
BIODIVERSITY

Biodiversity is usually defined at different levels i.e. genetic, species, population and ecosystem levels. The biodiversity component of tropical estuary can refer to the high diversity of species, life histories, habitats and links in food webs or the diverse pathways of the energy flows and nutrient cycle that couples terrestrial and marine ecosystems at the land sea interface. Mangrove vegetation dominates the intertidal zone of tropical deltas, lagoons, estuarine coastal systems that has significant inputs of terrigenous sediments.

Although, there are relatively few mangrove species, the biodiversity components of the mangrove ecosystems are unique and quite extensive because they include structural niches, food, feed and protection to numerous invertebrates and vertebrate species. Apart from the variety of other functions, the most dominant and important ecological function of mangroves is the maintenance of near shore marine habitats. These multiple functions of mangrove ecosystems results in the extremely high primary and secondary productivity of the tropical estuaries.

FLORAL DIVERSITY

Mangroves

Mangroves are rich in genetic diversity due to the occurrence of both terrestrial and aquatic species and their adaptability to withstand wide range of salinities, tidal amplitude, winds, temperatures, muddy and an aerobic soil conditions. About 56 % of the world's mangroves species occur in India, with associated species having 30 tree species, 24 shrubs, 18 herbs, six climbers, four grasses and four epiphytes. Their species diversity is highest in Orissa (101 species) followed by West Bengal (92 species), Andaman and Nicobar group of Islands (91 species) and lowest in Gujarat (40 species).

Mangrove forest ecosystem supports diverse group of organisms with a total of 4011 that includes 920 floral species and 3091 faunal species, perhaps largest biodiversity recorded in the world mangrove ecosystem. No other countries in the world recorded so many species present in the mangrove ecosystem with faunal species component 3.5 times greater than the floral component in mangrove ecosystem. There are number of components in mangrove ecosystem that interact within themselves and physical factors of the environment at different levels to produce very productive, self-sustaining, self-repairing, a unique and dynamic ecosystem.

Mangroves form very important part of the marine food chain. Their growth and survival are necessary in sustaining the life of all other organisms that live in the mangroves. Mangroves provide a variety of food for microorganisms, crustaceans, mollusks, fishes and higher animals and provide a refuge from predators for many species. Many commercial and non-commercial fish and prawn species breed, feed and live in mangroves. Tides and currents exchange nutrients with mangroves, enriching nearby ecosystems such as seagrass beds, seaweeds, coral reefs etc.

Microorganisms

The free living bacteria, fungi and yeasts were reported to have significant role in formation of detritus in the mangrove ecosystems. Various groups of bacteria and fungi like nitrogen fixer, phosphate solubilizes, cellulose decomposers, nitrifies and denitrifies, sulphur oxidizers, iron oxidizers and iron reducers were prevalent in this ecosystem. The phenolic compounds produced by bacteria during decomposition process favour the growth of heterotrophic bacteria and yeast. N_2 - fixing bacteria from mangrove swamps of the Sundarbans and phosphate

solubilizing bacteria from Vellar estuary at Parangipettai in the southeastern coast and the sulfate reducing bacteria have been documented from mangroves of Goa.

Role of the fungi in mangrove was well known which was presumably similar to that of other forest and swamp ecosystems. Mangrove fungi decompose vegetative materials and thereby allow colonization by bacteria and yeasts that further decompose the organic matter. The phylogenetic and functional description of microbial diversity in the mangrove ecosystem has not been well addressed to the same extent as that of the other environments.

There are different types of faunal communities in mangrove swamps which are dependent on the water component in one way or the other. The planktonic and benthic animal communities also play a very important role in the mangrove ecosystem just like the terrestrial animals. Analysis of microbial biodiversity from these ecosystems will help in isolating and identifying new and potential microorganisms having high specificity for various biotechnological applications.

Algae

Algae play a vital role in mangrove community food webs. Many estuarine and marine organisms feed directly on micro and macro-algae that thrive within mangrove communities. Micro-algae are important in mangrove ecosystems. They are epiphytic and grow on the aerial roots of the trees and on the sediments. The aerial and underground root systems of mangrove trees provide a hard substrate for the attachment of epiphytic algae such as diatoms and blue-green algae (Cyanobacteria).

Diatoms are the best represented division, as this group comprises 73% of the micro-algal composition. The most common genera are *Coscinodiscus*, *Cyclotella*, *Flagilaria*, *Gyrosigma*, *Navicula*, *Nitzschia* etc. Diatoms are generally known as one of the important bioindicators for assessing the quality of the water, particularly organic pollution and they can also be used to indicate the health level of aquatic ecosystems.

Cyanobacteria, a group of photosynthetic prokaryotes, are vital component of the micro biota

ranging from unicellular colonial to filamentous, a contributing source of nitrogen in every mangrove ecosystems. This is one of the ignored groups where only a very few studies have been conducted. The studies on cyanobacteria associated with mangroves are very important not only because of their abundance, but also of their high capability for nitrogen fixation, which are natural candidates for future reforestation and rehabilitation of degraded mangroves.

Division *Cyanophyta*, also known as blue-green algae, comprised 17% of the microalgal composition. Out of five genera recorded from this division, two of them namely *Anabaena* and *Oscillatoria* can be used as bio-indicator of the health status of the aquatic ecosystem. These two genera can also be related to eutrophic and polluted waters. In addition, the occurrence of the genus *Oscillatoria* is related to phosphate and nitrate enrichment of the area.

Seaweeds

Mangrove associated macro algae (seaweeds) are represented by a specialized group of plants occurring as epiphytes on the stems and roots of mangrove trees or growing on other substrata within the mangrove ecosystem. The genus *Bostrychia* in association with *Caloglossa*, *Catenella* etc. are found in mangroves of the west coast of India.

The small and inconspicuous size of mangrove associated algae, coupled with a lack of understanding of their role in the mangrove ecosystem may be a reason why they are frequently overlooked when mangrove flora assessments are undertaken. They are the main food source for a variety of fishes and invertebrates. Some algae are unique to certain mangrove habitats and an understanding of their diversity and biomass may indicate the health of mangroves.

Other red algae found in the mangroves belong to the genera *Laurencia*, *Gracilaria*, *Hypnea*, *Centroceras*, and *Polysiphonia*. The muddy mangrove areas are the habitats of green algae of the genera *Enteromorpha*, *Cladophora*, *Rhizoclonium*, *Bryopsis*, *Ulva*, *Monostroma*, *Avrainvilles*, *Caulerpa*, brown algal genera like *Ectocarpus*, *Hydroclathratus*, *Dictyota* and *Padina* etc. These seaweeds grow on mud flats by attaching

themselves to polychaete tubes, broken shells, stones, pebbles or any other material that get embedded in the mud.

Phaeophyta members were found to be few in mangroves; however, species of *Hydroclathrus clathratus*, *Padina tetrastromatica*, *Dyctyota* spp., *Sphacelaria furcigera* occur in many mangrove areas along the west coast of India. The high number of Chlorophyta species in mangrove may be attributed to the presence of domestic and industrial effluent.

The typical *Bostrychia* and *Caloglossa* algal community was observed only from *Bruguiera gymnorhiza* dominated site which also contains the highest diversity of species.

Sea grasses

Sea grasses are flowering plants (angiosperms) that live submerged in saltwater. They look a lot like grasses on land, but are not closely related to them. Like flowering plants on land, sea grasses have true roots, stems, and leaves. Sea grass beds are an important source of food and also provide shelter for animals like fish and crabs. Many fish species use these seagrass beds as nursery grounds. Sea grasses improve water quality because they can slow down the current, which helps fine sand particles to settle. Their dense roots systems help stabilize shorelines.

Many animals use mangroves, sea grasses and coral reefs, any two or all of these different habitats, at least for part of their life cycle and nutrients and organic material flow in and out of these systems as well. For example, when mangrove leaves, wood, and propagules fall in the water, bacteria and fungi in the water break down this plant material and make the nutrients that was stored in it available to be used by other animals and plants, such as algae and sea grasses, which, in turn, can be eaten by animals like snails, fish and turtles. The dead plant material will also be eaten by small shrimp or insects, which, in turn, will also be eaten by larger animals like fish.

