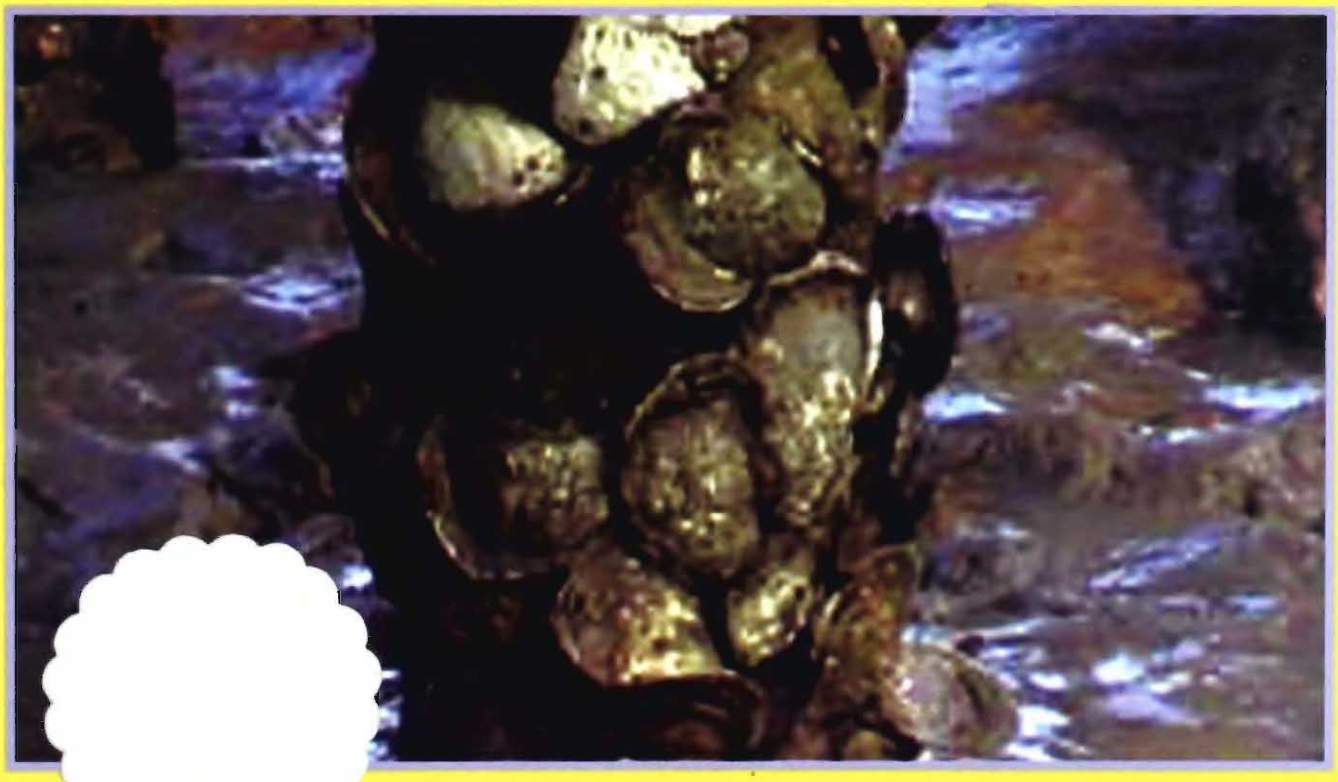
Handbook on

Mangrove Associate Molluscs of Sundarbans

ANIRUDHA DEY



ZOOLOGICAL SURVEY OF INDIA

Handbook on
Mangrove Associate Molluscs
of Sundarbans

ANIRUDHA DEY

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PREFACE

Mangrove is a common term applied to a community of trees or shrubs which grow in the sea. It may be any one individual species which constitutes that association. Mangrove ecosystem is a very specialized environment occurring in between land and sea in the tropical and subtropical regions. Mangrove plants are specially adapted to thrive the various salinity, recurrent tidal inundation and periodic desiccation. This ecosystem besides protecting the coastal line, by their typical root structures, support fishery, by developing a detritus based food web and help in regulating regional climate. Since this system is located in between sea and land, it includes several distinct habitats in terrestrial, intertidal and aquatic environment i.e. dominant forests, litter laden forest floor, tidal flat and continuous water causes by rivers, tidal creeks and channels, backwater neritic inlet and bays. It is the natural abode of many a group of animals and large number of species are known to feed, breed and take shelter in this ecosystem.

Mangroves are trees or bushes or bushes growing between the levels of high water of spring tides and a level close to but above sea land. They range all around the oceans of the tropics, only on sheltered shores, and they penetrate into the estuaries of rivers where soft water penetrates. Mangrove forest reaches maximum development and greatest luxuriance in front of South East Asia, Malaya, Sumatra and part of Borneo where rainfall is high and not seasonal, but they also occur as scrub thickets even on desert shore. Sundarbans is a unique mangrove forest which lies in between the two countries India and Bangladesh. The Mangroves were attaining one of their greatest diversities and luxuriance, and stretches through 4,24,124 hectors along the estuaries and coastlines of both South and North 24-Paraganas districts of West Bengal. In this ecosystem the diversified habitats like the true soil and water are occupied by different groups of organisms. The animals inhabiting the intertidal region exhibit constant interaction with variable salinity, muddy substratum and periodic tidal flash and are unique to this habitat. The fauna as a whole have greater mobility to choose the habitat.

Basically the Sundarbans mangrove ecosystem is considered as an estuarine ecosystem and the major fauna associated in the mangrove are virtually estuarine animals. Molluscs, are one of the major group constitute the resident fauna of mangrove. It is very difficult to characterize the mangrove fauna as a whole or define the true mangrove species. Many are obligate dwellers, a good number are also found in peripheral habitats. Yet the diversity in mangrove forest is so immense that it is not possible to give the account of all species. Only the dominant molluscs of the mangroves are accounted here.

This work is based on intensive studies made by the author for the last 12-15 years from this area. A total account of 56 species of molluscs including 31 gastropods and 25

bivalves along with their common name, ecological notes, distribution, economic uses in respect of each species as far as possible have been given. Keys have also been provided for families, genera and species where ever more than one taxa are included.

While offering this book to the naturalists, zoologists and research students the author sincerely hopes that it will provide sufficient information regarding the mangrove associate molluscs of Sundarbans tidal areas of India. It will be happy enough if this book can render any help to the readers with the information incorporated.

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CONTENTS

INTRODUCTION

Sundarbans – the most active and dynamic river basin has been formed from sediments washed down from the Himalayas. But the process of periodic flooding, aluvion and dilution changed the course of innumerable waterways that has criss-crossed the lower delta and made it a near impossible task for the geographers to define the area under deposit latitude and longitude and other logistic measurements.

Sundarbans can very well be defined as a group of islands starting from the mouth of river Hughly on the west and extending up to the river Meghna in the east, covering four districts at present *viz*, North and South 24–Paraganas (Hughly to Raimangal river) of India, Khulna (Raimangal to Madhumati river) and Backergunje, Barishal district (Madhumati river to Meghna river) of Bangladesh. The Bay of Bengal is considered as the southern limit and towards north, the boundary cannot be demarcated to any definite land mark, but in some places it extends inside the cultivated and human settled area as far as 150 kms. It lies approximately 87°51'–91°30' east longitude and 21°31'–22°30' north latitude.

As regards the total area of Sundarbans forest, a number of estimations were observed in literature. Clarke (1896) estimated about 20,000 sq. kms area, Prain (1903) 17,500 sq. kms. Gupta (1957) 20,480 sq. kms (7680 sq. kms in West Bengal, India) and 12,800 sq. kms in Bangladesh). Chakravorty (1979) put it to about 10,000 sq kms of which the Indian share being hardly 4000 sq. kms and rest in Bangladesh. Allen *et al.* (1970) made it 16,706 sq. kms of which 7,529 sq. kms in North and South 24-Parganas in India, 6,881 sq. kms in Khulna and 7,529 sq. kms in Backergunje of Bangladesh. The Backergunje part has already been reclaimed for human settlement and agriculture. In a recent estimation by Forest department it has been stated that 4,264 sq. kms forest persist within Indian territory and 4,109 sq. kms in Bangladesh.

The Indian Sundarbans at the apex of Bay of Bengal (88°03'–89°07' east longitude and 21°13' to 22°40' N latitude) is located on the southern fringe of the state of West Bengal, covering the major portion of North and South 24-Parganas districts. The region is bordered by Bangladesh in the east, the Hughly river in the west, Damper–Hodges line in the north and Bay of Bengal in the south.

With a considerable degree of marine characteristics in the major portion of the ecosystem, the important morphotype of the deltaic Sundarbans are beaches, mudflats, coastal dunes, sand flats, estuaries, creeks, inlets and mangrove swamps. Comparatively the Indian Sundarbans have very poor forest formation due to higher salinity and biotic interactions. The ecological succession is quite different in comparison to Bangladesh Sundarbans (Naskar and Guha Bakshi, 1982). These variation have played an important

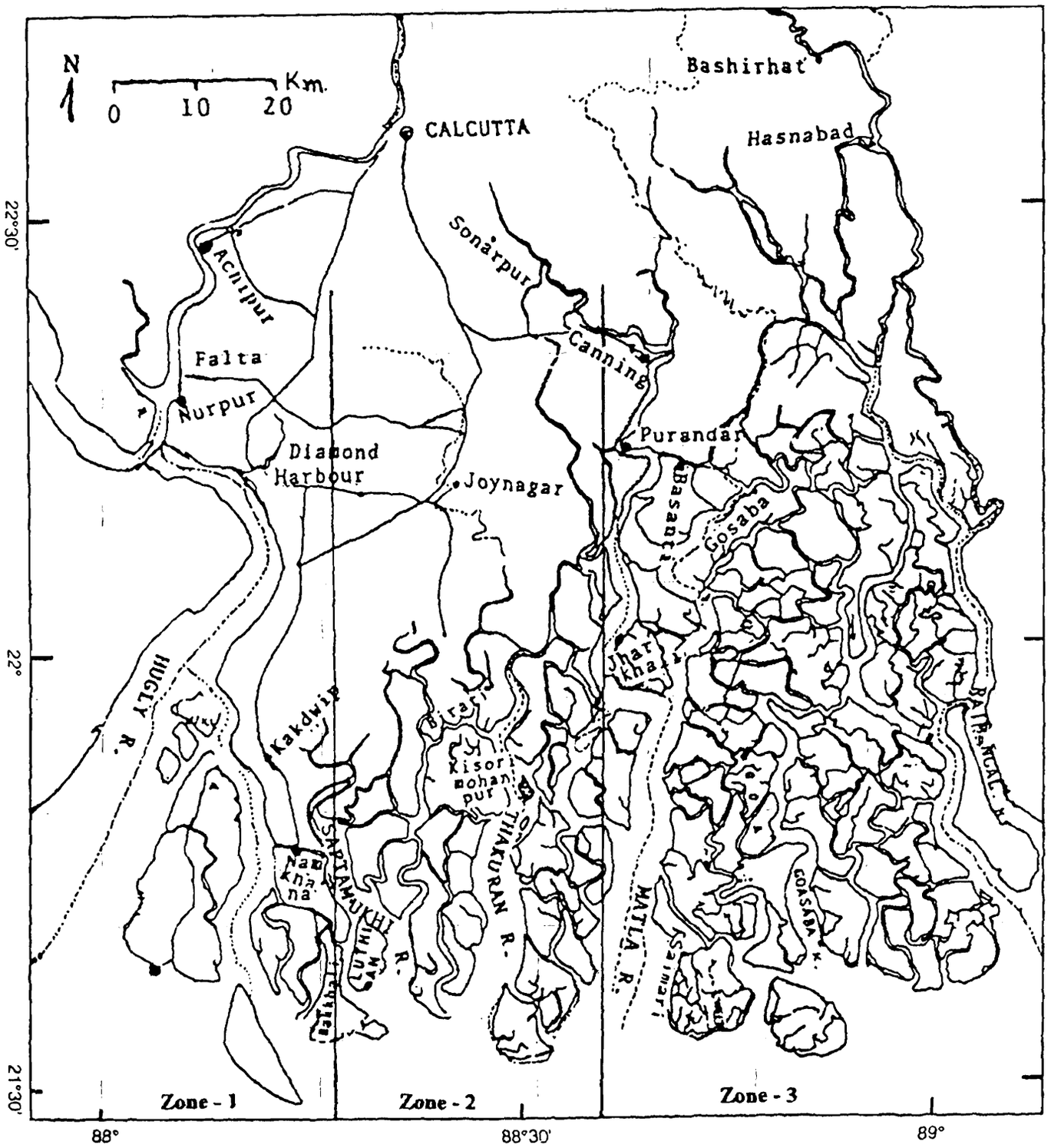
role in the growth pattern of different mangrove species (Blasco, 1975). Eastern islands in these Indian Sundarbans have a higher supply of freshwater and less human interaction; therefore these incorporate better forest formation than those of the western islands, while central islands form the transitory zones (Mukherjee and Mukherjee, 1978).

MANGROVE

Mangrove may be defined as the "Coastal tropical forest formation, encircled or spreaded by the tidal rivers and/or the sea water, flooded frequently by the tidal water" It does not necessarily mean by forest formation, they may be either covered by herbs or shrubs or trees, i.e. herbaceous, bushy or obsolescent or occasionally lacking of any vegetation. Mangrove may be differentiated from "Beach forest" of *Casurina* sp., *Thespesia* sp., *Terminala* sp. etc. as there is no tidal flow like that of pure mangrove formations. Puri (1960) considered "Beach forest" as subdivision of mangrove forest. Rao (1973) classified Indian estuaries into five major classes and the 'tidal mangrove" is one of such classes, abundant with true mangrove species. Blasco *et al.* (1975) defined "mangrove is the name given to coastal woody vegetation that fringed muddy saline shores and estuaries in tropical and sub tropical regions and at high tide much of the ground is covered by sea water"

Considering the extent of inundation Indian mangroves are distinguished into i) Swampy mangrove–situated below the high tide level, and submerged by sea water twice a day; ii) tidal mangrove–submerged only during spring tide and cyclones or exceptional tide (Qureshi, 1959).

Fig 1. Mangrove at Masjidbari, Sundarbans



Map of Sundarban, West Bengal

Mangrove forest has been the centre of interest for many biologists in the last century. In part, this interest was due to the unique form of the aerial roots of a mangrove tree. Most of the study carried out in mangrove forest was only to enumerate the tree species. It is understandable that the species composition varies from one forest to another and one island to another.

Mangrove forests comprise a diverse composition of trees and shrubs, which exhibit unique adaptation to an environment, being periodically inundated by salt water from one side and freshwater from the other. These plants are well adapted to encounter higher salinity, oppressive heat and tidal extremes; they can grow well in water logged and anaerobic saline soils of coastal environment where no other group of terrestrial plants can survive.

Mangrove ecosystems are highly productive and exchange matter and energy with adjacent terrestrial and marine ecosystems. The ecosystems constitute an important reservoir and refuse of rich microbial, floral and faunal components, feeding and breeding ground of large number of commercially important and ecologically significant animal species.

Ecologically the mangrove forests present a rather sharp transitional gradient between the marine and freshwater environments. Therefore only flora and fauna that have strong tolerance of that kind of environments can survive. This factor more or less predetermines the number of species that exist in a mangrove ecosystem. Each biota or group of biota occupies a niche and even form an aggregate and spatial zonation of its own. A combination of factors that may cause the species ecological preference such as :

i) Soil type : hard or soft, ratio between sand and mud contents.

ii) Salinity : daily variation, annual variation, the length of the time, depth and how frequently the ground is submerged.

iii) Species tolerance of wave action and currents.

iv) Tolerance level of young ones (seedling, larvae) of the preceding factors.

Since the mangrove ecosystem is located between land and sea it includes several distinct habitats in terrestrial, intertidal and aquatic environs such as mangrove dominant forests, litter laden forest floor, tidal flats (muddy, sandy, rocky) and contiguous water causes which may be rivers, tidal creeks and channels, backwater neritic inlets and bays. Berry (1963) demarcated several distinct habitats in mangroves as follows :

i) Tree canopy

ii) Higher part of mangrove

iii) Lower part of mangrove

iv) Forest floor in supra littoral zone

v) Mud flat/sandy mud flat in intertidal zone

vi) Dead tree and stumps

vii) Temporary pools

viii) Back of river channels

These macro habitats host diversified micro habitats, supporting rich taxonomically diverse microbial flora and faunal components making these ecosystems a reservoir of rich unique gene pool.

Several types of mangroves are recognised considering their location, such as deltaic, estuarine, backwater estuarine and coastal and insular. Mangroves of east coast deltaic type, whereas the west coast comes under remaining three types, e.g. mangroves of Normada and Tapti are estuarine, Saurastra and Gulf of Kutchch are backwater estuarine, Gulf, inlets and crecks of Pirutan Island (Gujarat) are coastal and insular; Andaman and Nicobar islands are insular.

In India mangroves distributed along the east and west coast and Andaman and Nicobar islands. Among east coast mangroves found in West Bengal (Sundarbans), Orissa (Mahanadi), Andhra Pradesh (Krishna and Godavari deltas), Tamil Nadu (Cauvery delta). In west coast Gujarat (Narmoda, Tapti estuaries, Gulf of Kutchch, Gulf of Khambat and Saurastra region), Maharastra (Ratnagiri, Malvan, Devgad and Vijoydurg), Goa (Mandavi and Zuari estuaries), Karnataka (Malpe and Hannovar) and Kerala (Kozhikode, Quilon, Vembanad and Trivandrum). Mangroves along the east coast are luxuriant and diverse due to the presence of nutrient rich deltas formed by the rivers like Ganges, Mahanadi, Krishna, Cauvery, which supplies the freshwater along the deltaic coasts. West coast, mangroves are not so luxuriant or diverse since there is no delta or alluvial soil deposits along the coast.

Mangrove forest of Indian Sundarbans

The mangrove forest of Indian Sundarbans has been variously estimated as 4,18,888 hectors (Sidhu, 1963; UNEP, 1985), 20,000–30,000 hectors (IUCN, 1989) and 4,26,300 hectors by West Bengal forest department. It has been further estimated that approximately 1,78,100 hectors are comprised water areas. These discrepancies in the figures for forest cover possibly arises from the fact that some denote areas designated as forest land which actually includes both, water bodies and degraded forests, while others represent an assessment of the area covered by vegetation only.

The mangrove forest of Sundarbans covers the extensive tract of swampy land along with the tropical seacoast and always fringe with muddy salt water, creeks, lagoons and estuaries. They form a characteristic dense evergreen and impenetrable mass of low trees with countless arched aerial roots and pneumatophores. The forests are formed only within the zone inundated daily by the high tides. UNESCO has clearly pointed out that the mangrove is a group of woody plant species about 50 in numbers, which possess wonderful adaptability to survive in a saline environment with a variety of tropical coastal land forms, typically in anaerobic soil. Out of these 50 species in the world, the Indian Sundarbans mangrove forest contains 35 true mangroves in addition to 28 mangrove associates and 7 obligate mangroves, under 29 families and 49 genera. Among them

adolescent species are so shrubs 20 and 20 herbaceous floras (Naskar and Guha Bakshi, 1987). Among the typical characteristic plant species of mangrove swamps of the Indian Sundarbans some 80 species which are among the part and parcel of this mangrove forest are not recognised by the Botanists for their smaller sizes and also for their not bearing any typical mangrove characteristic.

Mangroves attain their greatest diversity and luxuriance in the Sundarbans and cover 4, 23,804 hectares along the estuaries and coastlines of both South and North 24-Parganas districts of West Bengal. In this ecosystem the diversified habitats like the tree, soil and water are occupied by different groups of organisms exposed to different set of environmental conditions. The animals inhabiting the intertidal region exhibit constant interaction with variable salinity, muddy substratum and periodic tidal flush and are unique to this habitat. The fauna, as a whole have greater mobility to choose their habitat, unlike the plant community. Hence the number of species represented in a particular area is much greater than the number of plant species occurring in that area. The heavy rain during monsoon sometimes brings down the salinity to the lowest level even at the mid estuaries thereby bringing down the level of species diversity.

Fig. 2. Mangroves at Pakhiralaya, Sundarbans

MANGROVE FAUNA

The animal communities in mangroves include both resident and visiting or transient fauna. The resident fauna lives entirely on mangrove ecosystems and the visiting fauna exploit the mangroves for food, refuse/shelter and transit and also as breeding ground and nursery bed but lives elsewhere during the remaining period of life cycle. In fact the

visiting fauna of mangroves are more diverse. The terrestrial fauna mostly belong to the visiting category, which enter the mangroves from the adjacent forested and non-forested areas. Majority of the visiting fauna are insects among the invertebrates; birds, mammals and reptiles among vertebrates. The aquatic fauna mainly belong to fishes and crustaceans besides some molluscs and echinoderms.

Resident fauna are mainly benthic fauna of intertidal habitats and are grouped in two broad categories: i) epifauna and ii) infauna. Epifauna constitute the bulk of resident fauna comprises molluscs (mainly gastropods and some sessile bivalves) and crustaceans (mainly barnacles). On the other hand infauna predominantly comprising polychaetes, brachyuran crabs, wood boring animals, mud burrowing bivalves and some gobiid fishes, burrow and penetrate the substratum.

Resident fauna are found to exploit diversified microhabitats in the mangrove ecosystems. Gastropods are dominant, occurring on tidal flats and also inhabiting dead stumps, mangrove roots and even upper part of mangrove tree. Crabs usually live on self-constructed burrows occupying diversified niches such as crevices of mangrove logs, tree holes, under stone and puddles, cracked pneumatophores, deserted burrows of marine borers etc.

Aquatic components of mangroves show the maximum diversity and are represented by fishes followed by crustaceans and molluscs. Fishes are mostly transient fauna, which invade mangrove habitats from adjacent water spreads mainly for feeding and burrowing.

