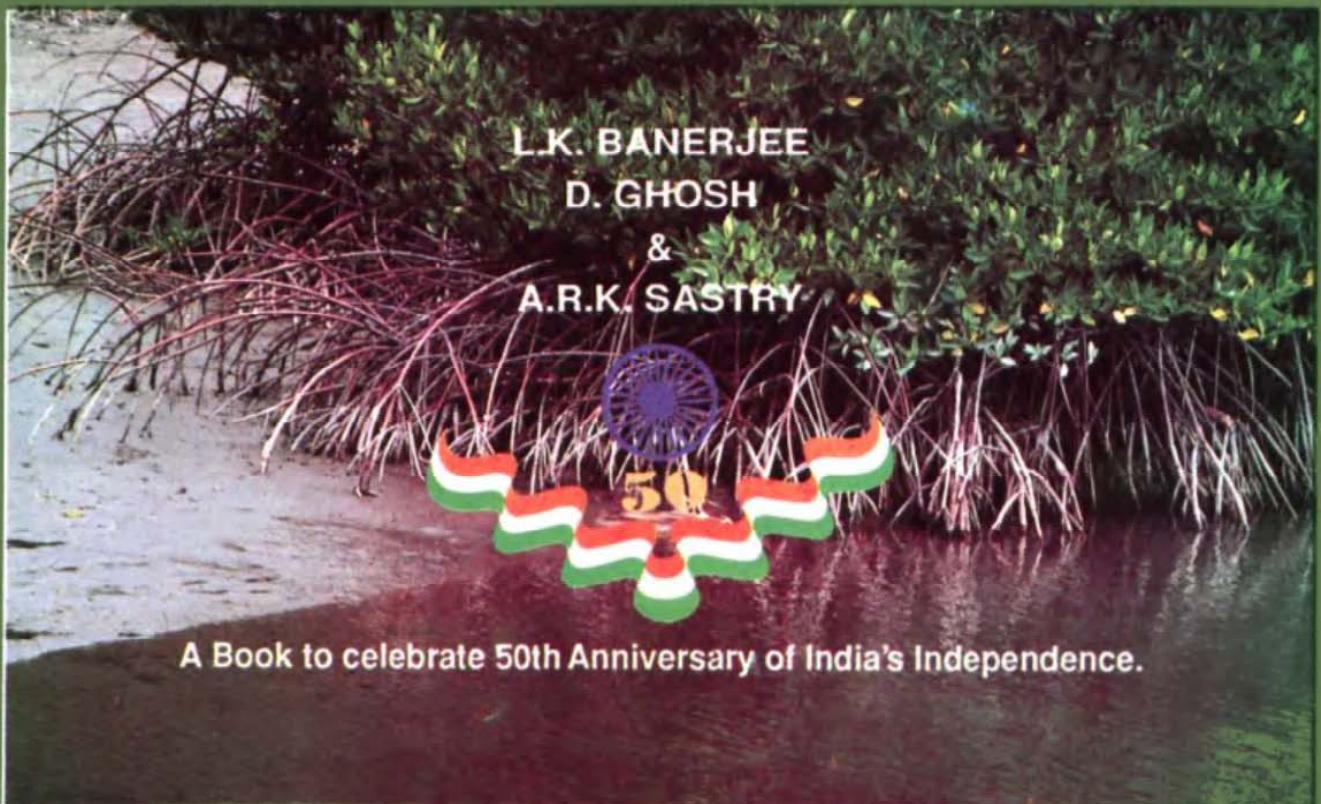




**MANGROVES, ASSOCIATES AND SALT MARSHES  
OF THE GODAVARI AND KRISHNA DELTA  
ANDHRA PRADESH — INDIA**



**L.K. BANERJEE  
D. GHOSH  
&  
A.R.K. SASTRY**

**A Book to celebrate 50th Anniversary of India's Independence.**

**BOTANICAL SURVEY OF INDIA  
ENVIS  
CALCUTTA**

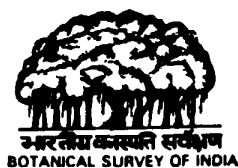


**MANGROVES, ASSOCIATES AND SALT MARSHES  
OF THE GODAVARI AND KRISHNA DELTA**

**ANDHRA PRADESH — INDIA**

**L. K. BANERJEE  
D. GHOSH  
&  
A. R. K. SASTRY**

*A Book to celebrate 50th year of India's Independence*



**BOTANICAL SURVEY OF INDIA  
ENVIS  
CALCUTTA**

© Government of India, 1998.

*No part of this publication can be reproduced, stored in a retrieval system or transmitted in any form or means by electronic, mechanical, photocopying, recording or otherwise, without prior written permission of the Director, Botanical Survey of India.*

Date of Publication : June 1, 1998.

*Price :*

*Cover Photos : Front Cover Photographs may be identified on the 1st & 2nd Photo Plates placed after Page No. 44 of this book.*

Published by the Director, Botanical Survey of India, ENVIS Centre, 1, Sudder Street, Calcutta 700 016; Computer typeset at DTP unit of ENVIS Centre, BSI, Calcutta 700 016, and printed by M/s. Scriptron, AC-200, Sector-1, Salt-Lake City, Calcutta 700 064.

## PREFACE

Mangrove formations along the sheltered places of Andhra Pradesh coastline, coastal backwater formations and the estuarine complex of the Godavari and Krishna Delta have been studied in detail. The importance and utility of mangrove ecosystems which provide significantly to social and economic benefit to the people living along the coastline are well-known even for more than thousand years. Mangroves and salt marsh plant species though were bounded together in the Godavari Krishna deltaic ecosystem over the long evolutionary time, majority of them were imperfectly known and less understood due to various constraints in the process of survey, collection, preservation and identification (specially the Krishna deltaic complex). Therefore the present intensive study of the mangroves of Godavari & Krishna Deltas in Andhra Pradesh provides a valuable data to assess the natural mangrove plant resources of Andhra Pradesh,

The book deals with the general features of mangrove areas, their topography, geomorphology, geology and river systems along with major environmental factors controlling the vegetation pattern and zonation of mangroves. Detailed floristic studies of the mangrove vegetation and some of the associated plant taxa have been described along with brief notes on ecological conditions, phenology and status in relation to geographical distribution. It deals with the uses and utilization of the flora, brief notes on existing faunas, phenology, regeneration and field characters of individual mangrove species identification along with notes on exploitation, management and conservation.

An attempt has also been made to compare the occurrence and distribution of mangrove in the Godavari Krishna Delta with those of the Sunderbans and that of the Mahanadi Delta.

L.K. Banerjee  
D. Ghosh  
A.R.K. Sastry



## **ACKNOWLEDGEMENT**

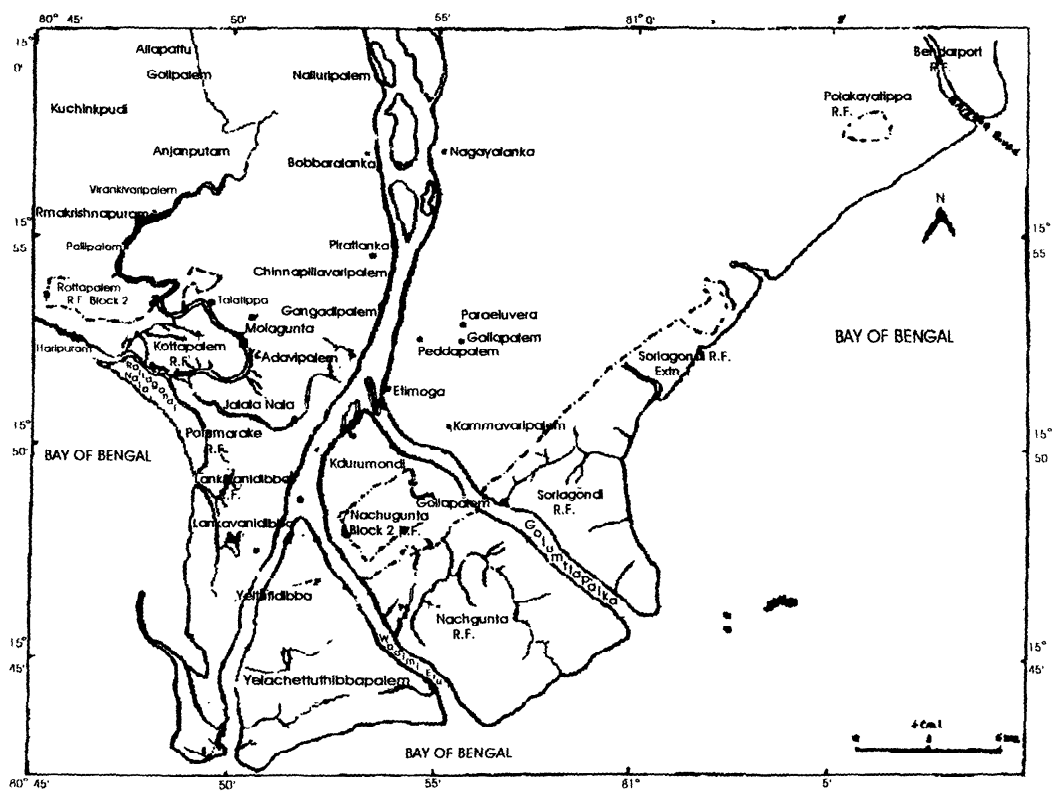
We express our deep sense of gratitude to Dr. P.K.Hajra, Director, Botanical Survey of India for going through the manuscript and giving valuable suggestion.

We are also thankful to the Scientific Assistants, Fieldmen and other staff members of the Ecology Unit, Botanical Survey of India and to the Forest Department of Andhra Pradesh, for the ready help in conducting the studies.

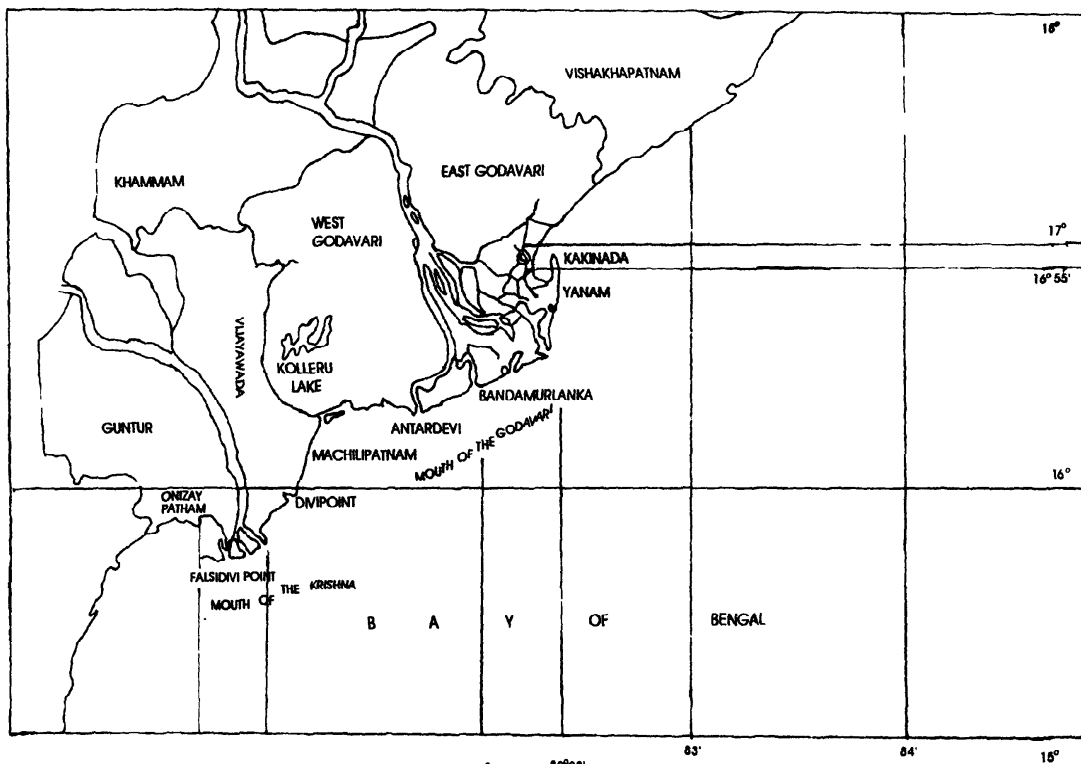
We are also thankful to the ENVIS CENTRE, Botanical Survey of India for the help rendered in processing and printing of this publication.

Botanical Survey of India.

L.K. Banerjee  
D. Ghosh  
A.R.K. Sastry

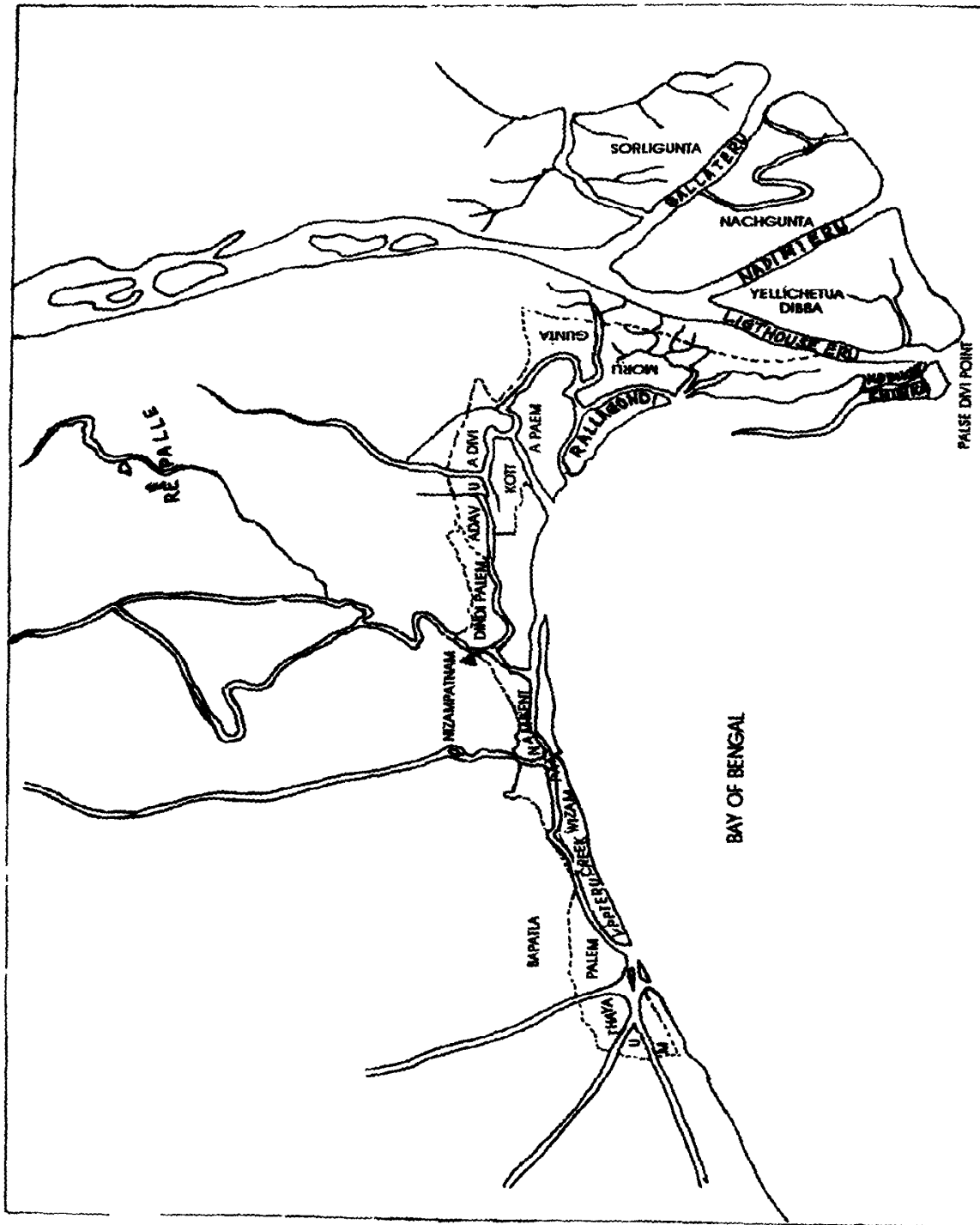


Map Fig. 1. : Distribution of mangals in Krishna estuary



80° 40' 81°  
SCALE: 1 CM = 18 KM

82° 82° 23' 83° 84° 18°  
MAP FIG. 2 GODAVARI AND KRISHNA DELTA



MAP FIG. 3 : COASTAL ANDHRA PRADESH AND THE KRISHNA MOUTH



## **Colour slides**

showing different topography  
and mangrove zonation  
in the Godavari and Krishna delta.





← *Avicennia officinalis* L.

*Xylocarpus granatum* Koen. with →  
fruits



← *Avicennia marina* (Forsk.) Vierh.

*Scyphiphora hydrophyllacea*  
Gaertn. f.  
Restricted in Godavari Delta. →





↑  
Hypocotyls of *Bruguiera  
gymnorhiza* (L.) Savigny



↑  
*Sarcobus globosus* Wall.



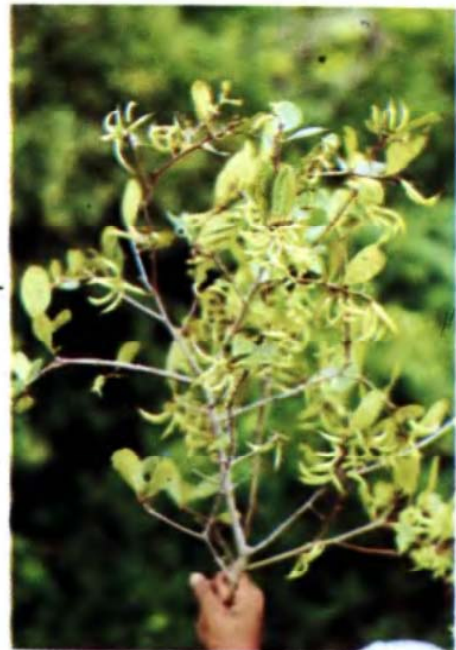
←  
*Lumnitzera  
racemosa*  
Willd





← *Aegialitis rotundifolia* Roxb.

*Aegiceras corniculatum* (L.) Blanco →



← *Exoecaria agallocha* L.  
Showing serpentine root system.





← *Rhizophora apiculata* Bl.



*Sonneratia apetala* Buch.- Ham. →



← *Bruguier cylindrica* (L.) Bl.



*Rhizophora mucronata* Poir →



↑  
Salt marsh formation along the Light  
house meru of the Krishna delta.



↑  
*Suaeda fruticosa* (L.) Frosk. ex Gmel.



←  
Backwater of  
the Godavari  
delta.



Mangrove creeks in Coringa of the Godavari delta.



The leaves of *Avicennia marina* (Forsk.) Vierh. are collected as a good fodder.



Showing the germination of hypocotyl in the intertidal region





Fish fair and processing in the Krishna delta.



The Crab catch in the estuarine area of the Krishna delta



Prawn culture in the mangrove areas of the Godavari delta



Fresh and Saline water fishes in the Krishna river.



Hammer headed Shark in the Krishna delta.



Showing the fish production in the Godavari delta.