Sea grasses and coral reefs are very important for the health of the mangrove ecosystem, and the other way around. Sea grasses help mangroves by slowing down the

ocean current, allowing the sediment to settle, and providing a calm spot for new mangroves to settle. Mangroves, in turn, help by filtering out potentially harmful excess nutrients before they reach the sea grasses and coral reefs.

The major sea grass beds in India are found in southern coast, Lakshadweep and Andaman group of islands. Out of 14 sea grass species reported from Indian coast, only 8 species have been reported from the west coast and that to are from Lakshadweep, while, only 4 species from rest of the west coast of India.

A patchy distribution of sea grass *Halophila beccarii* has been observed in the mudflats of Mandovi, Zuari, Chapora and Terekhol estuaries. This species was found to grow throughout the year in Terekhol estuary. *Halophila ovalis*, is found growing in the sub littoral swamps of Mandovi, and Chapora estuary, get exposed during low tide. This species grow during pre and post monsoon and disappears during monsoon months. The disappearance during monsoon months could be due to fresh water influx (decrease in salinity), disturbance due to erosion and turbidity of the water, a typical monsoon phenomenon. Along the west coast of India, not much work has been done on sea grasses except form the Lakshadweep group of Islands.

FAUNAL DIVERSITY

Zooplankton

The diversity of zooplankton in mangrove area composed of 12 groups comprising 52 species, major share of which comes from the copepods comprising about 17 species. *Protozoa* taxa are comprised by 5 species, *Coelenterata* and *Cladocera* are represented by 2 species each, Ctenophore comprised by single species whereas the larval forms comprised by 14 species.

The zooplankton community study of the mangrove ecosystem showed that, although, nutrient levels were not appreciable, relatively high densities of zooplankton were found. The onset and prolonged southwest monsoon played an important role in bringing about the drastic changes in the hydrographical conditions of the mangrove ecosystem resulting in to great variations in their abundance and distribution pattern.

Benthic animals (Invertebrates)

Benthos is the community of organisms which live on, in, or near the seabed, also known as the benthic zone. Benthos is divided into two groups, the filter feeders and the deposit feeders. Filter feeders such as bivalves and sponges filter their food by siphoning particles out of the water. Deposit feeders, such as molluscs and shrimp, ingest or sift through the sediment and consume organic matter within it. Mangrove fauna is comprised of terrestrial and estuarine organisms such as benthic communities (invertebrates), fishes and higher animals like reptiles, birds and mammals.

Benthos plays a critical role in the functioning of ecosystems. Benthic species are a diverse group that is a major link in the food chain. Filter feeders in the benthic community pump large amount of water through their bodies. As they filter this water for food, they remove sediments and organic matter from the water. Organic matter that is not used within the water column is deposited on the bottom of the sea floor. It is then re-mineralized by benthic organisms into nutrients which are given back into the water column. This re-mineralization of organic matter is an important source of nutrients to the ocean and is critical in maintaining the high primary production rates of estuaries.

Mangrove forest provides both hard and soft bottom habitats for variety of invertebrate life such as worms, clams, crustaceans, crabs, bivalves, sponges, juvenile fish and other tiny organisms that live in the bottom sediments. The extensive mangrove root systems, muddy bottoms, and open waters are all favourable habitats to invertebrates. These invertebrates feed on leaf litter, detritus, plankton, microorganisms and other small animals. Some of these animals reside in mangroves, some visits during the seasons or when food is plenty while others visit for breeding and feeding.

A total of 76 invertebrate taxa were recorded from the four mangrove stations along the Goa estuary. This includes 35 molluscs (16 bivalves and 21 gastropods), 22 crustaceans, 7, amphipods, 6 polychaetes, 3 barnacles and an oligochaete. Benthic macroinvertebrate faunal densities ranged from 140–1113 nos./m². Species dominance varied from 0.174 to 0.508, the minimum value of dominance was recorded in the pre-monsoon

season and maximum value during the monsoon season. Bivalve densities ranged from 12–20 nos./m². Among bivalves *Crassostrea madrasensis* was the most dominant, followed by *Meretrix meretrix*, *M. casta*, *Perna viridis* and *Anadara granosa*.

Crabs

Crabs are commonly found in mangroves. They are keystone species and contribute to the high biodiversity of the mangrove ecosystem. Crabs go through their larval stages in the water beneath the mangroves. When they are mature, they crawl up on the mangroves and feed on the leaves. They are crucial in the processing of the leaf litter. They can reach high densities. Burrowing activities also take place and micro-topography of the bottom is modified and the soil is aerated. This decreases the sulphide levels in the soil and positively influences the productivity of the trees.

It is not only their high species diversity but also their functional role that make crabs a fundamental component in the ecological diversity of the mangrove ecosystem. Mangrove crabs play a central role in the structure and energy flow of these coastal forests as well as influence the structure and chemistry of the mangrove soil. There are about 6 families which include 127 species that are found in the mangrove ecosystem of the world. Among brachyuran crabs belonging to 12 genera and 5 families; *Portunidae* and *Ocipodidae* were the most dominant, representing a total of 16 species. Six crab species are commercially important, out of which *Scylla serrata*, *Thalamitta crenata* and *Portunuss anguinentus* are caught in large quantities.

Scylla serrata, the large edible swimming crab, inhabits the muddy bottom of mangrove estuaries, as well



Scylla serrata



Fiddler crab

as coastal brackish water. *Thalassina anomala*, the mud lobster is also found along estuaries and tidal rivers. They build long tunneling burrows that can reach up to four meters in length and can be recognized by spectacular turrets of earth rising to two meters in height above the surface.

The mangrove tree crab resides in the canopy, feeding primarily on red mangrove leaves. Other crabs live in the intertidal mud flats, utilizing leaf litter and detritus as a food source. Horseshoe crabs are scavengers and may be found among mangrove mud flats feeding on algae, invertebrates and dead organisms. Mud flats of Godavari and Narmada rivers as well as Andaman and Nicobar group of Islands harbor large population of horseshoe crab along the east coast of India.

The fiddler crab *Uca* sp. and the various species of *Sesarma* are common inhabitants in the intertidal mangrove zones throughout the Indo-Pacific region. Snails, barnacles, bryozoans, tunicates, mollusks, sponges, polychaete worms, isopods, amphipods, shrimps, crabs, and jellyfish all live either on or in close proximity to mangrove root systems. Although, high diversity of crabs and its potential effect on the productivity of the mangrove forest has long been recognized, there is little quantitative data on community structure, population dynamics and ecological interaction between crab and mangrove litter production.

Prawns

The most common prawns include the giant freshwater prawn, *Macrobrachium rosenbergii* and the marine penaeid prawns *Penaeus indicus*, *P. merguensis*, *P. monodon* and *Metapenaeus brevicornis*. All of these species probably have a similar basic life history with



Penaeus monodon

spawning occurring offshore, an inshore migration of larvae, an estuarine juvenile stage followed by an offshore breeding migration to complete their biological life cycle. However, the species differ in the extent to which they move offshore during this migration.

After three to four months in mangrove estuaries, juvenile shrimps migrate into the shallow coastal waters from March to June where sexual maturity takes place. When larger, they move further offshore to spawning grounds in depths exceeding 10 fathoms. Major spawning migrations begin in June and continue to late January. Penaeid shrimps off the coast breed throughout most of the year but with observed peak periods during May-July and October-December, which coincide with the coming of the monsoons.

Molluscs

An important bivalve is the oyster. This species encrusts the pneumatophores and prop roots. When the tide is high, barnacles and mussels compete with the oyster for space on the roots. Gastropods are extremely important in the turnover of the organic material. Other species that occur in mangroves are tunicates, sponges, ants, hermit crabs, shrimps, fishes, etc.