Distribution pattern : In mangroves distribution of animals can not be dealt with by considering simply the tidal expanse and tidal amplitude as is usually done in the case of shore animals. Mangrove ecosystem comprises two main series of zones as mentioned by Berry (1963): i) horizontally from the landward mangroves towards the sea and ii) vertically from the tree canopy of mangroves down to the soil. Horizontal zones like seashores include supra littoral, littoral and sub littoral areas. Vertical zones which may little bit vary in different mangrove areas embrace, in general, tree canopy, higher part of mangroves, lower part including root of mangroves, forest floor of supra littoral zone, tidal flat, dead trees and stumps, edge of streams and rivulets etc.

Though it is very difficult to characterise the mangrove fauna as a whole, Ekman (1935) has stated that the mangrove fauna is characterised by its low species diversity represented by large populations. On the other hand, Fraser (1940) remarked that the faunal component should be considered as organisms originating from mudflats as well as from general brackish water. The faunal composition of mangroves can not be taken as of a specific nature as stated by Sandison and Hill (1966), while studying Indo-West pacific forest and mangrove fauna. Macnae (1966) stated that it is difficult to say which species are confined to the mangrove and are not occurring in other habitats. On the other hand, the same species may be available in various mangrove ecosystems within the same ecological region. Day (1974) however stated that the mangrove formation is large;

the fauna of the area will be distinct even though some of the species may simultaneously occur in non mangrove habitats also.

Basically the mangrove ecosystem of Sundarbans can be considered as an estuarine ecosystem and as such majority of mangrove fauna are virtually, estuarine animals. They differ in their habits and even one group of animals may exhibit or occupy two or more habit and habitats respectively. Among the mangrove fauna the non resident or visiting groups are very large and come from both terrestrial and aquatic zones. The precise distribution of such species within the mangrove habitat is determined by the factors such as salinity, soil type, vegetation etc.

MOLLUSCS

Molluscs are soft bodied, bilaterally symmetrical, coelomate metazoans, often secondarily altered to a symmetrical condition, without evidence of metamerism. In majority of cases the animals are protected by a calcareous shell; which may either be a single piece or of more than one piece, secreted by the mantle, the fold of body wall. The features of the phylum are the ventral body wall modified into a muscular organ for locomotion, the foot; a pharynx commonly with a radula and gills; heart with open circulatory systems and the excretory organ metanephredia. It is a collective name for familiar animals such as chitons, tusk shells, conch shells, slugs, mussels, clams, squids and octopuses. It is a highly diversified group of animals, differing in shape, size, as well as habit and habitat. Originating in the sea, it spread to freshwater and on to land.

Marine molluscs are mostly benthonic but gastropods have developed into three pelagic groups, Janthinids, Heteropods and Pteropods and many of the Cephalopods are also pelagic. Primarily molluscs are the inhabitants of the intertidal and littoral zones of the sea, they occasionally descend to a great depth up to 10,190 m (Bivalve), 8,210 m (Gastropod) and 6,940 (Scaphopod).

In India molluscs are recorded from diverse habitats, from deep sea (3,000 m) of Andaman and Nicobar Islands to high elevation (5000 m) of the Himalaya. They are more diverse and abundant in the rocky intertidal zone along the coast and in the coral reef areas of Gulf of manner, Lakshadweep, Gulf of Kutchch and Andaman and Nicobar Islands. Sandy stones, inter tidal flats, mangrove areas have also a much-diversified marine molluscs. Nearly 100 species of molluscs are reported from the mangrove areas of Indian subcontinent. The majority being snails and slugs (Class Gastropoda) and cockles, mussels, oysters and shipworms (Class Bivalvia). Many of them are well adapted to leave out of water for extended periods, and also are remarkably tolerant of salinity fluctuation, desiccation, and lack of oxygen compared to their relatives living in other coastal habitats.

Mangrove molluscs were studied earlier by the different workers. Ganapati and Rao (1959) reported 11 species from the Godavari estuary; Radhakrishna and Janakiram (1975) 9 species from Krishna estuary; Subba Rao and Mookherjee (1975) 20 species from

Mahanadi estuary; Murthy and Balaparameswara (1977) 10 species from mangrove swamp of Machlipatnam, Andhra Pradesh; Pillai and Appukuttan (1980) 6 species from the mangroves of Palk Bay and Gulf of Mannar; Kasinathan and Shanmugan (1985) 10 species from the Pichavaram mangrove and Das and Dev Roy (1989) 100 species from mangrove areas of Andaman and Nicobar Islands. Das and Dev Roy (1989) included the molluscs are inhabiting in the tree canopy, mangrove roots and stems, dead stumps, peddles, rock surface, brackish water pool and muddy substratum. They enlisted 23 species always associates with the mangroves of Andman and Nicobar Islands. Surya Rao and Maitra (1998) described the molluscan fauna of Mahanadi estuary and mentioned 23 species of molluscs associated with the mangroves.

Basically Sundarbans mangrove ecosystem is considered as estuarine ecosystems and major molluscs associated in the mangrove are virtually estuarine molluscs. Molluscs constitute resident fauna of mangrove. They are of intertidal habitats and are grouped in two broad categories: i) epifauna and ii) infauna. Epifauna constitutes the bulk of gastropods and some sessile bivalves. On the other hand infauna predominantly comprises wood and mud burrowing bivalves, which burrows and penetrates the substratum.

It is very difficult to characterize mangrove molluscs as a whole or define the true mangrove molluscan species. Many are obligate dwellers, a good number are also found in peripheral habits. Yet the diversity in mangrove forest is so immense that it is not possible to give the account of all the molluscan species. Only the dominant molluscs of the mangroves are accounted here. A total of 56 species (31 gastropods and 25 bivalves) are includes arranged in the systematic order used by Vaught (1989). Apart from descriptions, common names, ecological notes, habit and habitat, population in Sundarbans area, breeding biology (as far as known) of the species have been provided. Commercial importances have also been discussed.

Fig. 3. A part of mangrove area at Jharkhali, Sundarbans

SYSTEMATIC LIST

Class GASTROPODA
Subclass PROSOBRANCHIA
Order ARCHAEOGASTROPODA
Superfamily PATELLOIDEA
Family LOTTIIDAE
Genus ***Potamacmaea*** Peile, 1922

1. *Potamacmaea fluviatilis* (Blanford)

Superfamily NERITOIDEA
Family NERITIDAE
Genus ***Nerita*** Linnaeus, 1758

2. *Nerita (Amphinerita) articulata* Gould

Genus ***Neritina*** Lamarck, 1818

3. *Neritina (Vittina) smithi* Wood
4. *Neritina (Dostia) violacea* (Gmelin)
5. *Neritina (Pseudonerita) sulculosa* (von Martens)

Order MESOGASTROPODA
Superfamily LITTORINOIDEA
Family LITTORINIDAE
Genus ***Littoraria*** Griffith and Pidgeon, 1834

6. *Littoraria (Palustorina) melanostoma* (Gray}
7. *Littoraria (Littorinopsis) scabra* (Linnaeus)

Superfamily RISSOIDEA
Family STENOTHYRIDAE
Genus ***Stenothyra*** Benson, 1836

8. *Stenothyra deltae* (Benson)

Family ASSIMINEIDAE
Genus ***Assiminea*** Fleming, 1828

9. *Assiminea brevicula* (Pfeiffer)
10. *Assiminea beddomeana* Nevill

Superfamily CERITHIOIDEA
Family POTAMIDIDAE
Genus ***Telescopium*** Montfort, 1810

11. *Telescopium telescopium* (Linnaeus)

Genus ***Cerithidea*** Swainson, 1840

12. *Cerithidea alata* (Philippi)
13. *Cerithidea cingulata* (Gmelin)
14. *Cerithidea obtusa* (Lamarck)

Suborder HETEROGLOSSA
Superfamily EPITONOIDEA
Family EPITONIIDAE

Genus ***Amaea*** H. & A. Adams, 1853

15. *Amaea (Acrilla) acuminata* (Sowerby)

Order NEOGASTROPODA
Superfamily MURICOIDEA
Family MURICIDAE
Subfamily THAIDINAE

Genus ***Thais*** Roeding, 1758

16. *Thais lacera* (Born)
17. *Thais blanfordi* (Melvill)

Family COLUMBELLIDAE

Genus ***Pseudanachis*** Theile, 1924

18. *Pseudanachis duclosiana* (Sowerby)

Family NASSARIIDAE

Genus ***Nassarius*** Dumeril, 1806

19. *Nassarius faveolatus* (Reeve)
20. *Nassarius stolatus* (Gmelin)

Family MELONGENIDAE

Genus ***Pugilina*** Schumacher, 1817

21. *Pugilina cochlidium* (Linnaeus)

Subclass OPISTHOBRANCHIA
Order CEPHALASPIDEA
Superfamily PHILINOIDEA
Family HAMINEIDAE

Genus ***Haminoea*** Turton & Kingston in Carrington, 1830

22. *Haminoea crocata* Pease

Subclass GYMNOMORPHA

Order SYSTELLOMMATOPHORA

Superfamily ONCHIDIOIDEA

Family ONCHIDIIDAE

Genus ***Onchidium*** Buchanan, 1800

23. *Onchidium tenerum* Stoliczka

24. *Onchidium tigrinum* Stoliczka

25. *Onchidium typhae* (Buchanan)

Subclass PULMONATA

Order ARCHAEOPULMONATA

Superfamily ELLOBIOIDEA

Family ELLOBIIDAE

Genus ***Cassidula*** Ferussac, 1821

26. *Cassidula nucleus* (Gmelin)

Genus ***Ellobium*** Roeding, 1798

27. *Ellobium aurisjudae* (Linnaeus)

28. *Ellobium gangeticum* (Pfeiffer)

Genus ***Melampus*** Montfort, 1810

29. *Melampus pulchella* (Petit)

Genus ***Pythia*** Roeding, 1798

30. *Pythia plicata* (Ferussac) Gray

Superfamily AMPHIBOLOIDEA

Family AMPHIBOLIDAE

Genus ***Salinator*** Hedley, 1900

31. *Salinator burmana* (Blanford)

Class BIVALVIA

Subclass PTERIOMORPHIA

Order ARCOIDA

Superfamily ARCOIDEA

Family ARCIDAE

Genus ***Anadara*** Gray, 1847

32. *Anadara granosa* (Linnaeus)

Order MYTILOIDA
Superfamily MYTILOIDEA
Family MYTILIDAE
Genus ***Modiolus*** Lamarck, 1799

33. *Modiolus striatulus* (Hanley)

Order OSTREOIDA
Suborder OSTREINA
Superfamily OSTREDIDEA
Family OSTREIDAE
Genus ***Crassostrea*** Sacco, 1897

34. *Crassostrea cuttackensis* (Newton and Smith)
35. *Crassostrea gryphoides* (Schlotheim)

Genus ***Saccostrea*** Dollfus & Dautzenberg, 1920

36. *Saccostrea cucullata* (Born)

Suborder PECTININA
Superfamily ANOMIOIDEA
Family ANOMIIDAE
Genus ***Enigmonia*** Iredale, 1918

37. *Enigmonia aenigmatica* (Holten)

Subclass HETERODONTA
Order VENEROIDA
Superfamily SOLENOIDEA
Family SOLENIDAE
Genus ***Solen*** Linnaeus, 1758

38. *Solen brevis* Gray

Family CULTELLIDAE
Genus ***Pharella*** Gray, 1854

39. *Pharella javanicus* (Lamarck)

Genus ***Tanysiphon*** Benson, 1858

40. *Tanysiphon rivalis* Benson

Superfamily TELLINOIDEA
Family TELLINIDAE
Genus ***Strigilla*** Turton, 1822

41. *Strigilla splendida* (Anton)

Genus ***Macoma*** Leach, 1819

42. *Macoma birmanica* (Philippi)

Family SEMELIDAE

Genus ***Theora*** H. & A.Adams, 1858

43. *Theora opalina* (Hinds)

Superfamily ARCTICOIDEA

Family TRAPEZIIDAE

Genus ***Trapezium*** Megerle von Muehlfeld, 1811

44. *Trapezium sublaevigatum* (Lamarck)

Superfamily CORBICULOIDEA

Family CORBICULIDAE

Genus ***Polymesoda*** Rafinesque, 1828

45. *Polymesoda bengalensis* (Lamarck)

Superfamily VENEROIDEA

Family VENERIDAE

Genus ***Pelecyora*** Dall, 1902

47. *Pelecyora trigona* (Reeve)

Genus ***Meretrix*** Lamarck, 1799

46. *Meretrix meretrix* (Linnaeus)

Family GLAUCONOMIDAE

Genus ***Glauconome*** Gray, 1828

48. *Glauconome sculpta* (Sowerby)

Order MYOIDA

Suborder PHOLADINA

Superfamily PHOLADOIDEA

Family PHOLADIDAE

Genus ***Barnea*** Leach in Risso, 1828

49. *Barnea candida* (Linnaeus)

Family TEREDINIDAE

Genus ***Bactronophorus*** Tapparone-Canefri, 1877

50. *Bactronophorus thoracites* (Gould)

Genus ***Dicyathifer*** Iredale, 1932

51. *Dicyathifer manni* (Wright)

Genus ***Bankia*** Gray, 1842

52. *Bankia companellat*a Moll and Roch

53. *Bankia nordi* Moll

54. *Bankia rochi* Moll

Genus ***Nausitora*** Wright, 1884

55. *Nausitora dunlopei* Wright

Subclass ANOMALODESMATA

Order PHOLADOMYOIDA

Superfamily PANDOROIDEA

Family LATERNULIDAE

Genus ***Laternula*** Roeding, 1798

56. *Laternula truncata* (Lamarck)

MANGROVE MOLLUSCS : ACCOUNT

Key to the families

1. Animal covered with shell ..... (2)
- Animal not covered with a shell, covered with warty mantle ..... ONCHIDIIDAE
2. Animal covered with spirally coiled univalve shell ..... (3)
- Animal covered with bivalve shell ..... (16)
3. Shell minute, not exceeding 5 mm ..... STENOTHYRIDAE
- Shell more than 5 mm ..... (4)
4. Shell elongate, with many whorls; spire high ..... (5)
- Shell not elongate, nor with many whorls; spire low ..... (6)
5. Aperture rounded, without anterior canal; whorls rounded or keeled ..... EPITONIIDAE
- Aperture ovate, anterior canal prominent; whorls not keeled ..... POTAMIDIDAE
6. Shell cup shaped; spire absent; aperture large in proportion to the size of shell ..... LOTTIIDAE
- Shell globose, pear shaped but not cup shaped; spire distinct; aperture not large in proportion to the size of shell ..... (7)
7. Shell thin, fragile, spire sunken; animal cannot be withdrawn completely within the shell ..... HAMINEIDAE

- Shell thick, spire not sunken; animal can be withdrawn completely within the Shell ... (8)

8. Spire reduced, after almost on the same level; body whorl inflated and globular; aperture semicircular ..... NERITIDAE

- Spire elongate; body whorl not inflated and globular; aperture not semicircular ..... (9)

9. Shell without operculum ..... ELLOBIIDAE

- Shell with operculum ..... (10)

10. Anterior canal absent ..... (11)

- Anterior canal present ..... (13)

11. Shell globose, spire small, pointed ..... AMPHIBOLIDAE

- Shell not globose, spire usually large ..... (12)

12. Shell ovately conical, sub globose with horny epidermis; aperture ovate ..... ASSIMINEIDAE

- Shell turbinate, solid without horny epidermis; aperture sub circular ..... LITTORINIDAE

13. Columella smooth ..... (14)

- Columella with plications or with pustules ..... (15)

14. Shell pear shaped; upper part of body whorl smooth; anterior canal wide ..... MELONGENIDAE

- Shell not pear shaped; body whorl sculptured; anterior canal narrow ..... MURICIDAE

15. Aperture narrow, elongate ..... COLUMBELLIDAE

- Aperture wide ..... NASSARIIDAE

16. Shell greatly reduced covering only anterior tip of animal; worm like, with two pallets at the posterior end ..... TEREDINIDAE

- Shell well developed and encloses the entire animal; animal laterally compressed and different shaped, not worm like; pallets absent ..... (17)

17. Hinge with numerous undifferentiated teeth ..... ARCIDAE

- Hinge not more than five teeth when present or reduced or absent ..... (18)

18. Anterior adductor muscles reduced or absent; hinge teeth scarcely developed or absent ..... (19)

– Anterior adductor muscle well developed; hinge teeth also well developed and differentiated ..... (21)

19. Umbo terminal or subterminal; ligament without nodules ..... MYTILIDAE

– Umbo central; ligament with nodules ..... (20)

20. Shell strong, very thick; right valve without any foramen ..... OSTREIDAE

– Shell thin; right valve with a foramen ..... ANOMIIDAE

21. Shell elongate, cylindrical or flattened; gaping both the ends ..... (22)

– Shell trigonal to ovate, never cylindrical; gaping absent ..... (23)

22. Shell with one hinge teeth, straight, margins parallel ..... SOLENIDAE

– Shell with more than one hinge teeth, not straight, margins not parallel ..... CULTELLIDAE

23. Shell with more than one cardinal teeth, sometimes with laterals ..... (24)

– Shell with one cardinal tooth or edentulous ..... (29)

24. Hinge with well developed cardinal and lateral teeth; cardinals two in each valve ..... (25)

– Hinge with three cardinal teeth (cyrenoid type) 3a, 1 and 3b in the right and 2a, 2b and 4b in the left valve ..... (27)

25. Cardinal teeth two in either valve, tending to bifid; pallial line connected to adductor muscle scar by distinct pallial sinus ..... (26)

– Cardinal teeth two in either valve, but not bifid; pallial line mostly entire ..... TRAPEZIIDAE

26. Hinge plate without rounded socket ..... TELLINIDAE

– Hinge plate with rounded socket ..... SEMELIDAE

27. Hinge with strong anterior and posterior lateral teeth ..... CORBICULIDAE

– Hinge with weak anterior and posterior lateral teeth or absent ..... (28)

28. Shell trigonal, ovate or rounded; thick without periostracum; lateral teeth present ..... VENERIDAE

– Shell elongate, thin with periostraum, lateral teeth absent ..... GLAUCONOMIDAE

29. Shell without accessory plates ..... LATERNULIDAE

– Shell with accessory plates ..... PHOLADIDAE

Class	GASTROPODA
Subclass	PROSOBRANCHIA
Order	ARCHAEOGASTROPODA
Superfamily	PATELLOIDEA
Family	LOTTIIDAE

Shell cap shape, conical, oval more or less depressed with a little raised apex. Sculpture with radiating ribs and striae; apex towards the anterior end and inclined forward. Aperture large with well developed internal border. Interior is concave, saucer like, muscle scar horseshoe or pear shaped, open in front. Porcelaneous. Tentacles long and cylindrical with eyes on the upper part of the base; proboscis boardered with finger like process.

Herbivorous. Attached on rocks, mangrove stems bricks and dykes in the intertidal region.

The Limpet shell is rather conical and forms a stony cap under which animal lives secured. They have broad sole like foots which gives them power to cling tenaciously to the rocks, mangrove stems, on which they have their home. The broad muscular disc foot, function like suckers by the total exclusion of air from beneath it.

Genus ***Potamacmaea*** Peile, 1922

Potamacmaea fluviatilis (Blanford, 1868)
True Limpet

Shell thin, cup shaped; apex anterior, spire absent, periostracum olive brown with a number of radiating striae; aperture large in proportion to the size of the shell.

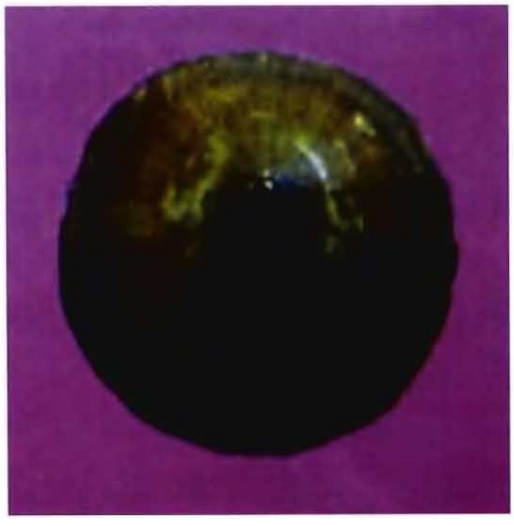


Fig 4. Dorsal view of *Potamacmaea fluviatilis* (Blanford)

Fig 5. Ventral view of *Potamacmaea fluviatilis* (Blanford)

Found mostly attached to the stem of *Avicennia* sp. upto the height of 90 cms above the ground; also found in the crevices of algal coated bricks and dykes. Breeding period May-June.

Distribution : India : Andaman and Nicobar Islands, West Bengal.

Elsewhere : Myanmar.

Superfamily NERITOIDEA

Family NERITIDAE

Nerites

Fig. 6. *Nerita* sp. on the stem of Mangrove at Jharkhali.

Shell small to medium (upto 40mm), thick, mostly globose with a few whorls. Spire low; suture shallow or strongly indented. Bodywhorl large, rounded and inflated. Aperture reduced to almost D shaped opening, its straight side bordered by the columellar edge.Umbilicus absent. Outer lip thick and toothed inside. Colour highly variable.Operculum generally calcareous with an internal appendage.

Tentacles long, a pair arises from the tentacular base on the dorsal side of head, at the base each tentacle raises an eyestalk with eye at the tip. Foot strong enlarged in freshwater forms. Buccal cavity consists of a long ribbon like radula. Radula rachiglossate type. Mantle cavity consists of a bipectinate ctenidium, a ridge like osphradium, kidney, hypobranchial gland and the terminal part of digestive and reproductive systems.

Sexes separate. Male has a penis and prostate gland. Fertilization internal. Egg capsules are deposited in shallow water filled depressions on the surface of the rock or underneath which afford some protection from sun.

Cosmopolitan in distribution. Inhabitant of intertidal rocks, mangrove swamps and jetty. Many species are amphibious in nature.

