

## **Mangrove: Nursery for Fisheries**

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### **ABSTRACT**

Mangrove habitats are of a great ecological and socioeconomic significance. Goa exhibits fringing mangroves comprised of 15 species. *Rhizophora mucronata*, *Avicennia officinalis*, *Sonneretia alba*, *S. caseolaris*, *Exoecaria agallocha* and *Acanthus ilicifolius* are dominant flora. Dense thickets and maximum number of species are confined to polyhaline (18-30‰) and mesohaline (5-18‰) zones of estuaries. Oligohaline regions are dominated by *S. caseolaris* and *Kandelia candal*. Total cover in the state has been estimated to be ~20 km<sup>2</sup> of which >75% occurs in the regions influenced by Mandovi-Zuari- Cumbarjua estuarine complex. These habitats are traditionally utilized for capture and captive fisheries, and reclaimed mainly for agriculture and urbanization. Lately these ecologically sensitive habitats are included under CRZ-I category of Coastal Regulation Zone (CRZ) Act of the country. Mangroves in the state being limited need stringent and effective management regulations.

### **INTRODUCTION**

Mangroves form a unique group of plants thriving in the regions influenced by tides. Dense mangrove cover bordering an estuarine bank indicates a healthy coastal ecosystem. They play multiple roles in preserving near shore environments. They play important role in land building process by enhancing sedimentation, shore stabilization and avoiding erosion. It also acts as a natural barrier preventing salt water incursion into mainland, thus protecting coastal agriculture and drinking water sources. The detritus rich mangrove habitats contribute significant amount of organic carbon sustaining the food web in the near shore coastal regions (Fig. 1).

Mangrove habitats being nurseries for commercial fishes, promote capture and captive fisheries of fisherfolk interest. Their timber supports fuel requirements and provides construction and packing material. Tender twigs and leaves are used as fodder

for domestic animals. Tender shoots of *Acrostichum* and ripened fruits of *Sonneretia* are consumed in a diet. The habitat harbour variety of biota, thus adding to the biodiversity of the region. However, mangrove habitats in the state are fast declining due to various human activities centred on immediate economic gains. The global efforts are being made to utilize these resources on sustainable basis. The present article provides state of art report on the mangroves of Goa.

## **STATUS**

### **Distribution:**

The segmented coast of Goa has seven major estuaries which are microtidal (tidal amplitude 0.01-2.4 m). Swamps along estuaries composed of laterite, loamy and alluvial soils. Coastal wetlands in the state cover ~130 sq km of which ~67.30 sq km are contributed by mudflats and mangroves, respectively.

Mangroves are confined mainly to the narrow intertidal mudflats along the banks of estuary. The fringing nature of mangroves could be attributed to the rising topography of the coast. Occassionally large patches of mangroves could also be noticed as in Charao island of Mandovi, along Cumbarjua canal, towards upstream regions of Zuari and polyhaline (salinity 18-30‰) regions of Terekhol and Galgibag. However, the major formations occur along Mandovi- Zuari- Cumbarjua estuarine complex, which constitute >75% of the total mangrove cover in Goa. Maximum extent and number of species occure in polyhaline and mesohaline (5-18‰) zones of estuaries.

The area extent in the state is very limited compared to other states of India. The satellite data does not show marked changes in the mangrove cover during recent past. It does not mean that mangrove in the state has remained constant. At several localities these habitats have been reclaimed, particularly for urbanization and agricultural purposes. Similarly, mangroves have also invaded reclaimed, agricultural and newly formed coastal marshy lands at several locations.