Crocodile farming in the mangrove areas.

Some times Olive Ridley tortoise are found at Nalimundi Beach.



## INTRODUCTION

Mangroves are peculiar as they represent the best example among plants of epharmonic convergence. Their uniqueness lies in the survival pattern along several biological levels on the littoral environment and withstanding capacity in the most diverse and hazardous ecological conditions with some physiological and environmental adaptive characters. Negatively geotropic roots and viviparous seedlings demand attention. Most interesting parameters of adaptations, such as chemical behaviour of seeds during germinations and salt control process, specialised biochemical reaction and rate of carbon assimilation in the saline conditions need further research. Natural mutagen in course of allosterism of enzymes may guide the biogenetic reaction in connection with their physiological and environmental adaptation. Photoperiodic variation and some polyploid nature may produce some secondary metabolites, The structure and utilization of the chemicals produced in secondary metabolites will be of immense interest in the chemical fields.

A wide range of minor uses of the mangrove seeds have been recorded from various parts of the world. They are used for recovering from various diseases such as, blood impurities, boils, rheumatism, ulcers, tumours, diarrhoea, leprosy and many others. They are also used for illuminants oils, medicinal oils, hair oils and high proteins. Active chemical constituents of all the uses still need attention. Some toxic substances are usually associated with the carbohydrate, proteins and oils of many mangrove seeds. These toxic constituents may be used as drugs, insecticides and nematicides

The word 'Mangro' was originally the common name of *Rhizophora mangals* in Surinam and in Portugal. The word 'Mangue' is for individual tree and the word 'Mangal' for the plant community. No hard and fast rule for defining the term Mangrove exists, but they are usually defined as those plants species derived from a variety of plants families that are capable of living under the influence of salt water tidal inundation of the tropical and subtropical littoral habitat with the development of some adaptive morphological characteristics. The littoral habitat including estuarine and deltaic ecosystem is subjected to continuous ecological changes. Erosion, deposition and consolidation of sediments are regulated by seasonal activities like fresh and salt water run off, tidal action, wind, river water current and wave action. Zonation and species composition of mangroves in these fragile ecosystems vary depending upon the changes of these littoral habitats.

Mangrove forest is usually characterised by uniform type of evergreen trees, shrubs and climbers belonging to different families of angiosperm. The forest is commonly restricted in moist saline soil of intertidal wetland ecosystem where the tidal flats are associated with many meandering creeks, channels, distributaries, coastal lagoons and river inlets for adequate supply of constant water current. It exhibits a similar physiognomy with dark green shining foliage, negatively geotropic root formation such as spongy, corky or woody pneumatophores and unique vivipary in which either fruits are enlarged or elongating hypocotyle pierces the apex of the fruit; presence of salt excretory glands and thickening of leaves for storage of excess salt in the system are also the interesting features in this forest. Paucity of common inland species, almost absence of epiphytes, general scarcity of parasite, undergrowth and localised occurrence of some lianas and climbers are the general characteristics of this forest system,

Environment in the littoral habitat can be divided into two distinct types: (1) OPEN SHORE ENVIRONMENT — where the physiography of the shore faces a direct and open contact with the sea waves and salt water spray, severe wind action and mechanism of shifting sands. Here rapid leaching action due to presence of sandy soils and absence of regular fresh water flow create high concentration of salt in the soil solution and poor ecological condition for the growth of mangrove plants. Vegetation is found stunted and restricted to a narrow band on the coast line. (2) SHELTERED SHORE ENVIRONMENT — where the physiography of the shore provides a shelter which prevents from the direct action of the sea waves and salt water spray, wind action and shifting sand mechanism. It is exposed to a continuous supply of fresh water from the source of upper catchment area, seepage and rainfall. This in turn dilutes salts from the soil solution in this region and the efficiency with which each species tolerates with the soil salinity, largely determines its position in the intertidal regions from the river mouth towards the tidally affected areas of the upstream.

Surface relief of the deltas and estuaries along the sheltered coastal topography varies greatly when the river courses flow down from the higher elevation towards the lower elevation and finally to the sea. Rivers in the deltaic regions produces many meandering creeks and channels at higher places before forming a true estuarine mouth to the sea. Nature of tidal flows, salinity conditions and sediment types are found different in relation to the different

elevation of terrain. Mangrove plant communities with their respective adaptive features are also found to form different zonation patterns according to the elevation of the terrain.

It is possible to distinguish a zone of outer estuarine mangrove along the broadest regions of the river mouth influenced by open shore environment and a zone of typical mangrove, a zone of semi mangrove and a zone of transitional or hinterland mangrove along the inner estuarine regions influenced by sheltered shore environment. It is interesting to point out that the zone of semi mangrove habitat which is pronounced in the Gangetic Sunderbans and the Mahanadi deltaic system along the middle part of inner estuarine complex is not observed in the Godavari Krishna deltaic complex.

The important role of mangroves for commercial and economic development to the nation has been well realised by UNESCO, UNDP, IUCN, FAO, WWF etc. and also by the Government of India. The value of mangrove resources have been well divided both from the direct product and the amenities provided by the resources. Mangroves are used as potential resources for fuel wood, charcoal, timber, particle board, house and boat building materials, synthetic fibres, viscous rayon, dye, tanning, sugar, alcohol, condiments adhesive, medicine, incense, paper and pulp, packing boxes, thatching materials, match sticks, toys and other dependent faunal product like fish, shellfish, edible crabs, honey, wax, reptile skin, birds and mammals. Mangroves serve as rich nursery grounds for many estuarine fishes, shellfishes, prawns and crustaceans. Many birds, crocodiles, honey bees and endangered mammals are depending constantly upon this ecosystem for food and shelter. Many of the unique and unusual characteristics of the flora and fauna of the mangrove ecosystem provide opportunities for education and research study. Amenities provided by the mangrove resources which cannot be measured in terms of monetary values are of various types for protection and conservation of natural ecosystem.

They serve as natural border security forces with self repairable capacity against high wind and cyclone and protect adjacent vegetation and properties. The mangrove stilt roots, and trunks substantially lower the tidal currents and cause deposition of suspended sedimentary materials, while roots ramifying through and binding also help in stabilizing the substrate.

### **INDIAN SCENARIO OF MANGROVE HABITATS :-**

Physical area of mangrove habitat in India has been regarded as an extension of the Persian Gulf. Total length of Indian Coastline which falls within the bounds of tropics has been estimated about 7400 km and



approximately 6740 sq.km of the littoral region is protected by extensive cover of the mangrove forests which are probably the third largest formation of the world after Indonesia & Australia. This ecosystem serves considerable commercial and economic value to the people nearby. Mangrove areas in India along the East Coast are found in the Gangetic Sunderban complex, Mahanadi deltaic complex, the Godavari-Krishna Deltas, the Cauvery estuarine system and the Andaman & Nicobar Island. Along the West Coast, Mangroves are confined to the backwater systems, innumerable interconnecting canals, lakes and creeks in Maharashtra, Karnataka & Kerala and salt marsh dominated mangrove areas of Kutch and Saurashtra of Gujarat State. The total area of Indian mangrove forest cover in respect of different states as estimated by previous workers and pointed out by Chaudhuri & Chaudhury (1994) is found different from our recent study. Table 1 & 2.

Table - 1

Location	Mathuda Khan (1957) ha	Waheed (1957) ha	Sidhu (1963) ha	Blasco (1977) ha
<b><u>WEST COAST</u></b>				
Gujarat	—	38,074	52,616	20,000
Maharashtra	—	24,864	62,208	20,000
<b><u>EAST COAST</u></b>				
Tamil Nadu	671.8	—	2,640	1,500
Andhra Pradesh	18,640.8	—	18,424	10,000
Orissa	12,140.8	—	12,000	5,000
West Bengal.	423,804.1	423,990	418,888	200,000
Andaman & Nicobar Islands	116,552	120,437	115,200	100,000
<b>Total</b>	<b>571,808.9</b>	<b>607,375</b>	<b>681,976</b>	<b>356,500</b>

The area estimated by us through survey and detailed data collection is presented below.

Table - 2

Location	Area in Sq.km
<b><u>WEST COAST</u></b>	
Gujarat	260
Maharashtra	330
Karnataka	90
Kerala	16
Goa	38
<b><u>EAST COAST</u></b>	
West Bengal	4,200
Orissa	215
Andhra Pradesh	251
Tamil Nadu	150
Andaman & Nicobar Islands	1,190
<b>Total</b>	<b>6,740</b>

The richness and diversity of the mangrove vegetation of the East Coast is due to its vast deltaic situation, fresh water flow and large intertidal mud flats with rich inorganic sediments. In contrast, the mangrove formation is poor in quality and extent due to its confinement to narrow sea inlets, lagoons and backwater system along the West Coast. Due to these major topographic differences, the east coastal mangroves including Andaman and Nicobar are considered to be the best habitat and commonly harbour 63 species out of the total 65 species in India. Well developed and luxuriant growth of mangroves are only seen in the Andaman and Nicobar group of Islands.

Of the four major Indian Deltas in the Eastern coast, namely the Gangetic Sunderbans, the Mahanadi, the Godavari Krishna & the Cauvery, the third largest mangrove formation of the world is located in Gangetic

Sunderbans. Next to Sunderbans is the Mahanadi deltaic mangroves including Bhitarkanika system, in Orissa for maximum number of species concentration in this area due to availability of adequate mixtures of fresh and saline water flow through out the seasons. Mangroves are relatively less in number and extent along the deltas of Godavari, Krishna and Cauvery. In fact, the Godavari-Krishna deltaic mangroves hold the third position in respect of species concentration of the four major Indian Deltas.

Both the Godavari and the Krishna Deltaic Complex due to their geographical proximity have been treated together as they blend themselves admirably for unity and in approach and for better understanding and appreciation. The Godavari river may be taken as a border line barrier for extent of distribution of some mangrove species which are available in both the Sunderbans and in the Mahanadi Deltas. It is evident that deltaic flora is very conspicuous in density, frequency and number of species concentration in the Sunderbans and in the Mahanadi Delta and relatively less in dominance and extent in the Godavari-Krishna Delta and Cauvery Delta. The Sunderbans of the Gangetic complex is the area of chief attraction among the many workers of the past and the present. The second best concentration of mangrove flora which is reasonably presumed to exist in the Mahanadi deltaic complex, has been recently studied in detail by the Botanical Survey of India. Despite the past stray collection, the Godavar-Krishna deltaic areas have received comparatively very little attention inspite of the emphasis laid by Rolla S. Rao *et al.* 1985, for further studies in depth, covering the entire mangrove localities of these two deltas and for understanding the valuable mangrove ecosystem of the state, Andhra Pradesh.

The early pioneering investigation of the mangrove of Godavari-Krishna Delta was conducted by Gamble(1918), Cornwell(1937) and Venkateswarlu(1944). Recently the delta has been studied by Sidhu S.S (1958), Rolla S. Rao (1959), Waheed Khan (1959), Rao T.A, *et al* (1974), Blasco(1975), Rolla S.Rao *et al.* (1985), Reddy C.S. (1982) and Prasad S. N. (1992). A comparison of these various accounts shows that most of the mangroves in the deltas have a tendency towards a phase of exploitation for fire wood, over utilization and many secondary developmental activities. As a result, the thickness became more and more open and lands are converted to oversaline scalds or salt marshes which is very prominent now towards Sorligunta, Lankavanidibba and Ellichitladibba near the Krishna mouth. It is also felt that survey of the entire mangrove formation of each forest blocks for obtaining a comprehensive data on the Krishna mangroves seems to have been neglected possibly due to remoteness and its association as a colonial penal settlement colony.

Extensive field survey from the Ecology Unit, Botanical Survey of India during 1989 to 1991 and scrutiny of available literature and herbarium materials reveal that though the mangrove formations of the Godavari-Krishna delta in Andhra Pradesh cover smaller areas than that of the Sunderbans yet occurrence of a few mangrove species which are not usually found in the Sunderbans areas is a major point of interest. It has become possible to report some mangrove species as new record for the state and first time report for the Indian mainland region.

Like other Indian Deltas, the Godavari-Krishna mangrove which provides the enormous resources for social, economic and commercial development is changing rapidly due to natural calamities, deforestation, aquaculture, resettlement etc. The vegetation is being destroyed either intentionally for short-term economic benefit and over-exploitation by traditional users or as a result of many secondary developmental activities.

In the absence of proper management and conservation plan and local awareness, mangroves of these deltas have reached an alarming stage specially all over the river mouths. It appeared, therefore, of value to study in detail the mangrove forests of this deltaic complex situated between the Godavari and the Krishna rivers.

The present account records the study of mangrove flora and vegetation made during several exploration tours. The work presented in four parts : the 1st part deals with the general account of the area with relevant details about the topography, geomorphology, river system, general climate, soil, river salinity and tidal inundation ; the 2nd part deals with the distribution and zonation of vegetation in relation with the interacting environmental factors, some aspects of classification and success pattern of the vegetation ; the 3rd part deals with the full synopsis of the flora with the keys, short description of the taxa, phenology, general ecology and distribution of the species ; and the 4th part deals with the conservation, utilization and management of the mangrove along the deltaic region of the Godavari-Krishna system in Andhra Pradesh,

#### **GENERAL FEATURES OF MANGROVE AREAS IN ANDHRA PRADESH**

The state of Andhra Pradesh according to Forest Survey of India's assessment in 1991 has a geographic area of 2,75,068 Sq.km Out of which an area of 63,726 Sq. km falls under the general forest cover which works

to 23.2% of the geographical area. The important mangrove formations are located only along the estuaries of Godavari & Krishna rivers. Out of these 63,726 Sq. km of forests cover, only 585 Sq. km are notified as reserved mangrove forests under the control of Forest Department, which works to be a mere 0.9% forest area of the state. The actual area under mangrove cover according to 1991 assessment of the F. S. I. is 399 Sq. km The Reserved Mangrove forest areas covering 585 Sq. km does not contain fully mangrove vegetation, because large areas included in these reserve forests remain as open blanks, sand bars and *Casuarina* plantation.

It is estimated that the effective area under mangrove cover in this state is around 251 Sq. km The mangrove forests of Andhra Pradesh are located in the estuarine complex of the Godavari and the Krishna rivers spreading over the districts of East Godavari, Krishna & Guntur.

The district wise distribution of the Reserved mangrove forest areas according to Working Plan, Forest Department, Andhra Pradesh, 1994 are furnished here :

S1. District No.	Name of Forest block	Area in Ha
1. East Godavari Kakinada Talug	1. Regita.F,	457.00
	2. Coringa R.F,	4,242.38
	3. Coringa Ext.R.F.19,	19,467.00
	4. Kothapalem R.F.	50.80
Mummidivaram Talug	5. Masonithippa R.F.	1,089.91
	6. Balusithippa R.F.	475.91
	7. Muori R.F.	147.37
	8. Rathukalava R.P.	2,043.32
	9. Kandikuppa R.F.	3,802.00
	10.Mattatippa R.F.	445.15
	11.Kothapalem Extension R.F.	61.52
	12.Bhairavapalem R.P.	971.05
		33,266.32 ha
		(or) 332.66 Sq.km

2. Krishna Divi	1. Nachgunta R.F.	6,064.64
Divi Talug	2. Nachgunta II R.F	75.48
	3. Sarlagondi R.F.	2,508.22
	4. Sarlagondi Extension R.F	2,691.18
	5. Yellichitla dibba R.F.	3,714.09
	6. Yellichitla dibba Extn R.F.	610.01
		<hr/>
		16,463.68 ha
		(or) 164.63 Sq.km
		<hr/>
3. Guntur Dist.	1. Adavula deevi	261.91
Repalle Talug	2. Adavuladeevi Extn I	40.87
	3. Adavuladeevi parra bit II	169.96
	4. Amudalapalli	464.94
	5. Dindi	51.14
TOTAL AREA IN	6. Kothapalem block I	1,553.91
Sq. km 585.10	7. Kothapalem block II	729.25
	8. Kothapalem Extn I	745.03
	9. Lankavani dibba	1,153.36
	10. Nizampatnam	1,629.28
	11. Pothumeraka	1,736.20
	12. Muthayapalem Extn I	291.37
		<hr/>
		8,782.22 ha
		(or) 87.82 Sq.km
		<hr/>

## TOPOGRAPHY

The coastal plains of the districts: East Godavari, West Godavari, Krishna and Guntur of Andhra Pradesh, have been formed by two types of shorelines formation : (1) The sandy shore line along the sea coast where no interruption occurs by rivers, backwater flows and channels for breaking the intact coast line ; (2) The alluvial or silty deltaic shore line at the mouth

of the rivers, distributaries, backwater flows where the intact coast line is being disturbed due to formations of many low lying tidal flats associated with numerous creeks and canals. These shallow, low lying areas with triangular or funnel shaped configuration along the mouth of the rivers Godavari and Krishna where a mixture of fresh and brackish water flow is very prominent form the delta,

The river Godavari in combination with its main distributaries, Gautami Godavari, Vasista Godavari and Vainataya Godavari forms an extensive deltaic plain and meet the Bay of Bengal at Yanam, Vandamurlanka and Antarvedi respectively, Similarly, the river Krishna with its main distributaries joins the Bay of Bengal at Sarlagondi, Ellichitladibba and Nachgunta respectively. The area under study falls between the 15°40' to 16°55' N and 81°40' to 82°23' E covering a distance of about 195 km long and 30 to 90 km wide extending from the port of Kakinada in the north-east and the port of Nizampattanam in the southwest.

The Godavari deltaic area is bounded in the north by Kakinada port and in the east by the Bay of Bengal, in the west by the Eastern Ghats and in the south by Machlipattanam. The Krishna deltaic area is bounded in the north by Divi point and in the east by Bay of Bengal, west by Repalle and in south by Nizampattanam (Map-Fig.1). Several creeks, canals and distributaries form the most conspicuous features of the whole landscape.

### GEOMORPHOLOGY AND GEOLOGICAL SETTING

**Godavari Delta :** The Godavari Delta has a projection of about 35 km into the sea from the adjoining coast. The shore of this delta is not lobate. It is probably a projected rectangle. The larger side of the rectangle lying parallel to the general coastal trend of North Circars is about 90 km long, while the two other sides projecting north-west to south-east are approximately of the dimension of the deltaic protuberance. This rectangular shape of the delta is rather unique and appears to be related to the local coastal trends and direction of winds (direction of wind is from south-west). The resulting long shore drift is likely to streamline the delta face from south-west to north-east. A similar south-west and north-east trend can also be seen in the delta face of the Mahanadi from Puri to Palmyras point.

The Godavari delta is the third largest among the Indian deltas after those of the Ganga and the Mahanadi. The geological and structural foundation of the Godavari delta are similar to those of the Mahanadi. The alluvial cover



is relatively shallow by crystalline basement, mostly Khondalites. This delta also lies towards the south-eastern end of a permocarboniferous Gondwana trough but the limits of this delta are markedly beyond this ancient rift valley. The occurrence of marine coastal tertiaries, in the region of delta head near Rajmundry, points to the fact that in geological recent past the area was occupied by the deltaic alluvium under the sea. Subsequent (Pleistocene) emergence of this submarine floor and the marine sedimentaries made this as a coastal plain. The subsidence in the coastal plain of this delta can be inferred to be much less than in the Ganga delta or even the Mahanadi delta. This, we could say on the basis of the size of the deltas. However it is surprising that the present deltaic alluvium appears to be post-pleistocene despite the fact that the basin of Godavari is larger than the Mahanadi.