Key to genera

1. Shell thick or solid with spiral ribs; columellar callus large; outer lip dentate ..... *Nerita* Linnaeus

– Shell thinner, less solid, without spiral ribs, columellar callus small; outer lip smooth. ..... *Neritina* Lamarck

Genus ***Nerita*** Linnaeus, 1758

Nerita (Amphinerita) articulata Gould, 1847

Shell thick, oblong ovate, semi globular with numerous growth striae, semicircles and crossed by finer spiral lines; whorls 2 ½ rounded and narrow; spire represented by elevated portion of the body whorl; aperture crescent shaped, with smooth, well developed, porcellaneous columellar callus; columella concave with 3-4 short teeth in the middle, outer lip margin with a deep inward slope, inner side thickened with 17-20 longitudinal elongated teeth, posterior two teeth larger and rest are knob shaped; sculpture with 25-35 purple black fine, oblique spiral ribs; colour dark reddish grey, aperture yellowish white, outer lip margin fringed with black.

Fig. 7. Dorsal view of *Nerita (Amphinerita) articulata* Gould

Fig. 8. Ventral view of *Nerita (Amphinerita) articulata* Gould

Found attached to *Avicennia* plant upto the height of 2 meters from the ground; also found on wooden pillars, bricks, crevices of the dykes. Either solitary or in clusters (upto 9 individuals). Youngones observed during the month of May under bark of mangrove plants

Distribution : India : Andaman and Nicobar Islands, Orissa (Mahanadi estuary), West Bengal (Hughly-Matla estuary).

Elsewhere : Indo-pacific.

Genus *Neritina* Lamarck, 1818

Key to the species

1. Shell with a distinct, elevated spire ..... *N. (Vittina) smithi* Wood

– Shell with a depressed or quite hidden spire ..... (2)

2. Shell ovately elongate, base not flat, with deep and coarse spiral striae; spire depressed ..... *N. (Pseudonerita) sulculosa* von Martens

– Shell arch shape, with flat base, smooth without spiral striae; spire quite hidden in the bodywhorl ..... *N. (Dostia) violacea* Wood

Neritina (Vittina) smithi Wood, 1828

Shell oval, solid, white or dull brown, with strong black, longitudinal, undulating and interrupted lines and bands, rarely with very fine, wavy and close set black lines; aperture broad; Columellar callus small and smooth; operculum semi lunar.

Fig. 9. Dorsal view of *Neritina smithi* Wood

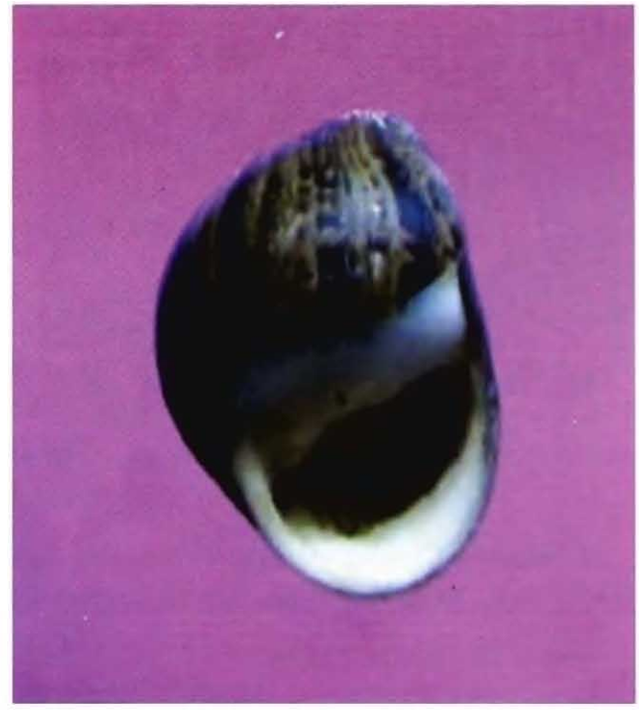


Fig. 10. Ventral view of *Neritina smithi* Wood

Found in the crevices of mud or under surface of bricks, dykes and also in between mid tide mark to high tide mark with grass. This species is primarily a backwater form extending into freshwater.

Distribution : India : West Bengal (Hughly-Matla Estuary).

Elsewhere : Myanmar (Irawaddy estuary).

Neritina (Dostia) violacea (Gmelin, 1791)

Shell ovate, arch shaped, much variable in colour; spire minute; periostracum yellowish brown; Columellar plate porcellaneous with 7 to 10 denticles; radula with central having broader cusp and strikingly than anterior end, the cups of the V lateral are not very large.

Common in the brackish water, back of mangrove areas. Mainly found in the upper mud flat, attached to pillars or in the crevices of the bricks. This species is euryhaline and can tolerate a wide range of salinity. It is also recorded from near freshwater close to the upper tidal limit.

Fig. 11. Dorsal view of *Neritina (Dostia) iolacea* (Gmelin)

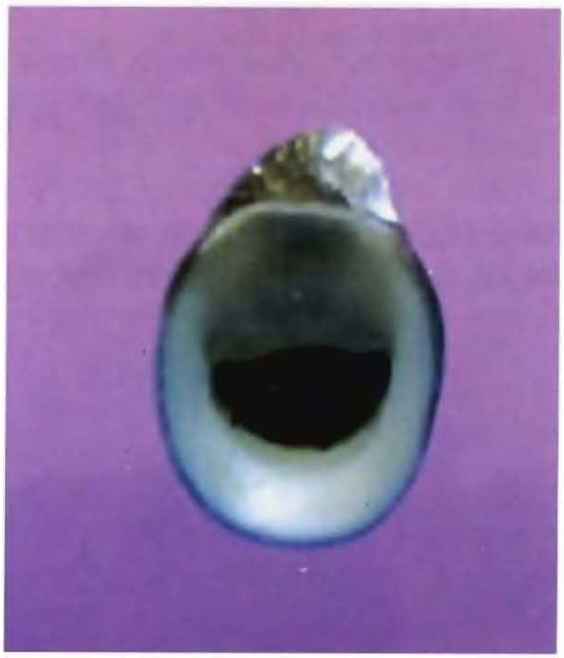


Fig. 12. Ventral view of *Neritina (Dostia) violacea* (Gmelin)

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Indo-pacific.

Neritina (Pseudonerita) sulculosa (von Martens, 1879)

Shell upto 8mm, obliquely oval, almost hemispherical; whorls three, spire lateral and projecting; aperture obliquely elliptical, Columellar margin concave with 9 to 11 strong teeth in the middle, outer lip broadly arched; sculpture with numerous deep, fine spiral striae crossed by axial striae giving decussate appearance; colour dark greenish gray, operculum gray with a black outer margin.

Fig. 13. Dorsal view of *Neritina (Pseudonerita) sulculosa* (von Martens)

Fig. 14. Ventral view of *Neritina (Pseudonerita) sulculosa* (von Martens)

Found adhering to wood under the bark or in the empty tunnels of shipworms and crevices of dykes, which are not completely exposed during the low tide.

Distribution : India : Orissa (Mahanadi estuary), West Bengal (Hughly-Matla estuary);

Elsewhere : Celebes, Indonesia, Flores.

Order MESOGASTROPODA
Superfamily LITTORINOIDEA
Family LITTORINIDAE

Periwinkles

Shell small to medium (upto 40mm), thin, light, turbinate to ovate conical or pyramidal with flattened or pointed spire. Aperture rounded to oval with thickened columella and thin outer lip. Umbilicus closed. Sculpture consists of spiral cords and axial growth striae. Operculum solid, chitinous, paucispiral with lateral nucleus.

Head with a pair of tentacles with dark eyes situated at their outer base. Foot moderate, sub circular in front and obtuse behind. Radula long and taenioglossate type (2-1-1-1-2). Mantle cavity with reduced monopectinate ctenidium and osphradium. Digestive system consists of oesophagus with a pouch and an elongate stomach containing style sac and gastric shield.

Sexes separate. Male has a penis behind the right tentacle and the female has a well marked groove to receive the sperms. Fertilization internal, oviparous or ovoviviparous.

Cosmopolitan. Commonest snails in the intertidal zones, clinging to rock or other hard substrate like mangrove stems, grasses, bricks and dykes in between the mid tide mark to high tide mark, sometimes even occurs a little above high tide marks receiving occasional splashes of the breaking waves.

Genus *Littoraria* Griffith & Pidgeon, 1834

Key to the species

- Columella narrow, rounded, not excavated; pale yellow with patterns of brown dots; parietal callus dark purple brown ..... *L. melanostoma* (Gray)
- Columella excavated or flattened, usually wide; pale with more or less dense pattern of black or dark brown dashes, aligned at suture and periphery to form oblique axial stripes ..... *L. scabra* (Linnaeus)

Littoraria (Palustorina) melanostoma (Gray, 1839)

Shell conical, imperforate, thin, with 6-8 flat sided whorls; Sculpture with shallow incised spiral striae and microscopic, wavy, spiral threads crossed by fine, oblique axial lines of growth; aperture oval, columella weakly concave, glazed, callus dark brown; colour pale yellowish, ornamented with closely spaced brown dashes arranged axially in zigzag fashion.

Very common at the supra tidal zone attached to the stem and leaves of mangroves and shrubs, either solitary or sometimes aggregated. Population recorded upto 8-9/m^2; probably grazing on the leaf hairs and epilithic algae. Adapted to terrestrial life, spending most of their time out of water even during high tides. Youngones are released into water either in egg capsules or as swimming veliger larvae.

Distribution : India : Throughout.

Elsewhere : Tropical and subtropical Indo-pacific.

Fig. 15. Dorsal view of *Littoraria (Palustorina) melanostoma* (Gray)

Fig. 16. Ventral view of *Littoraria (Palustorina) melanostoma* (Gray)

Fig. 17. *Littoraria* sp. on a branch of mangrove at Nafarganj.

Fig. 18. *Littoraria* sp. on a stem of mangrove at Nafarganj.

Littoraria (Littorinopsis) scabra (Linnaeus, 1758)

Shell upto 40 mm, with variable colour pattern, generally black or violet grey to reddish brown, nodules white, columella smooth, reddish brown; sculpture with spiral cords and a row of small nodules on the penultimate whorl and also two rows on the last whorl; aperture large, broadly rounded with numerous fine lines, spotted with brown both inside and outside.

Fig. 19. Dorsal view of *Littoraria (Littorinopsis) scabra* (Linnaeus)

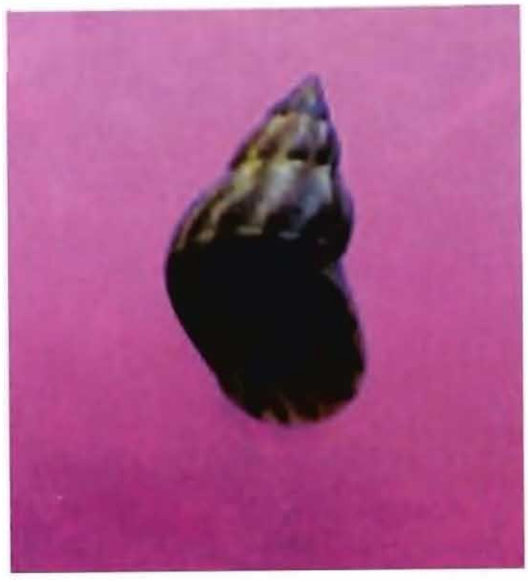


Fig. 20. Ventral view of *Littoraria (Littorinopsis) scabra* (Linnaeus)

Common on the mangroves and shrubs, observed upto 1.75 meter above the ground level and on crevices of bricks and dykes; gregarious with maximum population density of 120 no's/m^2. The population density increases in locations nearer to the sea.

Probably feeding on the colonies of algae which grow on the twigs and older leaves, they are not seen to rasp the leaves on which they are often found.

Distribution : India : Throughout.

Elsewhere : Tropical and subtropical Indo-pacific.

Superfamily RISSOIDEA

Family STENOTHYRIDAE

Shell minute upto 5 mm, sub cylindrical or ovate, imperforate to umbilicate, dorsoventrally compressed; whorls convex; surface smooth, often ornamented with minutely punctuated spiral lines, rarely with minute fine spines; body whorl descending into small, sub circular aperture; operculum horny or calcareous, paucispiral.

Foot long and narrow, spindle shaped with truncated at the anterior end and pointed at posterior end. Tentacles filiform and eyes situated at the raised bases of the tentacles.

Radula 2-1-1-1-2. Radular teeth relatively broader, but not well differentiated marginal and lateral teeth. Penis cylindrical and without lateral process.

India. Iran to Indonesia and Australia to Philippines, Japan and Western Pacific Islands.

Found in freshwater and brackish water.

Genus ***Stenothyra*** Benson, 1836

Stenothyra deltae (Benson, 1836)

Shell very small, upto 5 mm in length, sub cylindrical or ovate; whorls 4-6, body whorl flattened; sculpture with punctuated spiral lines; aperture small, sub circular; periostome, continuous, uniform and hardly thickened; operculum horny, brittle, internally with two transverse ridges.

This species occurs far above the area with tidal influence in pure freshwater as well as the brackish water. In Sundarbans they were observed crawling on the small muddy

Fig. 21. Dorsal view of *Stenothyra deltae* Benson

Fig. 22. Ventral view of *Stenothyra deltae* Benson

patches, above the high tide marks of mangrove areas, which inundated during the spring tides. Population varies from 2 to 485 no's/m^2 and maximum in the month of September (Subba Rao *et al.,* 1995).

Distribution : India : West Bengal.

Elsewhere : Australia, China, Formosa, Japan, Malay Archipelago, Myanmar, Philippines.

Family ASSIMINEIDAE

Shell small upto (10 mm), variable in shape, conical or globose, depressed including a cup like form; smooth or with spiral ridges; operculum paucispiral and corneous. Tentacles are reduced to short lobes containing eyes. Radula consist of a central tooth with or without basal denticles, a characteristic accessory plate lies between the lateral and first marginal teeth.

Cosmopolitan, abundant in tropical regions; brackish and freshwater near coast. Many species amphibious. They are common at all levels upto the landward fringes.

Genus *Assiminea* Fleming, 1828

Key to the species

– Shell depressed; spire obtuse, whorls not more than five ..... *A. beddomeana* Nevill

– Shell more globose; spire acute; whorls more than five ..... *A. brevicula* (Pfeiffer)

Assiminea brevicula (Pfeiffer, 1854)

Shell globose, thick, with bright brick red or yellowish tan colour, whorls 6-7; suture sharp, smooth; Columellar pillar whitish; operculum corneous, thin, elongate with nucleus far off to one side.

Fig. 23. Dorsal view of *Assiminea brevicula* (Pfeiffer)

Fig. 24. Ventral view of *Assiminea brevicula* (Pfeiffer)

Well adapted to living out of water, having a lung for respiration; presumably graze on denticles and surface algae on the mud. Found to crawl on the mud or to remain attached to grasses in the muddy localities. Population 100-120 no's/m^2 on an average. Copulating pairs common from August to December. Youngones recorded upto 2106 no's/m^2 on an average from October to April (Subba Rao *et al.*, 1995).

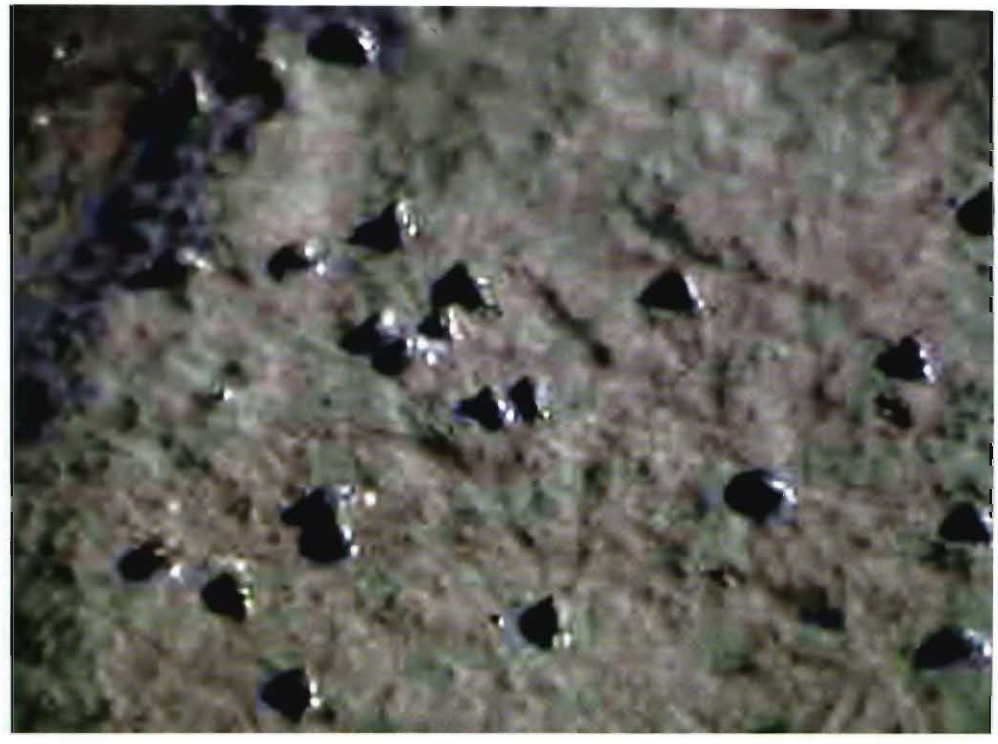


Fig. 25. *Assiminea brevicula* (Pfeiffer) crawling on the muddy bank.

Distribution : India : Andaman and Nicobar islands, Andhra Pradesh, Tamil Nadu, West Bengal.

Elsewhere : Borneo, Cebu, Malacca, Philippines, Singapore.

Assiminea beddomeana Nevill, 1880

Shell depressed, turbinate with quadrate foramen; spire obtuse, depressed with five whorls; aperture globose.

Very similar in habit to the preceding species; also recorded in the holes and crevices of the muddy substratum. Population density upto 550 no.s/m^2. Copulating pairs frequently observed from May to November and juveniles were observed from January onwards.

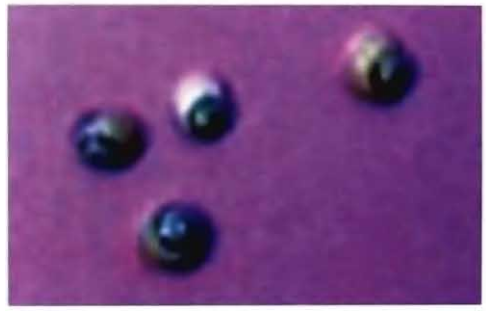


Fig. 26. Dorsal view of *Assiminea beddomeana* Nevill

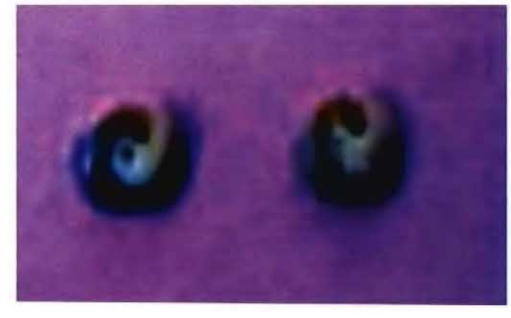


Fig. 27. Ventral view of *Assiminea beddomeana* Nevill

Distribution : India : West Bengal (Hughly-Matla estuary).

Elsewhere : Myanmar (Irawaddy delta).

Superfamily CERITHIOIDEA

Family POTAMIDIDAE

Horn shells

Shell small to large (upto 140mm), long, turreted and thick, whorls between 10-16, spire high. Aperture rounded or oval with a rudimentary anterior siphonal canal and in some a posterior siphonal notch; outer lip thickened grows beyond columellar base. Sculpture with spiral and axial ribs that are often broken into nodules. Operculum horny, thin pauci to multispiral, nucleus at the base.

Head broad with a prominent snout, a pair of tentacle projects from the neck, eyes situated at their outer base. Foot massive, anteriorly subcircular and obtuse posteriorly. Radula taenioglossate type. Mantle cavity deep and consists of an elongate and prominent osphradium and monopectinate ctenidium. Digestive system with a large stomach.

Sexes separate. Male without copulatory organ. A spermatophore is formed to store the sperm and to transfer them into the female, pallial gonoducts are open. Eggs laid in the form of mucus string as long coil.

Fig. 28. Cerithids crawling on the muddy substratum at Jharkhali

Detritus feeders, abundantly common in the estuaries, backwaters and mangroves. Common on mud banks and pools in the intertidal area and among the seaweed on which they feed. They are often seen moving on fluid slime, slowly creeping over low lying land and browsing on the tiny vegetative growths on the bases of the trunks and root of mangroves. They return to the slimy beds after feeding. They are capable to remain out of water for several days with the help of specialized breathing systems.

Economically horn shells are very important. In many parts of India (Andhra Pradesh and Tamil Nadu) they are used for preparation of quick lime. In West Bengal (Sundarbans) the shells are collected in huge quantities and brought to Canning, where they are crushed into powder and used for poultry feed.

Four species namely *Telescopium telescopium, Cerithidea alata, C. cingulata* and *C. obtusa* are commonly found in the mangrove areas of Sundarbans.

Key to the genera

– Shell small, not exceeding 50 mm, elongate; whorls less than ten; aperture extending anteriorly with straight canal ..... *Cerithidea* Swainson

– Shell large, more than 50 mm, conical; whorls more than ten; aperture not extending anteriorly ..... *Telescopium* Montfort

Genus ***Telescopium*** Montfort, 1810

Telescopium telescopium (Linnaeus, 1758)
Telescope snail

Shell large, thick heavy trochoid in shape, conically elevated with more or less 16 whorls; sculpture with 3 larger and, narrow spiral cordon whorls; columella twisted and channeled, labial lip acutely curved. Feeds on organic detritus and surface algae.