### **Composition:**

#### Mangrove Flora

The flora is comprised of 15 species (Table 1), and dominated by *Rhizophora mucronata*, *Avicennia alba*, *Sonneratia alba*, *S. caseolaris*, *Exoecaria agallocha* and *Acanthus ilicifolius*. They differ in their morphological features and hence individual species could be easily identified (Figs. 2 and 3). The maximum number of species and extent occur in the polyhaline (salinity 18-30‰) regions. The upstream oligohaline (salinity 5-18‰) regions are dominated by *S. caseolaris* and *Kandelia candal* (Fig. 4). Some of the species like *Ceriops tagal* and *Bruguiera gymnorhiza* have restricted distribution in a very limited numbers. *Ceriops* and *B. gymnorhiza* occur only along Terekhol and Zuari estuaries respectively. *Kandelia candal* has relatively better formations in Goa compared to other states along west coast.

### **Associate biota:**

Associate flora and fauna are important constituents as they enhance the productivity and recycling in the mangrove ecosystem.

#### Flora

The floral components include phytoplanktons, phaeopigments, marine algae, seagrasses, marine fungi, bacteria, ferns and angiosperms. The common flowering plants associated with mangroves are *Porteresia coarctata*, *Hibiscus tiliaceus*, *Thespesia populnea*, *Sesuvium portulacastrum*, *Cyperus* spp and *Derris heterophylla*. Thickets of *Acrostichum aureum* (Fern) are commonly occur in the upstream regions of estuaries. *Halophila beccarii*, an estuarine seagrass is commonly noticed in the vicinity of mangroves.

Total 44 spp of marine algae have been reported from mangrove environment. *Caloglossa leprieurii*, *Catnella impudica* and *Enteromorpha clathrata* form the characteristic algal flora and commonly occur throughout the year. Economically important algae such as *Monostroma* sp and *Gracilaria verrucosa* grow in the mangrove areas towards mouth region of Terekhol and Chapora. The maximum number of algae occurs during October to April when the salinity gradually increases

Microscopic blue green algae (cyanophyceae) dominate in the mangrove habitat during monsoon (June- September). Total 16 species of cyanophyceae have been found and *Oscillatoria*, *Phormidium*, *Spirulina* and *Anabaena* spp dominate the flora. Ambient water though fairly rich in nutrients and primary production, sustain a few phytoplankton species. These include mainly *Pleurosigma*, *Navicula* and *Nitzschia*, followed by *Bacillaria*, *Coscinodiscus* and *Cymbella*.

Microbial flora (fungi and bacteria) play significant role in the degradation of mangrove litter. Seventy-six species of higher fungi (manglicolous) have been recorded besides other terrestrial forms. Members of Ascomycetes dominate the manglicolous fungi. Mangrove environment harbour 50 bacterial strains, mostly gram positive. *Micrococcus*, *Brevibacterium* and *Kurthia* are predominant species.

#### Fauna

Zooplankton biomass in mangrove waters have been reported in the range of 6-113 mg/m<sup>3</sup> per day. Crustaceans and copepod species dominate. The annual mean count of copepods ranges from 570 to 1270/m<sup>3</sup>, and their diversity is low compared to estuarine and open ocean waters in the west coast.

Hundred and eleven species of macrofauna have been reported from the mangrove regions of Goa. Segmented worms (Polychaetes) and bivalves contribute over 70% of the macrofaunal component by number and weight. Dominant species are *Modiolus metcalfel*, *Mytilus viridis*, *Diapatra neapolitanea*, *Meretrix casta*, *Paphia malabarica*, *Cerithidea fluviatilis*, *Diogenes custus* and *Golycera alba*.

Meiofaunal density in the mangrove environments have been reported to range from 3538-111,000/m<sup>2</sup>. It is higher during the premonsoon and postmonsoon periods. Nematodes, especially Chromadoidae and Desmodoridae, account for 80% of the density, followed by copepods with 7%. Almost 60% of the meiofauna occur in the top 2cm layer of sediment.

Biodeterioration of mangrove wood is quite severe along the Indian coast. The destruction is caused by 14 species and one variety of borers belonging to the molluscan and crustacean family.

