	*Tadorna ferruginea*	M	+	+	-
6	Spot-billed duck	*Anas poecilorhyncha*	RB	+	-	-
7	Comb Duck	*Sarkidiornis melanotos*	RB	+	-	-
	Family: Upupidae					
8	Common Hoopoe	*Upupa epops*	M	-	-	+
	Family: Alcedinidae					
9	White-throated Kingfisher	*Halcyon smyrnensis*	RB	+	+	+
10	Lesser Pied Kingfisher	*Ceryle rudis*	RB	+	+	-
	Family: Meropidae					
11	Small Green Bee-eater	*Merops orientalis*	R	+	+	+
12	Blue-tailedBee-eater	*Merops phillippinis*	RB	+	-	+
	Family: Cuculidae					
13	Pied Cuckoo	*Clamator jacobinus*	rS	+	-	-
14	Asian Koel	*Eudynamys scolopacea*	RB	+	+	+
15	Greater Coucal R	*Centropus sinensis*	RB	+	+	+
	Family: Psittacidae					
16	Rose-ringed Parakeet	*Psittacula krameri*	RB	+	+	+
	Family: Apodidae					
17	House Swift	*Apus affinis*	RB	+	-	-
	Family: Strigidae					
18	Spotted Owlet	*Athene brama*	RB	-	+	+
	Family: Columbidae					
19	Blue Rock Pigeon	*Columba livia*	RB	+	+	+
20	Oriental Turtle Dove	*Streptopelia orientalis*	M	-	+	+
21	Spotted Dove	*Streptopelia chinensis*	RB	-	+	+
22	Eurasian Collared Dove	*Streptopelia decaocto*	RB	-	+	-
23	Yellow-footed Green Pigeon	*Treron phoenicoptera*	RB			
	Family: Gruidae					
24	Common Crane w	*Grus grus*	M	-	+	-
	Family: Rallidae					
25	White-breasted Waterhen	*Amaurornis phoenicurus*	RB	+	-	-
26	Purple Swamphen	*Porphyrio porphyrio*	RB	+	-	-
27	Common Coot	*Fulica atra*	RB,M	+	-	-
	Family: Rostratulidae					
28	Fantail snipe	*Gallinago gallinago*	M	+	-	-
	Family: Scolopacidae					
29	Black-tailed Godwit	*Limosa limosa*	M	-	-	+
30	Eurasian Curlew	*Numenius arquata*	M	-	-	+

31	Common Redshank s	*Tringa totanus*	M	-	-	+
32	Marsh Sandpiper	*Tringa stagnatilis*	M	+	+	-
33	Common Greenshank	*Tringa nebularia*	M	-	-	+
34	Green Sandpiper	*Tringa ochropus*	M	-	+	-
35	Common Sandpiper	*Actitis hypoleucos*	M	+	+	-
36	Sanderling	*Calidris alba*	M	-	-	+
37	Little Stint	*Calidris minuta*	M	+	+	-
38	Curlew Sandpiper	*Calidris ferruginea*	M	-	-	+
	Family: Burhinidae					
39	Great Thick-knee	*Esacus recurvirostris*	RB	+	-	-
	Family: Recurvirostridae					
40	Black-winged Stilt	*Himantopus himantopus*	RB	+	+	-
	Family:Charadriidae					
41	Red watteled lapwing	*Vanellus indicus*		+	+	+
42	Little Ringed Plover	*Charadrius dubius*	M	+	-	+
43	Kentish Plover	*Charadrius alexandrinus*	RB	-	-	+
	Family : Jacanidae					
44	Phesant tailed Jacana	*Hydrophasianus chirurgus*	RB	+	-	-
45	Bronze winged jacana	*Metopidius indicus*	RB	+	-	-
	Family: Dromadidae					
46	Crab Plover	*Dromas ardeola*	M	-	-	+
	Family: Laridae					
47	Brown-headed Gull	*Larus brunnicephalus*	M	-	-	+
48	Black-headed Gull	*Larus ridibundus*	M	-	-	+
49	Slender-billed Gull	*Larus genei*	M	-	+	-
50	Yellow legged gull	*Larus cachinnans*	M	-	+	-
51	Gull-billed Tern	*Gelochelidon nilotica*	M	-	+	+
52	Caspian Tern	*Sterna caspia*	RB,M	-	+	+
53	River Tern	*Sterna aurantia*	RB	+	+	+
54	Common Tern	*Sterna hirundo*	M	-	+	-
	Family: Accipitridae					
55	Black-shouldered Kite	*Elanus caeruleus*	RB	-	-	+
56	Black Kite	*Milvus migrans*	RB	+	-	-
57	Brahminy Kite	*Haliastur indus*	RB	-	+	-
58	Western Marsh Harrier	*Circus aeruginosus*	M	-	+	+
59	Montagu's Harrier	*Circus pygargus*	M	-	-	+
60	Shikra	*Accipiter badius*	RB	-	+	+
	Family: Podicipedidae					
61	Little Grebe R	*Tachybaptus ruficollis*	RB	+	-	-
	Family: Phalacrocoracidae					
62	Little Cormorant	*Phalacrocorax niger*	RB	+	+	-
	Family: Ardeidae					
63	Little Egret	*Egretta garzetta*	RB	+	+	-
64	Western Reef Egret	*Egretta gularis*	RB	-	+	+
65	Grey Heron	*Ardea cinerea*	RB	+	+	-
66	Purple Heron	*Ardea purpurea*	RB	+	-	-
67	Great Egret	*Casmerodius albus*	RB	-	+	+
68	Intermediate Egret	*Mesophoyx intermedia*	RB	+	+	+

69	Cattle Egret	*Bubulcus ibis*	RB	+	-	+
70	Indian Pond Heron	*Ardeola grayii*	RB	+	+	+
71	Black-crowned Night Heron	*Nycticorax nycticorax*	RB	+	-	-
	Family: Phoenicopteridae					
72	Lesser Flamingo	*Phoenicopterus minor*	RB,M	-	+	+
	Family: Threskiornithidae					
73	Glossy Ibis	*Plegadis falcinellus*	RB,M	+	-	-
74	Black-headed Ibis	*Threskiornis melanocephalus*	RB	+	+	-
75	Black Ibis	*Pseudibis papillosa*	RB	+	+	-
76	Eurasian Spoonbill	*Platalea leucorodia*	RB,M	-	+	-
	Family: Pelecanidae					
77	Great White Pelican	*Pelecanus onocrotalus*	RB,M	-	+	-
	Family: Ciconiidae					
78	Painted Stork	*Mycteria leucocephala*	RB	+	+	+
79	Asian Openbill	*Anastomus oscitans*	RB	+	+	+
80	White-necked Stork	*Ciconia episcopus*	RB	-	+	-
	Family: Laniidae					
81	Bay-backed Shrike	*Lanius vittatus*	RB	-	-	+
	Family: Corvidae					
82	Indian Treepie	*Dendrocitta vagabunda*	RB	+	+	+
83	House Crow	*Corvus splendens*	RB	+	+	+
84	Jungle Crow	*Corvus macrorhynchos*	RB	+	+	-
	Family: Oriolidae					
85	Eurasian Golden Oriole	*Oriolus oriolus*	M	-	-	+
	Family: Dicruridae					
86	Black Drongo	*Dicrurus macrocerus*	RB	+	+	+
	Family: Turdinae					
87	Oriental Magpie Robin	*Copsychus saularis*	RB	+	+	+
88	Indian Robin	*Saxicoloides fulicata*	RB	+	+	-
89	Common Stonechat	*Saxicola torquata*	M	-	+	-
90	Pied Bushchat	*Saxicola caprata*	M	-	+	-
	Family: Sturnidae					
91	Rosy Starling	*Sturnus roseus*	M	-	-	+
92	Common Myna	*Acridotheres tristis*	RB	+	+	+
93	Bank Myna	*Acridotheres ginginianus*	RB	+	+	+
	Family: Hirundinidae					
94	Dusky Crag Martin	*Hirundo concolor*	RB	+	-	-
95	Common Swallow	*Hirundo rustica*	M	-	-	+
96	Wire-tailed Swallow	*Hirundo smithii*	RB	+	-	-
97	Red-rumped Swallow	*Hirundo daurica*	M	+	-	-
	Family: Pycnonotidae					
98	White-eared Bulbul	*Pycnonotus leucotis*	RB	-	-	+
99	Red-vented Bulbul	*Pycnonotus cafer*	RB	+	+	+
	Family: Cisticolidae					
100	Ashy Prinia	*Prinia socialis*		+	-	-
101	Plain Prinia	*Prinia inornata*		+	+	-
	Family: Sylviidae					