Molluscs are source of nutrition for higher level



Oysters growing on mangrove roots

predators. Species that cannot tolerate the changing saline conditions can survive in the forest. In the tree canopy, vertebrate fauna and birds are common. The importance of shellfish as a source of readily accessible protein and an economic renewable resource for coastal dwellers makes it the single most important exploited species in mangroves.

Oysters and other bivalves

Mangroves ecosystem favour oyster and their larval settlement. This ecosystem supports a protection to oyster beds against strong wave action and speedy currents. Enrichment of organic carbon in the water column in mangrove regions possess adequate amount of nutrients for the production of plankton, which can support the growth and fattening of oysters. Oysters such as *Crassostrea madrasensis* and *C. cucullata* form edible, cheap and feasible source of commercial importance.

Other bivalves *Meretrix casta*, *Velorita cyprinoides*, *Polymesoda erosa* etc. are found in the Mandovi- Cumbharjua Cannal- Zuari estuarine system of Goa. *M. casta* are harvested from Ribandar and Banastari in Mandovi and Cumbharjua Canal. The growth studies on *M. casta* indicted prolong breeding activity in these areas resulting in to continuous recruitment of the stock. Earlier, *V. cyprinoides* a delicacy in Goa cuisine, used to be present in large quantities from interior of mangrove regions. Nowadays, its population has declined many folds due to the sand mining and intrusion of mining rejects on the estuarine beds. In Goa, four species of bivalves namely, *Meretrix casta*, *Paphia malabarica*, *Villorita cyprinoids* and *Katelysia opima* are commercially exploited.

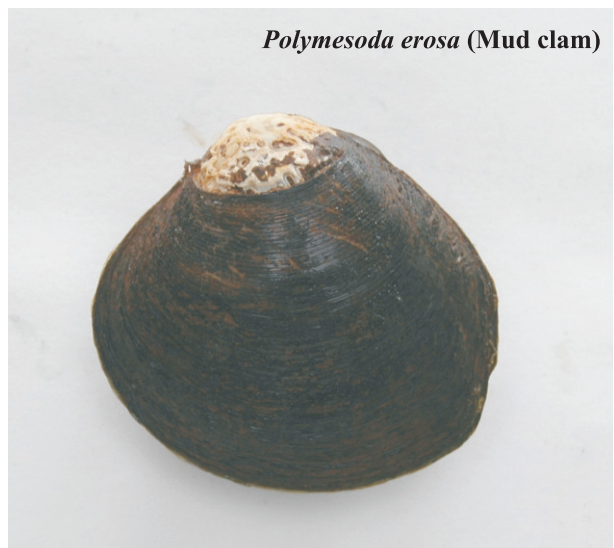
Polymesoda erosa grows in the vicinity of



Woman cleaning oysters

mangrove trees. They occupy intertidal zone starting from high tide to the low tide. There are around 147 species of *Polymesoda* found around the world. *P. erosa* occurs in India and is available throughout the west coast, while, *P. bengalensis* has been reported from the east coast; there are no records of their being exploited commercially. Study on *P. erosa* is limited to reporting its occurrence and some aspects of the population characteristic from Chorao mangroves of Goa This species is also reported from the other mangrove areas of Goa, Karnataka and Maharashtra.

This mud clam, *P. erosa* is recorded with high abundance and biomass in the high density *Avicennia* zone of the mangrove forest. The bacterial flora in sediments around *Avicennia*, probably is very important for the survival of this mangrove clam. It is indiscriminately harvested for human consumption, particularly during the monsoon season. It is one of the largest in size among the non-commercial species of bivalves and is found throughout the year in mangroves along the west coast of India.





Recent studies suggest that due to overexploitation and other anthropogenic changes, abundance of commercially exploited clam resources especially those in the backwaters and estuaries have been reduced considerably. Mining activities, sand extraction and industrial pollution are the main reasons affecting the clam fishery.

It is observed that the exploitation of natural bivalves is uncontrolled and would lead to total destruction of the population and meat revenue from the area. Destruction of natural beds has been noticed at several mangrove locations of the state. It is necessary to regulate bivalve collection for the sustainable development of mangrove dependent fisheries.

Marine wood borers

Marine wood borers fall under two main groups – mollusks and crustaceans. The mollusks belong to family Teredinidae and crustacean come under family Sphaeromalidae. The Teredinidae are highly specialized bivalves commonly called ship worms or pile worms, having worm bodies and are not enclosed in shell valves. They possess cellulolytic and lignimolytic enzymes that help them to digest cellulose and lignin from the wood. The shipworm can tolerate wide range of salinity. Out of the recorded 68 species of ship worm, 25 are found in mangrove habitat.

Borers are widely distributed in the mangroves and are reported to occasionally attack living but injured trees. Out of 14 species of crustacean borer recorded from the marine habitat only 5 are found in mangroves. Along the Goa coast, wood borer like *Martesia* sp., *Nausilora hedleyi* and member of *Sphaeroma terebrans* have

destroyed *Avicennia* spp.

It has been reported that the mangrove trees are relatively resistant to borers due to presence of tannic acid. It is considered that resins, silica, alkaloids, oil and acid present in live mangroves resist wood borer, however, increased incidences of boring on dead as well as living trees do not support such an assumption. Perhaps, mangroves provide suitable habitats for the borers and presence of thick calcareous tubes around their bodies may be one of the protective device produced by the borers.

VERTEBRATES

Fishes

The fishes found in mangrove habitats represent marine, estuarine and backwater species along with the some freshwater species. Mangrove ecosystem being a detritivorous based ecosystem, it supports variety of organisms that inhabit mangroves. Mangroves are well known as breeding, feeding and nursery grounds for estuarine and marine fishes and harbour number of commercially important fishes. Mangrove roots provide an ecologically important habitat for a wide variety of fishes as well as many other species of fish can be found among the tangled roots of mangroves. The mangrove roots and shallow waters offer shelter from predators until the juveniles reach a size large enough to avoid most predators.

There are over 120 species of fish found in mangroves, almost all of which are brackish water and estuarine species. Some of the common fishes in Indian mangroves are *Liza*, *Mugil*, *Lactes*, *Polynemes*, *Sciana*, *Hilsa*, *Metapenaes* etc. The species of commercial interest include mullets (*Mugil cephalus*), snappers, milk fish (*Chanos chanos*), sea bass (*Lates calcarifer*), tilapia etc. The bottom dwelling fish such as *Pleuronectiformis* sp. live in muddy bottom in channels or other water masses. The list of dominant fishes found in mangroves of Goa is given in Table 3.

The most conspicuous fish is perhaps the mudskipper (*Periophthalmus* sp.), which is endemic to the mangroves. Mud skippers are one of the fish which live on the mud flats associated with mangroves. This fish

Table 3. List of fishes reported from the mangroves of Goa

Sr. Nos.	Scientific name	English name	Local name
1.	<i>Etraplus suratensis</i>	Pearl spot	Kalundra
2.	<i>Scatophagus argus</i>	Spotted scat	Bannsire
3.	<i>Plectorhinchus gibbosus</i>	Black sweet lips	Harvil
4.	<i>Gerres filamentosus</i>	Whip fin silver biddy	Shetka
5.	<i>Acanthopagrus berda</i>	Black sea bream	Paloo
6.	<i>Letes calcarifer</i>	Giant Perch	Chonok
7.	<i>Mugil cephalus</i>	Mullet	Shevte
8.	<i>Sillago sihama</i>	Sand whiting	Muddosi
9.	<i>Lutjanus lineolatus</i>	Red Snapper	Tamso
10.	<i>Epinephalus malabaricus</i>	Grouper	Gobro
11.	<i>Eleutheronama tetradatylus</i>	Thread fin	Rawas
12.	<i>Hemiramphus xanthopterus</i>	Half beak	Tonki
13.	<i>Opisthopterus tardoore</i>	Herring	Patchali
14.	<i>Carageides oblongus</i>	Oblong Trevelly	Konkar
15.	<i>Osteogeneiosus militaris</i>	Cat fish	Sangot
16.	<i>Anchoviella commersonii</i>	Anchovy	Motiyali

Compiled from published reports

is well adapted to alternating period of exposure to air and submersion and is frequently seen hopping along the mud at the water edge. They are well camouflaged and able to change colour to match their surroundings. It respire under water like other fish but when out of the water gulp air. When submerged, it swims like a fish but on land proceeds by a series of skips. The mud skipper's most noticeable feature is a pair of highly mobile eyes perched on top of the head to increase the field of view and to enable it to see both under and over the water.