Number of fish, shellfish and crustacean have been reported in mangroves. Commercially important species include *Meretrix* sp., *Crassostrea* sp., *Peneaus* sp., *Scylla serrata* and *Mugil cephalis*. The commonly cultivated species are *Peneaus monodon*, *P. indicus*, *Metapenaeus monoceros*, *Mugil cephalus*, *M. persica*, *Chanos chanos*, *Etroplus suratensis*, and *Lates calarifer*.

*Crocodylus palustris*, *Varanus* sp., different kinds of monkeys, otters, deers, fishing cats, snakes and wild pigs are very commonly found in the mangroves. Common birds are herons, storks, sea eagles, kites, kingfishers, sandpipers, lits, bulbuls and whistlers.

## **CONSERVATION AND MANAGEMENT**

Mangroves are constantly threatened from increasing anthropogenic pressures such as indiscriminate cutting, reclamation mainly for agriculture and urbanization, fuel and construction and overgrazing by domestic cattle.

Since 1989, with the establishment of National Mangrove Committee (NATMANCOM), attempts are being made to protect, conserve and restore the mangrove habitats. Mangrove regions have been categorized presently under ecological sensitive zone, Vide Coastal Zone Regulation (CRZ) act of the country. As per the CRZ act no development in the mangroves or in the vicinity is allowed prior to environmental impact assessment and clearance from Ministry of Environment and Forest, Government of India (MoEF). Charao mangroves in the state have been conserved (Table 1) as Salim Ali Bird sanctuary. The technical know how for nursery and mangrove afforestation exists and implemented by state forest department to some extent. The state forest departments have been identified as nodal agencies for management of the mangrove resources. However, presently the department activities are confined only to the afforestation of mangroves. The concerned authorities need to have integrated approach for the effective management of mangrove habitat. The following additional recommendations may be of help for better management of the mangrove resources.

- i Qualitative and quantitative survey and regular monitoring of the mangrove resources would be of help in

- Listing of endangered, threatened, at risk, near extinct and extinct species
- Understanding composition, structure and function of the habitat
- Alterations in the mangrove land use pattern

#### ii Conservation and protection

- Luxuriant mangroves areas presently existing under revenue departments or private ownership land, could immediately be protected by amending the existing land revenue rules. Similarly Virgin and luxuriant mangroves regions be totally preserved as a protected areas, sanctuaries, genetic resources etc., where no anthropogenic activities such as modification, alteration, captive and capture fisheries, should be allowed.
- Captive and capture fisheries may be permitted in the mangrove areas of less importance, without causing damage to the existing vegetation.
- Panchayat Raj Institutions may be involved in protection, conservation and development of mangrove nurseries and afforestation. High density plantation programme could be taken up in the barren coastal lands under regular inundation for fodder, fuel and wood and creating awareness etc. The necessary incentives may be provided for such people.

#### iii Afforestation

- The existing technical know how could be encouraged in improving the techniques of nursery development and mangrove afforestation. The naturally grown seedlings could be used for transplanting of mangrove seedlings remain at their peak during monsoon (June-September) period. They require low salinity in the ambient environment for establishment and survival. Therefore, it is advisable to collect seedlings during monsoon for nursery development and transplantation activities.
- Intertidal areas under revenue department and with private ownership, may be transferred to forest departments by amending existing legislation, for afforestation activities.
- Forest officials are transferred every three years. The forest personnels trained in the management of mangroves environment, should be posted in the coastal regions of

the country so as to utilize their knowledge and experience, for the restoration of mangrove habitats.

- Compensatory mangrove rehabilitation for reclaimed mangrove habitats be made compulsory for the responsible organizations
- Disaster management plans for the accidental damage to the mangrove ecosystem should be made mandatory for the concerned organizations.

#### iv Agriculture

Following points may be followed while converting mangrove regions for agricultural purposes

- Identify the site where bunding has to be made, discuss the same with concerned ecologist through National Mangrove Committee. In case bunding is a must towards estuarine mouth or creek, the regions with minimum stands of mangroves could be selected.
- Impoldering could be taken in the upstream regions of the estuary, as in such areas mangrove vegetation remains rather poor, salinity of the overlying water and substratum is very low.
- Mangrove plantation could be taken towards the seaward slope of bund.