102	Thick billed warbler	*Acrocephalus aedon*	V	-	-	+
103	Indian great Reed Warbler	*Acrocephalus stentoreus*	RB,M	+	-	-
104	Booted Warbler	*Hippolais caligata*	M	+	-	-
105	Common Tailorbird	*Orthotomus sutorius*	RB	-	+	+
106	Common Babbler	*Turdoides caudatus*	RB	-	+	+
107	Large Grey Babbler	*Turdoides malcolmi*	RB	-	+	-
108	Jungle Babbler	*Turdoides striatus*	RB	+	+	-
	Family: Alaudidae					
109	Black-crowned Sparrow-Lark	*Eremopterix nigriceps*	R	-	-	+
	Family: Nectariniidae					
110	Purple Sunbird	*Nectarinia asiatica*	RB	+	-	-
	Family:Passeridae					
111	House Sparrow	*Passer domesticus*	RB	-	+	+
	Family: Motacillidae					
112	White Wagtail	*Motacilla alba*	M	+	-	-
113	Large Pied Wagtail	*Motacilla maderaspatensis*	RB	+	-	-
114	Yellow Wagtail	*Motacilla flava*	M	+	-	-
115	Grey Wagtail	*Motacilla cinerea*	M	+	-	-
116	Tawny Pipit	*Anthus campestris*	M	-	-	+
117	Baya Weaver	*Ploceus philippinus*	RB	+	-	-
118	White throated munia	*Lonchura malabarica*	RB	+	+	-

R - Residents; RB - Resident Breeding (Breeding recorded in Gujarat); M -Migratory;
S – summer visitor Breeding summer visitor

Table 2.9: Outline classification of obtained foraminiferan species from Mahi river estuary.

Order	Super family	Family	Genus	Species
Miliolida	-	Hauerinidae	Quinqueloculina	*Quinqueloculina spp.*
				Q. seminulum
	-	Miliolidae	Triloculina	*Triloculina oblonga*
				Triloculina spp. 1
				Triloculina spp.2
	-		Miliolinella	*Miliolinella subtrotuda*
				Milionella spp.
	-	Spiroloculinidae	Spiroloculina	*Spiroloculina spp.*
				Spiroloculina spp.2
		Soritidae	Peneroplis	*Peneroplis spp.*
Lagenida	-	Lagenidae	Procerolagena	*Procerolagena spp.*
		Vaginulinidae	Lenticulina	*Lenticulina spp.*
		Nodosariidae	Lagena	*Lagena maccullochae*
Rotaliida	Rotaliacea	Elphidiidae	Elphidium	*Elphidium spp.*
			Cribrononion	*Cribrononion simplex*
		Rotaliidae	Ammonia	*Ammonia beccari*
	Bolivinacea	Bolivinitidae	Bolivina	*Bolivina striatula*
				Bolivina spp. 1
				Bolivina spp.2
	Rosalinacea	Rosalinidae	Rosalina	*Rosalina spp.*
Foraminiferida	Rotaliacea	Discorbidae	Cancaris	*Cancris oblonga*
Textulariida	--	Valvulinidae	Eggerella	*Eggerella spp.*

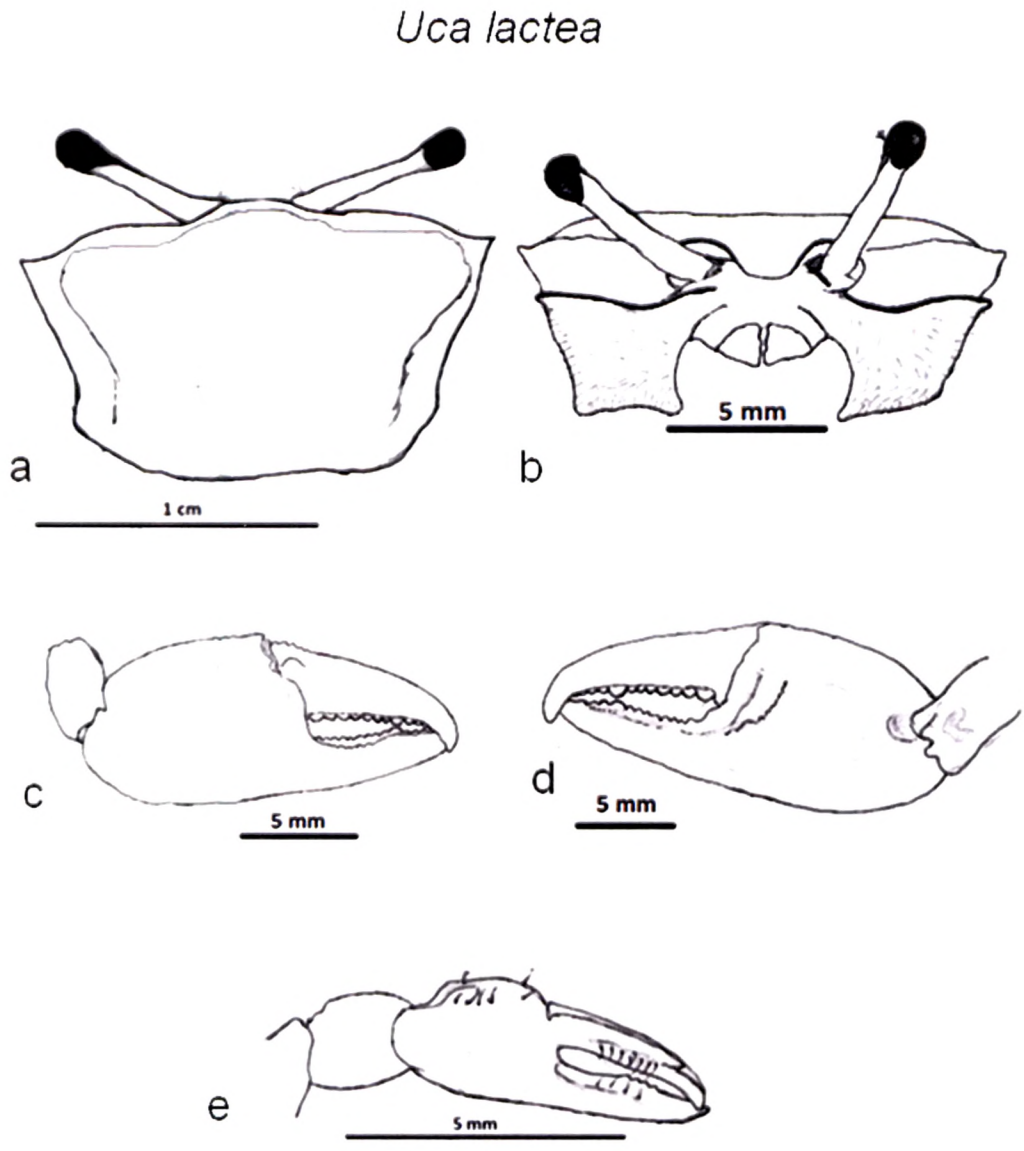


Fig. 2.1: *Uca lacteal.* a. General carapace features b. Frontal view showing orbital region and sub orbital portion. c. Outer view of larger chela/palm d. Inner view of larger chela showing arrangement and notch pattern on movable figure e. Upper view of samller chela