Mollusks and crustaceans found in mangroves have commercial value and are harvested by local people for consumption or sold at local market, The most valued species are oysters, crabs etc. On the bases of methodology of culturing and harvesting, mangrove



fishery is differentiated into three categories i. e. capture fishery, Mariculture and pond culture. Traditional fish farms are present in most of the mangroves in Goa as well as along the west and east coast of India,

The development of brackish water pond in mangrove areas for capture fisheries, raft, and cage and bottom culture fishes could be traced back to several centuries. More recently, pond based aquaculture system have increased and intensified which has resulted in the conversion of vast mangrove areas in to fish farms. This practice is still continued in many coastal areas along the Indian coast such as, Gujarat, Maharashtra, West Bengal, Odisha, Andhra Pradesh, Tamil Nadu etc. It has been estimated that mangrove dependent fishery yield about 30,000 m tons of fish and about 1, 30, 000 m tons of crab and prawns, annually. About 10 % of Indian coastal marine fisheries depend on estuarine complex.

A wide range of commercial and non-commercial fish and shellfish also depends on mangrove forests. The role of mangroves in the marine food chain is crucial and supports not only those organisms present in the mangrove ecosystems but also supports the vast diversity of organisms from nearby ecosystems. When mangrove

forests are destroyed, declines in local fish catches often result. Assessments of the links between mangrove forests and the fishery sector suggested that for every hectare of forest cleared; nearby coastal fisheries lose about 480 kg of fish per year.

Reptiles and amphibians

Reptiles are also common in mangroves and can include snakes, turtles and crocodiles. Crocodiles are some of the most significant reptiles that naturally inhabit marine and estuarine environments. The fresh water crocodile, *Crocodilus palustris* commonly found in mangroves, has adapted so well to salt water conditions that it can survive indefinitely in a range of salinity. They appear to have functional salt glands on their tongue.

In the early 70's, this species was reported from Gujarat and Kerala as well as from Karnataka. In Goa, it inhabits Mandovi-Cumbharjua-Zuari estuarine system and feeds on fishes, birds and other animals. They grow up to 4 m in length and weighs around 200 to 300 kg. Although, no census of this species is available it seems that about more than 100 individuals inhabit estuarine waters of Goa.

The largest living reptile happens to be the

estuarine crocodile, *Crocodilus porosus* thrive after brought back from brink of extinction. Today, its distribution is restricted to Bhitarkanika (Odisha), Sundarbans (West Bengal) and Andaman and Nicobar group of Islands. A small population of this species has been reported from Myanmar and Sri Lanka.

Species of turtles are found near the headwaters of mangrove systems. These species rely upon mangroves as its primary habitat. The loggerhead (*Caretta caretta*) and green sea turtle (*Chelonia mydas*) utilize the mangroves as juvenile nurseries, feeding ground and receives protection from predators. The green sea turtle and Hawksbill sea turtles (*Eretmochelys imbricata*) have been observed feeding on mangrove roots and associated submerged vegetation. The Ridley sea turtle (*Lepidochelys kempii*) is commonly observed in the mangrove.

Green turtle *Chelonia mydas* has been reported from Gujarat, Gulf of Mannar and Lakshadweep and Andaman Nicobar group of Islands. It is the largest hard shelled sea turtle. There are ten major and minor nesting sites reported from Indian coast. This species feed on *Gracilaria* spp. sea grasses (*Cymodocea*) etc. Another species of turtle Olive Ridley (*Lepidochelys olivacea*) is the



Crocodilus palustris (Mangrove crocodile)



Olive Ridley Turtle

most numerous of the species of sea turtles in the world. In all 12 nesting sites have been reported from India. It is known for its enormous nesting aggregation in north eastern coast of India.

The Hawksbill turtle (*Eretmochelys imbricata*) has wide distributional range in tropical waters. Seven nesting sites have been reported from Indian coast. Andaman and Nicobar group of Islands supports good population of this species. Leatherback turtle (*Dermochelys coriacea*) is widely distributed in tropical waters. Along the Indian coast it is relatively rare, however, fairly large population is found in Andaman and Nicobar group of Islands. About 8 nesting sites have been reported from Indian coast and Andaman and Nicobar group of Islands are major nesting sites. Loggerhead turtle (*Caretta caretta*) resembles Olive Ridley and has circum-global distribution inhabiting the continental shelf basins, lagoons, estuaries etc. It has been reported from Tuticorin and Gulf of Mannar of southern Indian coast.

The large lizards, *Iguana* (Iguana) and *Ctenosaura similis* (garrobo) are commonly found in the mangroves, where they are eaten by the local people, as are their cousins in West Africa (*Varanus exanthematicus*) and Asia (*Varanus salvator*). Indian monitor lizard, *Varanus salvator* is found in mangroves and also on the land ward fringe. There is not much work has been done about this lizard inhabiting mangroves.

A number of snakes can also be found in mangrove areas especially in the landward fringe. They inhabit the aquatic environment right from swimming to salt tolerance, to diving ability and breathe holding capacity. Three families including five sub families contain snake



Monitor Lizard

species that have adapted to live in the sea and estuaries. Three species of snakes namely, Beaked sea snake, (*Enhydrina schistose*), Wart snake (*Acrochordus granulatus*) and Dog faced water snake (*Cerberus rynchops*) have been reported from mangrove areas of Goa.

Birds

Birds are a prominent part of most mangrove forests and they are often present in large numbers. The shallow waters and exposed mud flats of the mangroves offer rich feeding grounds for many of the large and more spectacular species of birds. Mangrove forests make an excellent habitat for number of bird species, from the smallest Kingfisher and Plovers to the large Heron, Storks and majestic Raptors. All these birds have made mangroves and tidal marsh as their home sharing mutual relationship with the habitats. Mangroves thus provide a much diverse habitat for avifauna. About 121 species of resident and migratory birds are found in the mangrove forests. Long-legged wading birds utilize these and deeper waters along mangrove-lined waterways.

Species of ducks (*Dendrocygna javanica*), egret (*Egretta gularis*, *E. garzetta*), Kingfishers (*Halcyon smyrensis*, *H. pileata*, *H. capensis*), Kites (*Haliastur indicus*, *Milvas migrans*) cormorants (*Phalacrocorax niger*, *P. carbo*) etc. have been observed in the mangrove habitats. These floating/diving birds feed on fishes, plant materials and invertebrates. Some of these waterfowl are year round residents, while others occur during migration or as winter visitors. Birds of prey include permanent residents, summer residents, and winter visitors of mangrove habitats. These species also roost and nest within mangrove tree canopy.