#### v Fisheries

Detritus rich mangrove environments are considered to be highly productive and serve as a natural feeding, breeding and nursery grounds for coastal and estuarine organisms. Fisheries activities in the mangrove may be encouraged with proper legislation not to pollute and damage the existing mangrove environments. Fish farming or aquaculture may be taken up in the vicinity or in thinly populated mangrove regions, in consultation with the experts in the field.

#### vi Wildlife management and tourism

Tourism may be allowed in mangroves protected for sanctuaries and parks, with the objectives of recreation, education and awareness, without damaging mangrove environments.

#### vii Others

- Salt production: While allotting the land for such purposes mangrove ecologist may be concerned.
- Apiculture : This could be a lucrative business if properly planned and managed. The honey collected from *Avicennia* and *Sonneratia* spp is of high quality .
- Fodder & Fuel: Dense plantation of *Avicennia* spp could be tried in the upper littoral and infralittoral regions.
- Timber, wood and charcoal: Cannot be encouraged at this stage otherwise will cause further deforestation of the mangroves.

#### viii Education

It is very necessary to create awareness regarding the importance of mangroves, at school, college, postgraduate and other appropriate educational levels. The local people should be educated through various media like booklets, audio, video, documentary films, lectures, exhibition, posters, postal stamp, stickers, etc. of the mangroves.

#### ix Mangrove information centres

The mangrove information centres could be established at village, taluca, district and state levels. These centres would collect various types of information on mangrove such as area, composition, endangered species, fisheries, land use pattern, reclamation, etc. These centres would also be made responsible for educating, training the locals and awareness among them. Very recently efforts have been initiated by MOEF to form mangrove database networking.

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**Table 1. Distribution of Mangroves in different estuaries of Goa**

Species	Terekhol	Chapora	Mandovi	Zuari	Cumbarjua	Sal	Talpona	Galgi
<i>Rhizophora mucronata</i>	++	+	+++	+++	++	++	++	++
<i>R. conjugata</i>	-	-	-	-	-	-	+++	-
<i>R. apiculata</i>	-	-	++	-	+	-	-	-
<i>Bruguiera gymnorhiza</i>	-	-	++	+	++	+	-	-
<i>B. sexangula</i>	-	-	+	+	+	-	-	-
<i>Kandelia rheedii</i>	-	+	+++	+++	++	-	-	-
<i>Ceriops tagal</i>	+	-	-	-	-	-	-	-
<i>Avicennia officinalis</i>	++	++	+++	+++	+++	++	++	++
<i>A. marina</i>	-	-	+	+	+	-	-	-
<i>A. alba</i>	+	+	+	+	+	+	-	-
<i>Acanthus ilicifolius</i>	++	++	+++	+++	+++	++	++	++
<i>Sonneretia alba</i>	++	+	+++	+++	+	+	+	+
<i>S. caseolaris</i>	-	-	++	+	++	+	-	-
<i>Exoecaria agallocha</i>	+	++	++	++	++	+	+	+
<i>Aegiceras corniculata</i>	+	-	-	-	-	++	-	-
Associate mangroves								
<i>Derris heterophylla</i>	++	++	+++	+++	+++	++	++	++
<i>Acrostichum aureum</i>	++	++	++	++	++	++	++	++
<i>Porteresia coarctata</i>	++	++	++	+	-	+	+	++