Common on the exposed areas of small ditches, shallow pools or canals with a little flow of water during low tide or at extreme high tide mark in the soft mud or on pneumatophors of mangroves. Population (8-10 no's/m^2) reaching upto (20 to 25 no's/m^2) in the mangroves regions. Eggs are laid in gelatinous mass. Juveniles recorded during April–May. Often found associated with *Balanus* sp. but towards the sea usually found associated with *Saccostrea cucullata* (Born).

Distribution : India : Andhra Pradesh, Gujarat, Kerala, Pondicherry, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Australia (North), Indonesia, Malagasy, Myanmar, Philippines, Reunion, Sri Lanka.

Fig. 29. Dorsal view of *Telescopium telescopium* (Linnaeus)

Fig. 30. Ventral view of *Telescopium telescopium* (Linnaeus)

Fig. 31. Telescopium shells with *Balanus* sp.

Fig. 32. Telescopium crawling on the mud

Genus ***Cerithidea*** Swainson, 1840

Key to the species

1. Shell more elongated, slender; body whorl not much broad; whorls more than ten; sculpture with angulated axial ribs which are divided into nodules by three deep spiral grooves ..... (2)

– Shell less elongated, stout; body whorl much broad; whorls less than ten; sculpture with prominent spiral cords, nodules and slender axial ribs and short axial threads between cords ..... *C. obtusa* (Lamarck)

2. Outer lip reflected over the sinus ..... *C. alata* (Philippi)

– Outer lip not reflected over the sinus ..... *C. cingulata* (Gmelin)

Cerithidea alata (Philippi, 1847)
Horn shell or Cerithid snail

Shell upto 25mm, thick, with 12-13 whorls; suture distinct; aperture elongately ovate, outer lip and inner lip meet posteriorly at a point beyond the shell plane; siphonal sinus hollow and short, outer lip reflects over the sinus; sculpture with rounded, somewhat rectangular, close set axial nodules, three on each whorl; colour greyish brown, inner white.

This species closely resembles *C. cingulata* (Gmelin) in shell characters but can easily be differentiated by its typically detached aperture and sculpture.

Fig. 33. Dorsal view of *Cerithidea alata* (Philippi)

Fig. 34. Ventral view of *Cerithidea alata* (Philippi)

Fig. 35. *Cerithidea* spp. crawling on the mud at Jharkhali.

Found crawling on the mud throughout Sundarbans with *C. cingulata* (Gmelin) and segregate in many places. Population varies from 1000 to 1200 no's/m^2.

Distribution : India : Andaman Islands, Andhra Pradesh, Tamil Nadu, West Bengal;

Elsewhere : Indian Ocean.

Cerithidea cingulata (Gmelin, 1791)
Cerithid snail

Elongate, thick, with 13-15 whorls, flattened; sculpture with spiral ridges, tuberculated; aperture oblique, outer lip expanded broadly with distinct anterior canal; columella straight; outer lip thick, anterior siphonal canal distinct and short; colour dark brown, often with a whitish band above the suture, nodules dirty white interstices brown, interior of aperture white; operculum spherical with a central nucleus.

A dominating species of mangrove areas youngones found crawling on the mud mainly near the low water marks with the adults gradually replacing them towards high water

Fig. 36. Dorsal view of *Cerithidea cingulata* (Gmelin)

Fig 37. Ventral view of *Cerithidea cingulata* (Gmelin)

mark. Eggs laid in capsules in the form of mass of gelatinous threads. Population density recorded upto 12000 no's/m^2.

Distribution : India : Common in the estuaries and backwaters along East and West Coast.

Elsewhere : Indonesia, Japan, Myanmar, Pakistan, Sri Lanka.

Cerithidea obtusa (Lamarck, 1822)

Shell upto 60 mm, elongate, robust, solid with 7-8 whorls, body whorl as broad as high; sculpture with spiral threads crossed by prominent transpiral ridges; aperture strongly spherical, wide with expanded and recurved outer lip; columella weak; outer lip thick, flattened, interior smooth; operculum circular, multispiral with a central nucleus; sculptured with 6-7 spiral ridges and 8-10 axial ribs; colour pale pinkish, lip and columella white, aperture light brown with dark brown bands.

Found crawling on the mud or plants which get wet during the spring tide. It was also seen on the mangrove plants upto the height of 1.5 meters above the ground.

Population (2 to 10no's/m^2). Some individuals were attached to mangrove plants with a thin mucous thread and remained in hanging positions with their aperture turned upward.

Fig. 38. Dorsal view of *Cerithidea obtusa* (Lamarck)

Fig. 39. Ventral view of *Cerithidea obtusa* (Lamarck)

Fig. 40. *Cerithidea obtusa* (Lamarck) attached on the mangrove stem.

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, Orissa, West Bengal.

Elsewhere : Indian Ocean to Western pacific.

Suborder HETEROGLOSSA

Super family EPITONOIDEA

Family EPITONIIDAE

Wentle traps

Shell small to medium (upto 40 mm), highly conical to turretiform with numerous loosely coiled whorls. Spire pointed. Aperture circular, rounded, some are umbilicate, in some umbilicus closed by expanded columellar margin. Sculpture with regular oblique axial lamellae or varices, formed as reflected outer lips. Colour white or brown. A few may bear brown tinges and markings. Operculum horny, thin, paucispiral to multispiral, with central nucleus.

Head with long, pointed tentacles. Eyes situated on elevation at their outer base. Foot short. Radula stenoglossate type. Mantle cavity contains a ctenidium, a long bipectinate osphradium. Digestive system includes two pairs of salivary glands and a large stomach. Eggs laid in strings and covered by sand grains.

Cosmopolitan occurs from shallow intertidal region to great depths. Feeds on cnidarians, soft corals, many are parasitic. Found in all seas, a few of them found in the estuaries.

Genus ***Amaea*** H. & A. Adams, 1853

Amaea (Acrilla) acuminata (Sowerby, 1844)

Shell upto 32 mm, narrow, glossy, elongately turreted, acuminate; whorls 15 convex, suture impressed; aperture elongately ovate, columella thin and fragile, umbilicus absent;

Fig. 41. Dorsal view of *Amaea (Acrilla) acuminata* (Sowerby)

Fig. 42. Ventral view of *Amaea (Acrilla) acuminata* (Sowerby)

sculpture with very close set transpiral ribs, body whorl keeled at the base; colour cream with two brown spiral bands.

Distribution : India : Maharashtra, Orissa, Pondicherry, Tamil Nadu, West Bengal.

Elsewhere : Indo-pacific.

Found crawling on the mud flats where a little amount of water is retained during the low tide. Breeding season May. Egg capsules observed during May in bunches attached on substratum with the help of mucous. Each bunch with approximately 500 ash coloured capsules, each containing 200-250 white, rounded eggs.

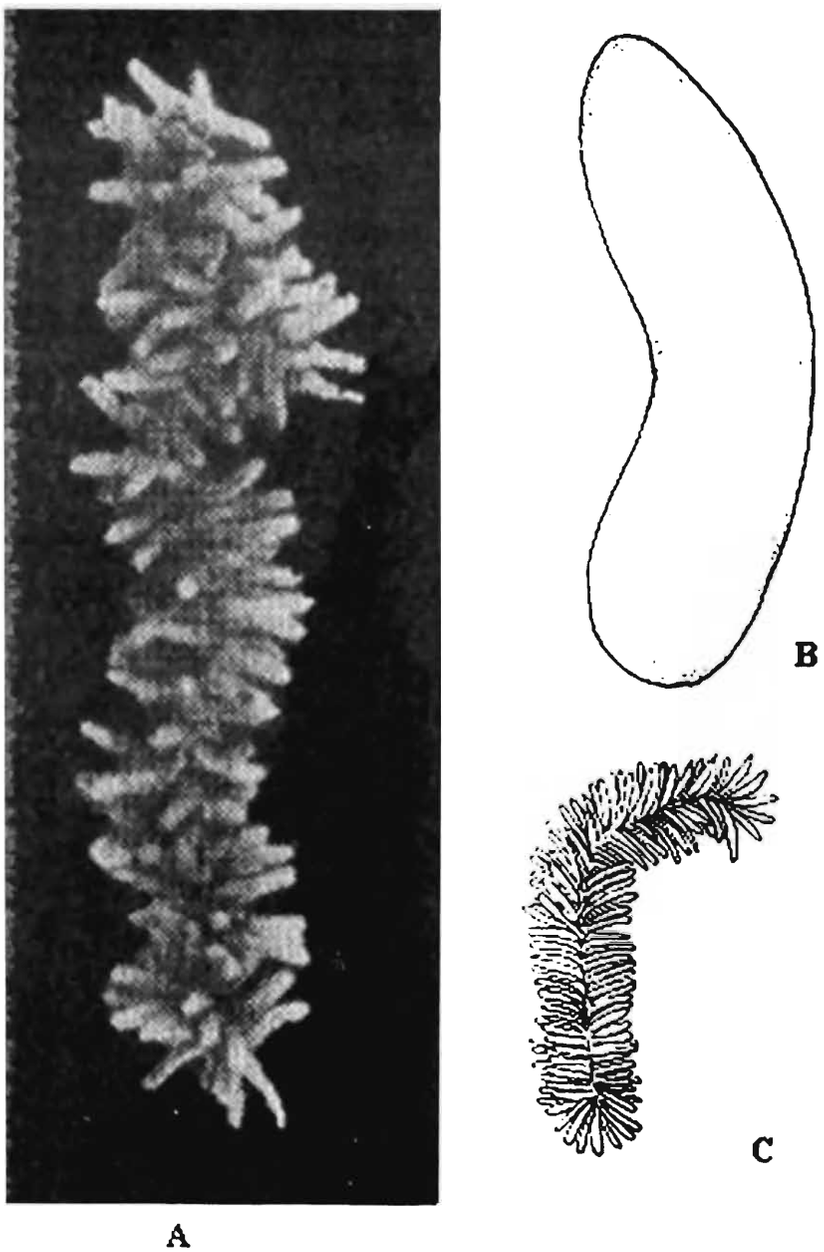


Fig. 43. Egg capsule of *Amaea (Acrilla) acuminata* (Sowerby) (After Subba Rao *et al.*, 1995)

Order NEOGASTROPODA
Super family MURICOIDEA
Family MURICIDAE

Murexes/Murex shells

Shell small to very large (upto 300 mm), variable in shape, elongate to fusiform to club shaped or biconic, with distinct spire, protoconch consists of a few whorls. Aperture rounded to ovate, columella without folds but often bearing plicae. Outer lip dentate, sometimes with long processes. Anterior siphonal canal short to long, narrowly open or entirely closed, posterior siphonal canal not distinct. Surface scabrous or lamellose, bear simple, foliated or spiny varices, axial sculpture consists of one or few ridges or knobs.

Cephalic tentacle pointed and bears eyes at the outer bases. Foot moderately long equipped an accessory boring organ, located on the mid anterior ventral surface. Siphon short or long. Radula long, stenoglossate type (1-1-1). Mantle cavity contains monopectinate ctenidium, a well-developed bipectinate, an osphradium and a hypobranchial gland. Proboscis moderate, long and extensile. Alimentary system has a pair of salivary glands and also a pair of smaller accessory salivary glands, esophagus has a posterior valve of Leiblein. A true anal gland present.

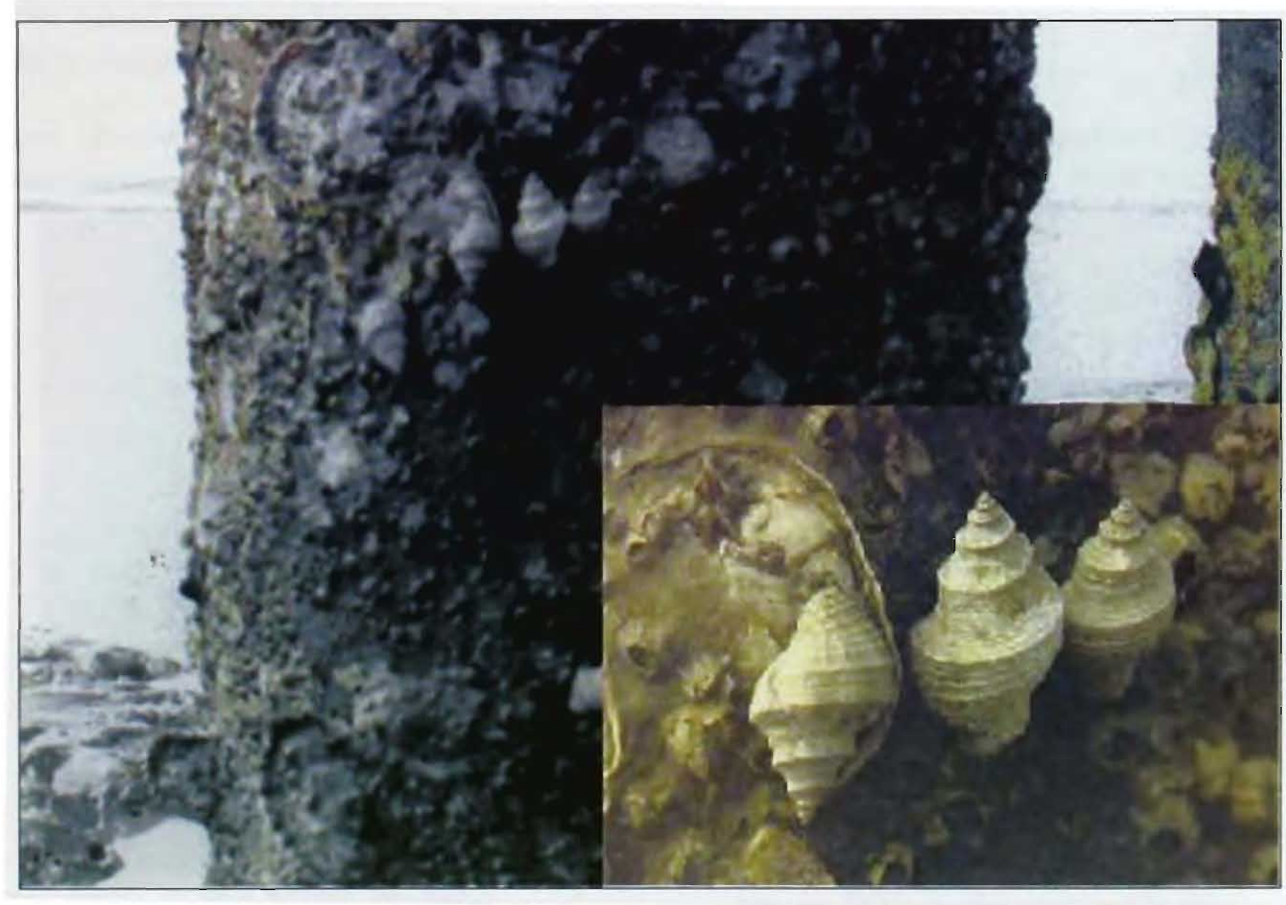


Fig. 44. Thais shells attached on a pillar of jetty at Gosaba

Sexes separate. Penis situated behind the right tentacle, wide bland and dorso-ventrally flattened, with a flagellum at the tip. Eggs laid in capsules, which are clusters and are attached on shells or seaweed.

Cosmopolitan, abundant in intertidal zone of rocky coast and reef systems. Majority occurs in littoral and sublittoral zones; a few extend to a depth of upto 1900 m. Carnivorous in habit.

Subfamily THAIDINAE

Rock snails

Genus *Thais* Roeding, 1798

Key to the species

- Whorls ornamented with tubercles at least one to two rows prominent; Sculpture both spiral cords, shoulder with single or two rows of spinose tubercles on body, rest with single row ..... *T. lacera* (Born)
- Whorls not ornamented with tubercles; Sculpture with rounded spiral cords, shoulder cord much prominent ..... *T. blanfordi* (Melvill)

Thais lacera (Born, 1778)

Shell moderately large, upto 55 mm, ovate, tuberculate, spire acute, whorls four, angulated; body whorl large, ovate, tuberculate on shoulder; aperture large, ovate, outer

Fig. 45. Dorsal view of *Thais lacera* (Born)

Fig. 46. Ventral view of *Thais lacera* (Born)

lip finely crenulated; columella smooth; sculpture with two rows of tubercles on the upper part of the body whorl, sometimes developed to spines with a flat, smooth callous; colour ashy brown; aperture light brown, margin white.

Distribution : India : East and West coast of India. Common.

Elsewhere : East Africa to Japan.

Common predator on bivalves drilling a hole through the shell of the victim and sucking out the contents using their narrow eversible proboscis. Found in jetties, in backwaters, rivers mouth attached to bricks, boulders, pillars and decomposed mangrove stems. Population 5 to 6 nos/m^2. Copulating pairs found during February/March and October/November. Egg capsules attached in clusters to the broken pitchers, bricks, piece of shell during March/April and November/December. Each cluster with 10-20 greenish yellow with pinkish tinge capsules, small, cylindrical in shape bulging in the middle, with an oval shaped opening at top, covered with a membrane.

Thais blanfordi (Melvill, 1893)

Shell upto 35 mm in length, ovately fusiform; spire acute, high, consists of four angulated whorls; body whorl large with distinct angulations at shoulder; aperture acute, ovate, anal sulcus broad, inverted U shaped, margin by a ridge; outer lip crenulated, interior lirate, eight in number arranged in pairs; inner lip smooth, slightly twisted anteriorly; sculpture

Fig. 47. Dorsal view of *Thais blanfordi* (Melvill)

Fig. 48. Ventral view of *Thais blanfordi* (Melvill)

with six major spiral threads above and below shoulder; axial sculpture consists of 11-12 low inconspicuous tubercles, dull grey, interior white, dark blotches on columella.

Distribution : India : Andaman and Nicobar Islands, West Bengal and West coast.

Elsewhere : Persian Gulf, Karachi, Sri Lanka, Singapore.

In Sundarbans commonly occurs in jetties, in backwaters, rivers mouth attached to bricks, boulders, pillars and decomposed mangrove stems, in clusters of 4 to 6 nos. Copulating pairs found during February/March and October/November. Egg capsules attached in clusters to the broken pitchers, bricks, piece of shell during March/April and November/December.

Fig. 49. A cluster of egg capsule of *Thais blanfordi* (Melvill)

Fig. 50. A portion of egg capsule of *Thais blanfordi* (Melvill)

Family COLUMBELLIDAE
Dove shells

Shell small to medium (upto 30 mm), fusiform, solid, whorls many with high acute spire and small to large body whorl. Aperture long and narrow, siphonal canal very short, outer lip thin or thickened, often with denticulations on the interior margin. Columellar margin smooth or weakly denticulate. Sculpture usually smooth, but sometimes with axial and spiral cords. Operculum small, horny and oblong when present, nucleus either terminal or on the border.

Cephalic tentacle long, slender, bearing eyes at their outer bases. Foot large and narrow. Siphon long and fleshy. Mantle cavity contains hypobranchial gland. Proboscis is pleurembolic with a distal buccal cavity. Radula rachiglossate (1-1-1 or 1-0-1).

Sexes separate. Male has a large tapering and tubular penis enclosed in a pouch. Eggs laid in hemispherical capsules on hard substratum.

Found on warm temperate and tropical seas from intertidal zone to 200 m depth a few occurs in mangrove areas.

Genus ***Pseudanachis*** Thiele, 1924

Pseudanachis duclosiana (Sowerby, 1847)
Mangrove dove shells

Shell upto 15 mm, acuminate, ovate, body whorl more than half the length of the shell; sculpture with fine longitudinal ribs, interstices of ribs finely striated; aperture broad,

Fig. 51. Dorsal view of *Pseudanachis duclosiana* (Sowerby)

Fig. 52. Ventral view of *Pseudanachis duclosiana* (Sowerby)

flexuous, denticulate on both sides; outer lip thickened, with denticles on the interior; canal shortly acuminated, some whorl reflected; columella with denticles on interior.

Rachiglossate type of radula, consisting of 108 transverse rows of teeth. Each row has one central flattened by one lateral on either side; central bears 12 strong denticulations and the laterally with stronger denticulations.

Distribution : India : Andhra Pradesh, Orissa, West Bengal.

Elsewhere : Indo-pacific.

Carnivorous, predating on polychaetes some omnivorous or herbivorous.

Found attached to brick crevices, decomposed wood of mangroves, in clusters, near the low water marks. Attached to the pneumatophores of mangroves upto the height of 35 cms above the ground level.