Table 4. List of bird species reported from the mangroves of Goa

Sr. Nos	Scientific name	Common Name	Status
1.	<i>Alcedo atthis</i>	Small Blue kingfisher	R
2.	<i>Halcyon smyrensis</i>	White Breasted King fisher	R
3.	<i>Halcyon pileata</i>	Black Capped kingfisher	R
4.	<i>Pelargopsis capensis</i>	Stork Billed Kingfisher	R
5.	<i>Todiramphus chloris</i>	Collard Kingfisher	R
6.	<i>Ceryle rudis</i>	Lesser Pied Kingfisher	R
7.	<i>Egretta garzetta</i>	Little Egret	R
8.	<i>Mesophoyx intermedia</i>	Median Egret	M
9.	<i>Audea alba</i>	Great Egret	M
10.	<i>Egretta gularis</i>	Western Reef Egret	R
11.	<i>Haliastur indicus</i>	Brahminy Kite	R
12.	<i>Milvus migrans</i>	Black Kite	R
13.	<i>Acridotheres tristis</i>	Common Myna	R
14.	<i>Acridotheres fuscus</i>	Jungle Myna	R
15.	<i>Phalacrocorax niger</i>	Little Cormorant	R/M
16.	<i>Phalacrocorax carbo</i>	Great cormorant	M
17.	<i>Ardea cinerea</i>	Grey Heron	R/M
18.	<i>Nycticorax nycticorax</i>	Black Crowned Nigh heron	R
19.	<i>Lanius schach</i>	Rufous Backed Shrike	R
20.	<i>Merops orientalis</i>	Small Bee Eater	R
21.	<i>Merops philippinus</i>	Blue Tailed Bee Eater	M
22.	<i>Dicrurus macrocercus</i>	Black Drongo	R
23.	<i>Streptopelia chinensis</i>	Spotted Dove	R
24.	<i>Psittacula krameri</i>	Rose Ringed Parakeet	R
25.	<i>Prinia socialis</i>	Ashy Prinia	R
26.	<i>Rallina eurizonoides</i>	Slaty Legged Crake	R
27.	<i>Porzana pusilla</i>	Baillon's Rail	R
28.	<i>Porzana fusca</i>	Rudy Breasted Crake	R
29.	<i>Oriole oriolus</i>	Eurasian Golden	R/M
30.	<i>Gallirallus striatus</i>	Blue Breasted Rail	R
31.	<i>Phalacrocorax fuscicollis</i>	Indian Shag (Indian Cormorant)	M
32.	<i>Sterna hirundo</i>	Common tern	M
33.	<i>Anus acuta</i>	Northern Pintail	M
34.	<i>Actitis hypoleucos</i>	Common sandpiper	M
35.	<i>Anhinga melanogaster</i>	Indian Darter	R/NT
36.	<i>Fulica atra</i>	Eurasian coot	M
37.	<i>Ardeola grayii</i>	Indian Pond Heron	R
38.	<i>Egretta sacra</i>	Pacific Reef Heron	R

Compiled from published reports

R - Resident; M - Migratory; NT - Nesting)

Some species of birds are entirely restricted to mangrove habitat, especially the Collard Kingfisher. A viable population of this species is found in the mangrove forest of Cumbarjua Canal. Mangrove forest makes a good roosting site for birds like Cormorants, Herons, Darters, Egrets etc. These birds congregate in the evening hours to roost on mangroves. Nesting of Black Kite and Brahminy Kites in mangroves of Cumbarjua Canal is very common site. The list of bird species recorded from mangrove areas of Goa is given in table 4.

The marshy areas like saltpans and tidal mudflats are the most productive areas for migratory birds. They provide abundant food to these bird species in the form of small mollusks, crustaceans, polychaete worms, insects etc. The mudflats of Mandovi and Zuari estuaries are the feeding grounds for birds like Pond Heron, Little Green Heron, Reef Egret, Little Egret, Large Egret and occasionally Grey and Purple Heron. They forage along the mudflats during low tides. Flamingoes flock the exposed mud flats, during the low tides. They use mangrove environment as breeding and feeding grounds. The huge mudflats in Mumbai, Gujarat, Tamil Nadu, Odisha, Andaman and Nicobar group of islands receive thousands of flamingoes every year.

Few of these bird sanctuaries have been located in mangrove areas. In India, bird sanctuaries such as Sajnakhali Bird Sanctuary, Sunderbans (West Bengal); Point Calimer Bird Sanctuary and Pulicat Lake Bird Sanctuary, Tamil Nadu; Chilka Lake Bird Sanctuary, Odisha; Sir Salim Ali Bird Sanctuary, Chorao, Goa are in mangroves.

Terrestrial animals

Many mammals frequent mangrove habitats but only a few live there permanently and fewer are restricted to them. In many countries however, the mangroves represent the last refuge for a number of rare and endangered mammals. There are number of terrestrial animals that inhabit mangroves for feeding, breeding and shelter. Animals such as wild boar, macaques, langur, flying fox and wild cats frequent mangroves. Cattle, goats, camels, sheep's graze on mangrove foliage.

A great deal of wildlife diversity is found in the mangrove forests of India. The mammals visiting mangroves include the Royal Bengal Tiger (*Panthera tigris*), leopard (*Panthera pardus*) and the spotted deer (*Axis axis*) in the Sundarbans; wild pigs (*Sus scrofa*) and mouse deer (*Tragulus* sp.) in Nipa swamps etc. Apart from these, small carnivores such as fishing cats (*Felix viverrina*), civets (*Viverra* sp. and *Vivererricula* sp.) and mongooses (*Herpestes* sp.), Otters (*Aonyxcinerea* and *Lutra* sp.) are common, but rarely seen. The Royal Bengal Tiger is one of the unique resident species of mangroves of the Sundarbans. The Sundarbans is only place in the world having tiger population breeding and feeding in the mangrove area and it is unique site of tiger sharing terrestrial and aquatic food webs.

Dolphins, such as the Gangetic dolphin (*Platanista gangetica*) and the common dolphin (*Delphinus delphis*) are also found in mangroves. Manatees (*Trichechus senegalensis* and *Trichechus manatuslatirostris*) and Dugongs (*Dugong dugon*) are found in mangroves. These species, are becoming increasingly rare and in many places are threatened with extinction. They are mostly found along the east coast and rare sighting of some of these species have been reported from west coast of India.

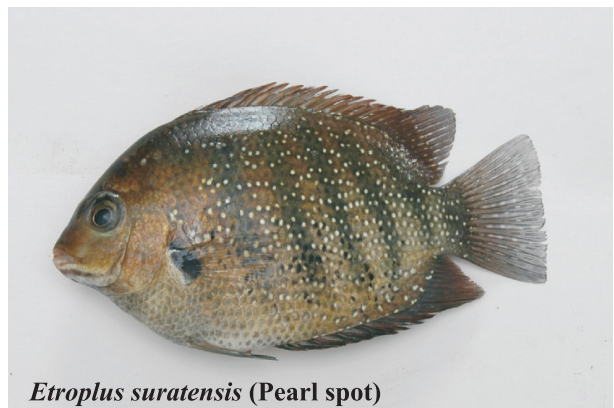
SOME OF THE IMPORTANT FISHES FOUND IN MANGROVES OF GOA

Etroplus suratensis Bloch

Common Name: Pearl spot

Description

Dioecious, external fertilization, guarders, clutch



Etroplus suratensis (Pearl spot)

tenders. Spawning throughout the year, but peaking once. After spawning, about 500 eggs are laid and attached to a submerged log, rock or sometimes roots and weeds, in still or slow flowing water. Parents guard and fan the eggs until hatching, usually about 4 days. The fry shoal around their parents during the first weeks of growth. Parents refrain from feeding from the time of spawning until the fry become independent. Max. size: 70 cm TL.

***Lates calcarifer* Bloch**

Common name: Giant perch

Description

Body elongate; mouth large, slightly oblique, upper jaw extending behind the eye. Lower edge of preopercle serrated, with strong spine at its angle, opercle with a small spine and with a serrated flap above the origin of the lateral line. Caudal fin rounded; upper profile of head more or less concave; height 3-3.1, 3.6-3.7 in length with caudal. Eye 6.4-7.7 (according to size of fish), 1.2-1.9 in snout. Inter orbital space convex, 1.2-1.7 in eye. Mouth somewhat oblique, lower jaw projecting, maxillary reaching beyond vertical through hind border of eye. Dorsal spines (total): 7-9; dorsal soft rays (total): 10-11, anal spines: 3; anal soft rays: 7-8. 11 gill rakers are present on lower arm of first arch. A diadromous, fish inhabit rivers before returning to the estuaries to spawn. Larvae and young juveniles live in brackish temporary swamps associated with estuaries, and older juveniles inhabit the upper portions of rivers. Breeds from late summer to rainy season. Size: 170-200 cm TL, Weight: 60 Kg.