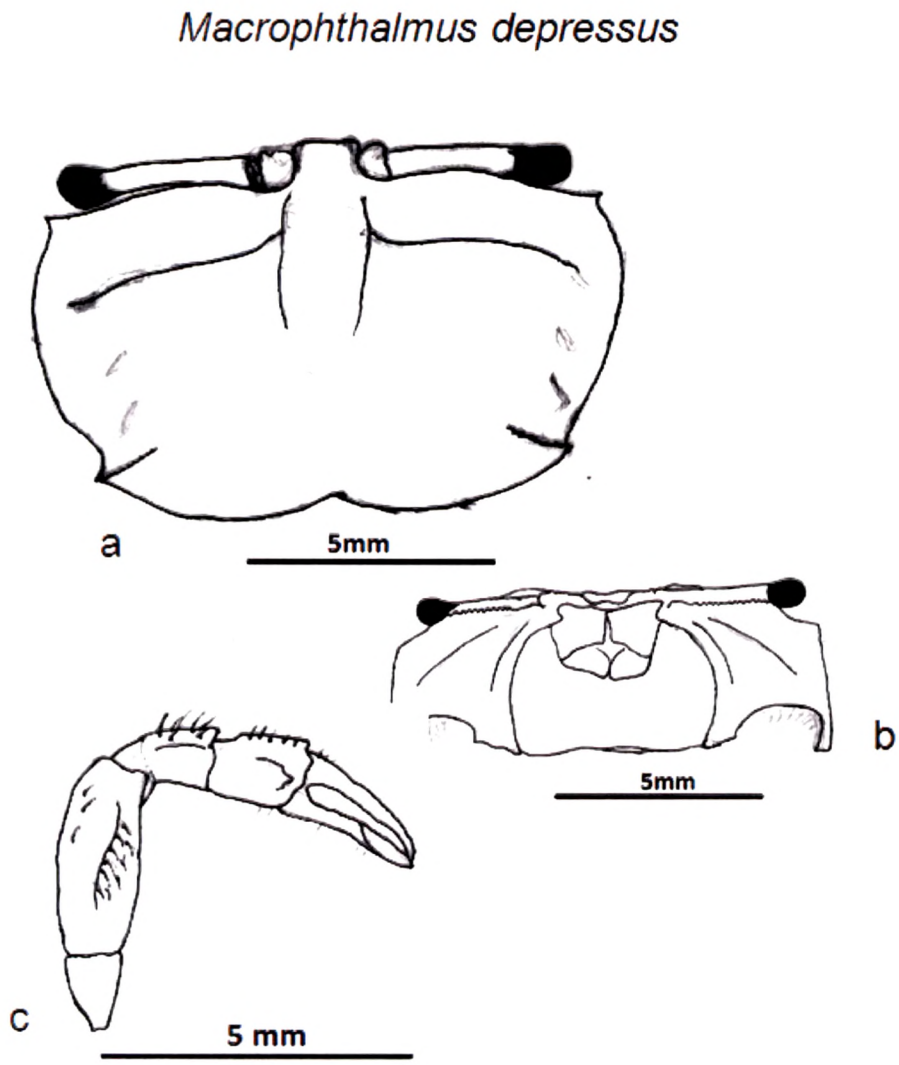


Fig. 2.2: *Macrophthalmus depressus* a. General carapace characters b. Frontal view showing orbital arrangement c. Overview to chela with simple dactylar arrangement.

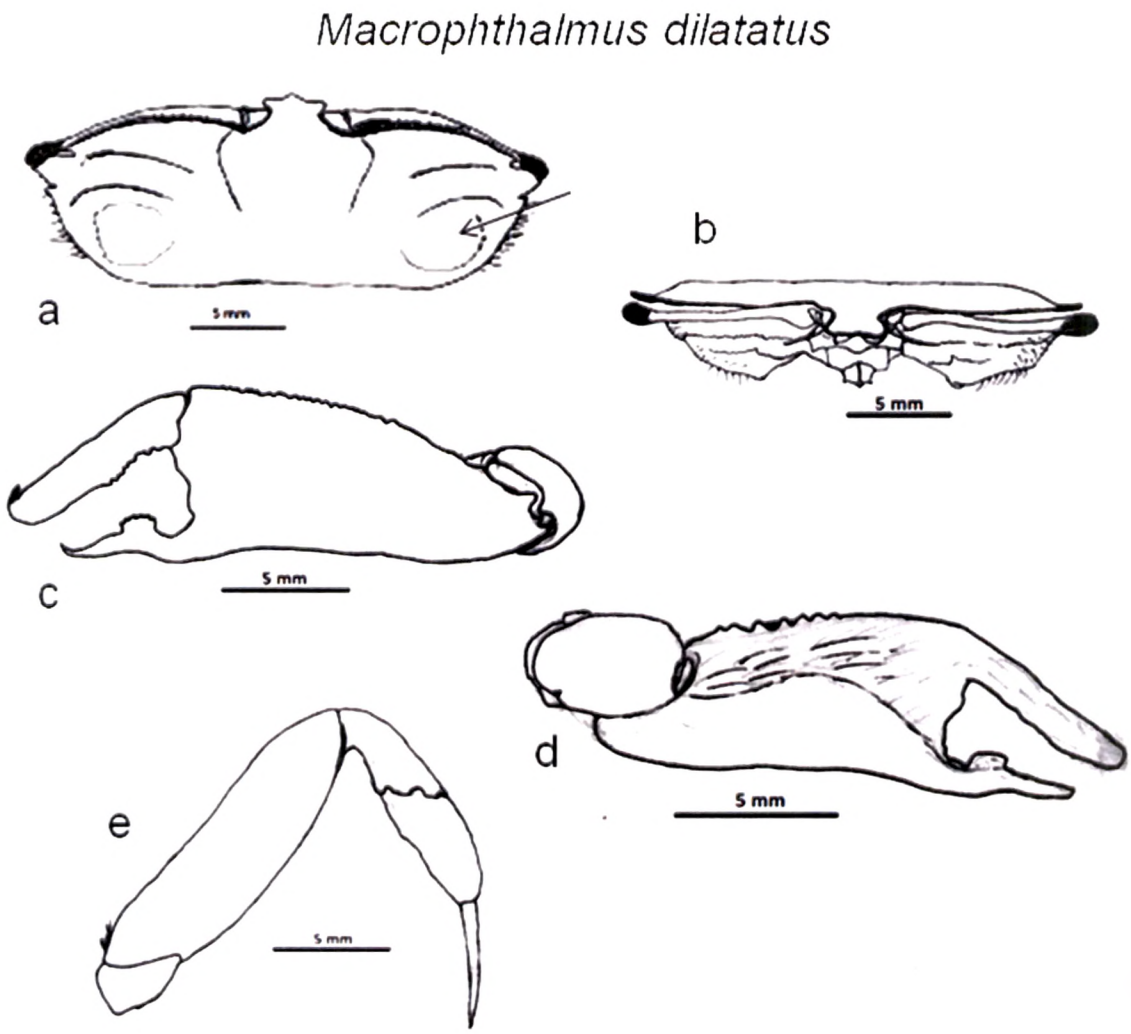


Fig. 2.3: *Macrophthalmus dilatatus.* a. Carapace features showing distinct circular impressions on each lateral side (branchial region) of the carapace b. Frontal view of species showing extension of eyestalk from the orbital socket as well as dorso ventrally depressed structure c & d. Outer and inner view of dactylus e. Outer view of periopod.