**Krishna Delta :** This delta has a protuberance of about 37 km and deltaic shore of about 90 km. This delta is unique among the Indian deltas as having the greatest protuberance in relation to its sea face which is relatively short. The basin of Krishna is almost as large as that of the Godavari but the amount of precipitation in the former is much lower than in the latter, resulting lower discharge of water and delta building sediments. The marked protuberance of the Krishna delta is probably a result of the relatively calm marine waters in which they have been built. The lee effect of Eastern Ghats has dominated the terrestrial over marine action with reference of the South-Western Monsoon in this region. Moreover, it is here that the Indian Coast line makes a sharp bend. The bays along the east and west of the Krishna delta are small resulting minor effect of wind and feeble wave action from south-west or north-east sides. Moreover, such winds would create longshore drifts parallel to the delta face and little action transverse to the sea face of the delta. The result is an unusual subordination of the marine forces in the region of the Krishna. These probably account for the unusual protuberance of the Krishna delta. It is near these delta head that the inner edge of the coastal zone seems to be deamed and the rocky out liners begin to appear (Pascoe, E.H. 1964) (Map Fig.-2).

## **GEOLOGICAL SETTING**

The deltaic regions of Andhra Pradesh with the districts of East Godavari, West Godavari, Krishna and Guntur are formed by the recent deposits carried out from the rivers Krishna-Godavari and their distributaries. Except in portion between Srikakulam in the North & Vishakhapatnam in the South, all the coastal plains of these regions are occupied by the recent deposits. The flood plains deposits which are confined to the vicinity of present creeks and channels have a strong similarity with the recent sediments.

## RIVER SYSTEM

The river Godavari is the second largest river in India covering about 1,530 km, the drainage area is about 2,90,400 Sq. km. The normal run off from the Godavari is estimated at 9206.3 million cubic metre. This is the largest river in peninsular India which has the drainage system towards the east and south-east and ascribed to the tectonic rise of the Western Ghats during the Miocene period (Vaidianathan 1977) which has caused a slight tilt of the peninsular to the East Coast.

The Godavari after passing through Papi Hill range emerges out at Palvaram into the coastal plain. The width of the river varies from 4 to 6 km. Below Rajamundry at Dowaliswaram, it divides into two major distributaries such as the Gautami Godavari or East Godavari and Vasista Godavari or West Godavari which further down stream gives rise to Vainataya Godavari. The extensive deltaic complex is formed by these three distributaries which join the sea near Yanam, Narsapur and Razolle respectively. The river system of the Gautami Godavari with its many distributaries, creeks and canals forms several islets and extensive mud flats at the mouth of the bay near Yanam region. Some of the important mangrove tidal flats are situated about 45 km away to the downstream of Yanam. They are namely Rajkawla, Kandikuppa, Sarcomento and Coringa in the Gautami Godavari complex of East Godavari district. The mouth of Vasista Godavari and Vainataya Godavari is of sandy formation and hardly any mangrove tidal flats are found on those places.

The river Krishna is the second important in the peninsular region. It is superimposed across the northern end of the Cuddapah ranges where the gradient is 0.7 m/km. Near the sea, the gradient gradually decreases and estimated to 0.15 m/km. The river carries enough silts and sands to cover an area of 5 Sq. km to a depth of 0.5 m during high floods.

It flows into two main distributaries near Pangadda in Krishna District enclosing the islands of Divi. About 16 km downstream, it splits into three branches to form extensive deltaic formation in association with many creeks and canals and join the sea at Sorligunta, Nachgunta and Yellichitladibba respectively. Some of the important mangrove tidal flats and salt marshes are seen here due to interconnection of several creeks and canals. They are namely Nachgunta I and II R.F., Sorligunta R.F. and Lankavanidibba in the Guntur district.

## ENVIRONMENT

Optimum environment for development of mangrove ecosystem along the coastal line depends upon the sheltered situation of the bay. In the deltas and backwaters, the vigour of the sea-surf, wind velocity and salt spray are not directly hitting the strands. Here the lands are encroached on by several creeks, channels and distributaries. Periodical changes of the tide levels in relation to different elevation of terrain, degree of admixture of fresh water with sea water and concentration of brackish water in different seasons are major environmental factors which control the formation and zonation of ecosystem communities from the river mouth towards inland areas. Velocity of wave action becomes more forceful when it enters through the creeks and canals. Flood tides provides oxygen and nutrients to the fringe-plant communities and ebbtide carries wastes away toward the sea. In view of the above variation of the environmental factors, the climate, salinity, tidal inundation and sediment types which influence the distribution and zonation of deltaic mangrove ecosystem have been discussed as follows :-

### Climate

The Godavari-Krishna deltaic regions enjoy tropical humid climate with moderate range of temperature throughout the year. Temperature commonly increases from the month of February to May. May is the hottest month with 33° C at Machilipattanam and 32° C at Kakinada. The coldest month is January which records temperature of 23° C in the coastal regions and 19° to 20°C in the interiors. Maximum temperature varies from 23° to 33° C and minimum temperature varies from 19° to 27°C. There is little variation in annual normal temperature because of the moderating influence of the sea. Rainfall decreases from coastal areas to the interior. Along the deltas it varies from 970 mm to 1180 mm (in Krishna delta 1047 mm). The areas usually get rainfall from South West Monsoon and the rainy season extends from the month of July to October and November. The rainfall decreases in Krishna delta compared to that of the other deltas because this region lies off the monsoon track and falls within the depression zone. Humidity generally prevails throughout the year in the deltaic regions and records 65% during June and 78% during November and December.

Wind velocity becomes 25-30 km per hour during monsoon and ranges from 10-15 km per hour during winter. Sometimes depression in the Bay

intensifies the velocity from 150 180 km per hour. As the Krishna Godavari delta is associated in depression track, the entire area is vulnerable to cyclone. About 200 cyclones (including the major two in 1977 and 1990) are reported to hit this region during the last 100 years and in most of the cases the areas of Kakinada, Yanam and Divi taluk of the Krishna river mouth bore the brunt.

TABLE - 1

**RAINFALL IN THE TIDAL FOREST AREAS OF ANDHRA PRADESH**

(in milimetre)

<b>MONTH</b>	<b>KAKINADA</b>	<b>MACHILIPATNAM</b>
January	7	5
February	8	14
March	12	11
April	16	18
May	39	34
June	119	107
July	166	162
August	141	159
September	157	62
October	216	218
November	142	147
December	15	17
Total for year	1,002	1,053
No. of rainy days	55	97
No. of months less than 50 mm	6	6
Mean annual humidity	73	74
No. of years	60	60



TABLE 2

TEMPERATURE IN THE TIDAL SWAMP FOREST AREAS OF  
ANDHRA PRADESH

( in centigrade)

At KAKINADA 8 m above sea level.

MONTH	MEAN	MEAN MAXIMUM	MEAN MINIMUM
January	23.2	27.3	19.1
February	25.4	29.8	20.9
March	28.2	33.2	23.1
April	30.7	35.6	25.8
May	32.5	37.3	27.6
June	31.6	36.0	27.2
July	29.1	32.4	25.8
August	28.9	32.1	25.7
September	28.9	32.1	25.6
October	27.7	31.1	24.4
November	25.2	28.4	22.0
December	23.1	26.9	19.1
Mean annual temperature		21.9	
Annual mean maximum		31.8	
Highest record		47.2	
Annual mean minimum		23.9	
Lowest record		13.9	
No. of years		60	

## General features of soil

The deltaic region of the Krishna-Godavari abounds in alluvial soil. Some transported red soils and black soils are also found in the interior parts of the delta. Alluvial soils are mostly found in the river valleys and deltaic tracts along the coastal line. Their composition and textures vary with the geological nature of the catchment area. These alluvial soils are usually of two types :— Coastal alluvium and Riverine alluvium. Riverine alluvium is found in the lower courses of the valleys of most rivers and deltaic regions. Soils are moderately alkaline, calcareous clay loam to sandy loam in texture with low organic matter, rich in lime, sodium chloride and sodium sulphate and poor in nitrogen and phosphoric acids. Organic matter content ranges from 0.3 to 1.5 per cent. Soil reaction is acidic subjected to wide seasonal variation. This acidic reaction of the Godavari-Krishna deltaic soil is peculiar in comparison to other Indian deltaic soils of the east coast. The riverine alluvium is common along the Krishna and Godavari estuarine areas, Coringa Bay, Kandikuppa, Nachgunta, Sorligunta, Nizampattanam, Kothapalem and Yellichitla dibba partly.

Coastal alluvium is common along Kakinada, Nizampattanam, some areas of Gautami Godavari mouth and Krishna's mouth. These soils are composed of varying admixture of fine and coarse sands with mixture of loam and humus. In some places, the sand is underlain by huge depth of silt and clay of fluvial origin.

Besides these two major types, another type of soil formation becomes more prominent in these deltaic areas which is known as saline soils. It is seen on the backshore of the sea board extension and on the banks formation within the middle part of the mangrove swamps.

As the banks of the rivers along estuarine areas rise above the tidal limits with fresh accretion of silt every year, the places become amenable to weathering which drives away the moisture but leaves the salinity in concentrated form and during the summer with further loss of water content, the salts are drawn to the surface by capillary action and the surface found encrusted with raw salt. This soil cause hindrance for the development of mangrove species and eventually found covered with salt tolerant species like *Suaeda*, *Salicornia* etc. of the salt marsh community.

**TABLE 3**  
**Soil Analysis Data**

Areas	Particle size distribution (depth 30 cm.)				pH	Organic matter %	EC ds m <sup>-1</sup>
	Clay %	Silt %	Fine Sand %	Coarse (1:25) Sand %			
<b>GODAVARI DELTA</b>							
Outer Estuaries	25	49	18	9	7.9	0.74	36.4
Inner Estuaries	45	25	20	10	8.15	0.95	31.5
Creeks & Canals							
Hinterland areas	21	11	35	33	8.2	1.50	22.8
<b>KRISHNA DELTA</b>							
Outer Estuaries	20	50	20	10	8.12	0.85	38.9
Inner Estuaries	51	26	15	7	8.25	1.05	33.8
Hinterland areas	19	16	41	24	8.28	1.15	21.5

\* Data represent average values of 10 samples from each type. (Soil samples analysed by Soil and Salinity Research Centre, Canning, C.S.I.R.).

## TIDAL RANGE AND WATER SALINITY

Tidal level varies from the estuarine mouth towards the inland areas subjected to wide seasonal variation. Maximum height observed from the tide datum is 4.3 m towards the estuarine mouth and 2.5 m towards inland areas during October and November. Minimum is 3.2 m and 1.5 m during May and June.

Water salinity of the river Gautami Godavari and Krishna rivers varies depending upon the amount of fresh water flow, tidal amplitude and amount of rainfall. It decreases from the river mouth to the inland areas. Seasonal salinity ranges at a depth of 30 cm indicates that maximum salinity is 38.9 EC (ds m<sup>-1</sup>) at the estuarine mouth during October and November which decreases gradually to 21.7 EC (ds m<sup>-1</sup>) towards the inner tidal creeks. The minimum ranged from 11 to 4 EC (ds m<sup>-1</sup>) in the hinterland areas.

TABLE-4

**Analysis of river water salinity and tidal levels of the Godavari-Krishna Delta**

Areas	Salinity EC (ds m <sup>-1</sup> ) Dept. 30 cm				Tide level from tide datum in Meter			
	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D
<b><u>GAUTUMI GODAVARI</u></b>								
Outer Estuaries	31.5	33.4	36.8	38.9	3.2	3.3	4.0	4.3
Inner Estuaries	16.6	17.3	19.6	26.6	2.8	3.0	3.4	3.8
Hinterland Area	12.2	13.2	14.5	21.7	1.5	2.0	2.3	2.5
<b><u>KRISHNA RIVER</u></b>								
Outer Estuaries	32.6	37.0	37.5	39.4	2.8	2.9	3.8	4.0
Inner Estuaries	18.8	19.8	20.3	27.6	2.4	2.5	3.2	3.6
Hinterland Area	14.2	15.7	16.5	22.3	1.5	1.9	2.1	2.5

Data represents average values of 10 samples from each type.



## MANGROVE VEGETATION

Studies on vegetation usually include some aspects on plant communities, their structure, function and classification in relation with interacting environmental factors. Under this pattern, the efficiency with which each plant tolerate environmental condition largely determines its phytogeographical position and nature of morphological adaptation. Knowledge of mangrove flora and vegetation in India is mainly based on the systematic studies of various published floras and articles since the time of publication of Hooker's Flora of British India. (Roxburgh, 1814; Clarke, 1896; Prain, 1903; Griffith, 1836; Heining, 1893; Naire, 1884; Hooker *f. et al.*, 1875-97; Cooke, 1901-1908; Blatter, 1905; Gamble, 1915-1935. The few recent publication pertaining to mangrove vegetation are from Kutch and Saurashtra and South Gujarat (Jain *et al.*, 1960a, b, 1969; Rao *et al.*, 1965, 1966, 1969, 1970; Tvor. 1958; Shaw, 1967). From Maharashtra state and Goa, (Bharucha, 1950; Satyanarayan, 1958; Shah, 1962; Navaikar, 1940, 1951, 1956, 1959, 1961; Navaikar and Bharucha, 1959; Untwalle *et al.*, 1975). Karnataka coastal areas, (Arora & Aggarwal, 1965; Rao *et al.*, 1990) Malabar Coast of Kerala state (Erlanson, 1936; Mudaliar & Kamath, 1952; Thomas, 1962; Rao *et al.*, 1977.) Tamil Nadu state (Marlange & Meher homji, 1965; 1973; Nayer, 1969; Lawrence, 1961; Rao *et al.*, 1953; Danieal, 1967; Rajgopalan, 1952; Blasco & Caratini, 1973; Caratini *et al.*, 1973; Rao *et al.*, 1975) Andhra Pradesh (Venketeshwaralu, 1944; Venketeshwaralu *et al.*, 1972; Rao, 1967; Rao *et al.*, 1970, 1971, 1972; Sidhu, 1963; Sastry and Rao, 1976; C.S.Reddi, 1982; Blasco, 1975) Utkal coast (Haines, 1924; Mooney, 1961; Raizada, 1949; Sanyal, 1957; Banerjee, 1989; 1990) and Bengal coast (Curtis, 1933; Champion and Seth, 1968; Rao *et al.*, 1971, 1972; Blasco, 1973; Mukherjee & Mukherjee, 1978; Banerjee, 1987; Sanyal & Banerjee, 1984; Naskar & Guha Bakshi, 1987).

Champion (1936) classified mangrove formation on the basis of physiognomic dominance of plant communities into vegetation type. He grouped the mangroves into tidal forest type purely based on edaphic conditions. In 1968, Champion and Seth while revising the vegetation types of India, brought the mangrove vegetation under Littoral and Swamp forests types, taking into account the situations under which they are growing. In between 1936-1957, stray attempts have been made by many authors as evidenced in the papers submitted at the mangrove symposium (1957). Most of the data presented at the above symposium were meagre, since majority of the papers dealt with summary account already available in the country.

During the recent years, Rao & Sastry (1973-74), Blasco (1973) & Banerjee (1987) have reclassified the mangrove vegetation in greater details

but adhering to the original framework adumbrated by Champion and Seth (1968). Rao and Sastry's broad based work was concentrated on coastal vegetation in regional setting, specially in respect of estuarine major and minor in general. Blasco has treated the entire coastal vegetation under the collective term 'Mangrove' and their details are worked out in respect of zonation, ecology, flora, silviculture and dynamism in general. However in this attempt the author has classified the region under the categories of 'Mangrove Proper', 'Back mangrove' & 'Palm Swamps'. Banerjee's broad based work was built on the strength of detailed investigation on mangrove throughout the Indian Deltas and Estuaries. His classification was based on the efficiency with which each species withstands the prevailing conditions and environmental factors in relation to the intertidal position and morphological adaptations. He divides the entire mangals into two major heads : the outer estuarine mangals and inner estuarine mangals. The inner estuarine or riverine mangals have been divided again into three minor heads depending on the zonation of species in respect of salinity conditions, soils, tidal level and morphological adaptations. He divided the zonation of the species into typical mangrove zone or true mangrove zone, less pronounced or semimangrove zone and hinterland mangrove zone.

Of the major 5 deltas, namely the Ganga-Brahmaputra the Mahanadi, the Godavari, the Krishna and the Cauvery, it is evident that the deltaic flora is very conspicuous in density, frequency and number of species composition in the Sunderbans and in the Mahanadi deltaic complex but relatively less in dominance and extent in Godavari Krishna complex and in the Cauvery delta. The Sunderbans of the Ganga Brahmaputra complex is the area of chief attraction among the many workers. The second best concentration of deltaic flora, reasonably presumed to exist, is in the Mahanadi complex. From the work of Haines (1921-23) and Mooney (1950), it is evident that the areas need further study in depth to understand the deltaic flora of Orissa. Recently, Banerjee (1980-1990) has studied this delta in details. The work in the Cauvery delta has been attempted by many recent workers (Meher Homji, 1975; Blasco & Caratini, 1973 and Caratini *et al.*, 1973) dealing mainly with the flora, vegetation zonation and phytogeography. Finally, despite the past stray botanical collection from the Godavari-Krishna delta, nothing is known about these deltaic vegetation as a whole. Though recently some work on the Godavari delta in respect of vegetation and flora has been attempted by Blasco (1977), Rao *et al.* (1972), Sidhu (1963), Venketeshawarlu (1944) and Reddi (1982) but the adjoining Krishna delta was the most neglected and remained

unexplored part of the Andhra Coast except the work of Prasad, S.N. (1992). Blasco (1975) made few collections from some parts of the Krishna delta but his study was not reflected on the basic pattern and zonation of the vegetation for the whole deltaic complex of the river Krishna. Thus the authors feel that a proper scientific and ecological study of the mangals of both the deltas with special interest on the Krishna complex is urgently needed to evolve a suitable management practices for sustained yields development of the mangrove ecosystem of both the deltas.

## MATERIAL AND METHODS

Field work was conducted at different mangrove forest blocks of the Krishna and Godavari deltaic areas during the year 1989, 1990 and 1991. Soil samples were collected at each representative habitat type from 0-30 cm depth. Water samples were collected seasonally at a depth of 30 cm in clean polythene bottles starting from the river mouth towards the inland areas. Conductivity was recorded by means of conductivity meter. Seasonal tide level was verified from Indian tide table data. pH, Organic contents and EC were analysed from the Soil and Salinity Research Centre, Canning, C.S.I.R. Laboratory and presented in tables. Collection of plant specimens made during the field tours have been identified and deposited in the Herbarium CAL.