Scatophagus argus

***Scatophagus argus* (Linnaeus, 1766)**

Description

Color: Ground colour greenish. Juveniles with a few large roundish blotches, about size of eye, or with about 5 or 6 broad, dark, vertical bars. In large adults, spots may be faint and restricted to dorsal part of flanks.

Body quadrangular, strongly compressed. Dorsal head profile steep. Eye moderately large, its diameter somewhat smaller than snout length. Snout rounded. Mouth small, horizontal, not protractile. Teeth villiform, in several rows on jaws. Dorsal spines (total): 10-11, Dorsal soft rays (total): 16-18, anal spines: 4, anal soft rays: 13-15.

The dorsal, anal and pelvic spines are believed by Philippine fishers to be venomous and capable of inflicting wounds. Max. size: 38.0 cm TL. Max. published weight: 1050-1200 gm.

***Lates calcarifer* (Giant perch/ Chonak)**



Gerres filamentosus Cuvier, 1829

Description

Color: Silvery and there may be 7-10 broken vertical bars on the upper portion along the sides. The fins are dusky hyaline to white

The body is oblong, moderately compressed and deep. The mouth is small and protractile and bears fine, villiform teeth in each jaw. The body is covered with firmly attached ctenoid scales. Head 2.9-3.2 in standard length, 3.8-4.3 in total length. Depth of body 2.3-2.5 in standard length, 3.1-3.5 in total length. Eye diameter 3.3-3.8 in head, 1.0-1.2 in snout and also in interorbital space. Maxillary reaching to below front border of eye. Lower pharyngeals united by mobile suture. Distance from tip of snout to dorsal fin origin a little more than height of body. Second dorsal fin spine often produced into a filament in large specimens. 2nd and 3rd anal fin spines subequal. Pectoral fin a little longer than length of head. Ventral fin shorter than head without snout. Number of spines and rays in the dorsal fin: IX, 10; number of spines and rays in the anal fin: III, 7; number of rays in the pectoral fin: 15-16; number of spines and rays in the ventral fin: I, 5; number of scale rows along the lateral line: 43-47; number of horizontal scale rows usually counted from origin of the dorsal fin to the lateral line and from anal origin to the lateral line: 5-6+1+12-13.

Acanthopagrus berda



Dioecious, external fertilization, batch spawner, nonguarders, open water/substratum egg scatterers. Breeds in late summer to early rainy season. Juveniles enter estuaries and mangrove areas at 1 cm SL and stay until they reach maturity, at which stage they move out to sea. Size: Maximum 35 cm; common about 15 cm

Acanthopagrus berda (Forsskal, 1775)

Description

Color: Grey, dark silver/grey or dull olive/brown with silvery or brassy reflections; upper part of body and base of scales darkest, lower part of head and body paler, a dark edge along opercle. Spinous dorsal fin with a dark edge and spines often silvery; pectoral fins dusky with a yellow tinge, soft dorsal, anal and pelvic fins blackish; caudal fin grey with darker shading.

Body fairly deep, compressed, its depth about



Gerres filamentosus

twice in standard length. Head 3 or 4 times in standard length, its upper profile straight (sometimes a bulge above eye); snout pointed; eye moderate in size; ventral profile almost straight to anus; in both jaws, 4 to 6 large, more or less compressed teeth in front, followed by 3 to 5 rows of molar-like teeth; upper lateral teeth of outer row conical and blunt; gillrakers 9 to 11 on lower limb of first arch. Dorsal fin with 11 (rarely 12) spines and 10 to 13 (usually 11 to 12) soft rays, 4th to 6th spines longest (spines appear alternately broad and narrow on either side); anal fin with 3 spines and 8 or 9 soft rays, 1st spine shorter than eye diameter, 2nd spine flattened laterally, longer and stronger than the 3rd; pelvic fins with a strong spine; caudal fin slightly forked, with rounded lobes. Scales large, 43 to 45 in lateral line (to base of caudal fin); 4 to 4.5 scale rows



Sillago sihama

Description

Color: uniform dark grey to brownish or blackish; large examples are sometimes mottled with light brown.

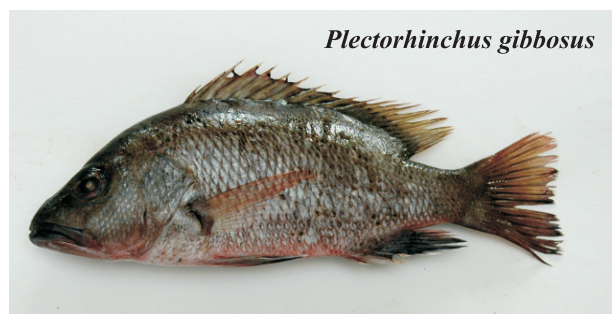
Lips fleshy, greatly swollen with age; chin with 6 pores but no median pit; gillrakers on first arch 26 to 30 (8 to 10 on upper limb 1 at corner and 17 to 19 on lower limb). Dorsal fin with 14 spines and 15 or 16 soft rays. Scales ctenoid (rough to touch). Lateral line with about 50 to 55 tubed scales. Max. size: 70 cm.

***Mugil cephalus* Linnaeus, 1758**

Common Name : Mullet

Description :

Body cylindrical, robust. Head broad, its width more than width of mouth cleft; adipose eyelid well developed, covering most of pupil; upper lip thin, without



Plectorhinchus gibbosus

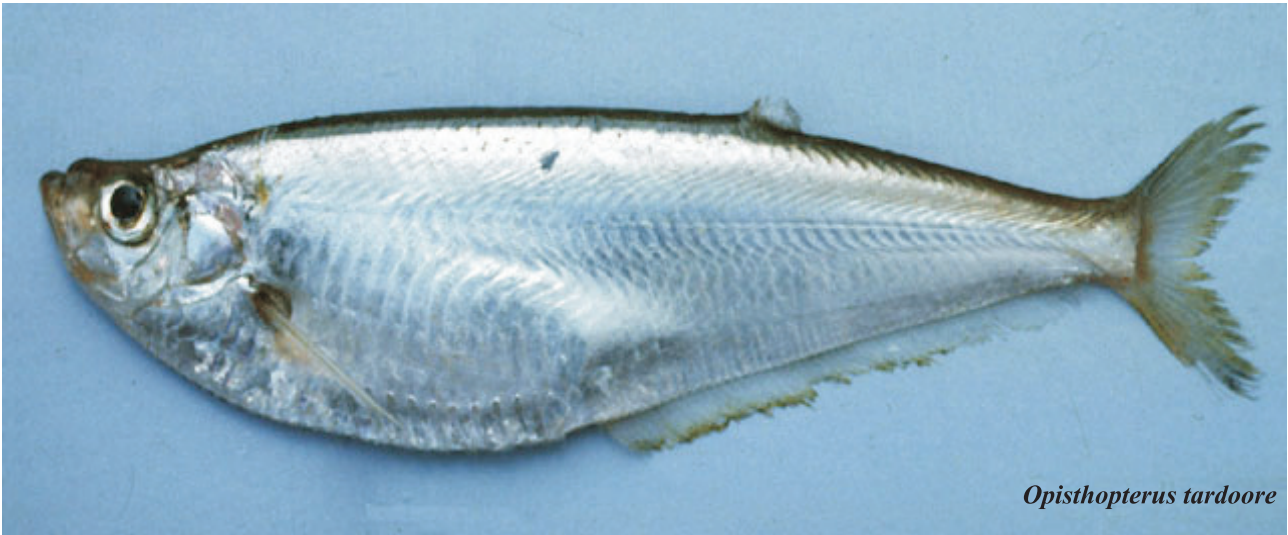
between lateral line and 4th dorsal spine; a scaly sheath at base of dorsal and anal fins; a long pelvic axillary process. Size: Maximum 75 cm; common to 30 cm. Max. weight reported: 3,200 g. Protandrous hermaphrodite, external fertilization. Age at sex change is 1.95 years.