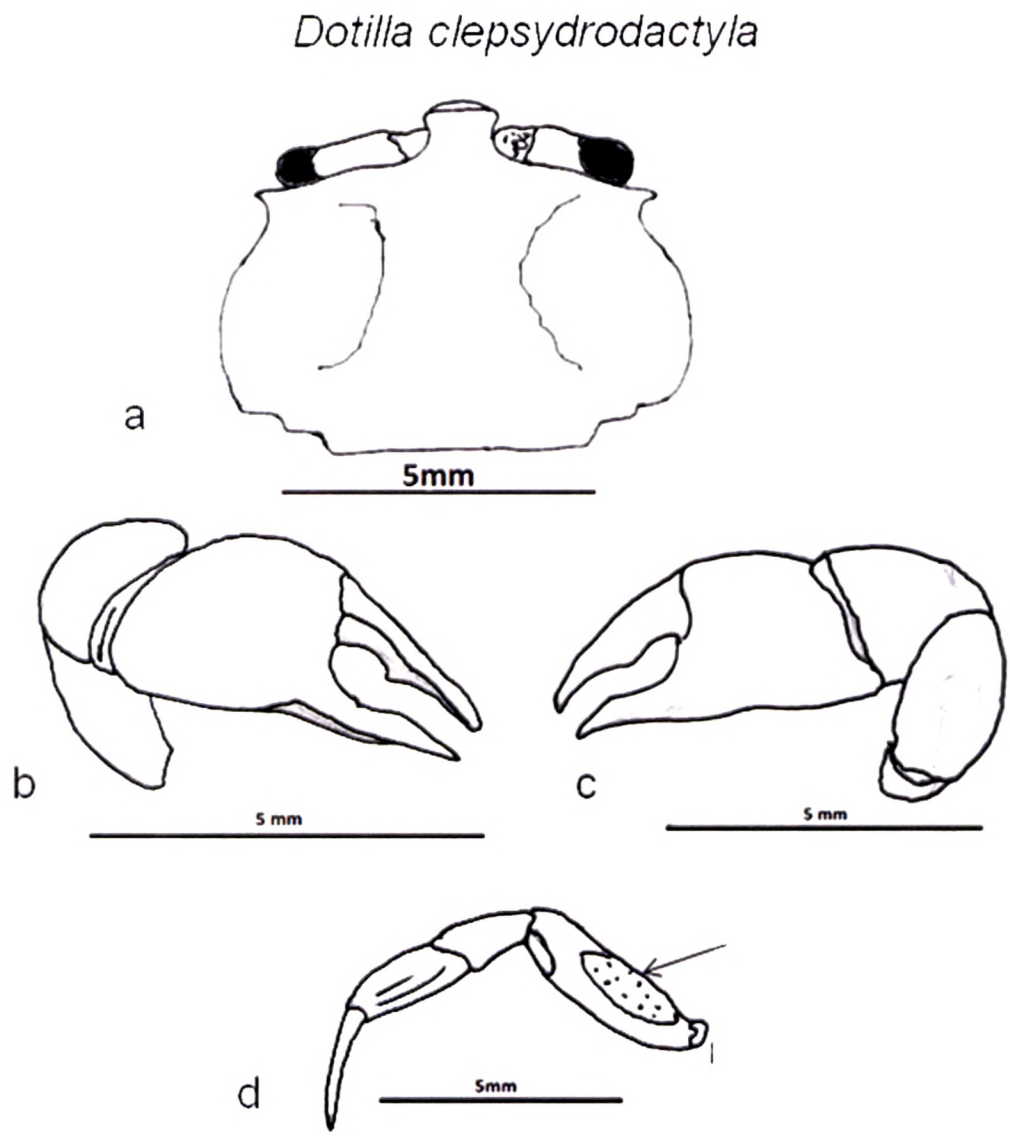


Fig. 2.4: *Dotilla clepsydrodactyla* a. Carapace features b & c. outer and inner view of dactyla d. 4th periopod with distinct semicircular tympanum on the merus.