## MANGAL ZONATION

Considerable changes in the zonation of the mangrove vegetation extending from the river mouth of the Godavari-Krishna to the influence of saline tide water flow towards the Inner riverine system have been recognised. The sequence of plant zonation is interrelated to the interacting environmental factors like soil salinity and tide level from the outer estuarine regions of the river mouth, towards the inner riverine system. In most of the cases, efficiency with which each mangrove species withstands the interacting environmental conditions largely determines its intertidal position and nature of morphological adaptations. The river mouth of the Godavari and Krishna or the outer estuarine regions with great ecological stress are usually influenced by open coast environment with the same salinity conditions as that of the sea. Here the tide action and wind velocity are more or less same as that of the sea but edaphic conditions differ due to deposition of maximum silt in these regions,

Some characteristic species with their adaptive mechanism for tolerating this environmental conditions are found to form a restricted zone in these areas. On the contrary, inner riverine landscape associated with several creeks and

islets develops a gradation of environmental conditions due to increased fresh water flow from the up stream regions. These regions harbour many interesting mangrove species with different adaptive mechanism and form a distinct zone. Depending on the small scale variations of the environmental conditions, this zone can be again subdivided into two zones in both the Krishna and Godavari deltaic areas : (1) True Mangrove Zones and (2) Transitional Mangrove Zones.

Inner riverine areas of the Godavari and Krishna delta show two stage development of mangrove formation behind the estuarine proper. Like the Ganga - Brahmaputra and Mahanadi delta the middle stage formation of 'semi mangrove zone' is totally absent in the Godavari Krishna areas. Therefore, it is seen that general pattern of mangrove zonation in these two deltas are unlike the other two deltas of the East coast and can be divided into only three major zones instead of four major zones as in the Sunderbans and in the Mahanadi Deltas. These zones are : Outer Estuarine Mangrove Zone, True Riverine Mangrove Zone and Transitional Mangrove Zone,

## OUTER ESTUARINE ZONE

Mangals along the outer estuarine region or broadest region of the river mouth has been studied near the estuarine regions of Gautami Godavari at Sarcomento Light House, its main distributaries at Coringa Bay and Nachgunta of the Krishna areas. These areas are influenced by more or less open shore environmental conditions with the same salinity conditions as that in the sea. Lower unit of these intertidal flats are mainly dominated by *Avicennia marina* (Forsk.) Vierh. pure communities, excluding the newly exposed areas covered with saline grass *Porteresia coarctata* (Roxb.) Tateoka.

Upper units are mainly covered with *Avicennia alba* Bl., *Bruguiera cylindrica* (L.) Bl., *Lumnitzera racemosa* Willd., *Scyphiphora hydrophyllacea* Gaertn.f. and *Sonneratia apetala* Buch.-Ham. Sometimes *Prosopis juliflora* (Sw.) DC. is also found to grow luxuriantly in the high salinity conditions along the sandy intertidal region of the estuary. Except *Sonneratia apetala* and *Prosopis juliflora* (Sw.) DC. all other species are found to be restricted along the banks of this river mouth. Presence of salt excretory glands in the petioles and leaves of *Avicennia marina* and increased water storage mechanism in the leaves of *Lumnitzera*, *Sonneratia* and *Scyphiphora* species are adaptive mechanism for withstanding high salinity conditions along the estuarine regions. The species *Aegialitis rotundifolia* Roxb. which is common along the outer estuarine zone in the Sunderbans, the Mahanadi delta and even at



Nachgunta of the Krishna delta is not found in the Godavari river mouth. Occurrence of *Scyphiphora hydrophyllacea*, Gaertn.f., a very rare mangrove recorded only from this Gautami Godavari mouth is of interest.

The Coringa Bay in the the East Godavari District near the city of Kakinada is considered to be the best representative mangrove ecosystem of the Krishna Godavari Delta. The area covers 224.5 Sq. km situated within 16° 42' North and 18° 52' East. This brackish water mangrove ecosystem though possesses poor vegetation of *Rhizophora* communities but is enriched by the *Avicennia* communities associated with other mangrove species of *Bruguiera*, *Ceriops*, *Lumnitzera*, *Excoecaria*, *Sonneratia* etc. Main attraction is the occurrence of 3 species of *Avicennia*, 2 species of *Sarcolobus* and 2 species of *Sonneratia*. This ecosystem is the source of maximum fuel wood, fishes, crabs, prawns, birds, many micro fauna and sea otters. Due to the presence of these keystone species and considering various problems such as destruction of mangrove forests due to heavy biotic pressure, conversion of mangrove areas for different land uses, dwindling of fisheries resources and pollution due to discharge of effluents from the nearby fertiliser plant, Ministry of Environment and Forests, Govt. of India has declared it as Mangrove Sanctuary and for the proper management and protection a budgetary sanction has been allotted to the Andhra Pradesh University, Waltair.

## INNER ESTUARINE ZONE

Proceeding from the above outer estuarine zone, at a distance of about 2-3 km down stream of the Coringa and the Godavari Krishna rivers, the landscape is associated with several creeks, channels and islets, compared to that of the outer estuarine conditions ; the vigour of sea surf is broken here as a result of several outlying creeks and channels. Strong wind action and continuous salt spray are not so effective due to sheltered situation of these places, and the relief show an improved condition in soil status having a low degree of salinity concentration and a better consistency in soil particles. These in turn give rise to a favourable habitat condition for luxuriant growth and concentration of many mangrove species such as *Rhizophora mucronata* Poir., *Avicennia officinalis* L., *Avicennia alba* Bl., *Ceriops decandra* (Griff.) Ding Hou, *Xylocarpus granatum* Koen., *Excoecaria agallocha* L., *Bruguiera gymnorrhiza* (L.) Savigny, along with *Myriostachya wightiana* (Nees ex Steud.) Hook.f., and *Acanthus ilicifolius* L. Compared to that of the outer estuarine zone, the flora become rich and diversified in this region.

Field observation reveals that grouping of plants with their characteristic adaptive features of mangrove species changes in relation with the small scale variation of tidal flow, elevation of terrain, salinity conditions, influence of fresh water and the sediment types. Depending on the small scale variation of interacting environmental factors and grouping of taxa with respective adaptive features, the inner estuarine zone can be again divided into two sub zones : (1) A true riverine mangrove zone and (2) Transitional or hinterland mangrove zone along the Coringa and Godavari Krishna areas.

### TRUE RIVERINE MANGROVE ZONE

Tidal flats situated at Coringa-Gaderu, Vasavakalwa, Bhairavapalem, 2-3 Km away from the Coringa river mouth and Rajkalwa, Kandikuppa, Sarcemento situated 3-4 Km away from the river mouth of Goutami Godavari and Nachgunta of Krishna are associated with maximum creeks and channels. The topography is elevated less than 3 m above the mean sea level and the areas are regularly influenced by every tidal flow. Here the salinity conditions are comparatively lower than the estuarine mouth due to the influence of fresh water flow from the downstream but tidal velocity is higher due to presence of creeks and channels. Due to distance from the estuarine mouth and impact of low degree of salinity concentration, soil texture, soil consistency and accumulation of organic matters changes gradually from the estuarine mouth towards the inner riverine areas and bring about an improved edaphic condition. Distribution and zonation of mangrove species along these tidal flats depend, mainly upon two land-forms arranged more or less parallel to the water line :- A lower unit or low intertidal zone which is exposed only during low tide and a higher unit or supratidal zone.

The lower intertidal zone is mainly dominated by *Rhizophora apiculata* Bl., *R. mucronata* Poir., *Aegiceras corniculata* (L) Blasco., *Bruguiera gymnorrhiza* Savigny., and *Ceriops decandra*(Griff.) Ding-Hou. The higher unit or supratidal zone is usually dominated by *Xylocarpus granatum* Koen., *Sonneratia apetala* Buch-Ham., *Derris scandens*(Roxb.) Benth., *Sarcolobus carinatus* Wall., *Avicennia alba* Blume, and some times *Acanthus ilicifolius* L. and *Excoecaria agallocha* L. occurrence of *Rhizophora*, *Aegiceras*, *Ceriops* and to some extent *Bruguiera* with their stilt roots and vivipary along the lower intertidal regions perhaps give rise a full protection against high tidal velocity to the vegetation of the next higher unit. In the supratidal zone where the soil become more sticky mud, and less aerated, occurrence of *Xylocarpus*, *Sonneratia* and *Avicennia* with their peculiar pneumatophores, probably give rise tolerance efficiency for providing aeration mechanism to the root system of the plant communities.

## TRANSITIONAL MANGROVE ZONE

Proceeding from true mangal zone, the relief towards upland about a distance of 5-6 km away from the estuarine mouth changes mainly due to the less duration of actual period of inundation and salinity factor. Here ranges of salt concentration become lower and a better consistency arises in the soils with moderate organic content and low alkalinity which eventually give rise a suitable conditions for the growth of many salt tolerant and fresh water species and the areas support a dense growth of *Acanthus ilicifolius* L., *Avicennia officinalis* L., *Caesalpinia nuga* Ait., *Clerodendrum inerme* Gaertn., *Dalbergia spinosa* Roxb., *Derris trifoliata* Lour., *Excoecaria agallocha* L., *Fimbristylis ferruginea* Vahl., *Ipomoea tuba* (Schlt) Don., *Hibiscus tiliaceus* L., *Myriostachya wightiana* Hook. f. and others.

Most of the species in this zone does not show any adaptive features like stilt roots, pneumatophores or knee roots. Further increase in elevation, deposition of sands and accumulation of more organic contents change the habitat which finally becomes unfavourable for growth of the above mentioned taxa and the areas become physiologically dry with increased salinity conditions. Some species like *Tamarix troupii* Hole., *Salvadora persica* L. in association with the species of *Suaeda*, *Salicornia*, *Aeluropus* are capable to withstand this unusual situation.

## SALT MARSHES

Salt marshes are formed in wet coastal environment along the bank of sea-wards edges, newly formed estuarine mud flats and elevated parts of mangrove swamps. There are two distinct types of salt marshes : Inland salt marshes and maritime salt marshes. The maritime salt marshes are essentially confined to the temperate regions of the coast where physical conditions usually afford areas of shallow and sheltered water. Salt marshes in the tropics occur especially in arid or monsoonal regions either within the mangrove zone or back regions of the mangrove belt. Salt marsh formation in tropical deltas are usually limited in extent compared to the temperate maritime formation. Though in the tropics, both mangals and salt marshes may occur in the same region but there are significant differences between the habitat conditions of the two types. Salt marsh vegetation usually occur in changed environmental situation where the areas suffer from regular drainage pattern, when middle regions or backward portion of the mangrove swamps became slightly elevated due to shut off of the regular drainage system, the fine sands and debris carried out by the tidal flow are deposited over the regions during the inflow of the high tide but velocity of the receding tide

becomes very slow causing deposition of all the debris and sands along the margin of the elevated flats.

In the long run margins of the flats become elevated keeping shallower places in the middle. Gradual accumulation of salt water in these shallower places, high evaporation rate during summer and lack of drainage make the areas more saline in comparison with the adjoining mangrove swamps. After a few years, the condition of the area becomes as such that except very high tide it does not receive regular tidal flow.

Geomorphological changes occur towards the backward regions of the mangrove swamps where the areas become automatically elevated due to regular deposition of sands and debris along with the tidal flow. Moreover, sudden shut off of the channels on those areas may aggravate the condition more easily. Once the condition of the area is changed, the gradual deposition of sands and debris during very high tide will continue until the land is sufficiently drained. This geomorphological changes associated with high evaporation rate of the salt water arrested in the mud flats are responsible for salt marsh formation in the mangrove swamps.

In the Godavari Krishna delta, salt marshes occur in three different environmental situations : (1) as a pioneer formation covering recently formed mud flats along the open coast which is inner region of estuarine islands or recently formed elevated regions along the estuaries ; (2) as halophytic community occupying saline soil on the inner edges of the mangrove swamp or within the mangrove swamps ; (3) as secondary formation on cut-over or degraded areas within the mangrove woodlands. The first situation is found in a few places on the Bay of Bengal Coast at Coringa, Kakinada, Sanjay Nagar beach near Kothapalem, Nalimundi beach near the Krishna estuary and in Sarlagunta beach near the estuary of Lighthusemeru of the river Krishna.

The areas are dominated by the presence of high level tidal mud flats having less chances of inundation by regular tidal water. These flats are exposed at least once in every 15 days for very high tidal inundation. As a result, the areas remain physiologically dry with high percentage of salt concentration. *Sesuvium portulacastrum* L. forms a pioneer zone along the most outer limit of the mud flats and *Aeluropus lagopoides* Trin., forms a pure strand on sandy-saline flats. Other halophytes which are mainly dominated over these regions are *Salicornia brachiata* Roxb., *Arthrocnemum indicum* Moq., *Suaeda maritima* Dumort., *S. fruticosa* L., *S. nudiflora* Moq., *Cressa critica* L, and *Fimbristylis feruginea* (L.) Vahl. The second situation prevails most common for salt marsh formation along the dry and slightly

higher elevated areas within the mangrove swamps or towards the land wards margins of the tidal mangrove forests at Coringa, Kandikuppa, Sarlagunta, Nachgunta, Ellichitladibba, Lankavanidibba (Muthyakalava), Kothapalem, Dindipalem, Morlagunta and many other places. Development of this situation is mainly due to anthropogenic and geomorphological factors, when some part of a mangrove forest is being cut down the area become elevated due to deposition of vegetation fragments and disturbance of surface soils. Gradual accumulation of salt water in gently sloping and shallower places together with high evaporation rate causes the soils to become more saline in comparison to that of the adjoining well drained mangrove areas. During this period seeds of halophytes including mangrove hypocotyles are carried in by the high tide within the salt marshes but only those species which are capable to withstand this unusual situation in this high saline soils begin to take root. The vegetation on this formation depend to a considerable extent on the nature of substrate. Plants such as the species of *Salicornia* and *Arthrocnemum* begin to grow on more or less fine sand.

As they grow, they trap more and more of the sediments brought in by the tide and gradually the substratum became silty or muddy. In the early stages, tidal flow and ebbs form a sheet and drop some of its load there. As the time goes on, these areas expand and the tidal flow and ebbs over the expanded regions become restricted. At this stage areas are usually inundated only by spring tides. This developmental condition is very prominent in the Godavari Krishna deltaic areas where *Suaeda maritima* Dumont., in association with *S. nudiflora* Moq. and *S. fruticosa* L. forms a dominant component. In the next stage, prolong dry period and high rate of evaporation on the areas induce strong capillary action resulting increased salt concentration over the surface soils. In this condition, *Aeluropus lagopoides* Trin., *Cressa critica* L., *Sesuvium portulacastrum* L., *Heliotropium curassavicum* L., and others form dominant community in association with *Suaeda fruticosa* L. and *Salicornia brachiata* Roxb.

Along the Sunderbans and the Mahanadi deltaic areas, some special type of situation arises where the backward regions of the mangrove swamps slowly dying away due to complete cut off from the regular inundation and increasing acidity condition of the soils, these areas are found covered with the mangrove fern *Acrosticum aureum* L. in association with other salt marsh species. Along the Godavari-Krishna regions, this fern is found surprisingly absent.

## MANGROVES ALONG COASTAL BACKWATER FORMATION

Besides the mangrove formation along the deltaic swamps and islands in the Godavari-Krishna deltas, there are some well established mangrove formations along the banks and swamps of coastal backwater flows. Such type

of coastal backwater formation is very prominent in the Repalle forest ranges near Kothapalem, Morlagunta, Dindipalem, Nizampattanam and Muthayapalem areas (Map Fig.-3).

In most of the cases these coastal backwater channels are interconnected with several small creeks and nalas. These nalas and creeks carry city's sewage water and finally throw it to the main backwater channels which meet to the sea. Roylagunta nala at Morlagunta, Jalanala at Kothapalem and Upputeru creeks at Nizampattanam are the passages of city's sewage water to the sea. Due to absence of any fresh water streams the swamps in these regions are influenced by sewage water and saline sea water flow. Here range of salinity concentration and tidal inundation vary depending upon the nature of reliefs, amount of sewage water influx and distance from the sea. General structure of the mangrove vegetation shows a mixed formation instead of distinct zonation pattern like "outer estuarine mangroves", "true mangroves" and "transitional mangroves" as found in the deltaic mangrove swamps. However, in some areas where the swamps are nearer to the sea with the influence of more silt particles, high salinity concentrations and less sewage water impact, *Avicennia marina* (Forsk.) Vierh. in association with *A. alba* Bl. form a pure stand behind the *Porteresia coarctata* (Roxb.) Tateoka and *Myriostachya wightiana* (Nees ex Steud) Hook.f., a pioneer grass belt in the newly formed lands. Away from the sea, where the swamps are influenced by more clay particles, less salinity concentration and more sewage water impact, a mixed formations of *A. officinalis* L., *A. officinalis* var. *tomentosa* Jack., *Sonneratia apetala* Buch-Ham., *Excoecaria agallocha* L., *Clerodendrum inerme* Gaertn., *Rhizophora apiculata* Bl., *Bruguiera gymnorrhiza* (L.) Savigny, *Ceriops decandra* (Griff.) Ding Hou and *Xylocarpus granatum* Koen. are found luxuriantly dominant. Mangrove communities in some of the backwaters formation at Kothapalem and at Morlagunta are very remarkable for their growth and development. Species of *Avicennia*, *Rhizophora*, *Sonneratia*, *Excoecaria* and *Bruguiera* attain more than 8 m height and 1.5-2m girth. In Dindipalem, degraded part of swamp which still receive regular inundation is dominated by luxuriant growth of *Lumnitzera racemosa* Willd. pure stand and those parts which receives tidal inundation only during high spring tide is dominated by salt marshes.

## MANGROVE ECOSYSTEM & ECOLOGICAL PROCESSES IN THE DELTAS

In the mangrove ecosystem, the plants, animals, soil microbes and surrounding physical environment are interconnected by a simple or complex



processes by which a continuous exchange and assimilation of energy occurs. There are two distinct processes such as (1) Internal processes and (2) External processes which interact with each other in a balanced condition for persistence of the ecosystem. Disturbance of any one may alter the ecosystem and ultimately will lead to its destruction. In the internal processes, some factors governing energy fixation, biomass accumulation, mineral cycling, organic deposition etc. are intimately influenced by some external factors like water availability, pool of available nutrients, stability of habitat etc. Both these internal and external processes in the ecosystem are responsible for biological diversity, structural and functional activities and to some extent determining the pattern of exploitation.

Establishment of mangrove ecosystem depends upon the following external processes such as adequate supply of water and nutrients and stability of substrate. Supply of water in the mangrove varies according to the frequency and volume of tide, volume of fresh water flow and evaporation rate of soil water. During high tide the salinity of surface soil approximately equilibrates to that of the adjacent water body. Mangrove plants are physiologically adapted to use water of this salinity. The effect of atmospheric evaporation and transpiration by plants increases the salinity content rapidly. With the rise of salinity there is a parallel increase in osmotic potential of the interstitial soil water and hinders the water uptake of the plant roots. Under these conditions the exclusion, storage or excretion of excess salt increases the energy expenditure of the plants. The efficiency with which individual species deal with this situation determines its position in the intertidal zone.

In absence of fresh water by rainfall or other fresh water sources, the concentration of the salt may increase and as such the soil may exceed the physiological tolerances to all mangrove species and under this condition mangroves may be found restricted to a narrow band on the coastline. The best development of mangrove ecosystem occurs where the upper tidal areas are exposed to continuous supply of fresh water. This occurs in the areas where the evaporation is less than rainfall.