***Plectorhinchus gibbosus* (Lacepede, 1802)**

Common Name : Harry hotlips



Mugil cephalus



Opisthopterus tardoore

papillae, labial teeth of upper jaw small, straight, dense, usually in several rows; mouth cleft ending below posterior nostril. Two dorsal fins; the first with 4 spines; the second with 8-9 soft rays; origin of first dorsal fin nearer to snout tip than to caudal fin base; origin of second dorsal fin at vertical between a quarter and a half along anal fin base. Anal fin with 8 soft finrays. Pectoral fins with 16-19 rays; pectoral axillary about one-third length of fin. Pyloric caeca 2. Scales in lateral series 36-45. Colour back blue/green, flanks and belly pale or silvery; scales on back and flanks usually streaked to form longitudinal stripes; dark pectoral axillary blotch.

Sillago sihama (Forsskål, 1775)

Common Name : Muddosi

Description :

Body elongate, snout oblong, conical. A flat triangular spine on opercle. Mouth small, terminal; villiform teeth present in jaws and on vomer. Gillrakers 9-10 lower, 3-4 upper. First dorsal fin higher than the second and with 11 weak spines; second dorsal fin with 1 spine and 20-23 rays; anal fin with 2 spines and 21-24 rays; caudal fin emarginate, its upper lobe slightly larger and longer than lower lobe. Scales moderately small, 2-3, mostly 2, series on cheeks; 5-6 rows above lateral line, 9-10 below. Lateral line with 66-73 scales and additional 9-12 scales on caudal fin. Colour: back light brown, lower

ventral flanks and belly whitish or silvery, without dark blotches. Both dorsal fins and caudal fin dusky, other fins pale. Size: to 25 cm SL, usually 15 cm.

Habitat: shallow coastal waters, close to sandy bottoms. Food: small; benthic invertebrates, particularly polychaetes. Reproduction: no data.

Opisthopterus tardoore (Cuvier, 1829)

Common name : Patchali

Description :

Dorsal spines (total): 0; Anal spines: 0; Anal soft rays: 51 - 63. Belly convex in front, with 29 to 35 scutes. Mouth pointing obliquely upward; lower gill rakers 22 to 28, increasing with size of fish. Pectoral fin usually about equal to head length or greater; dorsal fin small, well behind midpoint of body; anal fin long, its origin well before dorsal fin origin.

Found close to shore and also entering estuaries . Ascends rivers into the tidal zone. Feeds on mysids, Pseudodiaptomus and copepod eggs, also prawns and other small crustaceans, bivalve eggs and larvae, amphipods and small fishes. Spawns in late February or early March to July or August (around Karwar, India). Used as fish meal or fertilizer.

BIRDS ASSOCIATED WITH MANGROVES OF GOA

Phalacrocorax niger (Vieillot, 1817)

Common Name: Little cormorant

Description

This is commonest species of cormorant in India and is often very abundant. Often found in large flocks in lakes and reservoirs, also occurring singly or in small groups in rivers, occasionally found on the sea coast, hunts on small crab, tadpoles, frogs and fish in groups, breeds in mixed colonies from July to September.

Sexes alike. Has small and black body with stout and hooked bill, blackish at tip and bluish purple at base, domed forehead, stiff tail and without yellow gular skin. Iris greenish brown, toes are flattened and webbed. Nesting season in N. India chiefly July to September; S. India November to February and birds breeds in the



colonies of great size. Nest is a shallow twig platform, like a crow's, in trees usually in mixed colonies of egrets, storks, etc., both near and away from water. Eggs- 4 or 5, pale bluish green, with a chalky surface. Size: 51 cm.

Haliastur indicus (Boddaert)

Common Name: Brahminy kite

Description

Often solitary or in pairs, but roost communally and gregarious where common. A handsome rusty red or



Little cormorant (*Phalacrocorax niger*)

deep chestnut hawk with white head, neck, upper back, and breast, and brown abdomen. Under aspect of wings in overhead flight greyish with a cinnamon tinge; black at tips (primaries). Sexes alike.

Nesting season starts from December to April. Nest- a loose platform of twigs, lined with green leaves etc., built up in a large peepal, banyan or mangrove tree. Eggs- 2, greyish white, speckled and blotched with dingy reddish brown. Both sexes share in the domestic duties .Size: 48 cm.

Alcedo atthis

Common Name: Small Blue Kingfisher

Description

Brilliant turquoise-blue and orange kingfisher; blue green above, deep rust below; white neck patch; rust-red ear-coverts. Sexes alike; perches around 1-2m high at a vantage point, plunges headlong into the water to catch prey. Size: 18 cm

Halcyon smyrensis (Linnaeus)

Common Name: White-throated kingfisher

Description

A large Kingfisher with large red bill, chocolate-brown head and under-parts excepts white throat and center of breast; brilliant turquoise-blue upper parts, rump and tail. In flight, the bold white wing-patch is the diagnostic. Size: 28 cm

Nycticorax nycticorax (Linnaeus)

Common Name: Black-crowned night heron

Description

Back and crown black; wings, rump and tail grey; face, foreneck and underparts white; long occipital plumes white. Immature brown spotted with white above, below buff heavily streaked with brown. Iris crimson in adult, orange-yellow to red in immature; facial skin greenish, blue-black when breeding. Nocturnal or crepuscular except in breeding season. Sexes alike, strongly built grey, white and black heron with stout black bill. Crown, nape and occipital crest black with two or



rodents, birds, eggs, carrion, plant material and garbage at landfills. Length 58-65 cm.

Actitis hypoleucos (Linnaeus)

Common Name: Common sandpiper

Description

This species displays no sexual dimorphism in plumage, but females tend to be a little larger than males. Above and on sides of neck and chest uniform dark brown; below white extending around bend of wing; white superciliary stripe; conspicuous white wingbar in spread wing, breeding bird has noticeable streaking above and on neck and breast. Immature like adult; Iris brown, bill variable from grey or olive-grey to dark brown with ochre or pinkish base. Feet and legs variable from greenish grey to yellowish olive.

Generally solitary or in twos or threes in non-breeding season, regularly wags its tail and bobs the head constantly while feeding. Breeding typically occurs during May and June. The nest is a shallow depression, sometimes amongst shrubs and trees. Size: 20 cm.

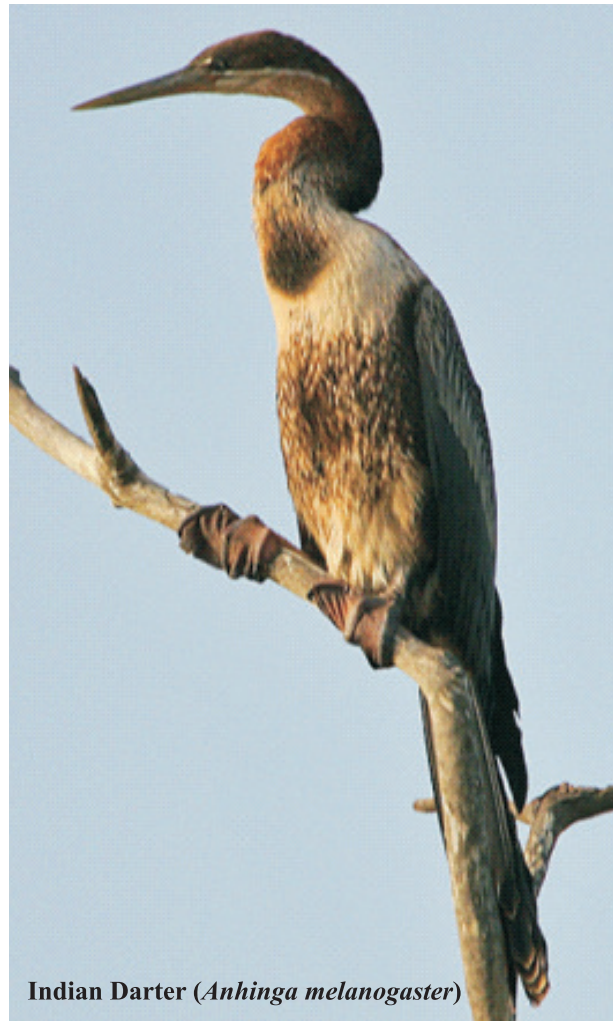
Anhinga melanogaster (Pennant)

Common Name: Indian darter

Description

A large black water bird with long snaky neck; spear like beak and white on the throat and neck. Swims, dives and flies well and perches on tree. Male are largely black with greenish gloss. Fore neck chestnut with a white lateral stripe; white streaks on scapulars, inner secondaries and wing coverts. Females and immature browner with light brown bell; Iris golden yellow with a brownish ring, facial skin brown yellowish brown; feet and legs brown to grey.