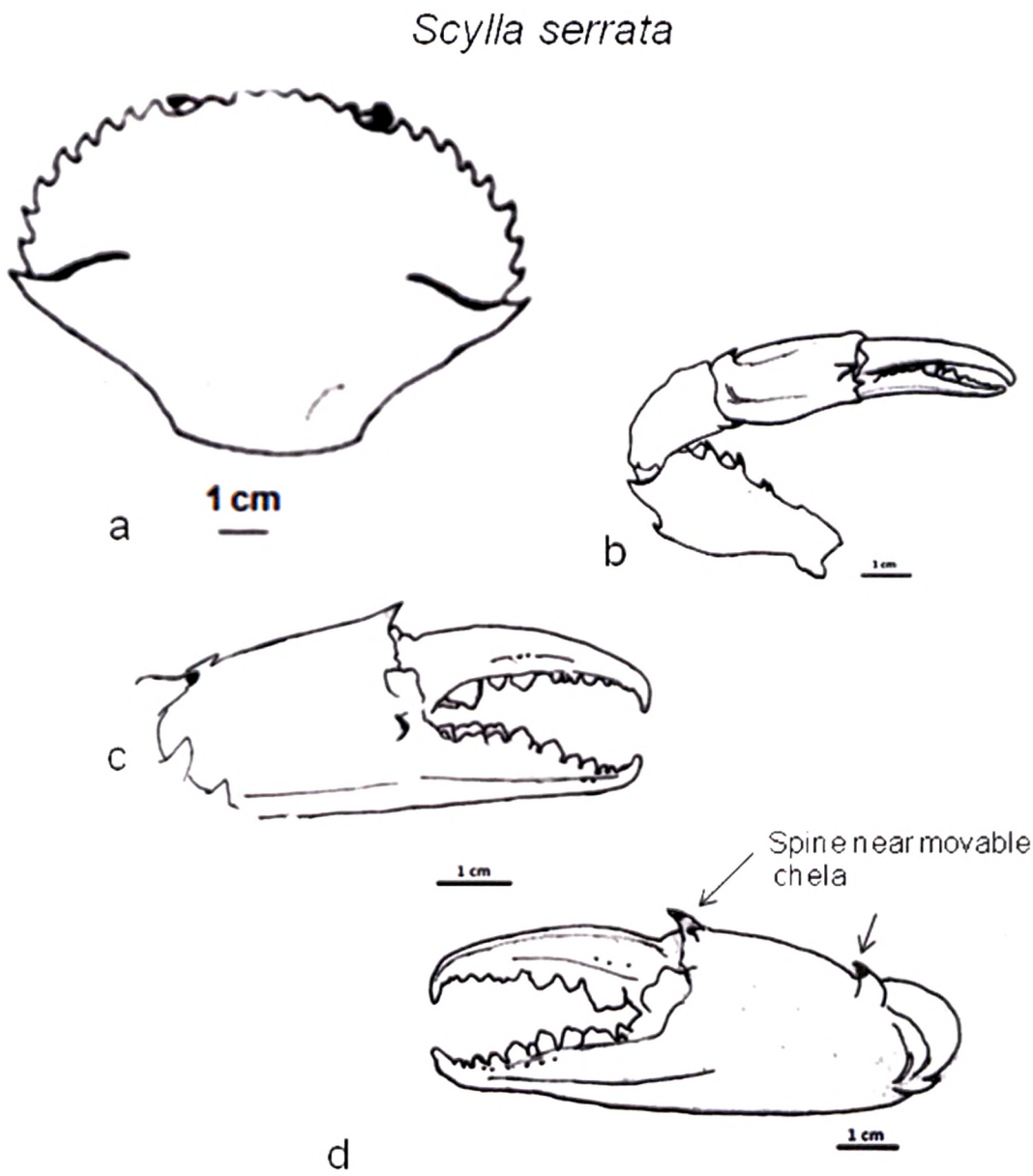


Fig. 2.5: ***Scylla serrata*** a . General carapace features with 9 anteriolateral spines b, Upper view of chelipid spines on teh merus c, inner view of dactylus d, outer view of davtylus with prominent spine at the davtylar end.

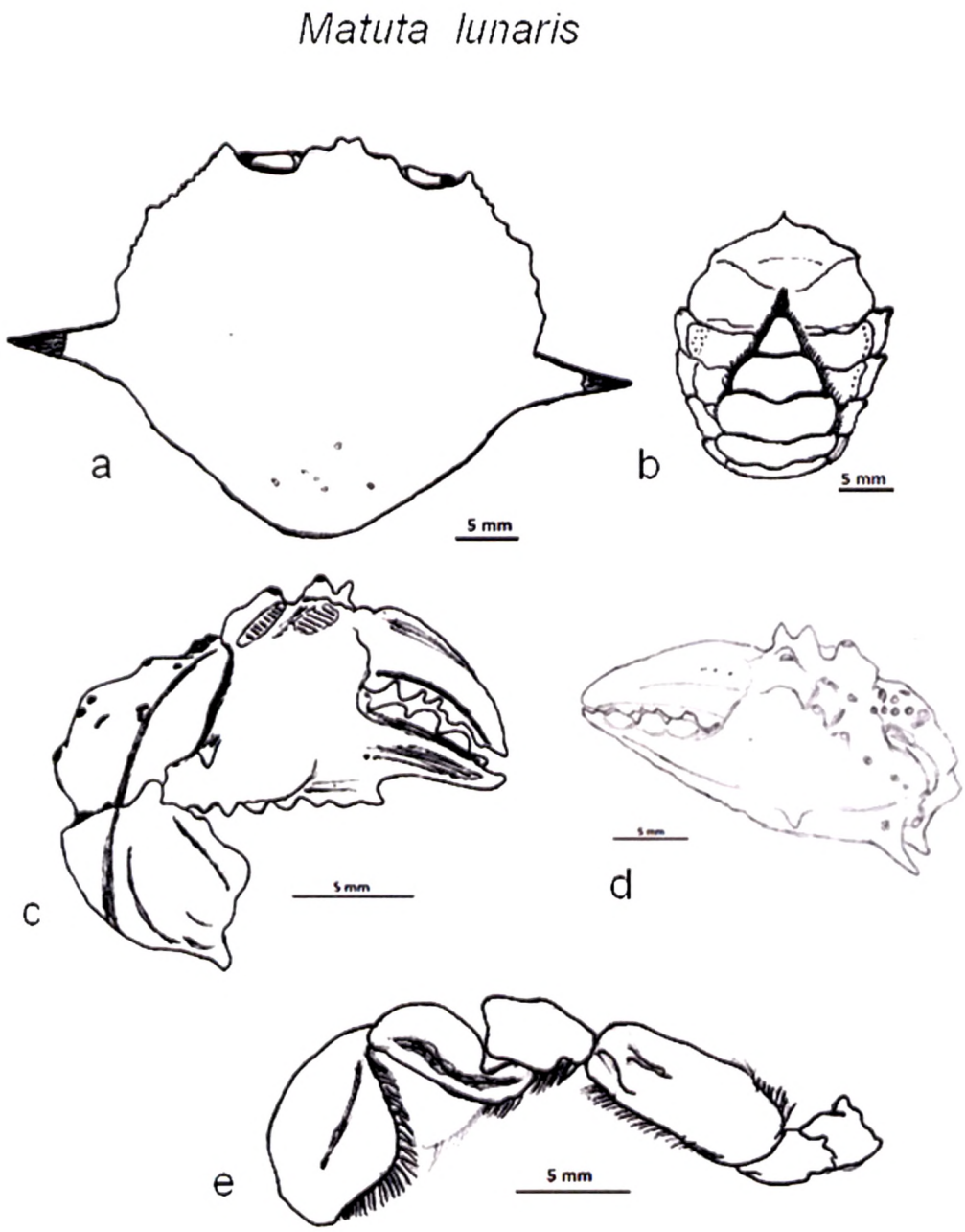
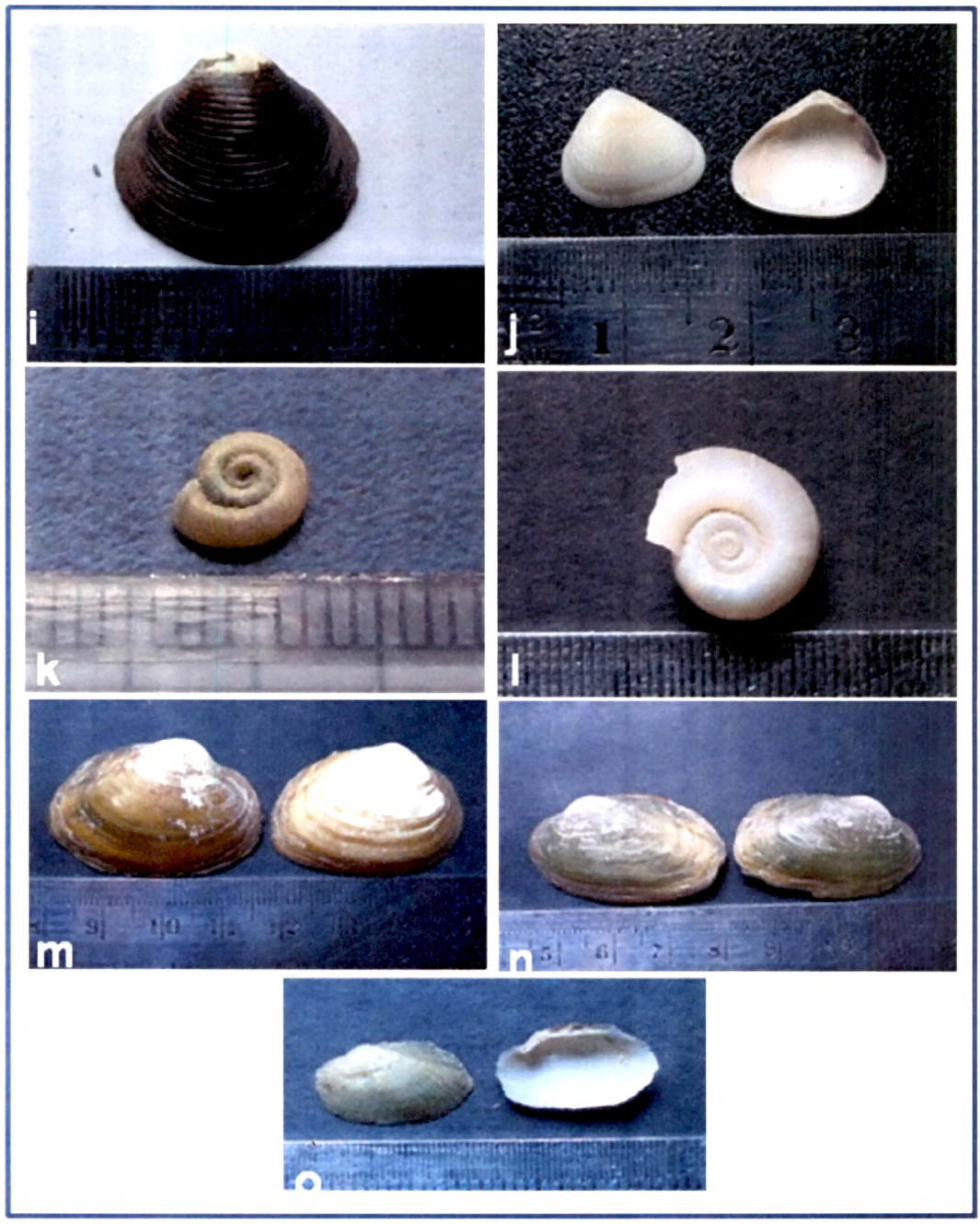