- Absent; + Rare; ++ Common; +++ Dominant

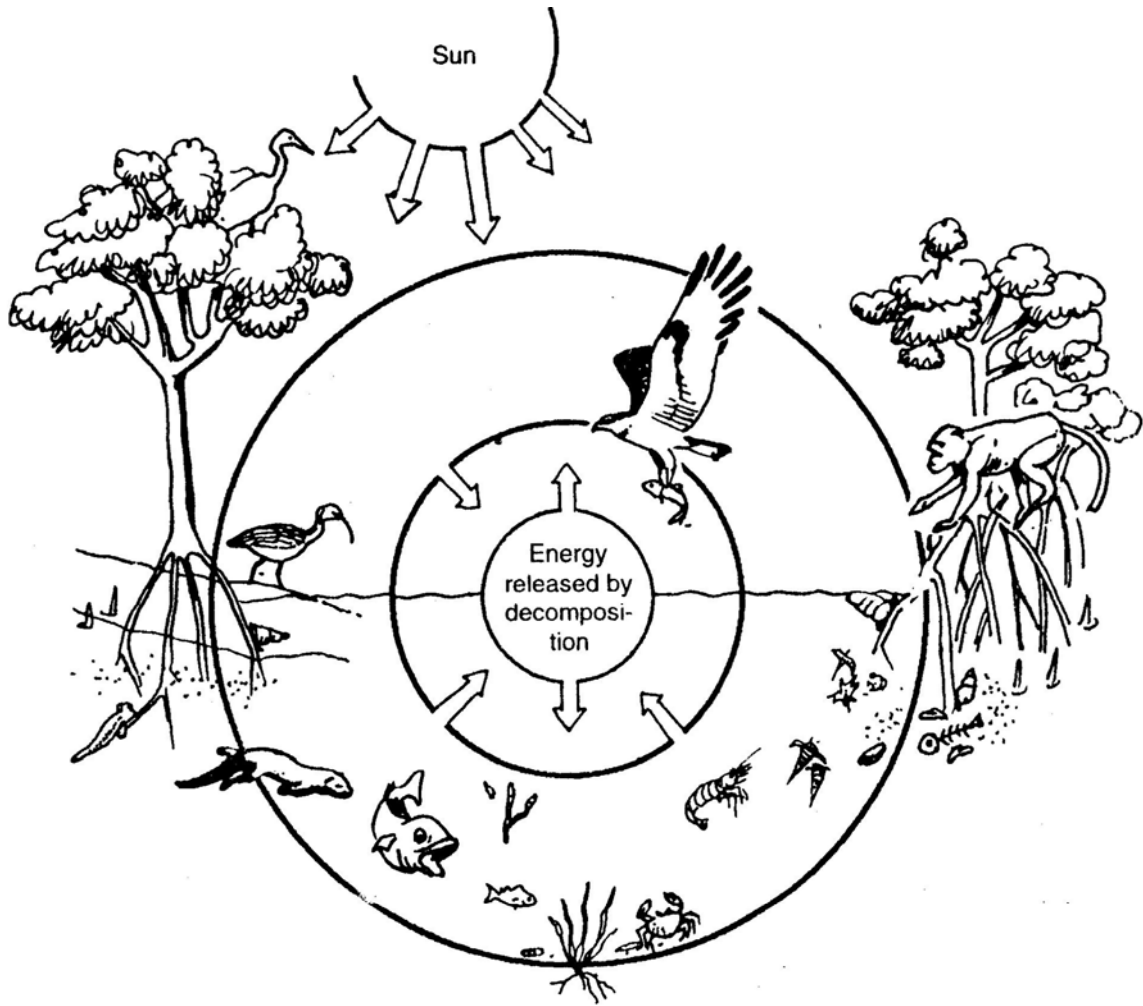


Fig 1. Energy transfer at various levels in the mangrove habitat

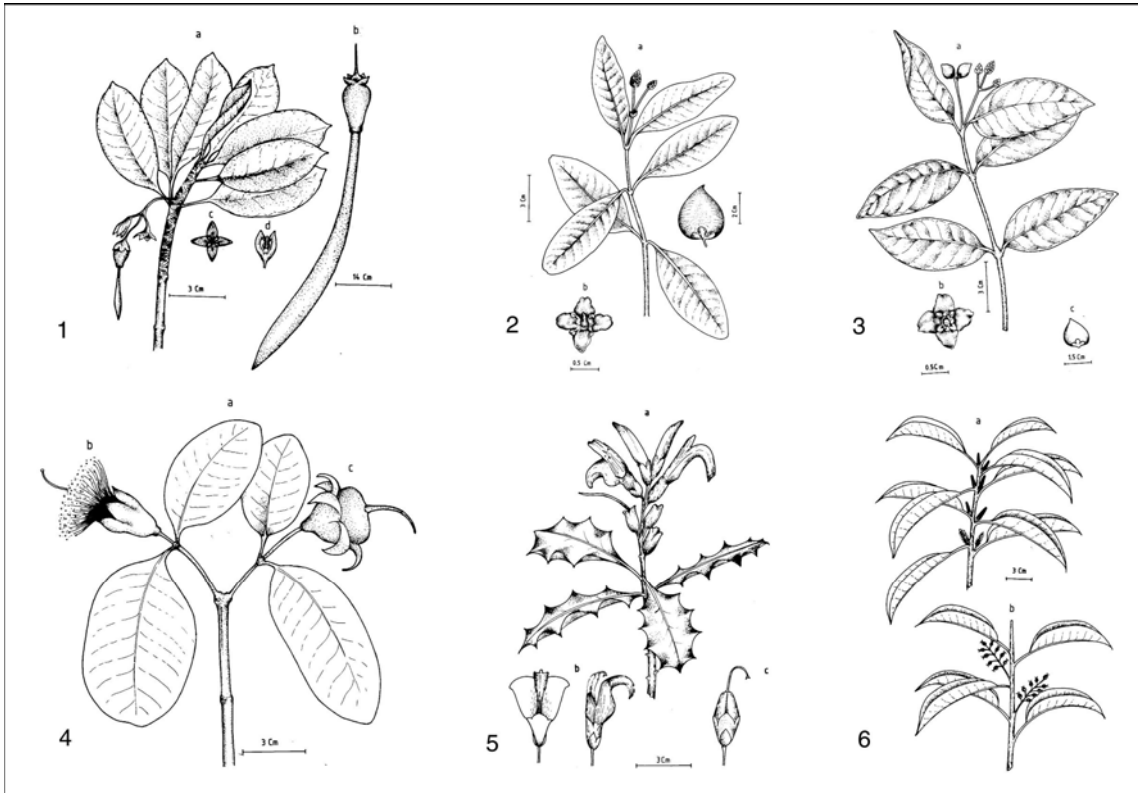


Fig 2. Morphological features of various mangrove species

Legends

1. *Rhizophora mucronata* (a- twig, b- seedling, c- open flower, d- l.s. of flower)
2. *Avicennia officinalis* (a- flowering twig, b- open flower, c- fruit)
3. *Avicennia marina* (a- flowering twig, b- open flower, c- fruit)
4. *Sonneretia alba* (a- twig, b- flower, c- fruit)
5. *Acanthus ilicifolius* (a- twig, b- flower, c- fruit)
6. *Exoecaria agallocha* (a- twig with male flower, b- twig with female flower)