Found in the tidal estuaries and creeks. Occurs singly, in twos or small flocks, rarely in large flocks; swims with submerged body with only snake-like head and neck protruding, which the bird turns from side to side, breeds gregariously in heronries from July to December. Size: 85-97 cm; Length: 71-79 cm.



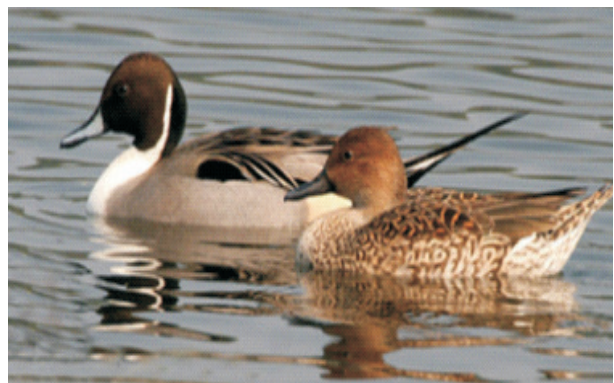
Indian Darter (*Anhinga melanogaster*)

Anas acuta (Linnaeus, 1758)

Common Name : Pin tailed duck

Description

Darke: upper plumage pencilled grey. Head



Pintailed Duck (*Anas acuta*)



Eurasian coot (*Fulica atra*)

chocolate, with band on either side running down into the white neck and underparts. Long, pointed pin-like feathers projecting well beyond the tail, usually sufficiently diagnostic. Characteristic elongated body and tapering tail, but without the pins. Differs from female Gadwall by absence of white in the wing, from female Mallard in lacking the bright wing-speculum. Pairs, or flocks, on reed-fringed vegetation-covered jheels. feed on grain fields, including rice, wheat, barley, and oats. Size: Length male 66 cm, female 51 cm. Color: Mottled brown and buff.

One of our commonest migrant ducks. Amongst the first species to rise out of gunshot after shooting has commenced on a jheel, as if conscious of the esteem it enjoys as a sporting and table bird. Largely vegetarian in its food preferences. Grubs in squelchy mud in inundated cultivation and on grassy tank margins. Also 'up-ends' in shallow water.

Nesting: Season- May to July. Nest- a depression in grass in open marshy grassland, compactly lined with rushes and down feathers. Eggs - 7 to 12, pale sea-green with a buffish tinge.

Fulica atra (Linnaeus, 1758)

Common Name : Eurasian coot

Description

A slaty black, dumpy, practically tailless waterbird, very duck-like when swimming in the distance. The ivory white pointed (not flat) bill and frontal shield (no forehead) are diagnostic. The peculiar lobed or scalloped toes are also characteristic.

As a resident found sparingly on rush-bordered



Indian Pond Heron (*Ardeola grayii*)

irrigation tanks etc. In winter numbers vastly augmented by immigrants from central and western Asian and then abundant on most large jheels, especially in northern India. Skitters along the water to take off, half running half flying, rises with much labour and pattering, but flies strongly when properly launched. The rapid almost hovering wing beats, the blunt barrel-shaped body and the legs trailing behind rail-like, distinguish it from a duck in flight. Sexes alike.

Nesting season- principally July/ August. Nest- a large compact mass of rushes among matted reeds slightly above water level. Eggs- 6 to 10 buffy stone-color, stippled and spotted with reddish brown or purplish black.

Ardeola grayii (Sykes, 1832)

Common Name : Indian pond heron

Description

Voice: Call- a harsh croak uttered when flying off. A low conversational note, waku and a variety of peculiar mumblings is produced by nesting pairs.

An egret-like marsh bird chiefly earthy brown when at rest, but with the glistening white wings, tail and rump flashing into prominence immediately it flies. In breeding season acquires maroon hair-like plumes on back, and long white occipital crest. Sexes alike. Singly, or loose parties, at jheels, ponds, etc.

Found wherever there is water, river, jheel, roadside ditch, kutch well, or temple pond, often even in the midst of populous towns. Also on the seacoast in the



mangrove swamps, tidal mudflats, etc. Its normal method of feeding is to stand hunched up at the water's edge watching patiently for movement and jabbing at the quarry when opportunity offers. Sometimes it wades into the shallows, moving forward stealthily and with circumspection, neck craned and bill poised in readiness.

Nesting season- chiefly May to September (SW. monsoon), November to January in S. India. Nest- an untidy twig platform like a crow's up in large mango, tamarind and such-like trees, shared with other egrets. Frequently within town limits, not necessarily near water. Eggs- 3 to 5, pale greenish blue.



Egretta garzetta (Linnaeus, 1758)

Common Name : Little egret

Description

White, dark morph varies from bluish grey to black. Long plumes on head neck and back when breeding. Immature like non-breeding adult. Bare parts: iris yellow, orange in breeding birds; lores greyish green, orange to purplish in breeding birds; bill black with pale horn on basal half of mandible; feet and legs: legs black, orange to red in breeding birds; feet yellow. Size: 55-63 cm; Length: 55-65 cm

Generally found in flocks, more gregarious than the two large species, roost communally on trees, breeds in colonies, often in mixed heronries from July to September.

Sexes alike. A pure white bird like the other egrets, but smaller with black bill and legs, and yellow feet. Breeding (July-September): A drooping nuchal crest of two long narrow plumes; filamentous ornamental feathers on breast and scapulars, a thick bunch of decomposed dorsal plumes extends beyond the tail. Non-breeding: The ornamental plumes are dropped through occasionally some of the scapular plumes are retained.

Nesting: Season- principally July/August in N. India; November to February in the south. Nest- a shallow twig platform, like a crow's, lined with straw, leaves, etc. Built in trees, amongst mixed heronries, often near a village. Eggs-4, pale bluish green.

Ardea alba (Linnaeus, 1758)

Common name : Great egret

Description

Voice: Usually silent, occasionally utters low kraak.

Diurnal, unsocial, generally solitary though roosts and feeds communally, breeds in mixed heronries of storks, darters and cormorants, etc. Generally breeds from May to November. Sexes alike, a snow white bird with yellow beak and black legs. Breeding birds with black beak, edge of gape, naked lores and orbital skin behind eyes bright green, three sets of long, transparent, white plumes growing from scapulars extending beyond tail.



Juvenile: Pure white.

The timing of the breeding season varies geographically although temperate breeders tend to nest in the spring and summer (e.g. April to July) and tropical breeders nest in the part of the rain cycle when food becomes maximally available (this may be during the rains or in the dry season). Nest- Nests are a flimsy platform constructed of sticks, twigs, and stems built as high as possible. The eggs are a pale greenish blue, and are incubated by both the male and female for about 23 to 24 days.

Lifespan/ Longevity: Great egrets have a lifespan of about 15 years in the wild (22 in captivity). Size 91 to 96 cms.

Egretta sacra (Gmelin, 1789)

Common Name : Pacific reef heron (Eastern reef egret)

Description

Solitary, intermittently in twos and threes, roosts communally, generally diurnal, active, captures prey by stalking, during high tide sits in hunched posture, breeds in colonies from May to September. Sexes alike. Adult: Dimorphic. One phase pure white, other slaty-black, bill yellow to blackish in dark phase and usually yellow in white, iris yellow. Legs pale yellowish green in white and nearly black in dark. A bushy nuchal crest and shorter plumes on breast and mantle identify breeding birds in both the color phases. Juvenile: Pied or mottled, in intermediate color stages. Size: 58 cm