### **NUTRIENTS IN MANGROVE ECOSYSTEM:**

An adequate supply of soil nutrients is a prerequisite for luxuriant growth of mangrove forest. The nutrient pool in this ecosystem is influenced by five interacting processes balancing each other in addition and depletion of the pool. These are :-

(1) Fresh water or tidal flooding add to the nutrient pool by transporting dissolved inorganic mineral ions to the root zone.

(2) Transportation of inorganic ion along with the clay, during fresh water flooding add to the nutrients pool,

(3) Blowing of inorganic ions from the coastal region by wind towards the mangrove system increases the nutrient pool.

(4) Flooding of the ecosystem during regular tidal action with fresh water, washes away organic matter thus depleting the nutrient pool.

(5) Microbial decomposition of organic matter assisted by benthic fauna (specially crabs) release inorganic nutrients in soluble form, providing for internal cycling of mineral ions within the nutrient pool.

The nutrients are provided to the mangrove ecosystem by the sea water and atmosphere, but most important ones are derived in great abundance from land. Thus, a steady flow of fresh water to the mangrove is of prime importance.

As the mangroves grow on, they receive enrichment of nutrient for export and cycling from both sea and land and in turn enrich the coastal and estuarine water. This is done by decomposable organic litter formed by the mangrove forest in huge amount. In the lower intertidal level and shallow estuarine areas decomposition of this litter are carried out by fungi and bacteria producing protein enriched fragments of detritus. This detritus is suspended in the estuarine water specially among mangrove areas. The detrital complex is the source of food for the major portion of the fauna of this area.

Sedimentation along the mangrove swamps has several effects. It increases the substrate accumulation which expand the shore line and thus providing newer areas for colonisation and subsequent development of plant communities. Sedimentation may also increase the height of the substrate thus decreasing the influence of tidal inundation. Root oxygen deficit also occurs where sedimentation obstructs drainage and may cause plant mortality. The rate of deposition of sediment in the intertidal zone depends upon (1) current velocity of the water body, (2) the sediment load (3) salinity and temperature of the water. These factors vary according to the season. The velocity of the water current depends on the tidal amplitude, intensity of rainfall in the catchment area, amount of run off water and amount of sediment load. The quality of land and the pattern of land use in the catchment area influence the amount of sediment load. Salinity and temperature influences the interface between saline and fresh water where the flocculation of sediments is caused leading to increased deposition.

### **STABILITY OF SUBSTRATE :**

The intertidal estuarine area is very sensitive and continually subjected to erosion deposition and consolidation of sediments by agents such as fresh water

run off, tidal action and wind action. The eroding agents are continually striving to destroy the plants on the water edges, while the depositional processes permit the sea water expansion to the plant community.

### SILVICULTURAL PRACTICES IN THE DELTAS

The silviculture in mangrove system is to be adopted depending primarily on the facility with which the species under consideration can reproduce itself naturally under the artificial conditions induced by forest operation or on the degree to which it lends itself to artificial regeneration. In the natural conditions reproductive ability of the mangroves are high. Majority of mangrove species are viviparous or incipient viviparous. Mangrove species as a rule start fruiting at an early age and generally heavy seeders and good seed years are common. In addition to the main crop, sporadic fruiting occurs during the most of the years. An adequate supply of seed to regenerate any area under any reasonable working scheme, is readily available. Natural regeneration is generally adequate and there is hardly any competition by weeds. Mangroves are light demanders but can tolerate overhead shade in initial stages. Absence of dense low covers appears to be a necessary condition for the regeneration of *Sonneratia*, *Aegiceras*, *Lumnitzera* etc. These are good coppicers and throw up pollard shoots from the stems and form crown of coppice shoots. *Rhizophora*, *Avicennia* etc. are however poor coppicers. In the Godavari Krishna delta, working plans have been prescribed in a rotation period varying from 25 to 30 years and prohibited removal of all trees with growth under 7.5 cm girth at base.

Dwindling of Rhizophoraceae could be attributed to its poor coppicing and pollarding power. The Godavari Krishna deltas now comprise mainly of *Avicennia*, *Excoecaria* and *Lumnitzera* species. The Rhizophoraceae hypocotyles are well adapted to establish itself beneath the parent tree, if they happen to fall at a state of tidal mud when they can grow themselves in the area, but they are not so well suited to water dispersal.

It is true that the hypocotyles retain their vitality for a long period of time, and the percentage of survivors is high, but the long radicles are liable to be caught up on any projection that they encounter and are completely prevented from reaching felled areas where there are accumulation of slash.

Earlier, the mangrove forests of these deltas were being controlled by private estate owners who used to follow clear felling system operation which gave rise to low and degraded forest structure. The other factors include the wild buffaloes, which are left free inside the forest through out the summer. The young shoots and seedlings are grazed by them and this is a great handicap for the regeneration. Another important aspect which comes in the way of natural regen-

eration is the local practise of sweeping the ground for mud fishes and shrimps, after draining of the tidal waters.

The mangrove forests of these deltas since 1933 have been brought under the Government control and systematic working was done to meet local fuel demands. Since 1977, all mangroves have been closed for working. The blanks created due to haphazard clear felling of mangrove are being replanted. A beginning has already been made during 1986-87 and 1987-88 on an experimental scale, certain blanks areas selected in the Coringa Wildlife Sanctuary have been successfully tackled with reforestation programme with the mangrove species. The techniques adapted is to install a motor pump, to pump water from the creeks on to the reforested areas and kept under water for 6 hours a day and then drain off the water in the balance period. This technique has proved very successful and the present reforested area has over 80 % survival with growth rate of about 1 - 1.5 m in the first years. The species tried were *Avicennia*, *Excoecaria*, *Rhizophora*, *Bruguiera* and *Aegiceras*. The same is proposed to be adopted for taking reforestation programmes over an area of about 10,000 ha spread over a period of 5 years. (Working plan, Dept. of Forest, Andhra Pradesh 1989.)

### USES & UTILIZATION OF MANGROVE ECOSYSTEM IN THESE DELTAS :

The value of mangrove resources are of two major types : the products that are directly coming out from the mangrove species and other is the facilities that are being provided by the mangrove plants indirectly for improving our environments.

#### Direct Uses

Mangrove trees, shrubs and herbs provide fuel, wood, charcoal, timber and wood for boat building, poles for fish traps, fishing floats, tannin for fish nets and leather industries. Mangrove plants also provide raw materials for paper pulp, sugar, alcohol, honey, cooking oil, vinegar, tea - substitute, fermented drink, desert topping, condiments-bark, sweetmeats, vegetable propagules, cigarettes wrappers and medicines and also act as fodder and green manure. A number of household articles, furniture, glue, hair dressing oil, tool handles, rice mortar, toys, match sticks, plywood and plywood adhesives, synthetic fibres, dye for clothes, packing box can also be produced from mangrove trees.

Some of the direct uses of mangrove forests of the Godavari-Krishna delta are as follows :

### Source of Fuel :

Most of the mangrove trees and shrubs are much weighed with high calorific values. A ton of mangrove firewood is approximately equivalent to 2 to 5 tons of Indian coal. Mangrove firewood burns with a oven heat and is also clean, does not create much smoke and ignites easily when partially dry. The common trees and shrubs used for this purposes are species of *Avicennia*, *Aegialitis*, *Excoecaria*, *Lumnitzera*, *Dalbergia*, *Acanthus*, *Rhizophora*, *Ceriops*, *Bruguiera* and *Sonneratia*.

Mangrove makes excellent charcoal. It has been found that mangrove wood yeilds fully charred charcoal 21.8% and half charred charcoal 10.2% from an average capacity kilns of 25 tons.

### Source of Timber

The tidal forests provide a large quantity of timber yielding species, though all this timber are not much valued for furniture making or other domestic uses. They are used for making boat building, household materials, furniture, electric poles, telegraphic posts and pilling pillars of bridges, jetties, stalk for fishing nets, boats, packing boxes, walling boards, plywoods, match splints, turnery articles, agricultural equipments and number of other commercial articles.

Stems of *Xylocarpus granatum* are straight and long ; therefore, these woods are used for furnitures, as telegraphic posts and pilling works. These woods are strong and durable and mature woods are not easily damaged by white ants, *Sonneratia apetala* woods are also hard but these woods are not much required for carpentry work for their course fibres, these are mainly used in building construction and making packing boxes, paper and pulp etc. *Lumnitzera racemosa* wood is hard and durable and occasionally used in carpentry works. *Rhizophora apiculata*, *R. mucronata*, *Bruguiera cylindrica* and *B. gymnorrhiza* woods are used for framework in building construction and pilling purposes. Woods from *Avicennia alba*, *A. marina*, *A.officinalis* are also valuable for timber and minor carpentry works, producing turnery articles, plywoods. agricultural equipment and fishing stalks. Woods from *Ceriops decandra* are commonly used in cottage walling, roof building and several other fencing works in rural areas, and roof for country boat.

Before 1977 the mangrove forests of Godavari and Krishna deltaic areas were mainly managed to meet fuel wood and charcoal requirement of the local population. It was seen that fuel wood per hector from the main felling in the mangrove felling series over a rotation on a period of 25 to 30 years was between 2.79 to 17.15 MT/ha. A return of 2.79 MT/ha from the Kandikuppa felling series was exceptionally low, probably being Panchayat felling series. By

and large the returns have been around 10 to 15 MT/ha only with an annual increment of 0.4 to 0.6 MT/ha. (M.G.Gogate 1982).

### Source of Fodder

Villagers near the mangrove forests have buffaloes, goats and cows. These cattles are left among the mangrove during the summer months and they graze the mangrove grasses viz. *Porteresia coarctata* (Roxb.) Tateoka., *Myriostachya wightiana* (Nees ex Steud.) Hook.f., *Aeluropus lagopoides* (L.) Trin. ex Thw. along with some herbs and shrubs from reclaimed areas. The green leaves of *Avicennia* species are reported to have high fodder value and are found to produce more milk in buffaloes. Leaves are collected by local people in large quantities for their cattles.

### Source of Tannins

Among the indigenous sources of vegetable tannins, the bark of the mangroves trees and shrubs are much valuable due to the presence of high percentage of tannin acid. Chemically tannin may be classified into hydrolyzable and condensed groups. Most important condensed tannins are extracted from the leaves, woods and barks of different mangrove species and are used in tanning fishing net, in leather industries, dyeing fabrics, making inks and various medical application.

Average content of tannin in different mangrove species (M.G.Gogate 1982.)

Name	Percentage
<i>Bruguiera cylindrica</i> Bl	17.8
<i>B. parviflora</i> W. & A	25.4
<i>B. gymnorrhiza</i> (L) Lamk.	36.0
<i>Ceriops decandra</i> Ding Hou.	29.0
<i>Rhizophora apiculata</i> Bl.	33.0
<i>Excoecaria agallocha</i> L.	12.0
<i>Sonneratia apetala</i> Ham	9.0
<i>Xylocarpus granatum</i> Koen.	25.0
<i>Aegiceras corniculatum</i> (L)Blanco.	7.0
<i>Aegialitis rotundifolia</i> Roxb.	12.2
<i>Lumnitzera racemosa</i> Willd.	19.2



**Sources of Adhesive :**

Tannin formaldehyde resin is much effective as plywood adhesive and is suggested for joining woods. Tannin extract from the barks of *Bruguiera* species is suitable for preparing adhesives for composit woods (Anonymous, 1950 & Mathanda, 1959). The barks from *Ceriops* species also produce much tannin, formaldehyde resin for plywood adhesives.

**Source of medicine :**

The mangroves also contain some important medicinal properties which are probably not much attended even today. The rural inhabitants are not much aware regarding the common medicinal values which could be obtained from the mangrove species. In course of studies on the Godavari and Krishna delta and field observation regarding the medicinal application of the plants by the rural people, some medicinal properties of the mangrove species were identified from the folk literature as follows :

Name of Species	Uses
<i>Acanthus ilicifolius</i> L.	Fruit pulp used for blood purifier
<i>Avicennia officinalis</i> L.	Bark gives medicine for skin and wounds.
<i>A. alba</i> Bl.	do
<i>A. marina</i> (Forsk.) Vierh.	do
<i>Bruguiera gymnorrhiza</i> (L.) Savigny	Medicine from fruits, pneumatophores are used for preparation of scent.
<i>B. cylindrica</i> Bl.	do
<i>Ceriops decandra</i> Bl.	Bark stops haemorrhage.
<i>Rhizophora mucronata</i> Poir.	Decoction of bark used for haematuria, diarrhoea, dysentery, leprosy, stops bleeding and neck inflammation.
<i>Sarcolobus carinatus</i> Wall.	Leaves and roots are said to be medicinal.
<i>Sonneratia apetala</i> Buch.-Ham.	Fermented juice said to check haemorrhage. Fruit is said to increase eye power.
<i>Xylocarpus granatum</i> Koen.	Seed paste is said to relief breast tumor and barks for cholera.

## DIRECT USES OF MANGROVES IN THE DELTAS

NAME OF SPECIES	USES
<i>Acanthus ilicifolius</i> L.	Fuel, Medicine.
<i>Aegialitis rotundifolia</i> Roxb.	Fuel, poles, extraction of salt from burnt wood
<i>Aegiceras corniculatum</i> (L.) Blanco	Fuel, super quality honeycomb culture.
<i>Avicennia officinalis</i> L.	Fire woods, charcoal, fodder.
<i>A. alba</i> Blume.	salt extraction, honeycombs
<i>A. marina</i> (Forsk.)Vierh.	fruits for fish.
<i>Bruguiera cylindrica</i> (L.) Bl.	Firewood, timber, condiments from knee roots.
<i>Bruguiera gymnorrhiza</i> (L.) Savigny	Firewood, timbers, poles,tannin, dye,adhesive from bark, scent from pneumato-phore and charcoal for substitute of petroleum, coke.
<i>Ceriops decandra</i> (Griff.) Ding Hou	firewood, tannin, house building materials, adhesive, honey-combs and good charcoal.
<i>Clerodendrum enerve</i> (L.)Gaertn.	Fuel, fodder.
<i>Dalbergia spinosa</i> Roxb.	Firewood, fodder, fruits as fish food.
<i>Derris scandens</i> (Roxb.) Benth.	Fibres, fish poison.
<i>Derris heterophylla</i> (Willd.) Back & Bakh.	
<i>Excoecaria agallocha</i> L.	Fire wood, paper pulp match wood, baskets, sap poisonous, honeycomb, fish float.
<i>Fimbristylis ferruginea</i> (L.)Vahl.	Fodder
<i>Heliotropium curassavicum</i> L.	Fodder, food during famine,salt.
<i>Hibiscus tiliaceous</i> L.	Strong fibres and fuel.
<i>Ipomoea tuba</i> (Schlt.) G. Don.	Fruits for fish food.
<i>Lumnitzera racemosa</i> Willd.	Firewood, timber, poles & tannin.
<i>Myriostachya wightiana</i> (Nees ex Steud.) Hook.f.	Good fodder for deer and pigs.

NAME OF SPECIES	USES
<i>Pandanus tectorius</i> Soland, ex Park.	Fuel, house poles and cottage industry,
<i>Porteresia coarctata</i> (Roxb.) Tateoka	Pioneer soil binder, fodder.
<i>Rhizophora apiculata</i> Bl. <i>R. mucronata</i> Poir.	Timber, fire wood, tannin, adhesive, charcoal as substitute for petrol and coke. Light wine may be made from juice of seedling.
<i>Salvadora persica</i> L.	Timber, fodder.
<i>Sarcocobus carinatus</i> Wall. <i>lobosus</i> Wall.	Fruits are edible & medicinal.
<i>Salicornia brachiata</i> Roxb.	Indicator of saline soil, extraction of salt.
<i>Scirpus littorea</i> Schrad.	Fodder and materials for mat.
<i>Scyphiphora hydrophyllacea</i>	Fuel, honey-combs and tannin. Gaertn.f.
<i>Sesuvium protulacastrum</i> L.	Good fodder, salt extraction
<i>Suaeda maritima</i> (L.)Dum.	and food during famine.
<i>S. nudiflora</i> (Willd.)Moq.	
<i>S. monoica</i> (Forsk.) ex Gmel.	
<i>Sonneratia apetala</i> Buch.-Ham.	Fire wood, paper pulp and match industries. Leaves and fruits are very good fodder. Fruits are edible and good fish food. Tasty jam or jelly may be prepared from fruits.
<i>Tespesia populnea</i> (L.) Sol. ex Correa	Timber, fire wood, fodder, medicine and yellow dye.
<i>Xylocarpus granatum</i> Koen.	Timber, furniture, tannin, oil from seeds used for illuminant and hair.Wood for pencils and slates. Paste of fruits applied for recovering breast cancer.

### Indirect Uses

Environmental value of the mangroves for protection and conservation of inland properties is so much that it cannot be assessed in terms of money. Mangroves serve as natural coastal border security forces for protection against storm, wind, flood and high tidal surges. Along the estuarine bank, they provide flood reduction function and along the river bank help to prevent soil erosion. They serve as spawning grounds and nursery ground to many marine fishes, and nesting ground for many birds, reptiles and honey bees. They provide valuable opportunity for education, scientific research and tourism. They are essential elements which maintain equilibrium of the vast salt water wetland ecosystem.

### MANGROVE FAUNA AND AQUACULTURE

Faunal composition in the mangrove ecosystem of these deltas are unique. Mangroves provide several kinds of niches for variety of animal population. The crowns of trees including trunks, branches, leaves, flowers and fruits provide a separate niche essentially for many terrestrial fauna like birds, reptiles, mammals, insects etc. The soil surface of mangrove provide a niche for such organism which can tolerate a high salinity fluctuations and many species of insects, molluscs, fishes, reptiles and variety of mammals are restricted to this edaphic condition. The water flow of several creeks and canals of the mangrove system is very rich in large varieties of microscopic planktons, prawns, fishes, amphibians, reptiles and some aquatic mammals. These deltas have an unique distinctions of having some endangered mammals like Dolphins and Dugongs apart from highly endangered species of estuarine crocodiles. Another important mammal which is found in these deltas is the smooth Indian Sea Otters (*Lutra persicillata*). Besides these, mangroves invariably attract large population of migratory birds, various species of molluscs, fishes, crabs, mud skippers. During low tide period the high ground of the mangrove swamps which contain rich sources of food are exposed for many species of birds. Over 120 species of birds are recorded from these deltas. Recently during field tour some dead specimens of Olive Redley tortoise have been located in the Nalimundi Beach.

Aquaculture or fish farming is rapidly increasing along the mouth of Krishna delta, since the brackish water fish firms for growing *Penacus monodon* (Tiger Prawn) are most profitable in the international market. Several low graded mangrove lands along the two deltas are given lease to the ex-servicemen for starting the brackish water fish firms. Recently, local people of the areas have

also started this profitable business in a large scale even encroaching deep forest areas. These have resulted consequent destruction of large tracts of mangrove forests, conversion of mangroves into brackish water farms has been particularly severe along the mouth of Krishna delta. In some situations, the areas become acidic and prawns are affected with diseases due to destruction of surrounding mangroves.