Fig. 2.6: *Matuta lunaris* . a. Semicircular carapace with prominent elongated spines at the junction of anterio and posterior lateral margin b. Ventral abdominal view showing arrangement of sternum and tergum c & d. showing heavily armoured chelipeds with their front and inner view e. Natatory leg with dactylar bristles.

PLATE 1

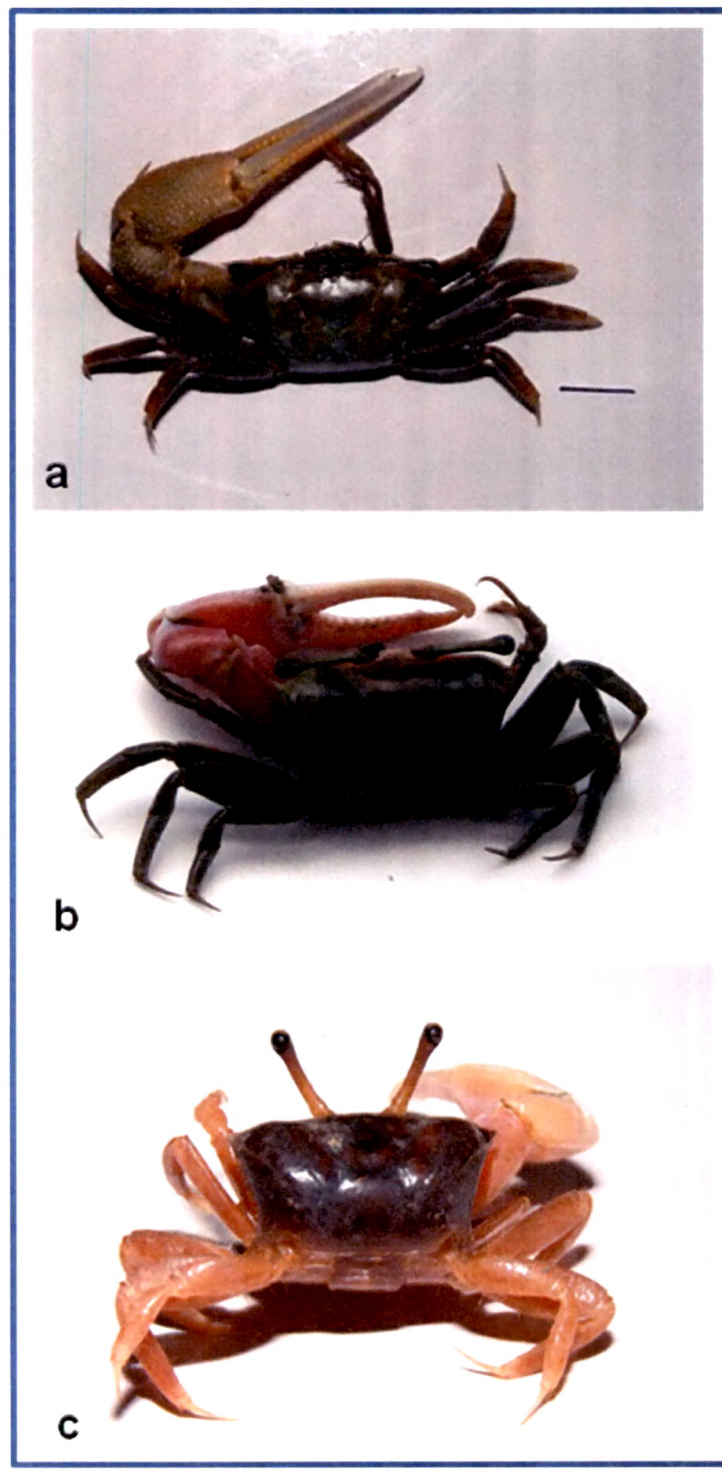
a. Bellamya crassa b. *Thiara scabra* c. *Thiara lineata* d. *Thiara sp.* e. *Assiminea sp.* f. *Thiara (Mel.) tuberculata* g. *Gabbia alticola* h. *Tricula montana*