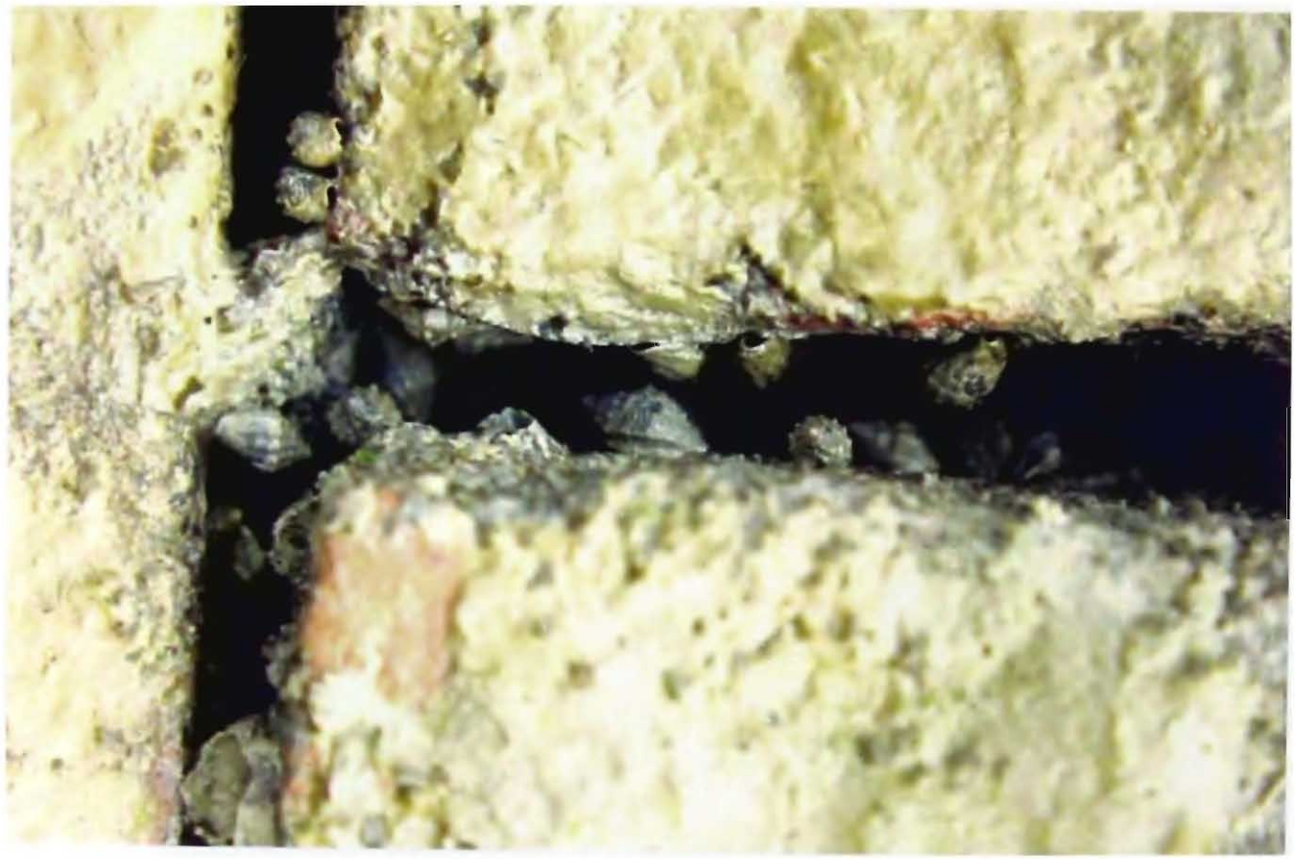


Fig. 53. *Pseudanachis duclosiana* (Sowerby) in crevices of dyke at Gosaba

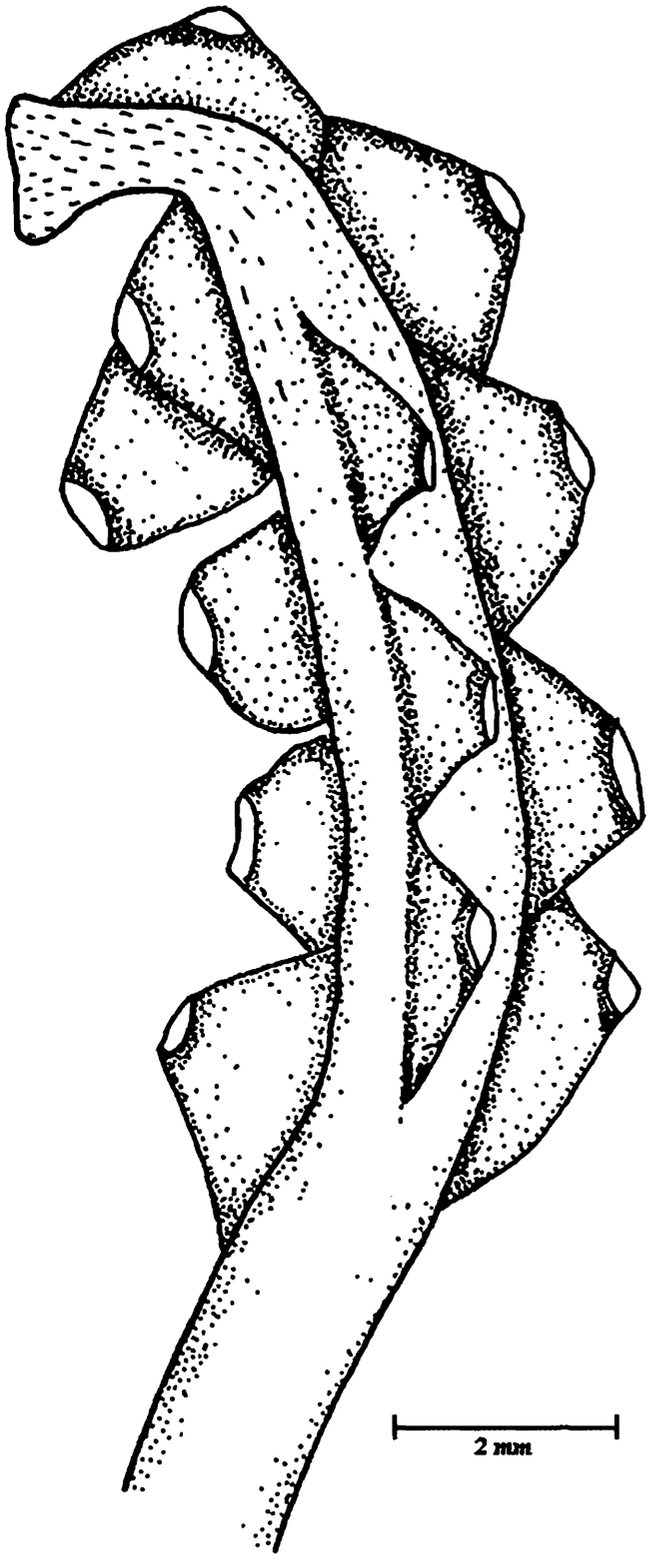


Fig. 54. Egg capsule of *Nassarius* sp. (After Subba Rao *et al.*,1995)

Family NASSARIIDAE
Mud snails, Dog whelks

Shell small to medium (upto 55 mm), broad and ovately rounded to slender and narrowly elongate with numerous whorls and an elevated spire. Sculpture with spiral and axial striae or ribs, often obsolete on the last whorls Aperture constricted, rounded to narrow, anterior canal short, posterior canal usually with a notch. Outer lip, smooth or interiorly lirate, Columella twisted, callus developed, Columellar shield variable, columella smooth or denticulate. Umbilicus covered. Operculum variable, small and of different shapes, irregularly ovate, subtrigonal or claw like and rarely serrate.

Foot large and broad or narrow and pointed sometimes bifurcated posteriorly, Tentacles moderate large, Eyes at the base. Siphon long and conspicuous. Mantle cavity with monopectinate ctenidium, bipectinate osphradium and hypobranchial gland; Proboscis long pleurembolic with terminal buccal cavity. Radula stenoglossate. Alimentary system consists of a small gland of Leiblein in the esophagus and a crystalline style in the stomach.

Sexes separate. Male has a tubular penis and a prostrate gland. Female with an accessory oviductal opening at the mantle cavity, a bursa copulatrix, capsule gland, seminal receptacle, ingesting gland and gonopericadial duct. Eggs laid in capsules.

Inhabitant of brackish water, shallow intertidal region to depth of the sea. Mostly carnivorous or scavenger feeder, a few are herbivorous.

Genus ***Nassarius*** Dumeril, 1806

Key to the species

- Shell oblongly-ovate; sculpture with fine axial ribs; body whorl without chocolate or brown bands ..... *N. foveolatus* (Reeve)
- Shell ovately conical; sculpture with prominent axial ribs; body whorls with chocolate or brown bands ..... *N. stolatus* (Gemlin)

Nassarius foveolatus (Reeve, 1853)

Shell upto 20 mm, oblong ovate; with elongated and acute spire, body whorl narrower; sculpture with close set, fine axial ribs on all whorls, interstices with spiral striae giving a cancellate appearance; aperture ovate, outer lip slanting, supported by varix, 12to 14 lirations on interior; columella sub rugose; colour yellow or yellowish brown, aperture cream.

Fig. 55. Dorsal view of *Nassarius foveolatus* (Reeve)

Fig. 56. Ventral view of *Nassarius foveolatus* (Reeve)

Radula rachiglossate with 62–65 transverse rows of teeth, central with 11 strong denticulations, lateral forked.

Distribution : India : Kerala, Maharashtra, Orissa, Tamil Nadu, West Bengal. Common.

Elsewhere : Indian Ocean.

Found crawling on mud in mangrove areas. Egg capsules found from November to April, attached to broken bricks, pitchers, shells or wooden structures.

Nassarius stolatus (Gmelin, 1791)

Shell upto 15 mm, ovate conoid, with inflated body whorl, rather smooth with chocolate or brown band on the body whorl; whorls convex; spire sharp; sculpture with slender axial ribs, obsolete on the central area on the back of last whorl, interstices fine and cancellate; aperture ovate with a small apical notch; columellar calloused, not expanded; outer lip thickened with 6-7 denticles on the interior.

Fig. 57. Dorsal view of *Nassarius stolatus* (Gmelin)

Fig. 58. Ventral view of *Nassarius stolatus* (Gmelin)

Distribution : India : Maharashtra, Pondicherry, Tamil Nadu, West Bengal. Common.

Elsewhere : Indo-west Pacific.

Well known as scavengers, prefer sandy muddy areas, during low tide waving their long narrow siphons, searching for dead animals, Detect prey using the osphradium, located at the base of the siphon. Population 3 to 5 nos/m^2 on an average. Cream colour egg capsules observed from November to April attached to the pieces of bricks, shells and mangrove pieces etc.

Family MELONGENIDAE

Crown Conchs or Whelks

Shell medium to large (upto 110 mm), thick, pyriform to fusiform, whorls few, more or less flattened or elevated spire, bearing a sizable protoconch, covered with brown or opaque periostracum. Sculpture not very conspicuous, with a few spiral cords at the base and strong knobs or tentacles at shoulder. Aperture large and wide with a thickened and smooth outer lip. Columella smooth without any plaits. Operculum thick, horny and unguiculate, with lateral nucleus.

Head with a pair of tentacles. Foot large and powerful. Mantle cavity contains a large monopectinate ctenidium, bipectinate osphradium and large hypobranchial gland. Radula stenoglossate (1-1-1) or may be absent. Alimentary system consists of pair of salivary glands without accessories glands and a gland of Leiblein.

Sexes separate. Male with a large penis on the right side and female has a large capsule gland. Eggs laid in clusters or strings. Free swimming larval stage.

Carnivorous or scavenger in habit occurring on muddy sand substrates in shallow water.

Genus ***Pugilina*** Shumacher, 1817

Pugilina cochlidium (Linnaeus, 1758)

Crown Conch

Shell variable, large, fusiform to pear shaped with high acute spire; covered with brown periostracum; whorls angulated, body whorl large; shoulder with tubercles; aperture ovately oblong; columella smooth, without plaits; aperture large wide with thickened and smooth outer lip; sculpture not very conspicuous; colour reddish brown, interior of aperture brownish yellow.

Distribution : India : East and West coast of India. Common.

Elsewhere : Indian Ocean.

Fig. 59. Dorsal view of *Pugilina cochlidium* (Linnaeus)

Fig. 60. Ventral view of *Pugilina cochlidium* (Linnaeus)

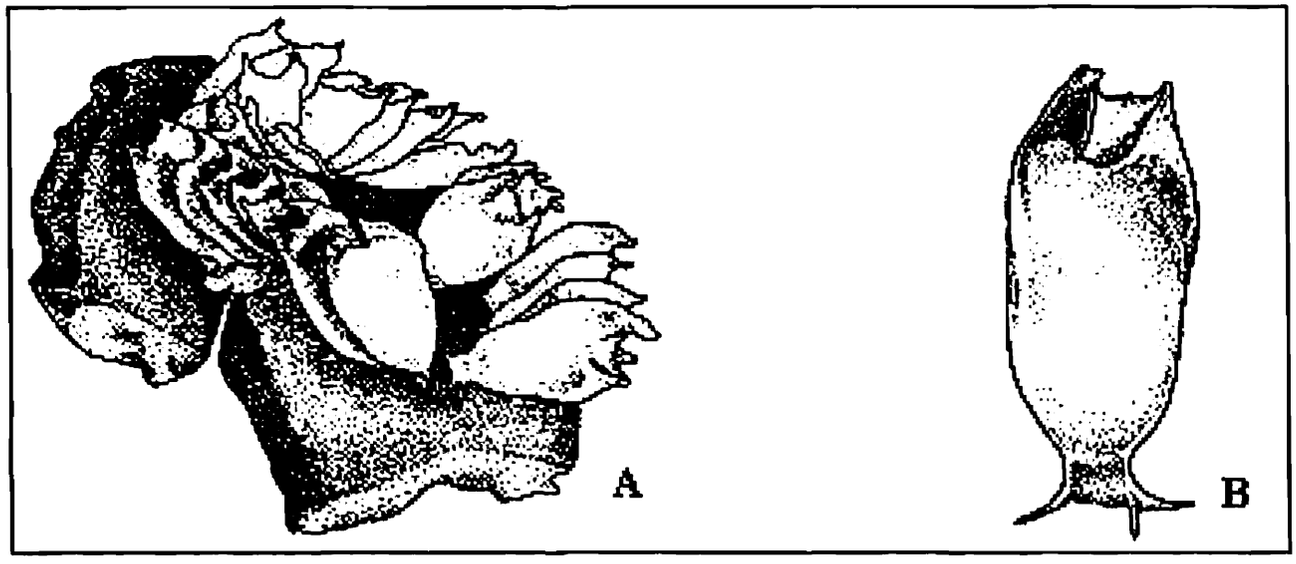


Fig. 61. Egg capsule of *Pugilinus cochlidium* (Linnaeus); A : Egg capsule attached on substratum; B : Individual egg capsule (After Subba Rao *et al.*, 1995).

Carnivorous feeds on the bivalves. Radula or buccal mass absent. The proboscis modified to capture the prey and convert it into digestible form. Observed crawling on the mud throughout Sundarbans. Population up to 5 nos./m^2. Copulating pairs observed from November to March. Egg capsules seen attached to the broken pieces of bricks, shell, mangroves plants etc. Capsules are yellowish green, broad at upper end and gradually narrow with an elongate stalk at the base; flattened and bounded by low longitudinal ridges at two ends and become pointed at the tip. Each cluster contains 10 to 30 capsules.

Subclass OPISTHOBRANCHIA
Order CEPHALASPIDEA
Superfamily PHILINOIDEA
Family HAMINEIDAE

Bubble Shells

Shell thin, fragile, with involute spire covered by the expansion of the body whorl. Aperture large, extending along the length of the shell and posterior part of the outer lip detached from the apex. Shell without pronounced sculpture. Colour generally white, covered with a brownish periostracum. Shell without operculum.

Foot large, Parapodia well developed. Cephalic shield consists of two short rounded posterior lobes covering the anterior part of the shell. Gizzard has strong plates. Sexes united with a protrusible penis.

In habitant of muddy and intertidal sandy areas, a few of them may extend up to the depth of 300 m. Common on the surface of mud under the shade of the trees.

Genus ***Haminoea*** Turton & Kingston in Carrington, 1830

Haminoea crocata Pease, 1860

Shell upto 15 mm, fragile, thin, oval shaped, posterior end broad, and semi transparent; light bluish in colour. In live condition mantle covers most part of the shell.

Fig. 62. Dorsal view of *Haminoea crocata* Reeve

Fig. 63. Ventral view of *Haminoea crocata* Reeve

Distribution : India : Orissa, Tamil Nadu, West Bengal (Hughly-Matla estuary).

Elsewhere : Sri Lanka, New South Wales.

Common on the muddy areas in the shaded part of forest, detritus feeders. Being disturbed secrete a sticky, purple secretion that may be distasteful to predators. Population 80 to 90nos/m^2. Copulating pairs observed in April to May. Egg capsules usually found in the water attached by lower end to muddy substratum. Capsules are gelatinous, transparent and whitish. Egg capsule contains 15 to 25 light yellowish or creamy eggs.

Subclass GYMNOMORPHA

Order SYSTELLOMMATOPHORA

Superfamily ONCHIDIOIDEA

Family ONCHIDIIDAE

Jomra Poka or Nona Jownk

Slug like animals, without shell with thickened mantle covering the dorsal surface, with papillae or tubercles and accessory eye like structures. The mantle has repugnatorial gland, which released repulsive secretions. Head with roof like frontal shield. Body with dorsal notum separated from the lateral hyponotum or girdle like border by a groove called perinotum. Foot large, broad with a median sole. Radula broad with tricuspid central teeth and numerous lateral and marginal teeth.

Sexes united. Female genital pore located posteriorly and male genital pore (gonopore) located anteriorly. Penis has an accessory gland.

Amphibious, occurring mainly in estuaries. Three species namely *Onchidium tenerum* Stoliczka, *O. trigrinum* Stoliczka and *O. typhae* Buchanan are common in the mangrove areas of Sundarbans.

Genus ***Onchidium*** Buchanan, 1800

Key to the species

1. Body soft; pulmonary orifice at posterior end of mantle ..... *O. tenerum* Stoliczka

– Body hard; pulmonary orifice near to anus ..... (2)

2. Foot narrow; tip of tubercle with more than one jet black dot ..... *O. typhae* Buchanan

– Foot broad; tip of the tubercle with one jet black dot ..... *O. tigrinum* Stoliczka

Onchidium tenerum Stoliczka, 1869

Animal upto 35 mm in length and 19 mm in width, ovate, elongate, flabby; mantle greenish grey and with dark spots and fine granules, eye black and centrally situated in transverse fold; eye pedicle-stout at the base with distinct swollen, granular tips; pulmonary orifice situated at the base of posterior end of mantle.

Distribution : India : West Bengal (Hughly Matla estuaries).

Fig. 64. Dorsal view of *Onchidium tenerum* Stoliczka

Fig. 65. Ventral view of *Onchidium tenerum* Stoliczka

Found burrowing on the mud of forest floor, under wood and even climbing on the mangrove trees. Probably graze on detritus and surface algae. Nocturnal in habit, air breathing; breeding season February to March.

Onchidium tigrinum Stoliczka, 1869

Comparatively small upto 17 mm in length and 13 mm in width, ovate with strong coriaceous, mantle hard; upper surface of the body with small granules enclosed between large tubercles each with a jet black dot at the tip; pale greenish with irregular black spots; foot broad and expanded upto mantle; pedicle and head dark green, pedicle thick at the base, thin in the middle, and slightly thickened at tip, bears black eyes at upper surface.

Distribution : India : West Bengal (Hughly Matla estuaries).

Found burrowing in the mud of mangrove floor, underwood inside crevices of dykes and bricks: crawling in the mud, bricks and also climbing on the mangrove trees. They are hermaphrodite; probably graze on detritus and surface algae. They create a spectacular sight of churned sand on the smooth sandy bank during low tide, as they emerge from their burros to graze above ground.

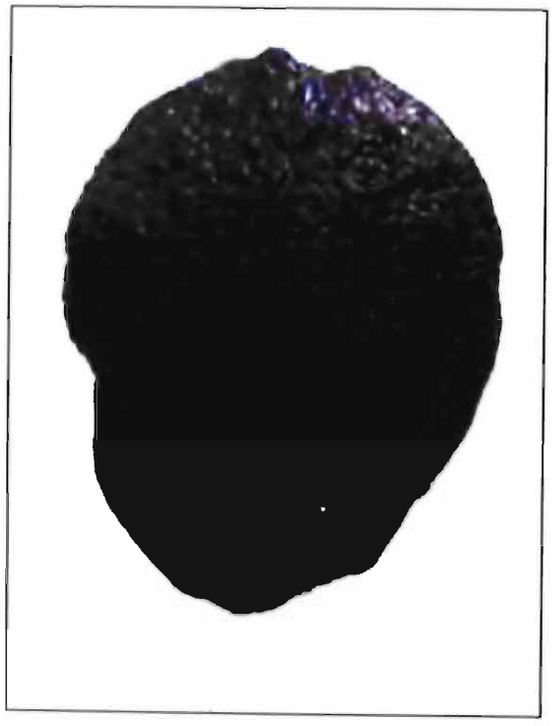


Fig. 66. Dorsal view of *Onchidium tigrinum* Stoliczka

Fig. 67. Ventral view of *Onchidium tigrinum* Stoliczka

Onchidium typhae (Buchanan, 1800)
Mangrove slugs

Body narrow, elongated during motion; anterior and posterior end obtuse; mantle greenish with various shades upwards, numerous small and large tubercles distributed throughout the dorsal surface; tip of the tubercles provided with 2 to 4 jet black dots; foot narrow, greenish yellow and not as broad as mantle.

Fig. 68. Dorsal view of *Onchidium typhae* (Buchanan)

Fig. 69. Ventral view of *Onchidium typhae* (Buchanan)

Distribution : India : West Bengal (Hughly Matla estuaries).

The most abundant species among the three, found crawling on the mud, bricks and crevices during low tides. Nocturnal in habit, burrowing on the mud of mangrove forest and also climbing on the tree. Breeding season February to march. Egg capsule transparent and ribbon like in structure reaching up to about 90 cms in length.