### **DISTRIBUTION OF MANGROVES IN THE GODAVARI KRISHNA DELTA AND COMPARED TO THAT OF THE SUNDERBANS AND THE MAHANADI DELTA.**

The Sunderbans of the Gangetic delta covers an area of 4,266 sq.km towards the southern part of 24 Parganas of West Bengal, where the river Hoogly in combination with various tributaries, innumerable meandering creeks and channels forms an extensive deltaic tidal flat. Due to vastness in extent and innumerable ramifications of the riverine systems resulting in the formation of several estuarine islands, the diversity and richness of mangrove species in the Sunderbans areas are highest in India. Recent comparative study (Banerjee, 1987) indicates that due to the change of the main river flow, the supply of fresh water discharge has been reduced surprisingly over the vast areas and consequently mangrove species diversity has shifted towards the eastern part of the Sunderbans, now in Bangladesh.

A similar deltaic tidal flat covering an area of 250 Sq.km in the mouth of the rivers Mahanadi, Brahmani and Baitarini is situated in the Cuttack district of Orissa state where the rivers Mahanadi, Brahmani, Baitarini in combination with their main tributaries like, Patshala, Dhamra and many creeks and channels form extensive mangrove formation. Due to its unique ecological conditions resulting from the regular fresh water discharge and increased rate of accretion by the several rivers the diversity of mangrove species is remarkable in this delta and many mangrove species that need the influence of more fresh water flow, grow luxuriantly in the Bhitarkanika tidal forests in this delta. Similar mangrove formation in Andhra Pradesh covering 585 Sq.km are located in the estuarine complex of the river Godavari and Krishna and spread over the districts of East Godavari, Krishna and Guntur. Here the rivers with their main tributaries, creeks and channels form extensive mud flats in association with many coastal back water flows.

These tidal flats are associated with less number of creeks and channels in comparison with that of the Sunderbans and the Mahanadi deltas and consequently formations of open blanks, sandbars and dry mud flats are more common phenomenon in these regions. Mangroves are concentrated here only towards the

very estuarine tidal flats and along the banks of coastal backwater flows with less number of species and minimum diversity.

Zonation pattern of mangrove vegetation along these three deltas has been observed, and found distributed in a graded sequences from the estuarine mouth towards the inner riverine tidal flats. The sequences of plant zonation is interrelated to the interacting environmental factors like soil conditions, salinity range and tidal inundation. In most of the cases, efficiency with which each mangrove species withstands the interacting environmental conditions largely determines its intertidal position and nature of morphological adaptation.

Pattern of mangrove vegetation from the estuarine mouth towards the inner tidal flats in the Sunderbans and in the Mahanadi delta are arranged in 4 developmental phases such as —

**Outer Estuarine Mangrove Zone** where the environmental conditions are same as that of open coast condition with high salinity, tidal action and wind velocity. Some species like *Avicennia marina*, (Forsk.) Vierh., *A. alba* Bl., *Aegialitis rotundifolia* Roxb., *Bruguiera cylindrica* (L.) etc. which are capable of tolerating maximum salinity by means of salt excreting glands or by increasing water storage tissue in their leaves, are found dominant over the areas. The estuarine mouths of Godavari and Krishna deltas are characterised with the same pattern of plant zonation as in the Sunderbans and the Mahanadi delta. Absence of *Sonneratia griffithii*, *Bruguiera parviflora* (Roxb.) Wt.& Arn. ex Griff. and *Ceriops tagal* (Perr.) Robin. in the outer estuarine zone of the Godavari and Krishna delta is a notable difference from the Sunderbans and Mahanadi delta.

**Riverine Mangrove Zone** from the estuarine mouth towards the inner riverine areas where the land masses are notably influenced by innumerable meandering creeks and channels resulting the formation of several fringes and islets with less salinity conditions and greater tidal forces than the above, are mostly dominated by *Rhizophora apiculata* Bl., *R. mucronata* Poir., *Ceriops decandra* (Griff.) Ding Hou, *Kandelia candel* (L.) Druce, *Bruguiera gymnorrhiza* (L.) Savigny, *Aegiceras corniculatum* (L.) Blanco, *Xylocarpus granatum* Koen., and others which are mostly adapted by means of stilt roots for withstanding greater tidal forces. This developmental stage is more or less uniform in the three deltas but absence of *Kandelia candel* (L.)Druce, in the Godavari-Krishna delta and restricted occurrence of *Scyphiphora hydrophyllacea* Gaertn.f., in the Godavari mouth are the surprising differences.

**Riverine Semimangrove Zone** Innermost tidal flats along the Sunderbans and the Mahanadi delta are more or less elevated and surrounded by



several creeks and channels and are subjected to greater fresh water influence due to the situation of tidal flats nearer to the riverine fresh water sources. These tidal flats are characterised by remarkable brackish water mangrove formation mainly dominated by *Heritiera fomes* Buch.-Ham., *Phoenix paludosa* Roxb., *Cerbera manghas* L., *Aglaia cucullata* (Roxb.) Pellegrin, *Intsia bijuga* (Coleb.) Kuntz., *Cynometra iripa* Kostel., and others.

This riverine semimangrove formation which is most striking features along the Sunderbans and in the Mahanadi delta is found totally absent in the Godavari Krishna deltaic areas. This indicates that mangrove formations of the Godavari Krishna delta have passed through 3 developmental phases from the estuarine mouth towards the Inner riverine tidal flats in contrast with the 4 developmental phases in the Sunderbans and in the Mahanadi delta.

Riverine Transitional Mangrove Zone Uplands situated in a transitional habitat towards the inland part of the true and semimangrove formation are usually devoid of regular tidal flow and subjected to less duration of salt water submergence from the actual period of inundation. Better consistency arises in the soils due to lower degree of salinity and alkalinity. In all the three deltas these areas are found mainly dominated by *Acanthus ilicifolius* L., *Clerodendrum inerme* Gaertn., *Dalbergia spinosa* Roxb., *Derris trifoliata*, *Sarcolobus sp*, *Hibiscus tiliaceous* L., and others. Most of the species in this zone do not show any marked morphological adaptations like stilt roots, pneumatophores and vivipary indicating the transitional situation of the habitat. The absence of *Acrostichum aureum* L., in the transitional habitat of the Godavari Krishna delta is also a major difference from the Sunderbans and the Mahanadi delta.

**DISTRIBUTION OF MANGROVE SPECIES IN THE FOUR DELTAS ARE SHOWN IN THE TABLE**

Name of the Species	Sundarban Delta	Mahanadi Delta	Krishna Delta	Godavari Delta
<i>Acanthus ilicifolius</i> L	+	+	+	+
<i>A. volubilis</i> Wall.	+			
<i>Acrostichum aureum</i> L.	+	+		
<i>Aegialitis rotundifolia</i> Roxb.	+	+	+	
<i>Aegiceras corniculatum</i> (L.)Blanco.	+	+	+	
<i>Aglaia cucullata</i> (Roxb.) Pellegrin. (+)		+		

<i>Avicennia officinalis</i> L.	+	+	+	+
<i>A. alba</i> Bl.	+	+	+	+
<i>A. marina</i> (Forsk.) Vierh.	+	+	+	+
<i>A. marina</i> var. <i>acutissima</i> Staff & Mold.	+	+		
<i>Brownlowia tersa</i> (L.) Kostm.	+	+		
<i>Bruguiera cylindrica</i> (L.) Bl.	+	+	+	+
<i>B. gymnorrhiza</i> (L.) Savigny	+	+	+	+
<i>B. parviflora</i> (Roxb.) Wt. & Arn. ex Griff.	+	+		
<i>B. sexangula</i> (Lour.) Poir.	+	+		
<i>Caesalpinia bonduc</i> (L.) Roxb.	+	+	+	+
<i>C. crista</i> L.	+	+	+	+
<i>Cerbera manghas</i> L. (+)		+		
<i>Ceriops decandra</i> (Griff.) Ding Hou	+	+	+	+
<i>C. tagal</i> (Perr.) Robin.	+	+		
<i>Clerodendrum inerme</i> Gaertn.	+	+	+	+
<i>Cynometra iripa</i> Kostel.	+	+		
<i>Dalbergia spinosa</i> Roxb.	+	+	+	+
<i>Derris scandens</i> (Roxb.) Benth.	+	+	+	+
<i>D. heterophylla</i> (Willd.) Back. & Bakh.	+	+	+	
<i>Excoecaria agallocha</i> L.	+	+	+	+
<i>Fimbristylis ferruginea</i> (L.) Vah	+	+	+	+
<i>Finlaysonia obovata</i> Wall.	+	+		
* <i>Heliotropium curassavicum</i> L.	+	+	+	+
<i>Heritiera fomes</i> Buch.-Ham.	+	+		:
<i>H. littoralis</i> Dryand.		+		
<i>Hibiscus tiliaceus</i> L.	+	+		+
<i>Intsia bijuga</i> (Coeb.) Kuntz. (+)		+		
<i>Ipomoea tuba</i> (Schl.) G. Don.	+	+	+	+
<i>Kandelia candel</i> (L.) Druce	+	+		
<i>Lumnitzera racemosa</i> Willd.	+	+	+	+
<i>Merope angulata</i> (Willd.) Swingle		+		
<i>Mukuna gigantea</i> (Willd.) DC.	+	+		
<i>Myriostachya wightiana</i> (Nees ex Steud.) Hook. f.	+	+	+	+

<i>Nypa fruticans</i> (Van.)Wurumb.	+			
<i>Pandanus tectorius</i> Soland. ex Park.	+	+	+	+
<i>Phoenix paludosa</i> Roxb.	+	+		
<i>Pluchea indica</i> L.	+			
<i>Porteresia coarctata</i> (Roxb.) Tateoka	+	+	+	+
<i>Rhizophora apiculata</i> Bl.	+	+	+	+
<i>R. mucronata</i> Poir.	+	+	+	+
<i>R. stylosa</i> Griff.		+		
<i>Salacia prinoides</i> (Willd.) DC.	+	+	+	+
<i>Salvadora persica</i> L.	+	+	+	+
<i>Sarcolobus carinatus</i> Wall.	+	+	+	+
<i>S.globosus</i> Wall.	+	+	+	+
* <i>Salicornia brachiata</i> Roxb.	+	+	+	+
<i>Scirpus littoralis</i> Schrad.	+	+	+	+
<i>Scyphiphora hydrphyllacea</i> Gaertn.f.				+
* <i>Sesuvium portulacastrum</i> L	+	+	+	+
* <i>Suaeda fruticosa</i> L. Forsk.			+	+
* <i>S.maritima</i> (L.) Dum.	+	+	+	+
* <i>S. nudiflora</i> (Willd.) Moq.	+	+	+	+
* <i>S.monoica</i> (Forsk.) ex Gmel	+	+	+	+
<i>Sonneratia apetala</i> Buch.-Ham.	+	+	+	+
<i>S. caseolaris</i> (L.) Engl.	+	+		-
<i>S. alba</i> J. Sm.		+		
<i>S. griffithii</i> Kurz.	+	+		-
<i>Stenochlaena palustre</i> (Burm.) Bedd.	+	+		
<i>Stictocardia tilliaefolia</i> Hallier.f.	+	+		-
* <i>Tamarix troupii</i> Hole	+	+		+
* <i>T. ericoides</i> Rottl.		+		
* <i>T. dioica</i> Roxb.	+	+		-
<i>Thespesia populnea</i> (L.)Sol. ex Correa	+	+	+	+
<i>T. populneoides</i> (Roxb.) Kostels	+	+	-	-
<i>Tylophora tenuis</i> Bl. (+)		+		
<i>Xylocarpus granatum</i> Koen.	+	+		

<b>X. mekongensis</b> Pierre.	+	+	-	-
<b>X. molluccensis</b> (Lamk.) Roem.	-	-	-	-

---

(+) indicates that the species is not found in the divided Sundarbans of Indian territory.

\* indicates that the species is found in salt marshes,

**KEY TO THE FAMILIES**

**SYNOPSIS TO GROUPS**

- A. Cotyledons 2.....**Dicotyledones**
- B. Fruit crowned by calyx-lobes or calyx-rim, derived from inferior or half inferior ovary.
- BB. Fruits not crowned by calyx-lobes or calyx-rim derived from superior ovary.
- C. Fruits compound, from 2 or more pistils.
- CC. Fruits simple from a single pistil.
- D. Fruits fleshy, indehiscent (berry, drupe)
- DD. Fruits dry, dehiscent or indehiscent
- E. Fruits dehiscent (capsule, follicle, legume, loment, schizocarp, siliqua).
- EE. Fruits indehiscent (achenes, anthocarp, nut(let), utricle).
- AA. Cotyledon 1.....**Monocotyledones**

**A. DICOTYLEDONES**

- B. Fruits crowned by calyx-lobes or calyx-rim, derived from an inferior or half-inferior ovary.**
- 1a. Viviparous. Mangroves. Drupe elongate, 1-celled, 1-seeded; persistent calyx reflexed .....**35. Rhizophoraceae**
- 1b. Non-viviparous. Non-mangrove (except *Lumnitzera*) :
  - 2a. Parasites (epiphytic). Seeds with obscure testa; funicle not well differentiated. Leafy. Drupes on elongate stalks  
.....**27. Loranthaceae**
  - 2b. Autophytes. Seeds with distinct testa; funicle well differentiated :

- 3a. Fruits an achene, from a capitulum. Calyx reduced to pappus  
 .....9. **Asteraceae**
- 3b. Fruits other than achene, not from a capitulum. Calyx otherwise :
- 1b. Neither climber nor straggler :
- 5a. Leaves opposite :
- 6a. Fruit a berry :
- 7a. Armed shrub. Branchlets zigzag. Seeds 4, ellipsoid  
 .....5. **Apocynaceae**
- 7b. Unarmed tree. Mangrove. Berry 10-15 celled; seeds infinite  
 .....38. **Sonneratiaceae**
- 6b. Fruit Drupe :
- 8a. Drupe 4-seeded. Persistent calyx cupular.40. **Verbenaceae**
- 8b. Drupe 1(2)-seeded :
- 9a. Seeds arillate ..... 15. **Celastraceae**
- 9b. Seeds not arillate. Pericarp pulpy.....37. **Salvadoraceae**
- 5b. Leaves alternate:
- 10a. Leaf margin entire. Ripe fruits dark blue. Leaves stipulate  
 .....21. **Euphorbiaceae**
- 10b. Leaf margin serrate or dentate. Berry with seeds more than 3  
 .....23. **Flacourtiaceae**
- E. Fruit simple dehiscent (Capsule, follicle, legume, loment, schizocarp, siliqua)**
- 1a. Fruit a legume, loment or follicle (dehiscing along the sutures) derived  
 from 1 celled ovary:
- 2a. Fruit a legume, or loment. Dehiscence along two longitudinal (legume)  
 or transverse (loment) sutures..... 22. **Fabaceae**
- 2b. Fruit a follicle. Dehiscence along one (ventral) sutures :



- 3a. Mangrove. Leaf margin retuse. Follicle falcate; seeds free central  
.....30. **Myrsinaceae**
- 3b. Non-mangrove. Seeds with coma and margined  
.....8. **Asclepiadaceae**
- 1b. Fruit a capsule, schizocarp or a siliqua derived from (1)2 more carpellary  
ovary :
- 4a. Fruit schizocarp :
  - 5a. Stipules free-lateral. Plants stellate hairy; Mericarps dorsally flattened  
.....28. **Malvaceae**
  - 5b. Stipules 0. Plants strigose hairy; endument bulbous based.  
.....11. **Boraginaceae**
- 4b. Fruit a capsule or siliqua :
  - 6a. Fruit (epicarp) woody. Seeds often winged. Capsule globose  
.....29. **Meliaceae**
  - 6b. Fruit (epicarp) thin or crustaceous. Seeds not winged :
    - 7a. Capsule 1-celled; placentia free-central, parietal or basal :
      - 8a. Capsule exclusively 1 seeded. Fruiting calyx glandular- hairy.  
Leaf margin entire. Capsule circumscissile  
.....33. **Plumbaginaceae**
      - 8b. Capsule 4-infinite seeded :
        - 9a. Plants woody. Leaves reduced. Capsule 3-valved.  
Seeds plumose .....39. **Tamaricaceae**
        - 9b. Plants herbaceous. Leaves opposite. Dehiscence circumscissile  
.....14. **Caryophyllaceae**
    - 7b. Capsule 2 or more celled; placentae axile :
      - 10a. Capsule dehiscence circumscissile or by irregular splitting.  
Petiole sheathing at, pouched at base.....2. **Aizoaceae**
      - 10b. Capsule dehiscence septicidal or loculicidal :
        - 11a. Mangrove. Capsule leathery. Seeds 4, pendulous between  
the axile wings, exalbuminous.....10. **Avicenniaceae**
        - 11b. Non-mangrove. Capsule crustaceous, longer than broad.  
Seeds attached by curved funicle.....1. **Acanthaceae**

## EE. Fruits simple, dry indehiscent (achene, anthocarp, nut(let), utricle)

- 1a. Fruiting perianth scarious, erect and stiff. Utricle 1-seeded  
(a few : *Celosia*) .....3. **Amaranthaceae**
- 1b. Fruiting perianth calcyine, concave, membranous. Utricle or achene  
exclusively 1-seeded. levae alternate, margin entire, when opposite,  
leaves obscure .....16. **Chenopodiaceae**

## AA MONOCOTYLEDONES

- 1a. Fruits syncarpic. Syncarps woody. Trees or shrubs. Leaves armed, in  
tristichous spirals.....32. **Pandanaceae**
- 1b. Fruits other than syncarpic:
- 2a. Fruits fleshy and indehiscent. Drupes woody. Leaves palmate or pinnate.  
Seeds often endospermous.....6. **Areceae**
- 2b. Fruit dry dehiscent or indehiscent :
- 3a. Capsules. Seeds 3 to several or very numerous. Leaves well developed.  
Spathe like bract persistent.....4. **Amaryllidaceae**
- 3b. Caryopsis. Seed 1 :
- 4a. Pericarp adnate to testa. Leaves 2 ranked. Stem terete, nodal  
.....34. **Poaceae**
- 4b. Pericarp free from testa. Leaves 3 ranked. Stem trigonous not nodal  
.....20. **Cyperaceae**

## 1. A C A N T H A C E A E

## ACANTHUS L.

*Acanthus ilicifolius* L., Sp.Pl. 639. 1753; Gamble, Fl.Pres.Madras 2 : 712.1957 (Repr.ed).

Erect, ascending or scandent, thistly shrubs or undershrubs, 0.3-2 m tall, stem terete, glabrous with two sharp spines at the leaf axils; stilt roots are present at stem base. Leaves 5-11x3-10 cm, ovate-oblong or ovate-lanceolate, coriaceous, spiny, narrowed at base. Flowers 3.5-4 cm long, blue-violet, pubescent within, arranged in terminal spikes, 5-20 cm long; bracts caducous at or before anthesis; bracteoles 3-4 mm long, subtending the calyx. Capsules 2-3 cm, ovoid-oblong, compressed, apiculate, shining green or brown. Seeds reniform.

Fl. & Fr. : April-Oct.

Distrib : Throughout India; Sri Lanka, Australia and S.E. Africa.

Ecological Notes : Common in and around the mangrove forests along the banks of creeks and channels. Sometimes found towards more fresh water conditions, showing capacity to tolerate various salinity ranges.