PLATE 2



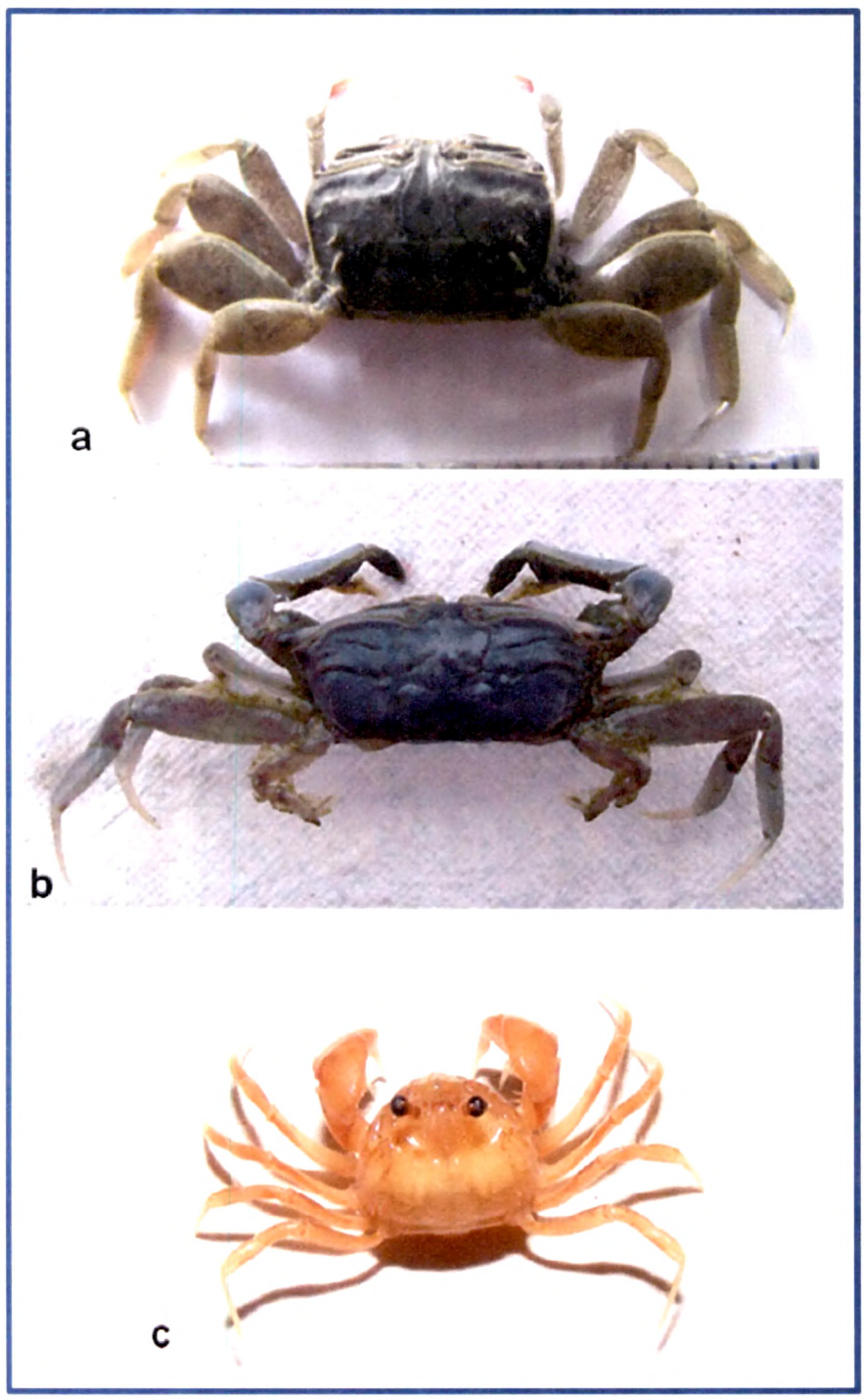
i. *Corbicula penninsularis* j. *Donax incarnatus* k. *Gyralus spp.* l. *Indoplanorbis exustus* . m, n & o, *Parrysia spp.*

PLATE 3



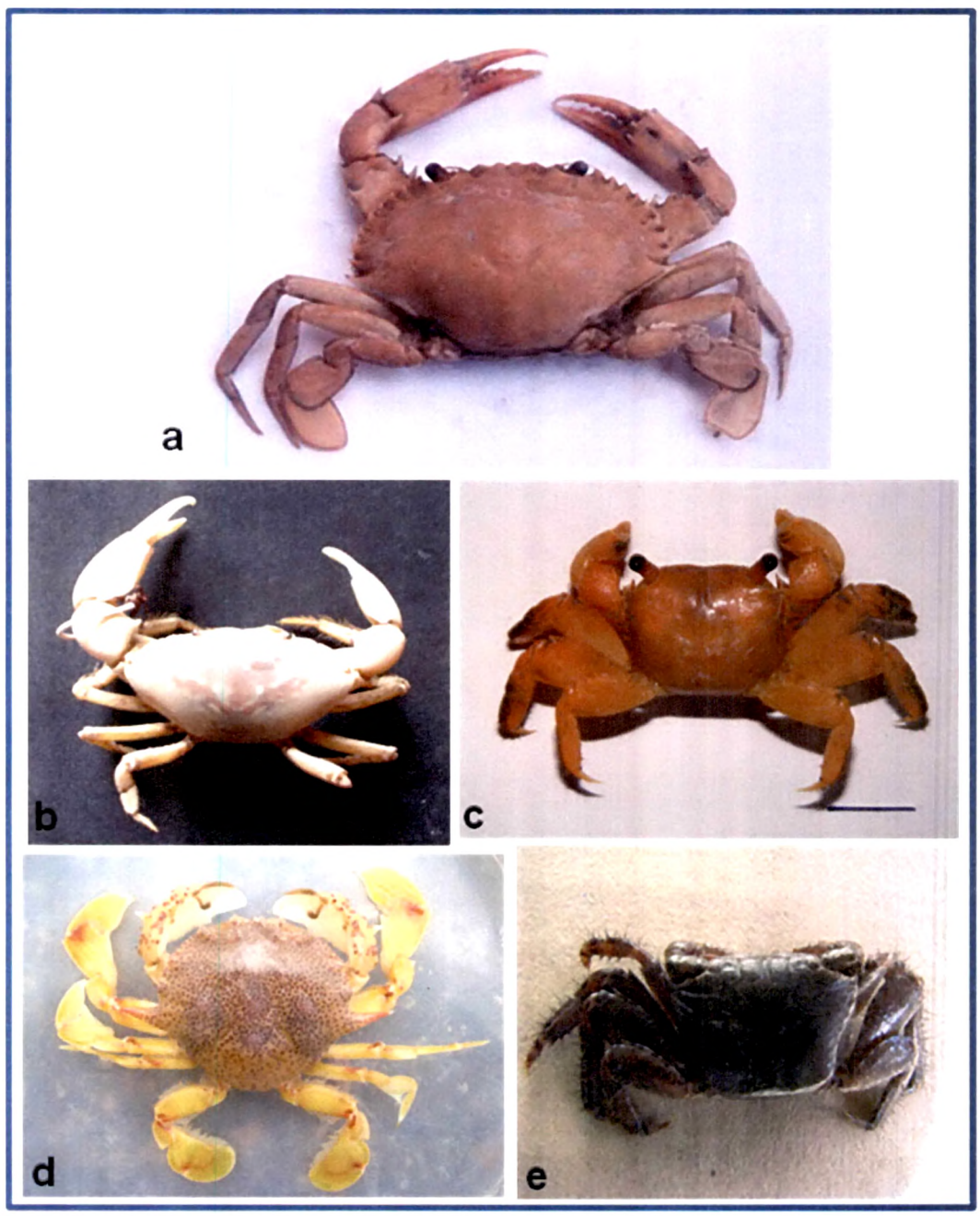
a). *Uca dussumerrie* b). *Uca lactea annulipes* c). *Uca vocans*