Fig. 70. *Onchidium* spp. crawling on the mud at Goshaba

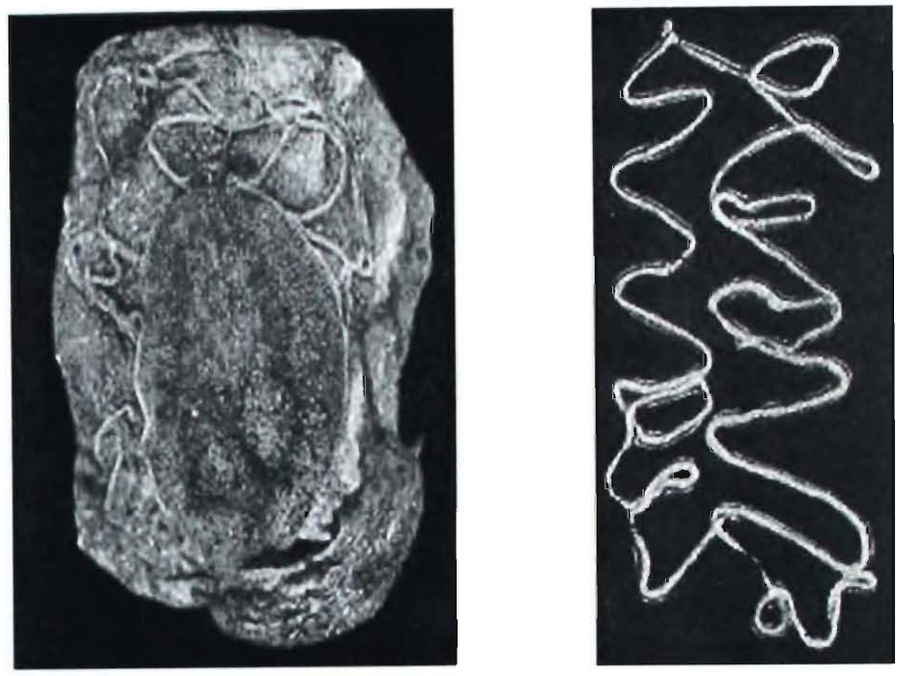


Fig. 71. A : *Onchidium typhae* (Buchanan) with egg capsule; B : Egg capsule of *Onchidium typhae* (Buchanan) (After Subba Rao *et. al.*, 1995)

Subclass PULMONATA
Order ARCHAEOPULMONATA
Superfamily ELLOBIOIDEA
Family ELLOBIIDAE

Shell small to moderate (upto 60 mm), thick to thin, ovate to cylindrical, spire short, body whorl large. Aperture elongate, outer lip thick, often reduced in size due to presence of teeth. Columella with folds and teeth, Outer lip with one to several teeth, surface generally smooth but sometimes with striations.

Fig. 72. *Cassidula nucleus* (Gmelin) on a stem of a mangrove

Animal can totally retract into the shell. Animals with a pair or rounded retreuble tentacles bearing eyes at the base. A small respiratory orifice, pneumatophore present on the posterior part of the mantle. Foot with small transverse furrows, sexes united, penis retractile and has a chitinous stylet.

Cosmopolitan. About 100 species belonging to 21 genera occur on land, in estuaries and intertidal zone of the sea. They are common at the upper level at the bruguiera forest, in ceriops, thickets and under the litters of landward fringes. Represented by four genera *Cassidula, Ellobium, Melampus* and *Pythia. Cassidula* and *Ellobium* are characteristic of the lower levels of the landward fringe and extend downwards almost to the seaward edges of the bruguiera and rhizophore forests. Species of *Melampus* are cryptic forms living under the leaves, logs etc, which litter the surface of the landward fringes. *Pythia* is the most terrestrial, its species ranging from the upper levels of the landward fringe into the rain forest above high tide marks. To some extent these molluscs are responsible for breaking down fallen leaves and humus. Although they are recorded as living on the slimy mud around the mangrove roots and pneumatophores. *Cassidula* and *Ellobium* are usually found where fallen leaves are common. *Melampus* is normally cryptic occurring under leaves and driftwood or under the trailing plants.

Key to the genera

1. Shell oblong ..... (2)

– Shell ovate ..... *Ellobium* Roeding

2. Outer lip denticulate ..... (3)

– Outer lip non denticulate ..... *Pythia* Roeding

3. Outer lip thick, denticle upto three ..... *Cassidula* Ferrussac

– Outer lip thin, denticle more than three ..... *Melampus* Montfort

Genus ***Cassidula*** Ferussac, 1821

Cassidula nucleus (Gmelin, 1791)

Shell upto 25 mm, ovate, with short spire and convex body whorl, angular at the shoulder; apex purplish brown; sculpture with sharp, fine, incised striae on the body whorl; aperture narrow, larger than spire; outer lip thickened, ventricose, obsoletely denticulate and angulated; columella with a callous shield and two folds; colour cream or fawn ornamented with brown bands.

Fig. 73. Dorsal view of *Cassidula nucleus* (Gmelin)

Fig. 74. Ventral view of *Cassidula nucleus* (Gmelin)

Distribution : India : Maharashtra, Tamil Nadu, West Bengal (Estuaries and Mangroves).

Elsewhere : Indo-west pacific.

Found attached to the stem of mangrove plants upto 1.5 m from the ground level and also crawling on the mud, prefers shady area.

Genus ***Ellobium*** Roeding, 1798

Key to the species

– Spire short, whorls upto six; columella with two plication ..... *E. gangeticum* (Pfeiffer)

– Spire elongate, whorls more than six; columella with more than two plication .... *E. aurisjudae* (Linnaeus)

Ellobium aurisjudae (Linnaeus, 1758)

Shell medium upto 50mm, elongately ovate, spire short, suture incised; sculpture with numerous, close set and wavy longitudinal striae and spiral rows of granules; aperture narrow, umbilicus absent; outer lip calloused, columella calloused with 3 folds, middle fold large and angular.

Distribution : India : Andaman and Nicobar Islands, Gujarat, Maharashtra, Orissa, West Bengal (Estuaries and Mangroves).

Elsewhere : Indo-pacific.

Air breathing, hermaphroditic, found on logs and trees of mangrove, grazing on epilithic algae in eulittoral zone. Juveniles are common in August. They are also common in the holes or crevices of the mud flats.

Fig. 75. Dorsal view of *Ellobium aurisjudae* (Linnaeus)

Fig. 76. Ventral view of *Ellobium aurisjudae* (Linnaeus)

Ellobium gangeticum (Pfeiffer, 1855)

Shell upto 30 mm, fusiformly ovate, thin, and covered with straw coloured epidermis; spire short, whorls tumid; aperture slightly expanded below; columella with two plaits, periostracum straight.

Fig. 77. Dorsal view of *Ellobium gangeticum* (Pfeiffer)

Fig. 78. Ventral view of *Ellobium gangeticum* (Pfeiffer)

Distribution : India : Andhra Pradesh, Orissa, West Bengal (Estuaries and Mangroves).

Elsewhere : Myanmar, Sri Lanka.

Air breathing, hermaphroditic, common on the mangrove stems and also in the holes and crevices of the mud flats. Population density 1 to 3 nos/m^2.

Genus ***Melampus*** Montfort, 1810

Melampus pulchella (Petit, 1842)

Shell upto 8 mm, ovate fusiform, perforate, solid with convexly conoid striae mucronate apex; linear suture; 6 to 7 whorls; strong columellar plait; sharp outer margin and short columellar margin; aperture narrow, produced at the base; outer lip denticulate; colour light brown, surface with fine growth line.

Fig. 79. Dorsal view of *Melampus pulchella* (Petit)

Fig. 80. Ventral view of *Melampus pulchella* (Petit)

Distribution : India : Maharashtra, West Bengal (Estuaries and Mangroves).

Elsewhere : Philippines.

Common on logs in damp and wet places, undersurface of the leaves, and the mud flats and also in the crevices of stones forming a part of dyke created for the prevention of erosion.

Genus ***Pythia*** Roeding, 1798

Pythia plicata (Ferussac) Gray, 1825

Shell upto 25 mm, ovate, compressed, light purple with white band along the outer lip; spire acute, body whorl large; suture impressed; aperture narrow; outer lip margin reflected, dentate in side; columella calloused with three conspicuous folds, umbilicus deep; colour light purple with white band along the outer lip.

Fig. 81. Dorsal view of *Pythia plicata* (Ferussac) Gray

Fig. 82. Ventral view of *Pythia plicata* (Ferussac) Gray

Fig. 83. *Pythia plicata* (Ferussac) Gray moving on the ground.

Distribution : India : Orissa, Pondicherry, Tamil Nadu, West Bengal (Estuaries and Mangroves).

Elsewhere : Indo-pacific.

Common on mud of mangrove areas, sometimes found attached on the trunk of *Avicennia* sp. during the high tide when the area gets inundated. Juveniles were recorded during August.

Super family AMPHIBOLOIDEA

Family AMPHIBOLIDAE

Shell small to medium (upto 30 mm), globose, spirally coiled. Suture impressed. Whorls rounded. Sculpture smooth or with spirally or longitudinally ridged, ribs, knobs or tubercles, imperforate. Aperture large; umbilicus wide and conspicuous. Operculum smaller than aperture, oval, corneous with subcentral nucleus.

Head large, tentacles short, bearing eyes at the bases. Pulmonary cavity large, gill absent but an osphridium present. Hypobranchial gland present or absent, if present in the roof of mantle cavity. Sexes separate. Penis mascular. Eggs laid in capsules.

Mostly brakishwater, partly buried in the muddy or sandy substratum of the estuaries, backwaters and mangroves. In Sundarbans (West Bengal) one species found on the mangrove areas of Hughly-Matla estuary.

Genus ***Salinator*** Hedley, 1900

Salinator burmana (Blanford, 1867)

Ovately-globose, imperforate, thin, translucent, smooth, brownish in colour; spire conoidal, suture deep, whorls five rounded, obsoletely striated, regularly descending,

Fig. 84. Dorsal view of *Salinator burmana* (Blanford)

Fig. 85. Ventral view of *Salinator burmana* (Blanford)

the last tumid; aperture subelliptical, vertical and angulated above; Columellar margin expanded.

Observed crawling on the muddy substratum of mangrove areas, population 4-5 no's/ m^2 on an average. Egg capsules were recorded in December.

Distribution : India : West Bengal (Hughly-Matla estuary).

Elsewhere : Myanmar (Irawaddy delta).

Class **BIVALVIA**

Sub class PTERIOMORPHIA

Order ARCOIDA

Super family ARCOIDEA

Family ARCIDAE

Ark Shells

Shell small to large, equivalve or inequivalve, elongate or elongate-ovate, usually thick; beak recurved, covered with a fibrous epidermis. Ligamental groove chevron shaped. Hinge line straight and with numerous regular sized teeth. The adductor scars are equal or unequal, connected by pallial line. Pallial sinus absent. Byssal gape narrow or side. Ligament external. Sculpture with smooth or granulose radial ribs. Faecal pellet ungrooved ribbon type.

Sedentary. Lives in intertidal region, a few of them live at the depth upto 300 fathoms, often in muddy sandy localities; attached by a byssus to the substrate. Buried in sand or mud; some frequent reefs and hard substratum.

Genus ***Anadara*** Gray, 1847

Anadara granosa (Linnaeus, 1758)
Granular Ark Shell/Padma Jhinuk

Shell orbicularly-ovate, equivalve, side slightly angulated. Sculpture radiately ribbed; ribs upto 20, tuberculate and crenulated.

Fig. 86. Exterior view of *Anadara granosa* (Linnaeus)

Fig. 87. Interior view of *Anadara granosa* (Linnaeus)

Commonly known as Ark shell, occurs on the muddy substratum of Sundarbans. Shell burrower and lives partly buried in the sediment (semi-in fauna), and because of this is most frequently found in sheltered conditions, with the umbonal margin directed upwards. Population recorded 2-31 nos/m^2. It is an important commercial species. Huge quantities of shells are collected from Sundarbans and brought to Canning, where it ground into powder and used for poultry feed.

Distribution : India : Andhra Pradesh, Gujarat, Kerala, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Indo-pacific.

Order MYTILOIDA
Super family MYTILOIDEA
Family MYTILIDAE

Mussels

Shell elongate, thin equivalve, anteriorly beaked. Ligament long and narrow rest on a resilial ridge along the dorsal margin. Hinge teeth absent, but simple, small feeble teeth (dysodont type) may be present in front of or behind the ligament. Anterior adductor

scar small or absent. Sculpture often smooth, but in some species have weak ribs. Margins crenulated. A strong byssus of numerous fine thread is often present. Colour purple, interior polished but non nacreous. Periostracum brown. Mantle often in front and folded at the posterior end into a sessile excurrent siphon. Foot worm shaped with a disk shaped end. Faecal pellets grooved ribbon type.

Found attached to rocks, pillars or buried in soft or mixed sediment with byssus threads attached to sediment particles.

Widely distributed family, represented in cold seas as well as warmer waters.

Genus ***Modiolus*** Lamarck, 1799

Modiolus striatulus (Hanley, 1844)

Highly variable species shell elongately trapezoid and gibbous in the middle; sculpture with radiating ridges which are wider and more distinct on the anterior margin. Faecal pellet grooved ribbon type, longitudinally grooved and ridged.

Fig. 88. Exterior view of *Modiolus striatulus* (Hanley)

Fig. 89. Interior view of *Modiolus striatulus* (Hanley)

Occurs attached to rocks, stones, wooden jetties in submerged water.

Distribution : India : Andaman and Nicobar Islands, Kerala, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : China. Gulf of Thailand, Japan, Myanmar, Philippines, Singapore.

Order OSTREOIDA
Sub Order OSTREINA
Super family OSTREDIDEA
Family OSTREIDAE

True Oysters

Shell shape varied, generally subcircular to elongate oval, more or less equilateral but in some inequivalve the cemented left valve being more inflated. Sculpture with foliaceous lamellae, occasionally developed into hollow spines. Adductor muscle scar single situated

Fig. 90. *Crassostrea* sp. attached on a pillar of jetty at Gosaba.

off centre towards the posterior ventral edge. Hinge without teeth, but a variety of marginal ridges or pustules known as chomata present. Nodular chomata circular to oval, rounded denticle, postulose chomata like pin head, multiple over the inner margin, Variable in colour. Faecal Pellets grooved ribbon type, longitudinally grooved and ridged, bicrescentic in section.

Mostly estuarine, euryhaline and stenohaline. Sedentary and remain confined to the spot where the spat (juvenile) settles. Shape and sculpture resulted according to the nature of substratum and salinity.

Dioecious or hermaphrodite. But even when dioecious a certain percentage of its members change their sexes. Dispersal occurs chiefly through a planktonic larval phase. Fertilization external and development occurs in the estuaries.

Key to the genera

– Umbonal cavity deeper; chomata strong; conical rudistiform or cornupia like shape ..... *Saccostrea* Dollfus and Dautzenberg

– Umbonal cavity shallow, well developed in left valve; chomata absent; slender spatulate form ..... *Crassostrea* Sacco

Genus ***Crassostrea*** Sacco, 1897

Key to the species

– Shell more elongate; adductor muscle scar broad, more or less oblong .... *C. gryphoides* (Schlotheim)

– Shell subcircular to slightly elongate; adductor muscle scar semi lunar type .... *C. cuttackensis* (Newton and Smith)

Crassostrea cuttackensis (Newton and Smith, 1912)
Kausturi Jhinuk

Shell very heavy, bulky, irregularly subcircular to elongate. Sculpture smooth or weakly lamellate, without pustules. Nodular chomata present near the hinge, pustulose chomata often present in right valve. Externally whitish, internally lustrous white.

Fig. 91. Exterior view of *Crassostrea cuttackensis* (Newton and Smith)

Fig. 92. Interior view of *Crassostrea cuttackensis* (Newton and Smith)

Commonly occurs in Sundarbans, attached to lock gate, bricks and dykes, Pillars of jetties and also inside the river.

Distribution : India : Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Bangladesh, Malaysia, Indonesia, Myanmar, Philippines.

Crassostrea gryphoides (Schlotheim, 1813)
Kausturi Jhinuk

Shell irregular in shape, stout, bulky, elongate, inner margin pearly white; cavity beneath the hinge well marked; Muscle scars broad and more or less oblong striations present on the muscle scar.

Commonly occurs on the muddy substratum, canals of Sundarbans.

Distribution : India : West Bengal.

Elsewhere : Myanmar.

This species is considered as a fossil species by many authors. Newton and Smith (1912) collected this species and concluded that *C. gryphoides* was a Miocene species and this was supported by Brown (1924). Awati and Rai (1931) and Ahmed (1971) treated it as a living species. Subba Rao *et. al.* (1995) recorded the bed of living oysters in the canals of Bagna, Jhilla areas of Sundarbans. This is a commercially important species

Fig. 93. Exterior view of *Crassostrea gryphoides* (Schlotheim)

Fig. 94. Interior view of *Crassostrea gryphoides* (Schlotheim)

and huge number of dead and living shells are used as calcium resourcers in the poultry feed. At Canning a shell factory used about 100 to 150 tonnes/year of these shells, grind them into powder and send them to different places of West Bengal, where they used as calcium resources for preparation of poultry feed.

Fig. 95. Heap of Oyster shells at Canning shell factory.

Genus ***Saccostrea*** Dollfus & Dautzenberg, 1920

Saccostrea cucullata (Born, 1778)

Variable in shape, inequivalve, irregularly circular to oval, left valve more thick, deep and large than right valve sometimes cup like, sometimes flat; outer margin with a series of sharp folds which interlock with each other; sculpture of oppressed lamellae, some becoming spiny, other worn, smooth; muscle scars kidney shaped. Nodular chomata usually present around all margins. Colour whitish or greenish white, marked with deep purple towards the margins, muscle scars darker than surrounding shell area.

Fig. 96. Exterior view of *Saccostrea cucullata* (Born)

Fig. 97. Interior view of *Saccostrea cucullata* (Born)

Fig. 98. *Saccostrea cucullata* (Born) on a pillar of Jetty at Frasergunj.

Very common throughout Sundarbans. Found attached to wooden jetties, bricks, dykes, mangrove stems, wooden pillars and even to shells where an otherwise suitable substratum is not available.

Distribution : India : Throughout

Elsewhere : Indo-pacific.

Suborder PECTININA
Superfamily ANOMIOIDEA
Family ANOMIIDAE

Saddle Oysters

Shell irregular, circular to oval. True hinge teeth absent, but divergent umbonal ridges (crural teeth) may be present. Muscle scars distinct, best seen in the upper valve, consisting of a sub central adductor scar with one or more pedal and byssal retractor scars above it. Lower valve closely conforms to the substrate but is not cemented to it. Attachment is obtained by a plug like, calcified byssus which passes through a large notch in the lower valve. Sculpture rough, much coarse, irregular, inner smooth, may be glossy, lustrous. Faecal pellet ungrooved ribbon type. Colour variable.

Found attached to rocks, mangrove stems and other shells from mid tide line to inwards. *Enigmonia* species is a suspension feeder.

Genus ***Enigmonia*** Iredale, 1918

Enigmonia aenigmatica (Holten)

Fragile, thin shelled, inequivalve, almost round; purple coloured, right valve bigger than left; muscle scar well developed; adductor muscle single and smaller than byssal retractor, crurum oblique. Faecal pellet ungrooved ribbon type.

Fig. 99. Exterior view of *Enigmonia aenigmatica* (Holten)

Fig. 100. Interior view of *Enigmonia aenigmatica* (Holten)

Highly mobile saddle oyster actively crawling over the leavels of *Avicennia*. It also found attached on surface of mangrove (*Avicennia* and *Rhizophorus* spp.) trunks, pneumatophores and other hard substances by its right valves with byssus pad. However juveniles are able to detach and re attach themselves, thus allowing for migration from one place to another during high tide by crawling and passive drifting.

Abundant throughout Sundarbans.

Distribution : India : Maharashtra, Orissa, West Bengal.

Elsewhere : Bangladesh, Myanmar, Philippines, Singapore.

Subclass HETERODONTA
Order VENEROIDA
Superfamily SOLENOIDEA
Family SOLENIDAE

Razor clams

Shell thin, smooth, greatly elongate, cylindrical with wide gape at both the ends. Beaks more or less terminal. Hinge reduced with only a few cardinal teeth and behind them the external ligament. Sculpture smooth and covered by thin glossy periostracum. Siphons short. Pallial sinus shallow. Faecal pellet rod like form with definite linear segmentation.

Highly adapted for rapid burrowing into sand and mud.

Genus ***Solen*** Linnaeus, 1758

Solen brevis Gray, 1842

Shell flattened, almost straight, tapering slightly at posterior end; posterior margin sub truncate; anterior margin distinctly angled; sculpture with prominent growth lines. Posterior adductor scar relatively broad. Colour olive brown, white sharply tinged pink posterior to umbones.

Common in the mud of low tide onwards in different areas of Sundarbans, in the small creeks leading to the main rivers.

Distribution : India : Orissa, Tamil Nadu, West Bengal.

Fig. 101. Exterior and Interior view of *Solen brevis* Gray

Family CULTELLIDAE
Jack Knife Shells

Shell elongate, subcylindrical, smooth, glossy, thin with a gape at both the ends. Beak close to mid line. Ligament external. Hinge with only a few cardinal teeth, sometimes with small peg like cardinal. Cruciform muscle scars absent. In some species there is an additional internal radial rib running from the hinge towards the ventral margin. Siphons are short and the pallial sinus is correspondingly shallow. Faecal pellet ellipsoid type, elongate and elliptical in shape.

Key to the genera

– Shell thin, subcylindrical; hinge with two cardinals in right valve and three in left valve ..... *Pharella* Gray

– Shell thick, glauconomon shape; hinge with three cardinals in each valve ..... *Tanysiphon* Benson

Genus ***Pharella*** Gray, 1854

Pharella javanicus (Lamarck, 1818)

Shell thick, compressed, attenuated, anterior side short, narrow, with more gape and evenly rounded; posterior side oblique, broad, curved, slightly produced ventrally; ventral margin contracted in the middle; covered with thin, pale olive epidermis.

Fig. 102. Exterior and Interior view of *Pharella javanicus* (Lamarck)

Occurs in upper hard mudflats, where the *Sonneratia* plants are very common. They burrow and lie at a depth of 2-3 times than its body length. Externally the existence can be noticed by a distinct slit like shape of their burrows.

Fig. 103. Slit like opening of *Pharella javanicus* (Lamarck) on mud.

Distribution : India : Orissa, West Bengal.

Elsewhere : Indonesia, Java, Malaya, Pennag, Philippines, Singapore.

Genus ***Tanysiphon*** Benson, 1858

Tanysiphon rivalis Benson, 1858

Shell thin, small, oblong, transversely elongate, inequilateral, covered with yellowish or greenish yellowish periostracum; umbo elevated, slightly anterior; anterior margin rounded, posterior margin broad and truncated; ventral margin slightly convex. Muscle scars well developed. Pallial sinus larger.