Uses : It serves as natural fencing materials due to the spines, acts as soil protector and decoction of leaves and fruits is used for remedy of Asthma, dyspepsia, neuralgia and rheumatism.

## 2. A I Z O A C E A E

## Key to Genera

- 1a. Capsules 3 5 celled.....1.*Sesuvium*  
1b. Capsules 1 2 celled.....2.*Trianthema*

## 1. SESUVIUM L.

*Sesuvium portulacastrum* (L.) L., Syst. : 1058.1759 ; Gamble, Fl.Pres. Madras 1: 388.1957 (Repr.ed).

Succulent, ascending or decumbent, much branched, spreading herbs, rooting at the nodes. Leaves 2-6 x 0.5-1.5 cm, linear-spathulate, entire, thick, glabrous, sessile, narrowed at base, obtuse at apex. Flowers 5-8 mm long, purple or pinkish-

violet, axillary, solitary. Capsules 5-7mm across, included within the perianth. Seeds many, reniform, smooth with long funicles.

Fl. & Fr. : Aug Dec.

Distrib : Pantropic.

Ecological Note : Frequent on sandy or muddy sea beaches, saline bunds and embankments in between the mangrove swamps and coastal backwater flow. A salt loving plant which can tolerate high salinity conditions.

Uses : Useful sand binder and indicator of saline soils, often serves as major fodder and food during famine.

### 1. TRIANTHEMA L.

Key to Species :

1a. Stamens 10 or more.....*protulacastrum*

1b. Stamens less than 10.....*triquetra*

*Trianthema protulacastrum* L., Sp. pl. 223. 1753; Gamble, Fl. Pres. Madras 1: 389. 1957 (Repr.ed).

Prostrate herbs, 60 m or more long, stems glabrous or slightly pubescent, often tinged purple. Leaves 2.5-3 x 2.4-3cm, obovate, fleshy with a dilated sheath of petiole at the base. Flowers purple, solitary axillary. Capsules many seeded dehisce transversely.

Fl. & Fr. : June-August.

Distrib : Throughout India; Pantropic.

Ecological Notes : Frequent along the river banks of Godavari Krishna as well as on sea-shore sand.

Uses : Plants are used as a tonic for heart and anaemia.

*Trianthema triquetra* Rottl. & Willd., Ges. Naturf. Neue. Schr. 4:181.1880 ; Gamble, Fl. Pres. Madras 1: 389.1957 (Repr.ed).

Much branched, diffused herbs. Leaves 3-7 mm long, elliptic-oblong, fleshy, acute at apex; petioles slightly sheathing at base. Flowers creamy white, sessile, fascicled in the axils. Capsules with an annular depressed cushion at the top. Seeds 2, with concentric line.

Fl. & Fr. : June-Oct.

**Distrib** : Throughout India ; Sri Lanka ; Burma and Tropical saline regions.

**Ecological Notes** : Common along the river banks and sea-shores.

**Uses** : Sometimes the plants are used as vegetable.

### 3. A M A R A N T H A C E A E

#### Key to Genera

1a. Leaves alternate.

2a. Flowers unisexual ..... 1. *Amaranthus*

2b. Flowers bisexual.

3a. Flowers Capitata; fruit with one seed ..... 2. *Allmania*

3b. Flowers in racemes; fruit with more  
than one seed ..... 4. *Celosia*

1b. Leaves opposite or fascicled.

4a. Flowers in wooly tomentose spikes;  
bracts soft ..... 3. *Aerva*

4b. Flowers in galbrous spikes;  
bracts hard, spinescent ..... 5. *Achyranthes*

5a. Imperfect flowers converted into hooked  
bristle, anthers 2-celled ..... 6. *Pupalia*

5a Imperfect flowers not as above;  
anther 1-celled ..... 7. *Alternanthera*

#### 1. AMARANTHUS L.

*Amaranthus spinosus* L., Sp.Pl. 991. 1753; Gamble, Fl. Pres. Madras 2:891.1957 (Repr.ed).

Erect or prostrate, spinous herbs 35-65 cm high, upto 5 x 2cm, ovate-lanceolate, galbrous, obtuse at apex, cuneate at base. Flowers greenish white, sessile in axillary clustered or in terminal panicles. Utricles ovoid, rugose.

**Fl. & Fr.** : May-July.

**Distrib** : Throughout the temperate and tropical coastal regions; a native of America.

**Ecological Notes** : Frequent along river banks, road sides and coastal thickets.

**Uses** : As a vegetable, it acts as good blood purifier.

## 2. ALLMANIAR. Br.ex Wight

*Allmania nodiflora* (L.)R.Br. ex Wight in Hook.J.Bot. 1: 226. t. 128. 1834; Gamble, Fl.Pres.Madras 2: 817.1957 (Repr. ed).

Ascending herbs 10-60 cm long with long taproot; stems angular, dichotomously branched. Leaves 1.5-7.0 x 0.5-20 cm linear-oblong or spatulate, glabrous, acute, obtuse, rounded to abruptly mucronate at apex, narrowed at base. Flowers variable in colours, purple, yellow or pinkish in terminal or leaf-opposed globose head. Utricles circumscissile below the middle. Seeds 2.5 mm, pale brown with 2-lobed cupular arils.

**Fl. & Fr. :** March-August.

**Distrib :** Along the E.& W.Coast in India; Malaysia; Sumatra; Java and Philippines.

**Ecology Notes :** Frequent on sandy places inside the mangrove forests in Coringa and moist shady areas near Kothapalem.

**Uses :** Acts as a sand binder.

## 3. CELOSIAL.

*Celosia argentea* L., Sp.Pl. 250. 1753; Gamble, Fl. Pres. Madras 2: 816. 1957 (Repr. ed).

Erect, glabrous herbs 30-90 cm high. Leaves 2.5-12 cm long variable, linear-lanceolate, acute or obtuse at apex, attenuate at base. Flowers pinkish-white in terminal spikes 2.5-15 cm long utricles ellipsoid, circumscissile about middle.

**Fl.& Fr. :** Aug-Oct.

**Distrib :** Throughout the tropics.

**Ecological Notes :** Frequent in moist places along the river banks and sea shore on both Krishna and Godavati delta.

**Uses :** Several forms are cultivated for ornamental purpose.

## 4. AERVA Forsk.

*Aerva lanata* (L.) Juss., Ann. Mus. Nat. Hist. Paris 11 : 131. 1808; Gamble, Fl. Pres. Madras 2 : 816. 1957 (Repr. ed).

Erect, diffused or prostrate herbs 20-70 cm high much branched. Leaves 0.5-5.0 x 0.3-3.0 cm, elliptic-ovate or sub-orbicular, pubescent above and wooly beneath. Flowers white in dense spike 5-25 mm long. Utricles ovoid. Seeds shining black.

**Fl. & Fr. :** Nov-Jan.

**Distrib :** Widely in the tropics of Asia and Africa.

**Ecological Notes :** Frequent on waste sandy places along the river banks and road sides on both the deltas.

### 5. ACHYRANTHES L.

*Achyranthes aspera* L., Sp.Pl. 204. 1753; Gamble, Fl. Pres. Madras 2 : 8.1957 (Repr. ed).

Erect or scandent perennial herbs upto 1 m high. Leaves 2-10 x 1-5 cm, decussate, obvate or elliptic-lanceolate, glabrous or pubescent, acute at apex, attenuate at base. Flowers 4-6 mm long white in elongated terminal spike 10-40 cm long. Utricles enclosed by perianth and bracteoles.

**Fl. & Fr. :** April-Sept.

**Distrib :** Throughout the tropics.

**Ecological Notes :** Frequent in waste sandy places along the river banks, sea shores and road sides on both the deltas.

**Uses :** Plant juice is a good blood purifier.

### 6. PUPALIA Juss.

*Pupalia lappacea* (L.) Juss., Ann. Mus.Nat. Hist. Paris 2 : 132. 1803; Gamble, Fl. Pres. Madras 2 : 8. 1957 (Repr. ed.).

Erect or rambling, much branched, perennial herbs upto 2m high. Leaves 3-10 x 2-6 cm, glabrous, ovate-oblong or elliptic, acute at apex, obtuse at base. Flowers pale green or purple, clustered in terminal spiciform racemes upto 30 cm long, imperfect flowers form hook-like bristles. Utricles one seeded.

**Fl. & Fr. :** Oct-Jan.

**Distrib :** Throughout Indian coast; Malaysia, Java, New Guinea and Africa.

**Ecology Notes :** Frequent in sandy scrubs and coastal thickets near Kothapalem and Nuchgunta.

## 7. ALTERNANTHERA Forsk.

*Alternanthera sessilis* (L.) ex DC., Cat. Hort. Monspel. 4 : 77.1813; Gamble, Fl. Pres. Madras 2 : 825. 1975 (Repr. ed).

Creeping perennial herbs with swollen nodes. Leaves 1.0-10.0x0.5-2.0cm, variable, linear-oblong or oblanceolate, glabrous, acute at apex, attenuate at base. Flowers sessile, white, clustered in axillary globose head. Utricles obcordate, yellowish-brown.

Fl. & Fr. : Through the year.

Distrib : Pantropic.

Ecological Notes : Common in swampy places, roadsides and river banks near Moraliqunta.

Uses : Used as fodder and green manure.

## 4. A M A R Y L L I D A C E A E

## CRINUM L.

## Key to species

1 a. Leaves 10 20 cm broad ..... *asiaticum*

1 b. Leaves 2 3 cm broad ..... *defixum*

*Crinum asiaticum* L., Sp.Pl.419.1753; Gamble, Fl.Pres. Madras 3 :1050. 1957 (Repr. ed).

Stout herbs with tunicated, long necked bulbs. Leaves 1-1.5m x 10-20 cm, acuminate at apex, sheathing at base. Flowers white, fragrant, arranged in umbels subtented by spatheaceous bracts. Fruits globose 3-50 cm across, spongy.

Fl. & Fr. : July-Oct.

Distrib : Throughout the Indian coast; Sri Lanka, Malaysia and Java.

Ecological Notes : Frequent along river banks in brackish water conditions.

Uses : Locally cultivated as ornamental plant.

*Crinum defixum* Ker-Gawl., J.Sci. & Arts 3 : 105,1817; Gamble, Fl. Pres. Madras 3: 1051. 1957 (Repr. ed).



Herbs with subterranean ovoid, long-necked bulbs. Leaves 60-80 x 2-3 cm, linear-lanceolate, glabrous, shining, rounded at apex. Flowers white with purple filaments arranged in axillary umbels. Fruits sub-globose, shortly beaked.

Fl. & Fr. : July-Sept.

Distrib : Throughout the estuarine and deltaic formation of E.& W. coast in India and Sri Lanka.

Ecological Notes : Common along the intertidal banks of creeks and channels in Mangrove forests in association with *Sonneratia apetala* at Kothapalem, Nuchgunta.

## 5. A P O C Y N A C E A E

Key to Genera

- 1a. Spinescent shrubs or small trees;  
fruits berries ..... 1. *Carissa*
- 1b. Glabrous lianas : fruits follicles ..... 2. *Ichnocarpus*

### 1. CARISSA L. nom. cons.

*Carissa spinarum* L., Mant. 559.1771; Gamble, Fl. Pres. Madras 2:565. 1957 (Repr. ed).

Bushy spinescent shrubs 1-2 m high with divaricate, forked spines on branches. Leaves 3-4 x 2-3 cm ovate-oblong, coriaceous, apiculate at apex, obtuse at base. Flowers white, fragrant in terminal corymbose cymes. Fruits ellipsoid, 4-seeded berries.

Fl. & Fr. : April-Sept.

Distrib. : Throughout the coastal parts and dry regions in India and Sri Lanka.

Ecological Notes : Frequent in sandy scrubs, river banks and coastal thickets, locally cultivated.

Uses : Fruits are edible.

### 2. ICHNOCARPUS R. Br.

*Ichnocarpus frutescens* ( L.) R.Br., Mem. Wern.Soc.1 : 62.1809; Gamble, Fl. Pres.Madras 2 : 577.1957 (Repr. ed).

Rusty tomentose, twining shrubs. Leaves 5-10 x 3-4 cm, elliptic-oblong, membranous, pale beneath, acute at apex, narrowed at base. Flowers white, fragrant in compound paniculate cymes. Fruits 5-17 cm long cylindrical, curved and pointed follicles.

Fl. & Fr. : Sept.-Dec.

Distrib. : India Sri Lanka, Malaysia, Java and Australia.

Ecological Notes : Frequent in riverine scrubs and coastal thickets at Dindipalem and Nizampatanam.

Uses : Used for fibres and medicine.

## 6. A R E C A C E A E

### Key to Genera

- Leaves palmate .....1. *Borassus*  
 Leaves pinnate .....2. *Phoenix*

### 1. BORASSUS L.

*Borassus flabellifer* L., Sp.Pl. 1187. 1753; Gamble, Fl.Pres.Madras.3 :1090. 1957 (Repr. ed).

The common palmyra Palm, stem stout, about 30 m tall with simple, palmately fan-shaped leaves upto 1.3 m diam, dioecious spadices and large globose fruits upto 20 cm diam with 1-3 fibrous pyrenes.

Fl.& Fr. : June-Sept.

Distrib. : In the dryer parts of India, perhaps a native of tropical Africa.

Ecological Notes : Very common, wild as well as cultivated, along the river banks, coastal thickets and back sides of the mangrove swamps.

Uses : Its wood, leaves, fruits, pulps and sap of the peduncles are used variously.

### 2. PHOENIX L.

#### Key to species

- 1a. Stem 6 to 16v m tall.....*sylvestris*  
 1b. Stem very short, less than 1 m tall.....*farinifera*

*Phoenix sylvestris* (L.) Roxb., Fl.Ind. 3 : 787. 1832; Gamble, Fl.Pres. Madras 3 : 1088. 1957 (Repr. ed).

Stem 10-16 m tall. Leaves upto 1.8 m long, pinnate, leaflets upto 35 x 2.2 cm rigid, folded with acicular tips. Male spadix upto 80 cm long white, spathes scurfy, split into 2 boat shaped valves ; female spadix similar to male spadix, distant. Fruits upto 3 cm long, yellow or reddish when ripe.

Fl. & Fr. : Nov-May.

Distrib. : Throughout India along the water course.

Ecological Notes : Frequent on river banks and coastal thickets, wild and cultivated.

Uses: Fruits, saps, leaves and woods are variously useful.

*Phoenix farinifera* Roxb., Cor. Pl. T.74.; Gamble, Fl.Pres Madras 3 :1088.1957 (Repr. ed).

Stem very short, thickly clothed by old leaf-sheaths. Leaflets rigid , with yellowish pulvinus at the junction of rachis.

FL.& Fr. : Fl. Jan. ; Fr. April-May.

Distrib. : Only along coromandel coast.

Ecological Notes : frequent on coastal thickets at Kothaplaem & Dindi.

Uses : Leaves are useful for cottage industries.

## 7. A R I S T O L O C H I A C E A E

### ARISTOLOCHIA L.

*Aristolochia indica* L., Sp.Pl. 960. 1753 ; Gamble, Fl.Pres. Madras 2 : 841. 1957 (Repr. ed).

Perennial twining or creeping herbs with greenish-white tube; stems ribbed, often purple-coloured. Leaves 5-10 x 2-5 cm variable, ovate-oblong or sub-cordate at base. Flowers 2-3cm long, greenish-white in axillary racemes, often clustered with prominent bracts. Capsules globose 3-4 cm diam, septicidally dehisching into 6 valves from below to the upwards along with the pedicels. Seeds many, ovate-deltoid, winged.

Fl.& Fr. : Aug.-Nov.

Distrib. : Throughout the low plains in India ; Sri Lanka and Chittagong.

Ecological Notes. : Frequent in sandy sea shore, coastal thickets and riverine scrubs at Kothapalem, Dindipalem and Machilipatanam.

Uses : A bitter plant and roots are used for the treatment of snake-bites, fevers, purgative and anthelmintic.

## 8. ASCLEPIADACEAE

### Key to Genera

- 1a. Pollinia pendulous on the corpuscle.
- 2a. Erect shrubs with tomentose leaves;  
corolla valvate in bud .....1.*Calotropis*
- 2b. Twining shrubs with glabrous leaves;  
corolla rotate in bud .....2.*Pentatropis*
- 1b. Pollinia erect on the corpuscle.
- 3a. Corona absent; follicles globose;  
seeds without coma .....3.*Sarcolobus*
- 3b. Corona present; follicles lanceolate;  
seeds with coma.....4.*Tylophora*

### 1. CALOTROPIS R.Br.

*Calotropis gigantea* (Willd.) Dryand. ex Ait.f., Hort.Kew. ed.2.2 : 78. 1811; Gamble, Fl. Pres.Madras 2 : 585. 1957 (Repr. ed).

Powdery tomentose shrubs, 1-2 m tall. Leaves 7-13 x 3-6 cm, decussate, ovate-oblong, acute at apex, obtuse at base. Flowers white or purple in lateral cymes. Follicles 7-10 x 3-4 cm ovoid-oblong, oblique at base, uncinatate at apex. Seeds ovoid with silky white coma.

Fl. & Fr. : July-Dec.

Distrib. : Throughout India; a native of tropical Asia.

Ecological Notes : Common along the river banks, road sides, sea shore and coastal sandy hedges at Sarcemento, Machilipatanam, Dindipalem and Nizampattanam.

Uses : Potentially useful for Charocoal, fibre, cotton and medicinal.

### 2. PENTATROPIS Wt. & Arn.

*Pentatropis capensis* (L.f.) Bullock, Kew Bull. 9: 284. 1955; Gamble, Fl. Pres. Madras 2 : 587. 1957 (Repr. ed).

Slender twining herbs. Leaves 1.1-3.1 x 1.1-2.2 cm, ovate or elliptic-oblong, coriaceous, apiculate at apex, sub cordate at base. Flowers greenish-white in extra axillary umbelliform cymes. Follicles 4-6 m long smooth with comose seeds 5 x 4 m.m.

Fl.& Fr. : Sept.-Dec.

Distrib. : All along the Indian coast; Sri Lanka, Malaysia and Java.

Ecological Notes : Frequent on hedges and thickets along the river banks and back mangrove areas.

### 3. SARCOLOBUS R.Br.

#### Key to species

- 1a. Corolla pubescent within; follicles globose,  
not keeled ..... *globosus*
- 1b. Corolla glabrous within; follicles ellipsoid,  
keeled ..... *carinatus*

*Sarcolobus globosus* Wall., Asiat. Res. 12 : 568.t.4. 1816; Hook.f., Fl. Brit. India 4 : 27. 1883.

Twining glabrous shrubs with stout branches. Leaves 4-10.5 x 1.5-4 cm, ovate-oblong, coriaceous apiculate at apex, obtuse at base. Flowers 4-6 mm across light purple in axillary corymbose cymes. Follicles 2-3 cm in diam, globose, thick, coriaceous, seeds flattened, not comose.

Fl.& Fr. : August-Oct.

Distrib. : Godavari delta, Sunderbans and Andaman in India; Burma and Malacca.

Ecological Notes : Frequent along the intertidal banks of creeks and channels in the mangrove forest at Kandikuppa near Godavari river mouth.

Uses : Follicles and fleshy roots are fish poison.