PLATE 4



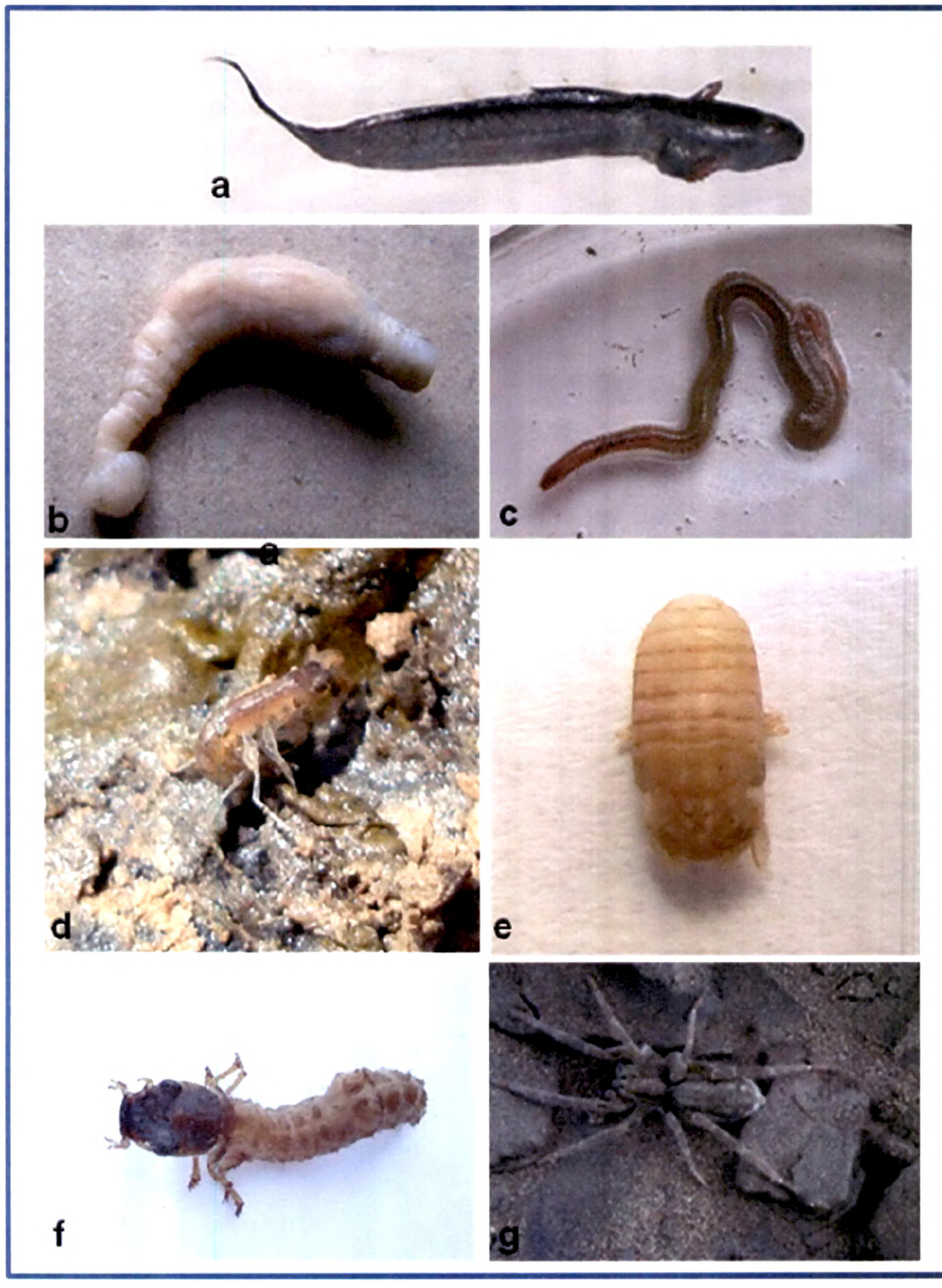
a). *Macrophthalmus depressus* b). *Macrophthalmus dilatatus* c). *Dotilla clepsydrodactyla*

PLATE 5



a). *Scylla serrata* b). *Cardisoma carnifex* c). *Parasesarma pictum* d). *Matuta lunaris* e). *Metopograpsus messor*

PLATE 6

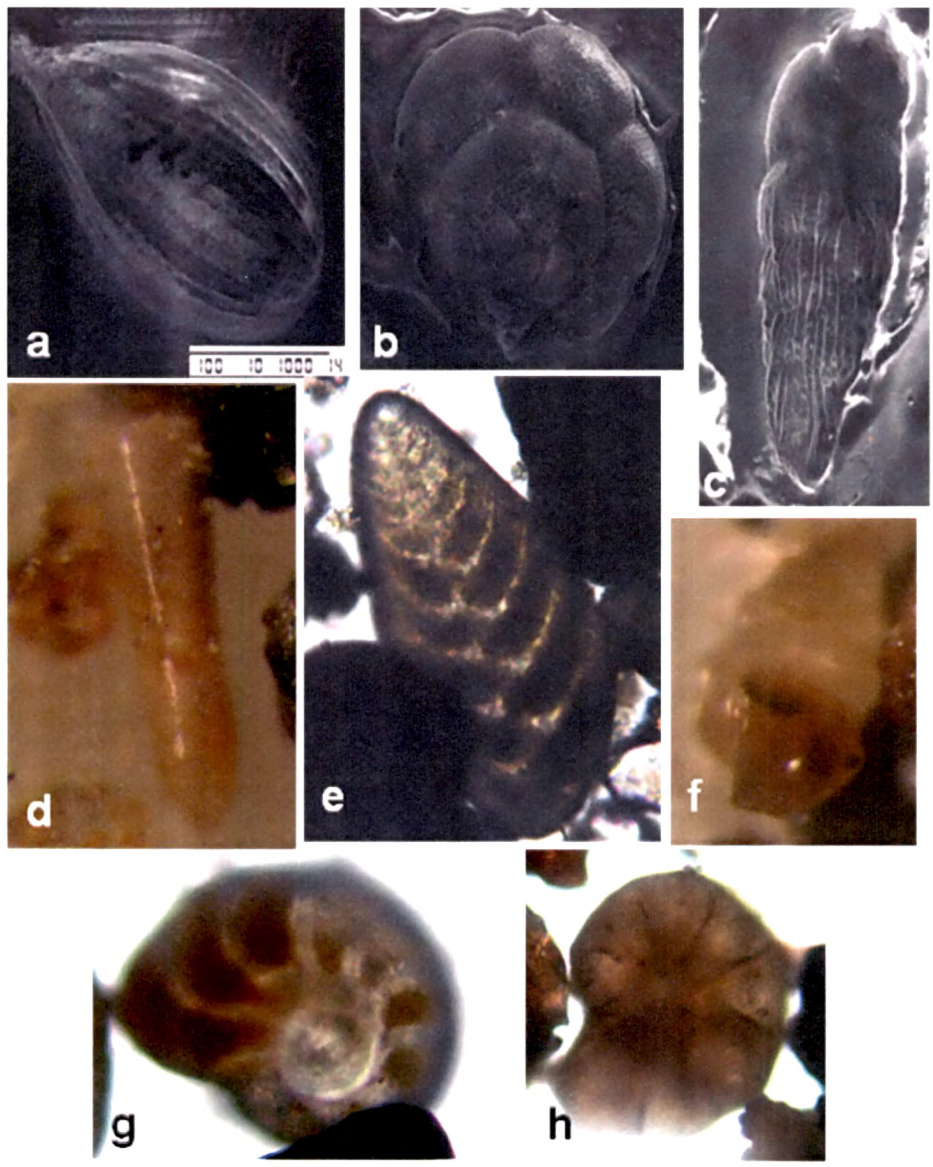


a). *Mudskipper spp.* b).. *Siouncula spp.* c). *Neries spp.* d). *Amphipod spp.* e). *Spheroma spp.* (isopod) f). *Insect larva (megacephala*) vi). *Unidentified Spider spp.*

PLATE 7

Z-605: Kamboi Zone 5/6, sample taken from 0-5 inch, Sa 0-5: Sarod 0-5 inch

PLATE 8



a). *Lagena maccullochae* b). *Rosalina sp.* c). *Bolivina striatula* d). *Procerolagena sp.* e). *Bolivina sp.* f). Unidentified molluscan sp. g). *Peneroplis sp.* h). *Ammonia sp.*/*Elphidium sp.*