Occurs in the muddy substratum of mangrove areas, prefers low salinity (upto 4.0 mg/l). Population density 80-90 nos/m^2.

Distribution : India : West Bengal.

Fig. 104. Exterior view of *Tanysiphon rivalis* Benson

Fig. 105. Interior view of *Tanysiphon rivalis* Benson

Superfamily TELLINOIDEA

Family TELLINIDAE

Tellin or Sunset shells

Shell small to large, compressed; usually ovate, sometimes orbicular or suborbicular, thin to heavy, posterior end usually twisted. Valves unequal, left slightly longer than the right valve. Sculpture varies. Umbos inflated, more or less pointed. Ligament external, opisthodetic. Cruciform muscle scars posterior. Byssal apparatus obsolete. Hinge with two cardinals, the left anterior and right posterior bifid. Lateral dentition present or absent. Adductor muscle scars varies. Pallial sinus large, ventral edge partly confluent with pallial line. Faecal pellet discoid type, discoidal and consists of compacted detritus.

Animal dioecious, mostly marine a few of them also abundant in the estuaries. Active sand burrowers with a large foot and long siphons, a few of them found in muddy areas of intertidal region.

Key to the genera

– Lateral teeth present at least in one of the valve; sculpture with oblique scissulations in both valves ..... *Strigilla* Anton

– Lateral teeth absent in either of the valve; sculpture with spaced growth lines and minute concentric striae ..... *Macoma* Leach

Genus ***Strigilla*** Turton, 1822

Strigilla splendida (Anton, 1833)

Shell orbicular, thin, delicate, inequivalve, the right more convex than the left valve. Colour varies, generally white with yellow or rosy suffused. Umbo acuminate. Ligament small, shrunken; lunule partly situated on the left valve. Cardinal complex with bifid anterior teeth in the left valve, and a thin anterior and bifid posterior on the right valve; laterals

Fig. 106. Exterior view of *Strigilla splendida* (Anton)

Fig. 107. Interior view of *Strigilla splendida* (Anton)

present. Sculpture with oblique scissulations on the posterior part of both the valves, anterior part with fine concentric striae. Muscle scar moderately impressed.

It is an estuarine species, abundantly occurs in the Hughly Matla estuary extends from far interior of the estuary, to river mouth near the confluence of the sea.

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, Orissa, West Bengal.

Elsewhere : Indonesia, Philippines.

Genus ***Macoma*** Leach, 1819

Macoma birmanica (Philippi, 1833)

Shell subovate, oblong, inequivalve, the left one heavy and more convex than the right valve; umbo posterior; sculpture with spaced growth lines and minute concentric striae; hinge with cardinal teeth only.

These clams are very common at Sundarbans detritus feeders and suck the mud, algae and organic matters by their long siphon (8 to 15 times more in length than body length).

Fig. 108. Exterior view of *Macoma birmanica* (Philippi)

Fig. 109. Interior view of *Macoma birmanica* (Philippi)

Found buried in the muddy substratum of Hughly-Matla estuary, generally at depths twice the shell length, but often burrows deeper than that. The siphon orange in colour, extends to 0.7 to 1.00 meter (8 to 15 times the shell length). Youngones observed from July to November at 4-5 nos/m^2.

Distribution : India : Andhra Pradesh, Orissa, West Bengal.

Elsewhere : Myanmar.

Family SEMELIDAE

Shell trigonal, elongate or trapezoidal in shape, sometimes with irregular outline, compressed, thin or thick. Ligament both external and internal. Resilium sunken or lodged in small chondrophore. Sculpture divaricating or with concentric striae, in some cases with radial also or oblique. Hinge typically with two cardinal teeth in each valve but laterals may or may not be present. Pallial sinus large rounded. Cruciform muscle scars close to the ventral extremity of the pallial sinus. Siphons are typically very long and the pallial sinus correspondingly deep. Faecal pellet either discoid, ovoid or ellipsoid type.

Deposit feeders, wide range of habitats from littoral mobile sand to deep transquill mud. Active borrowers living at regulating deep levels within the substrate.

Genus ***Theora*** H. & A.Adams, 1858

Theora opalina (Hinds, 1843)

Fig. 110. Exterior and Interior view of *Theora opalina* (Hinds)

Shell thin, fragile, umbo anterior, acuminate; creamy white; anterior dorsal straight and gradually sloped, oposterior dorsal straight; sculpture smooth or with fine concentric striae; muscle scars well developed.

Occurs on the muddy banks of creeks of mangrove area with preference of salinity (upto 12.0 mg/L). Subba Rao *et al.*, (1983) studies the population in Muriganga estuary and found 1.6-10 no's/m^2

Distribution : India : Kerala, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Indonesia, Molucca, Philippines.

Superfamily ARCTICOIDEA

Family TRAPEZIIDAE

Shell moderate, ovate to subtrapezoidal. Sculpture consisting of coarse concentric growth lines and radial riblets. Beak anterior. Ligament external. Hinge with two cardinal teeth and anterior and posterior lateral teeth. Internal margin smooth. Pallial line usually entire, without sinus. Colour uniformly white or yellow.

Common in Tropical and Subtropical seas, primarily byssate nestling forms living in the crevices or beneath coral debris and rocks.

Genus ***Trapezium*** Megerle von Muehlfeld, 1811

Trapezium sublaevigatum (Lamarck, 1819)

Shell oblong; umbo small and anterior; periostracum greenish brown; dorsal margin sloping towards the posterior; ventral margin straight; anterior rapidly sloped; posterior produced; obtusely rounded.

Fig. 111. Exterior view of *Trapezium sublaevigatum* (Lamarck)

Fig. 112. Interior view of *Trapezium sublaevigatum* (Lamarck)

Occurs in the empty holes of pneumatophores of *Avicennia* plant to which they attach with the byssus threads.

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, Gujarat, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Indo-pacific.

Superfamily CORBICULOIDEA

Family CORBICULIDAE

Shell rounded-trigonal to oval, thick, strong fibrous periostracum. Sculpture concentrically striated or ribbed. Hinge with three cardinal teeth in each valve and one or two laterals. Ligament strong, external. Pallial sinus absent or shallow if present. Colour yellow, green or brown, internally whitish.

Foot large, siphonal opening prolonged into small tubes, orifices with or without papillae, Gills two pairs, outer pair smaller than the inner, the later serving as brood pouch. Faecal pellet simplest being a plain rod rounded in section.

Inhabitant of freshwater extending to brackish water.

Genus ***Polymesoda*** Rafinesque, 1828

Polymesoda bengalensis (Lamarck, 1818)

Shell large, solid, subtrigonal, tumid, thick, roughly striate; dorsal margin rather angulated; posterior margin abruptly sloping; anterior slope rather concave. Periostracum blackish

brown. Umbo elevated and anterior. Cardinal and lateral teeth well developed. Muscle scars impressed, anterior adductor scar elongated; posterior adductor scar, broad, oval.

Fig. 113. Exterior view of *Polymesoda bengalensis* (Lamarck)

Fig. 114. Interior view of *Polymesoda bengalensis* (Lamarck)

Found buried in stiff mud of the mangroves areas, well adapted to the habitat, being able to tolerate long periods of low tide, and has the ability to resume filter feeding rapidly when inundated.

Distribution : India : Andaman and Nicobar Islands, West Bengal (Gangetic delta).

Elsewhere : Myanmar (Irrawaddy deltas) and Western Coast of Thailand.

Superfamily VENEROIDEA

Family VENERIDAE

Venus clams

Shell small to large, orbicular to elongate, trigonal, tumid, solid and inequilateral. Sculpture with concentric or lamellate ridges and occasionally cancellating radial striae. Hinge with strong and well developed teeth, typically three cardinals in each valves with anterior lateral teeth, but laterals may be absent in many cases. Beak anterior. Ligament short and external placed in a prominent nymph. Adductor muscle scars are equal or subequal. Pallial line with distinct sinus. Inner margin smooth or finely crenulated. Foot hatchet shaped. Siphons very short to moderately long. Intertidal. Inhabit wide variety of substrates but are most often an important part of the fauna of sand flat and the more consolidated sediments offshore. Faecal pellets plain rod like.

Tropical species lives in clean coral sand and muddy sand localities. Found in all seas. Animal burrows but not deeply into the sand. Moves freely by means of flattened tongue shaped foot.

Key to the genera

– Shell ovately trigonal; sculpture with concentric striae ..... *Pelecyora* Dall

– Shell subovate to subcircular; sculpture with growth lines only.....*Meretrix* Lamarck

Genus ***Pelecyora*** Dall, 1902

Pelecyora trigona (Reeve, 1850)

Shell triangularly ovate, thick; umbone pointed and curved; sculpture with concentric striae, strong at the ventral margin. Ligament small. Lunule large, superficial, almost obsolete. White in colour or with some tinge of rust brown.

Fig. 115. Exterior and Interior view of *Pelecyora trigona* (Reeve)

Commonly found in the muddy canals. Populations vary from 1-2 nos/m^2 to 106-108 nos/m^2. Maximum population recorded during the month of March.

Distribution : India : Kerala, Orissa, West Bengal.

Elsewhere : Red Sea.

Genus ***Meretrix*** Lamarck, 1799

Meretrix meretrix (Linnaeus, 1758)
Jat Jhinuk

Shell large, heavy, thick, ventricose; umbo pointed, elevated and slightly anterior in position; anterior margin rounded, ventral margin convex, posterior margin angulated; sculpture with concentric growth lines; anterior adductor scar elongately ovate, posterior adductor scar broader posteriorly and pointed anteriorly; pallial sinus shallow. Posterior lateral teeth in the left valve and corresponding depression in the right valve are finely

Fig. 116. Exterior view of *Meretrix meretrix* (Linnaeus)

Fig. 117. Interior view of *Meretrix meretrix* (Linnaeus)

denticulate or striate. It is highly variable in colour and shape which leads to description of several varities.

Distribution : India : Commonly occurs in river mouths and backwaters of east and west coast.

Elsewhere : Aden, Borneo, China, Japan, Java, Myanmar, Philippines. Red sea, Sri Lanka, Sumatra.

Fig. 118. Heap of *Meretrix* shells at Chandipur collected for making poultry feed

This is commercially important species of Sundarbans. Tonnes of shells of this species were collected from the mud and river mouth and brought different places of West Bengal and used as poultry feed after crushing them into powder. About 1200 tonnes of shells are crushed annually (Bojan, 1984).

Family GLAUCONOMIDAE

Shell elongate, smooth or wrinkled with conspicuous periostracum. Ligament external, opisthodetic. Sculpture patterns are primarily concentric throughout. Hinge with three cardinal teeth in either valve, laterals wanting. Adductor scars are equal or subequal in size. Periostracum light to dark green.

Typical mud living form, common in intertidal zone burrowing, posseses a large hatchet shaped foot. Lives superficially and so the siphons are short.

Reported from Indo-pacific region only.

Genus ***Glauconome*** Gray, 1828

Glauconome sculpta (Sowerby, 1894)

Elongate, oblong shell with short anterior end and angularly attenuated posterior end; sculpture with fine concentric striae and growth lines but eroded at the umbonal region; light greenish straw in colour.

Fig. 119. Exterior view of *Glauconome sculpta* (Sowerby)

Fig. 120. Interior view of *Glauconome sculpta* (Sowerby)

Occurs in the burrow of hard muddy inter tidal substrate and their presence inside can be made out by the comb like appearance of holes in the area. It has a long fused siphons that content its filter feeding apparatus with the out side world, Population density varies from 12 to 503 no's/m^2 in different parts of Sundarbans.

Distribution : India : Orissa, West Bengal.

Elsewhere : Bay of Bengal.

Order MYOIDA
SubOrder PHOLADINA
Superfamily PHOLADOIDEA
Family PHOLADIDAE
Pholads or Piddocks

Shell small to large, subovate to sublong, thin or moderately heavy with a wide anterior gape and a large posterior gape; anterior gape sometimes closed by calcareous plate

called callum. Sculpture with concentric lamellae towards anterior part. Umbonal area bears reflected ridge and radial cords and in some cases a sulcus extending from the beak to ventral margin. Hinge without teeth or ligament. but has 1 to 3 shelly plates on the dorsal margin known as protoplax, mesoplax and metaplax. Anterior and posterior adductor scars present in some cases a ventral adductor scar also present. Pallial line occasionally with a definite sinus. Faecal pellets discoid with a single spiral cord.

Animals are adopted for boring into hard wood, soft rocks, corals, clay and shells of other molluscs, certain species have proved to be as destructive as in the Teredinids and caused a considerable damage toward water front sometimes concrete pillars, jetties etc.

Genus ***Barnea*** Leach in Risso, 1828

Barnea candida (Linnaeus, 1758)

Shell subventricose, thin, divided into two or more areas the anterior slope usually having a sculpture of toothed concentric lamellae, which acts as a rasp when making boring movements. Unbonal region bears reflected ridges. Hinge tooth less and the small ligament is supported by a chondrophore, projecting from the umbonal cavity is a long calcareous process called apophysis to which pedal retracts are attached. Protoplax anterior to the beak lies over and protects the anterior adductor muscle. Mesoplax lies over the beaks themselves and the metaplax posterior to them covers the posterior dorsal gape. A fourth plate hypoplax may be present to cover the posterior ventral gape. Sculpture with strong concentric ridges, but less prominent on the anterior part; radial ribs almost through out the body except a small portion of anterior end.

Fig 121. Exterior view of *Barnea candida* (Linnaeus)

Fig 122. Interior view of *Barnea candida* (Linnaeus)

Occurs in the burrows of hard muddy inter tidal substrate along with *Glauconome sculpta* in different areas of Sundarbans.

Distribution : India : Maharashtra, Orissa, West Bengal.

Elsewhere : Atlantic and Indo-pacifc.

Family TEREDINIDAE
Shipworms/Nonapoka

The family includes Shipworms, are highly specialized bivalves adapting for boring into wood. They are most closely resemble to Pholadidae (Piddocks), The important characteristic of this group are closed mantle; foot discoid truncated; hinge greatly reduced; a small internal ligament; small anterior muscle and a large strong posterior adductor muscle. The anterior adductor muscle is protected by the cephalic hood. Shells have a large pedal gape. Sculptured with anterior slope and pronounced dorsal and ventral condyle. Stylloid apophyses extend from beneath the umbo for attachment of foot muscles.

Body worm like, shell greatly reduced, with pallets, spcialised organs located at the base of siphon close the burrow when the siphons are withdrawn. Siphons relatively short, united or separated and protrude through the minute opening of burrow into the water for respiration and feeding.

Shell hemispherical, with a deep right angled notch in the ventral half of the anterior margin. Parallel to edge of notch the exterior surface of each valve sculptured with fine ridges, appear as rows of minute teeth used for rasping. Foot large muscular, protruded through the gape, circular, truncated and acts as a suction disc to hold the valves tightly when burrow. The anterior muscle contracts during boring, bringing the anterior end of the valves together and spreading the posterior ends. The foot is firmly attached to end

Fig. 123. Mangrove stem infested by *Terodo* sp.

of burrow and the valves are drawn as far forward as possible, bringing the denticles hard against the wood. The forceful contraction of posterior adductor muscle, spreads the valves anteriorly and the denticles scrape against the wood with sufficient force to rasp off fine particles. The alternating rhythmic contraction and relaxation of the anterior and posterior adductor muscles repeated many times before the animal rests. The large posterior adductor muscle supplies the force for boring and the shell act as a tool with which it works.

The surface of foot and mantle has ciliary tracts which carried the fine particles of wood into the mantle cavity and the mouth. They are finally extruded through the excurrent siphon after passing through the digestive tract. The extent of which the wood can be utilized as food probably varies with the species.

Shipworms invade a new wood during short free swimming larval period. The initial entrance hole extremely small and is normally only slightly enlarged throughout the life of the animal. Consequently, the damage which they do often go undetected until the interior is nearly or completely destroyed and the wood disintegrates. It is for this reason that they are referred as "termites of the Sea" As agents in the reduction of wood and its constituent elements they serve a useful purpose, but when they attack man's handiwork they become an important economic problem.

Temperature, Salinity, presence of wood are the main factors for the distribution of shipworms. Other hand factors such as strong current, tides, pollution, turbidity and bottom fouling communities are also involved, but these are often difficult to detect and are usually local in effect.

In Sundarbans several species of trees in living condition and also dead stumps are attacked by the shipworms, commonly known as "nonapoka" Generally where the mangroves are submerged by the spring tides the submerged portions of the trees are subject to serious boring of trunks, especially at the base (2 to 3 feet of the trunk above ground level and 2 feet or more of the tap root below ground level) by the shipworms. Occasionally the whole trunk and main branches for a length of upto 20 feet get bored, but this evidently happens in bent trees where the branches also get submerged beneath the water during the spring tides. The tree becomes hollow at the base due to attack of the shipworm and breaks the base even though the upper portion may be alive. These shipworms are serious pest of mangrove forest all over the Sundarbans causing serious damage of the different mangrove plants like Baen (*Avicennia officinalis* Linnaeus, *A. alba* Blume), Goran (*Ceriops roxburghiana* Linnaeus), Genwa (*Excoecaria agallocha* Linnaeus), Keora (*Sonneratia apetala* Ham), Khalsi (*Aegiceras* sp.), Sundri (*Heritiera minor* Roxb), Satari (*Aegialitis rotundifolia* Roxb), Garjan (*Rhizophora conjugata* Linnaeus).

About 35 species are reported from Indo-pacific region and 23 from India, out of which only 6 species are reported from mangrove swamp of Sundarbans.

Key to the genera

1. Pallets with broadly oval to greatly elongate blade, composed of segments built on stalk which extends the length of the blade; segmented ..... (2)

– Pallets variable in shape, not segmented ..... (3)

2. Pallet with elongate blade; segments separated as distinct cones ..... *Bankia* Gray

– Pallet with broadly oval or elongate blade, segments fused, sometimes with a papillose calcareous incrustation on the distal end ..... *Nausitora* Wright

3. Blade composed of basal cup with an inner element protruding or second medially divided cup inserted ..... *Dicyathifer* Iredale

– Blade composed of single piece (Basal cup with dagger like extension) .... *Bactronophorus* Tapparone–Canefri

Genus ***Bactronophorus*** Tapparone-Canefri, 1877

Bactronophorus thoracites (Gould, 1856)

Fig. 124. *Bactronophorus thoracites* (Gould)

Dorsal portion of anterior slope of adult with the disc and the posterior lobe appear eroded; internally the auricles form a shelf where the disc overlaps; apophyses arising from shelf at the junction of slope and disc. Pallet asymmetric, corneous, basal portion of blade almost triangular in out line with a shallow cup form, postulose, dagger like extension.

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Indo-pacifc.

Genus ***Dicyathifer*** Iredale, 1932

Dicyathifer manni (Wright, 1866)

Shell triangular with a broad dorsal margin, anterior lobe varies in size and ridges; anterior portion of the disc well developed with narrow median and posterior portion. Pallets large, heavy, calcareous and almost triangular in shape. The blade has flat inner face with convex outer face, outer margin of blade U shaped, and inner margin straight as slightly curved.

Fig. 125. *Dicyathifer manni* (Wright)

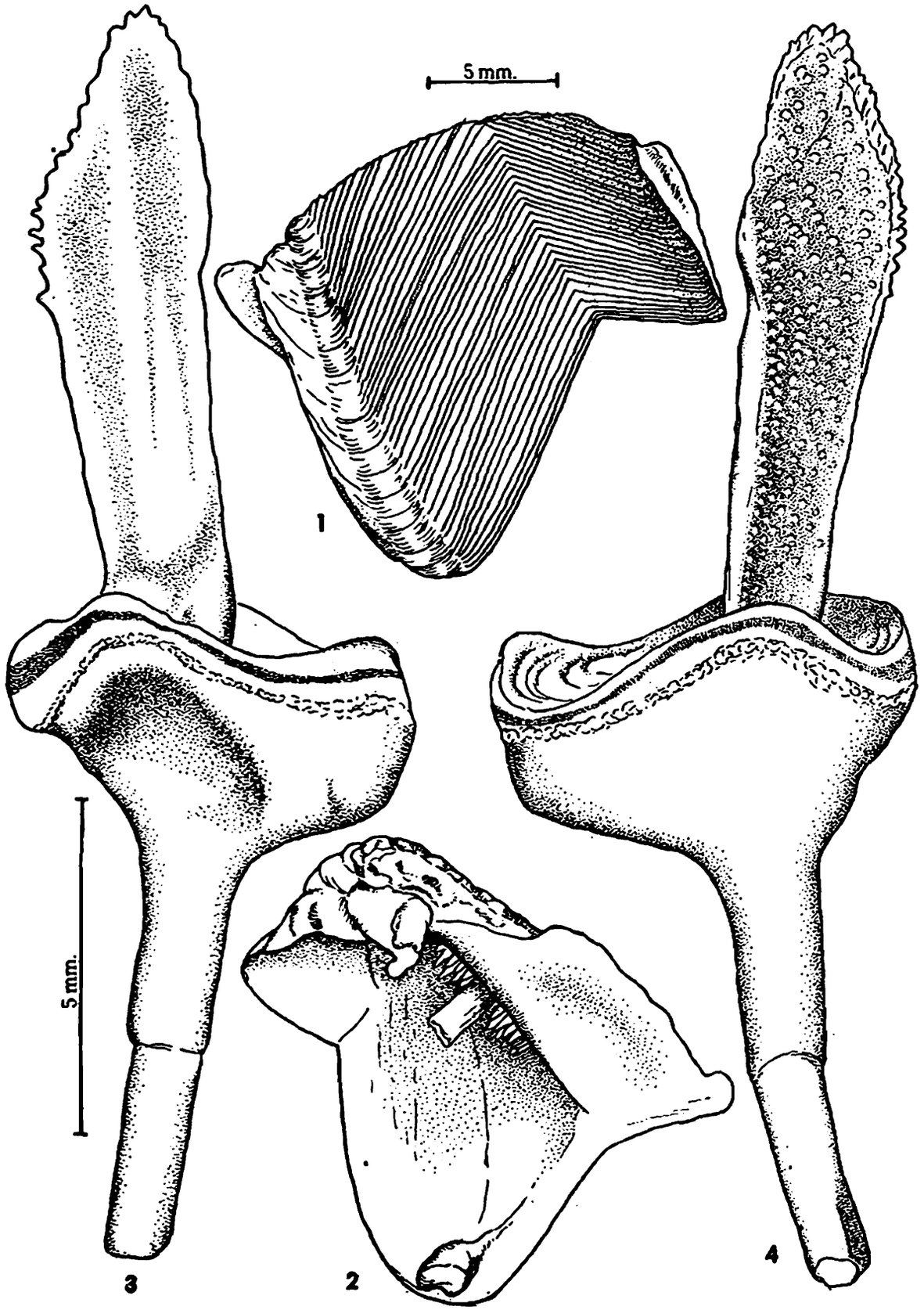


Fig. 126. Pallet of *Bactronophorus thoracites* (Gould)
1. Outer view of shell; 2. Inner view of shell; 3. Inner face of pallet; 4. Outer face of pallet.