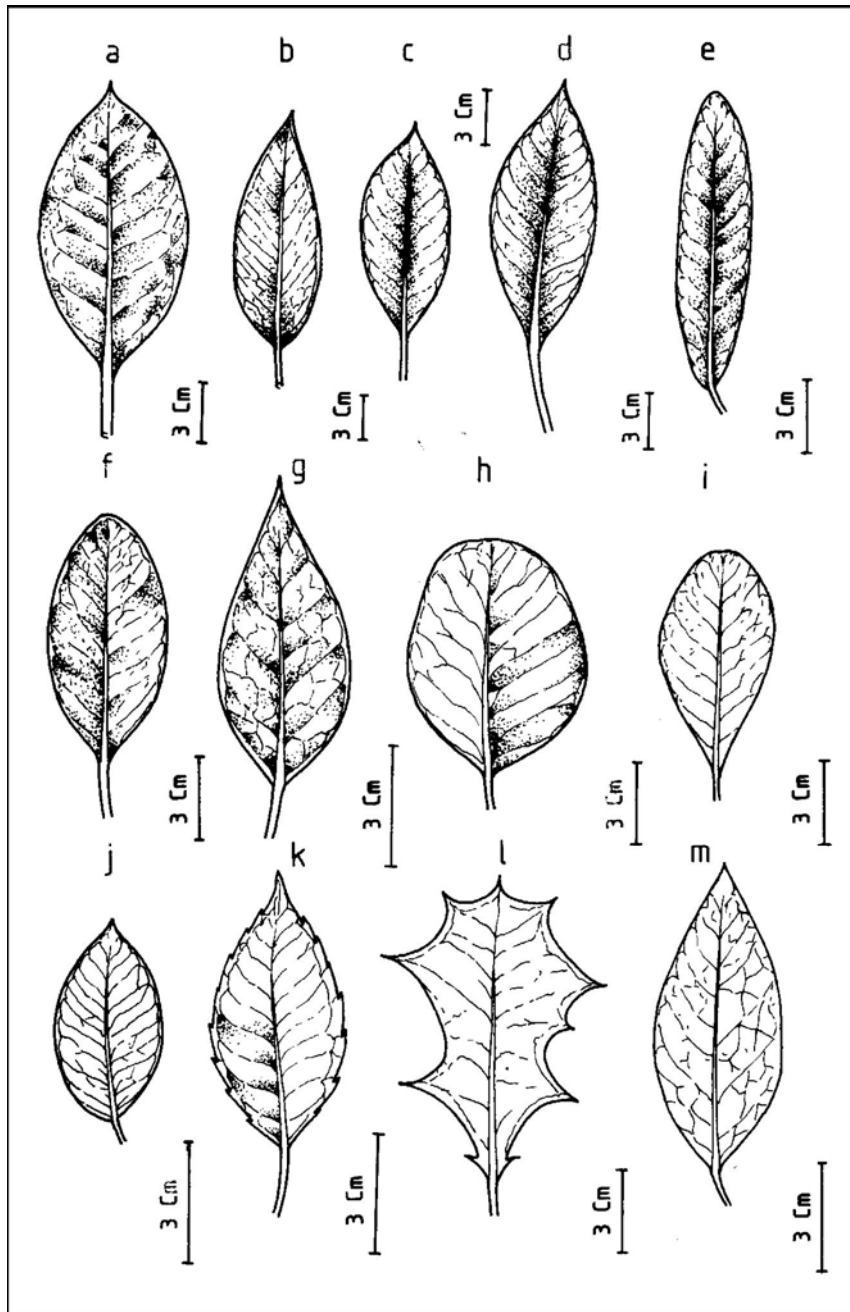


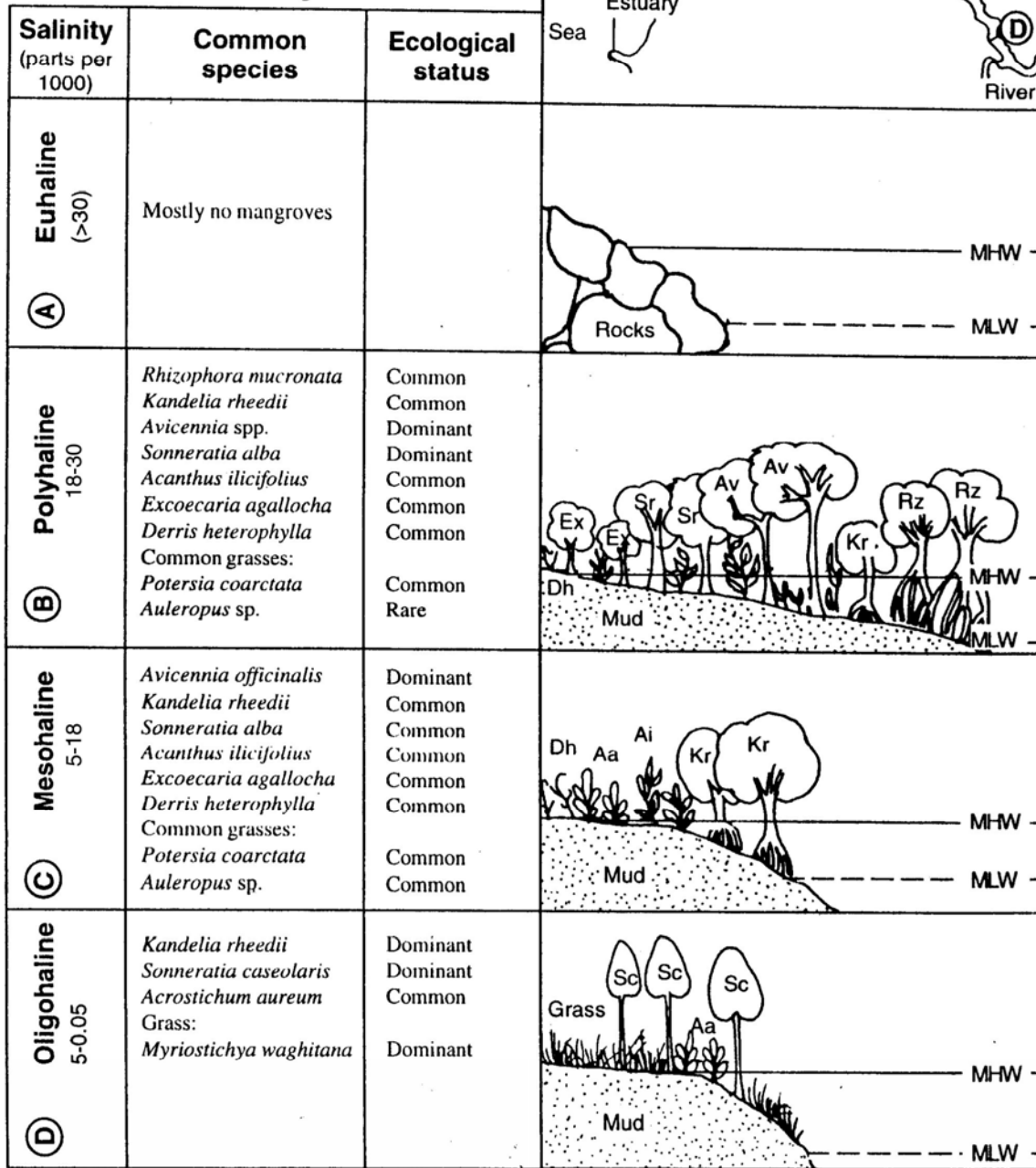
Fig 3. Features of leaves of different mangrove species.

Legends

- a. *Rhizophora mucronata*
- b. *R. apiculata*
- c. *Bruguiera gymnorrhiza*
- d. *B. parviflora*
- e. *Kandelia rheedii*
- f. *Avicennia alba*
- g. *A. marina*

- h. *Sonneretia alba*
- i. *Aegiceros corniculatum*
- j. *Derris heterophylla*
- k. *Exoecaria agallocha*
- l. *Acanthus ilicifolius*
- m. *Salvadora persica*

**Fig. 4. Profiles showing distribution of mangrove species along Mandovi estuary of Goa.**



Rz	<i>Rhizophora mucronata</i>	Kr	<i>Kandelia rheedii</i>	Av	<i>Avicennia</i> spp.
Sr	<i>Sonneratia alba</i>	Sc	<i>Sonneratia caseolaris</i>	Ex	<i>Excoecaria agallocha</i>
Aa	<i>Acrostichum aureum</i>	Dh	<i>Derris heterophylla</i>	Ai	<i>Acanthus ilicifolius</i>
MHW	Mean high water	MLW	Mean low water		