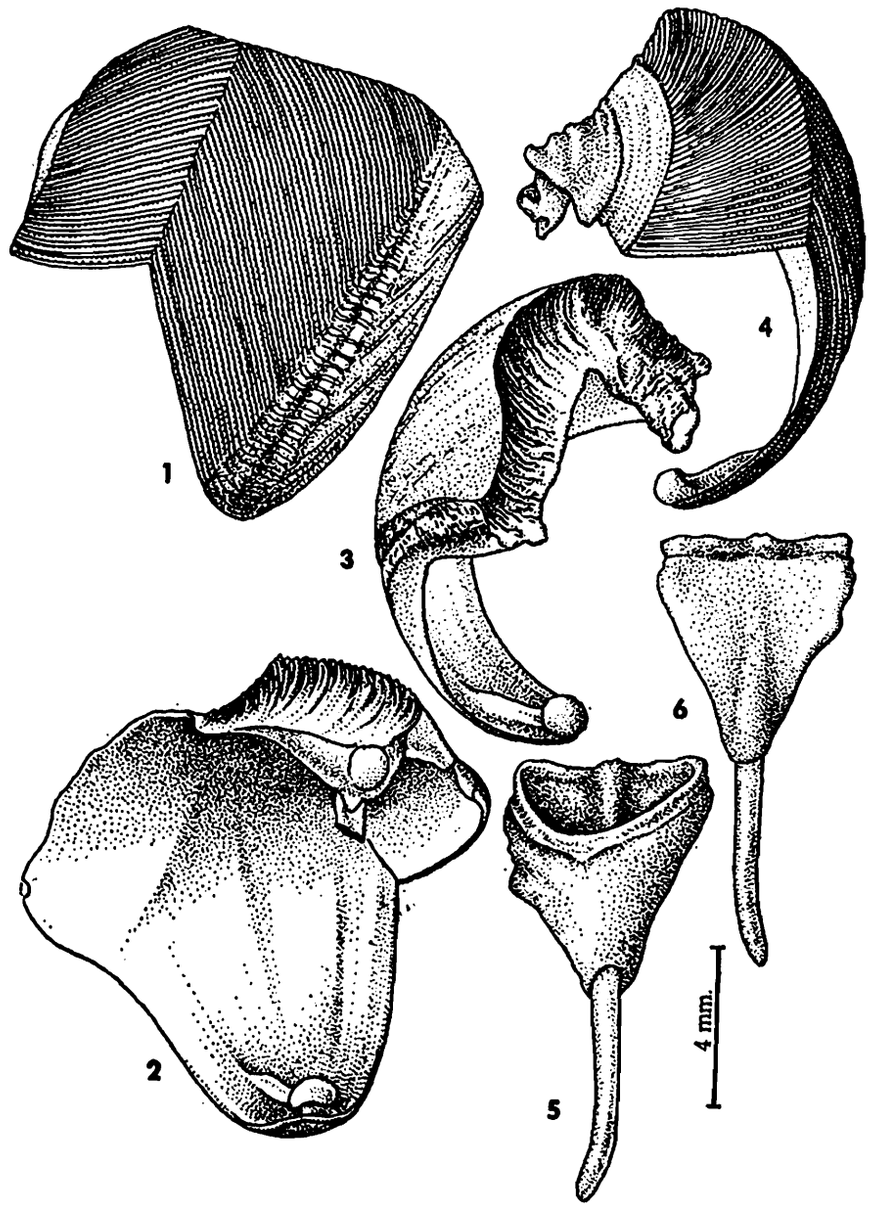


Fig. 127. Pallet of *Dicyathifer manni* (Wright)
1. Outer view of shell; 2. Inner view of shell; 3. Posterior view of shell; 4. Anterior view of shell; 5. Outer face of pallet; 6. Inner face of pallet.

Genus ***Bankia*** Gray, 1842

Key to the species

1. Margin of cups on pallet dentate ..... (2)
– Margin of cups on pallet not dentate ..... *B. campenellata* Moll and Roch
2. Cups not so compact; awns extended on its sides ..... *B. rochi* Moll
– Cups compactly arranged; awns not extended on its sides ..... *B. nordi* Moll

Bankia campanellata Moll and Roch, 1931

Shell ridge extended from umbo to ventral margin and also from anterior disc; auricle well developed; apophysis blade like; curved; pallets with a series of spaced cones, calcareous portion of cone funnel shaped, periostracal margin wide, flattened and bell shaped with a central notch in the margin of outer surface.

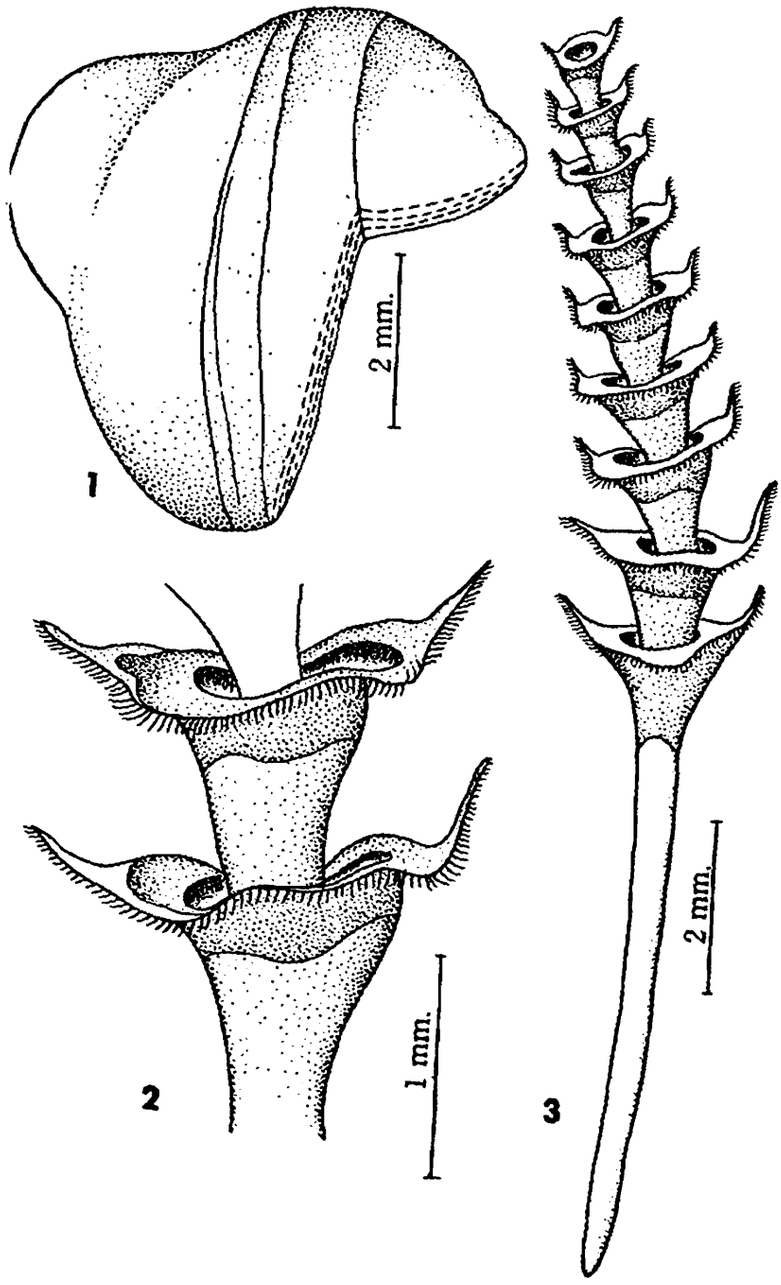


Fig. 128. Pallet of *Bankia campanellata* Moll and Roch
1. Outer view of shell; 2. Enlargement of cones; 3. Outer face of pallet.

Distribution : India : Andhra Pradesh, Orissa, Tamil Nadu, West Bengal (Sundarbans); *Elsewhere* : Indo-pacifc.

Fig. 129. *Bankia campanellata* Moll and Roch

Fig. 130. *Bankia nordi* Moll

Bankia nordi Moll, 1935

Shell globular and translucent; auricle fairly large, pallets elongate, solid with a short cylindrical stalk and a long blade, also with a series of transverse v shaped imbrications covered by golden brown periostracum; lateral margin of cones more or less fused.

Distribution : India : Andhra Pradesh, Karnataka, West Bengal.

Elsewhere : Indo-pecific.

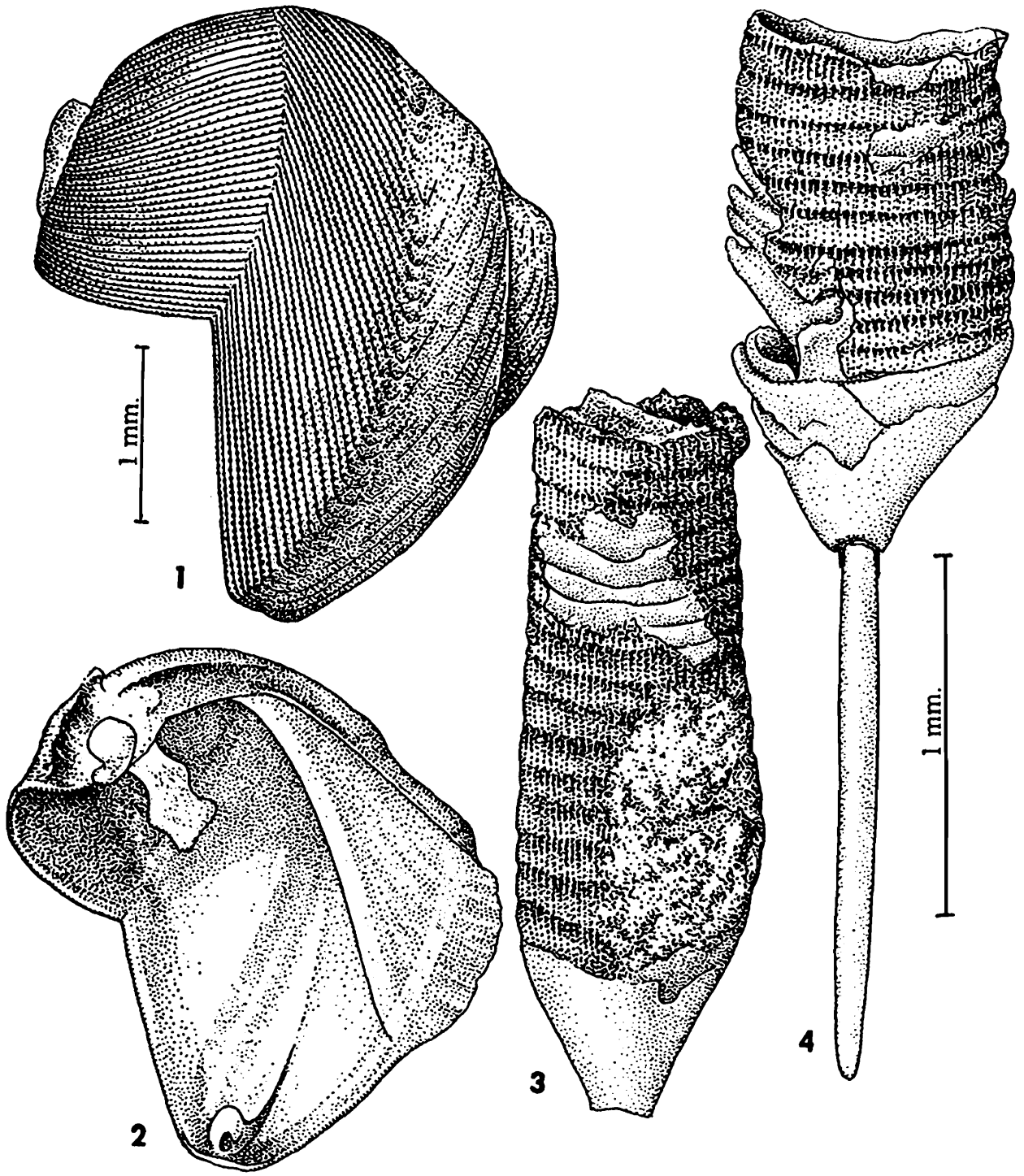


Fig. 131. Pallet of *Bankia nordi* Moll

1. Outer view of shell 2. Inner view of shell 3.& 4. Outer face of two fragments of pallet.

Bankia rochi Moll, 1931

Shell small to medium disc well marked, ribs on anterior lobe close with coarse sculpture; pallets with a series of cones arranged on central disc; calcareous portion u shaped and

Fig. 132. *Bankia rochi* Moll

covered by periostracum and the margin with comb like striation in both faces; stalk long and cylindrical.

Distribution : India : Andaman Islands, Maharashtra, Orissa, West Bengal (Sundarbans).

Elsewhere : Indo-pacifc.

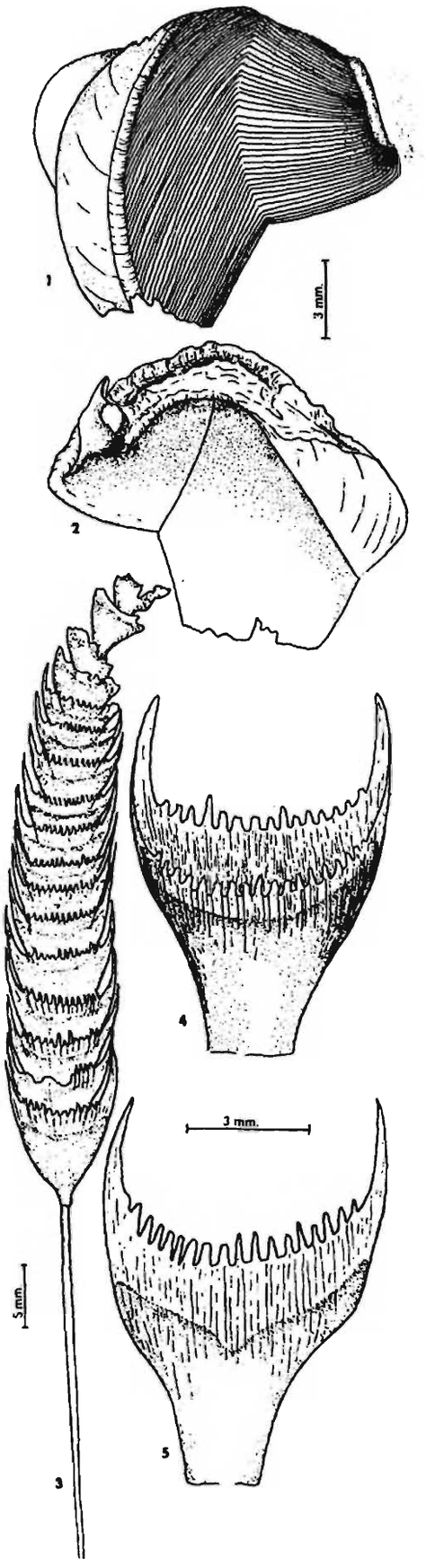


Fig. 133. Pallet of *Bankia rochi* Moll
1. Outer view of shell
2. Inner view of shell
3. Outer face of pallet
4. Outer face of enlarged cone
5. Inner face of enlarged cone

Fig. 134. *Nausitora dunlopei* Wright

Genus ***Nausitora*** Wright, 1884

Nausitora dunlopei Wright, 1884

Shell large; anterior slope extend upto half of ventral margin; broad anterior disc; sculptured with coarsely denticulate ridges; median and posterior disc narrow; auricle greatly reduced; apophyses flattened, umbonal area broad, condyles well developed pallets symmetric with broad, smooth basal portion; blades often covered with periostracum; upper portion of blade composed of fuse close set, eroded cones; lips of the pallets pustulate; inner face of the cones distally marked; upper cones more or less fused.

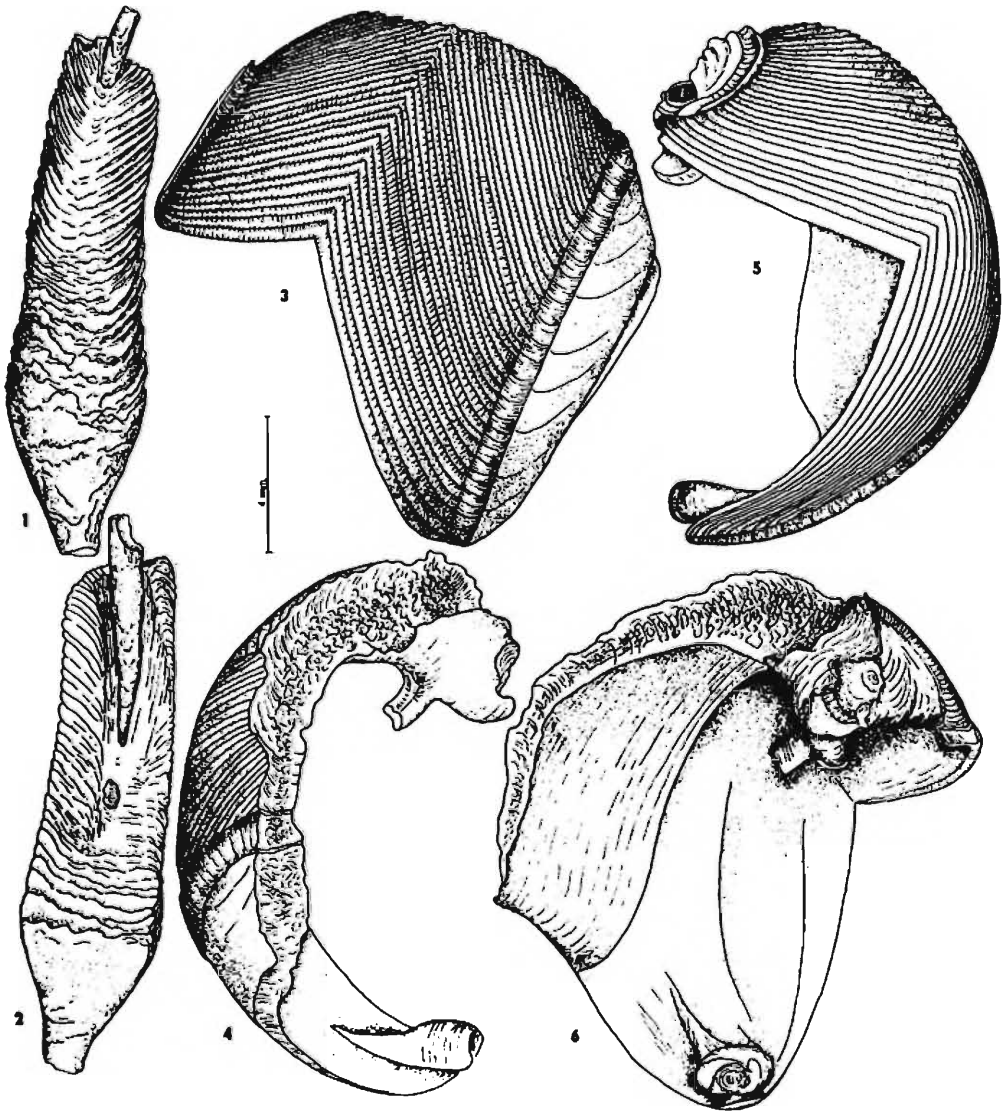


Fig. 135. Pallet of *Nausitora dunlopei* Wright

1. Outer face of pallet; 2. Inner face of pallet; 3. Outer view of shell; 4. Posterior view of shell; 5. Anterior view of shell; 6. Inner view of shell.

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, Orissa, Tamil Nadu, West Bengal (Sundarbans).

Elsewhere : Indo-pacifc.

Subclass ANOMALODESMATA
Order PHOLADOMYOIDA
Superfamily PANDOROIDEA
Family LATERNULIDAE
Lantern shells

Shell thin, fragile and oblong. True hinge teeth lacking. Ligament lies on a projecting internal chondrophore supported by two buttresses. A distinct split in the shell from the umbo is ventrally seen. Faecal pellets short rod with irregular out line.

Typical mud living forms burrows deeply in mud or sandy mud from the intertidal zone downwards.

Genus ***Laternula*** Roeding, 1798

Laternula truncata (Lamarck, 1818)

Shell thin, fragile, oblong, elongate, white in color with reddish brown out lines; umbo anterior; anterior dorsal straight and posterior dorsal concave; ventral margin almost straight; anterior end rounded straight square; posterior end with large gape. Hermaphrodite.

Occurs buried in mud with only their camouflaged siphons protruding. Instead of using the resilience of its ligament as the opposing force to the action of adductor muscle as in most bivalves the flexibility of the shell is utilized to aid shell movement and water flow.

Distribution : India : Orissa, West Bengal (Sundarbans).

Elsewhere : Indian ocean Islands, Japan, Philippines.

Fig. 136. Exterior and Interior view of *Laternula truncata* (Lamarck)

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INDEX