*Sarcolobus carinatus* Wall., Asiat. Res. 12 : 570. t.5.1816; Hook.f. in Fl. Brit. India 4 : 28.1883.

Slender, twining shrubs with swollen stem base and fleshy roots. Leaves 3-7.5 x 1-3.5 cm, smaller and narrower than *S.globosus*, variable in shape, ovate or elliptic-

oblong, coriaceous, acute at apex, rounded at base. Flowers 2-3 mm across, yellowish-white in axillary pedunculate cymes. Follicles 4-6 x 2.5-30 mm, ellipsoid, keeled along the dorsal suture. Seeds winged, not comose.

**Fl. & Fr.** : April-Sept.

**Distrib.** : Along the Sunderbans, Mahanadi delta and Andamans in India ; Margui island.

**Ecological Notes** : Common along intertidal banks of creeks and channels in the mangrove forests of Kandikuppa, Nuchgunta, Saraligunta and Yellichetladibba near the river mouth of Krishna and Godavari.

**Uses** : Roots and follicles are used to poison fish.

#### 4. TYLOPHORA R. Br.

*Tylophora indica* (Burm.f.) Merr., Philip. J. Sci. 19: 373. 1921; Gamble, Fl. Pres. Madras 2 : 593.1957 (Repr. ed).

Perennial twining shrubs. Leaves 3-15 x 1.5-7.5 cm, ovate-lanceolate, pubescent below, apiculate at apex, sub cordate at base. Flowers 1-1.5 cm across, greenish-yellow in axillary or in terminal many flowered cymes. Follicles paired each 5-8 cm long, in a line with each other, acuminate at apex. Seeds comose.

**Fl. & Fr.** : April-Sept.

**Distrib.** : Throughout India; Sri Lanka, Borneo and Java.

**Ecological Notes** : Frequent in sandy hedges and river banks at Kothapalem and Dindipalem.

**Uses** : Leaves are used for remedy of asthma.

## 9. A S T E R A C E A E

### Key to Genera

1a. Heads with 1-2 florets.

2a. Leaves pinnatifid.

3a. Heads solitaty, yellow.

4a. Peduncles bracteolate .....1. *Launaea*

4b. Peduncles ebracteolate .....2. *Grangea*

- 3b. Heads many, purple .....3. *Cythocline*
- 2b. Leaves not pinnatifid.
- 5a. Flowers ligulate.
- 6a. Anther cleft at base .....4. *Vernonia*
- 6b. Anther tailed at base .....5. *Blumea*
- 5b. Flowers eligulate .....6. *Eclipta*
- 7a. Plants not woolly, stems winged;  
pappus absent .....7. *Sphaerenthus*
- 7b. Plants woolly, stems not winged;  
pappus present .....8. *Gnaphalium*
- 1b. Heads with many florets .....9. *Eupatorium*

### 1. LAUNAEA Cass.

*Launaea sermentosa* (Willd.) Sch.-Bip. ex Kuntze, Rev. Gen. 1 : 350. 1891.  
Gamble, Fl. Pres. Madras 2 : 515.1957 (Repr. ed).

Stoloniferous, glabrous, trailing herbs 15-35 cm long rooting at nodes with secondary rosettes. Leaves 2.5-3.5 x 0.7-1 cm, rosulate, spatulate, pinnatifid, rounded at apex, tapering at base. Heads 1.5 cm long bright yellow, solitary, axillary in bracteolate peduncles. Achenes 4 mm long, linear with cottony pappus.

Fl. & Fr. : Throughout the year.

Distrib. : India, Sri Lanka, Java, Egypt and E.African coast.

Ecological Notes : Common along sandy sea shores and sand-bars in between the mangrove forests.

Uses : Good sand binder.

### 2. GRANGEA Adans.

*Grangea maderaspatana* (L.) Poir., Lamk., Encycl. (Suppl.2) : 825. 1812;  
Gamble, Fl. Pres. Madras 2 : 478.1957 (Repr. ed).

Sticky, pubescent annual, deffused herbs 5-15 cm long. Leaves 2-7 cm long, cauline, more or less deformed. Heads globose, yellow with purple tinge arranged in terminal peduncles. Achenes 1-1.5 mm long compressed, glandular with fimbriate pappus.

**Fl.& Fr. :** March-June.

**Distrib. :** Throughout the tropical Asia, Africa, Malaysia and Java.

**Ecological Notes :** Frequent on moist sandy waste places and dry ditches ;

**Uses :** Used for nasal disease.

### 3. CYATHOCLINE Cass.

*Cyathocline purpurea* (Butch.- Ham. ex Don.)Kuntze, Rev. Gen. Pl. 333. 1891; Gamble, Fl. Pres.Madras 2: 478. 1957 (Repr. ed).

Erect or decumbent, aromatic herbs 30-60 cm high with soft adpressed hairs; stems much branched, striate. Leaves 3-8 cm long pinnatisect, segments irregularly serrate, hispidulous. Heads heterogamous, reddish-purple in terminal panicles. Achenes minute, smooth; pappus absent.

**Fl.& Fr. :** March-June.

**Distrib. :** India ; Burma and Sri Lanka.

**Ecological Notes :** Frequent along river sides, road sides and cultivated fields.

**Uses :** Leaves are used to recover headache.

### 4. VERNONIA Schreb.

*Vernonia cinerea* (L.) Less., Linnaea 4 : 291. 1829; Gamble, Fl.Pres. Madras 2: 475. 1957(Repr. ed.).

Decumbent, polymorphous herbs 15-70 cm. Leaves 2-8 x 1-4 cm variable, elliptic, puberulous, acute at apex, decurrent at base. Heads 2-3 mm diam, purple arranged in terminal corymbs. Achenes 1.5 mm long brown, pubescent with white pappus.

**Fl.&Fr. :** April-July.

**Distrib. :** India, tropical Asia, Africa, Australia, South America and West Indies.

**Ecological Notes :** Common weeds along the river beds, road sides and waste places, frequent on sandy sea shores.

**Uses :** Juice of plant given in piles and fresh juice of leaves for blood dysentery. Externally flowers are administered for conjunctivities and rheumatism.

Seeds are used for intestinal colics, cough, leucoderma, skin diseases.



## 5. BLUMEA DC.

*Blumea lacera* (Burm.f.) DC., Wight. Contrib. Bot. Ind. 14: 1834; Gamble, Fl. Pres. Madras 2: 483. 1957 (Repr. ed).

Erect herbs 30-80 cm high, with strong smelling, viscid stems. Leaves 3-13 x 1.2-5 cm, ovate-oblong glandular hairy on both surface, dentate, obtuse at apex, narrowed at base. Flowers yellow in axillary or terminal panicles. Achenes 0.5 mm, ribbed, hairy.

Fl. & Fr. : May-August.

Distrib. : India Burma, Malaysia, Indo-China, Java Australia and Africa.

Ecological Notes : Frequent along roadsides, river banks and sandy sea shores.

Uses : Leaves are used for stopping bleeding.

## 6. ECLIPTA L. nom. cons

*Eclipta prostrata* (L.) L., Mant. Pl. 2 : 286. 1771; Gamble, Fl. Pres. Madras 2 : 496 1957 (Repr. ed).

Prostrate, annuals, 20-30 cm high rooting at the nodes. Leaves 2-5 x 1-1.5 cm elliptic, hispidulous, acute at apex, rounded at base. Head 3-5 cm high mostly from upper axils. Achenes 3-3.5 mm long, warted without pappus.

Fl. & Fr. : Throughout the year.

Distrib. : Throughout the tropics.

Ecological Notes : Frequent on moist places, river banks and rice fields.

Uses : Leaf-juice is used for hair tonic.

## 7. GNAPHALIUM L.

*Gnaphalium polycaulon* Pers., Syn Pl. 2: 421. 1807; *G. indicum* L., Gamble, Fl. Pres. Madras 2: 491. 1957 (Repr. ed).

Soft wooly annuals 5-15 cm high, with many branches from the base. Leaves linear-spathulate, wooly on both surfaces, acute at apex, narrowed towards base. Heads upto 3.5 mm diam heterogamous, yellow, crowded in the axile of leafy spike. Achenes minute, slightly papillose.

**Fl. & Fr. :** January-March.

**Distrib. :** Throughout the tropics.

**Ecological Notes :** Frequent on dry ditches, moist sandy places along the river banks and sea shores.

## 8. EUPATORIUM L.

*Eupatorium odoratum* L., Syst.Nat.ed.10.1205.1759; Hook.f., Fl. Brit. India 3: 244. 1881.

Straggling undershrubs upto 1 m long. Leaves upto 10 x 5 cm decussate, ovate, crenate-serrate, glandular, acute at apex, cuneate at base. Heads 8-10 mm across bluish-white in terminal corymbs. Achenes upto 4.5mm long, scabrescent with long uniseriate pappus.

**Fl. & Fr. :** Nov-Jan.

**Distrib. :** India, South-East Asia and tropical Africa. A native of Central America.

**Ecological Notes :** Obnoxious weed, rare along the degraded parts of mangrove forests and coastal thicket.

**Uses :** Leaf-juice is used for coagulating blood.

## 10. AVICENNIA CEAE

### AVICENNIA L.

#### Key to species

- 1a. Stem blackish in colour; leaves lanceolate; inflorescence spicate; capsules ellipsoid, pointed .....*alba*
- 1b. Stem whitish-grey; leaves obovate or elliptic; inflorescence umbellate; capsules ovoid.
  - 2a. Trees 10-30 m tall; leaves obovate; capsules broadly ovoid, beaked .....*officinalis*
  - 2b. Trees 2-4 m tall; leaves elliptic; capsules ovoid apiculate, not beaked .....*marina*

*Avicennia alba* Blume, Bijdr. Fl. Neder. Ind. 821. 1826; Gamble, Fl. Pres. Madras 2: 774. 1957 (Repr. ed.).

Shrubs or small trees upto 5 m tall with smooth, black-coloured stems and narrowly pointed, numerous spongy pneumatophores 8-15 cm long. Leaves 8-15 x 2.5-4 cm, lanceolate, dark-green, shining above, silvery papillose below, acute at base. Flowers 3-6 mm across, yellow in axillary or terminal spikes. Capsules 3-4 cm long, ellipsoid, narrowly pointed, tomentose. Seeds consists of two green, fleshy conduplicate cotyledons developed with in the mother plants. Hairy radicles and plumules come out while the capsules freely float along the water current.

**Fl.& Fr. :** July-Sept.

**Distrib. :** Throughout the mangrove forests in India; Sri Lanka, Malaysia, Java, Philippines and China

**Ecological Notes :** common along the intertidal banks of creeks and channels throughout the mangrove forests of the Godavari and Krishna delta in Andhra Pradesh.

**Uses :** Potentially used for fuel woods, fodder, fish-food, honey bee culture and checking soil erosion.

*Avicennia officinalis* L., Sp. Pl. 110. 1753; Gamble, Fl. Pres. Madras 2: 774. 1957 (Repr. ed.).

Trees up to 30 m tall with greyish-white coloured stems and numerous, spongy, narrowly pointed pneumatophores 10-50 cm long. Leaves 6-10 x 4-6.5 cm, obovate or ovate-oblong, coriaceous, silvery papillose beneath, rounded at apex, narrowed at base. Flowers upto 1 cm long, yellow, fragrant in axillary or terminal umbellate cymes. Capsules almond-shaped, broadly ovoid, silvery papillose, beaked at apex. Seeds same as in *A. alba*, incipiently viviparous.

**Fl.& Fr. :** July-Oct.

**Distrib :** Throughout the mangrove forests in India; Burma, Sri Lanka, Malaysia, Java and China.

**Ecological Notes :** Common mangroves along the supratidal regions of several creeks and channels of the Godavari and Krishna delta and coastal back-water flows of Kothapalem, Morlagunta and Muthapalem areas.

**Uses :** Potentially used for fuel woods, timber, house building, boat making, fodder, fish-food and honey-bee culture.

*Avicennia marina* (Forsk.) Vierh., Beitr. Kennt. Fl. Sudarb. Socotra. in Denkschr. Akad. Wissensch. Band. 71.435.1907; Gamble, Fl. Pres. Madras 2: 774. 1957(Repr. ed.).

Shrubs or small trees up to 3 m tall with yellowish-grey stems and narrowly pointed, spongy pneumatophores. Leaves 5-6 x 2.5-3 cm elliptic to elliptic-oblong, coriaceous, shining above, yellowish papillose beneath. Flowers 2-4 mm across, yellow, fragrant in axillary or terminal, condensed umbellate cymes. Capsules ovoid, tomentose, half the size of *A. officinalis*, apiculate at apex.

**Fl. & Fr.:** July-Oct.

**Distrib :** Throughout the mangrove forest of the world.

**Ecological Notes :** Common, specially restricted along the estuarine mouths of the Godavari and Krishna delta, a pioneer tree species under influence of maximum tide, silty sediments and high salinity conditions.

**Uses :** Potentially useful for fuel wood, fodder, tannin, fish-food, boat building materials and soil bindings.

*Avicennia marina* var. *tomentosa* Jacq., Enum. Pl. Carib.

Trees up to 20 m tall with yellowish-grey stems; young branches papillose. Leaves 6-8 x 2.5-4 cm, ovate-oblong or elliptic-oblong, yellowish-green, shining above, yellowish-papillose beneath, acute or rounded at apex, cuneate at base. Flowers 2.5-4 mm across, yellow, crowded in axillary or terminal condensed cymes; peduncles trichotomously branched, papillose; calyx densely pubescent with long marginal hairs. Capsules ovoid, pubescent.

**Fl. & Fr.:** July-Sept.

**Distrib :** Only in this delta from India.

**Ecological Notes :** Rare, only collected from Morlagunta block at Kothapalem in association with *A. marina* and *A. officinalis*.

**NOTE:** Further detail study should be made after collecting the fruiting specimens. BANERJEE, NO. 18851. August 1990.

## 11. B O R A G I N A C E A E

## HELIOTROPIUM L.

*Heliotropium curassavicum* L., Sp. Pl. 130. 1753; Gamble, Fl. Pres. Madras 2: 130. 1957(Repr. ed).

Glaucous, fleshy, prostrate herbs. Leaves 2.5-4.5 x 0.5-0.7 cm, spatulate, entire, rounded at apex. Flowers 2-3 mm long, white, yellow in centre arranged in short pairs of unilateral spikes. Fruits 2 mm across, ovoid, separating into 4 nuts.

Fl.& Fr. : July-Nov.

Distrib : Throughout the coastal saline swamps in India and other tropical coasts; introduced from West Indies.

Ecological Notes : Common in salt marshes river banks and embankments of the coastal back water

Uses : Plants are used as vegetables during famine.

## 12. C A C T A C E A E

## OPUNTIA L.

Key to the species.

1a. Spines straight; flowers pink .....*elatior*

1b. Spines curved; flowers yellow .....*dillenii*

*Opuntia dillenii* (Ker-Gawler) Haw., Suppl. Pl. Succ. 79. 1819; Gamble, Fl. Pres. Madras 1:387. 1957(Repr. ed).

Erect, spiny shrubs 1-3 m. high with obovate, articulated phylloclades, articulated part surrounded by ring of spines. Flowers 7-10 cm long, yellow, solitary, axillary on upper half of the internodes. Fruits pear-shaped, tubercled.

Fl.& Fr. : May-Sept.

Distrib : A native of tropical America and W. Indies; naturalised in India.

Ecological Notes : Fruquent an Sandy river bank and back mangroves.

Uses : Phylloclades and fruits are used for remedy of whooping cough and bile secretion.

*Opuntia elatior* Mill., Gard. Dict. n. 4. 1768; Gamble, Fl. Pres. Madras 1 : 387. 1957 (Repr. ed.).

Spiny xerophytic shrubs with widely branched articulated phylloclades, spines surrounding the articulation straight, slender, purplish black. Flowers 5-6 cm. across, rose-pink in upper half of the internodes, axillary, solitary. Fruits pear-shaped.

Fl. & Fr. : July-Sept.

Distrib : Along the coast, down to the Godavari and Krishna river-mouth; introduced from Central America.

### 13. C A P P A R I D A C E A E

Key to the Genera.

- 1a. Leaves simple; sepals free but closed in buds.....1.*Capparis*  
 1b. Leaves 3-foliolate; sepals free but open in buds.....2.*Crataeva*

#### 1. CAPPARIS L.

*Capparis brevispina* DC., Prodr. 1:246. 1824; Gamble, Fl. Pres. Madras 1 : 32. 1957 (Repr. ed).

Erect, thorny shrubs with rigid branches. Leaves elliptic-oblong, glabrous, strongly reticulate below, mucronate at apex, rounded at base. Flowers white, solitary in terminal axils. Fruits ovoid berries, red when ripe.

Fl. & Fr. : April-August.

Distrib : India and Srilanka.

Ecological Notes : Frequent in coastal scrubs and sand bars within the mangrove forest along the Godavari and Krishna deltas.

Uses : a good fodder.

#### 2. CRATAEVA L.

*Crataeva adansonii* DC. ssp. *odora* (Buch.-Ham.) Jacobs, Blumea, 12: 198. 1964; Gamble, Fl. Pres. Madras 1: 34 1957 (Repr. ed).

Deciduous trees with unarmed branches. Leaves digitately 3-foliolate, each elliptic or oblanceolate, membranous, cuneate at base, acuminate at apex. Flowers

yellow arranged in terminal corymbs. Fruits fleshy berries with many seeds imbedded in pulp.

**Fl. & Fr. :** May-Sept.

**Distrib :** India, Burma, Malaysia, Vietnam and Combodia.

**Ecological Notes :** Rarely found along the river banks and sand bars within the mangrove forests of the Krishna delta.

**Uses :** Barks are used for sedative, antipyretic, kidney and tubercular glands.

## 14. C A R Y O P H Y L L A C E A E

### POLYCARPAEA Lam.

*Polycarpea corymbosa* (L.) Lamk., Tabl. Ency 1. 2 : 129. 1797; Gamble, Fl. Pres. Madras 1 : 46. 1957 (Repr. ed.).

Annual 10-40 cm high, with much branched, pubescent stems. Leaves 5-15 x 1 mm. in whorls, linear, glabrous, acuminate at apex. Flowers silvery brown in terminal branched cymes. Capsules elliptic, brown with 6 reniform seeds.

**Fl. & Fr.:** August-Oct.

**Distrib :** India, Malaysia, tropical Africa and Australia.

**Ecological Notes :** Frequent on sandy sea shores and river banks.

**Uses :** Sand binder.

## 15. C E L A S T R A C E A E

### MAYTENUS Molina

*Maytenus emerginata* (Willd.) Ding Hou, Fl. Males. 6(2); Gamble, Fl. Pres. Madras 1 : 151 1957 (Repr. ed).

Thorny shrubs 2.5 m tall, with much branched stems; thorns long, straight frequently bearing leaves and flowers at the tip. Leaves 4-10 x 2-6.5 variable, obovate or ovate elliptic, coriaceous, emarginate at apex, attenuate at base. Flowers polygamous, white, densely clustered in terminal cymes. Fruits obovoid pyriform, splitting into 3-valved. Seeds 1-2 in each chamber with cupular aril at base.

**Fl. & Fr. :** Jan-March.

**Distrib** : In dry areas and coastal thickets in India; Sri Lanka, Malaysia, Java, Phillipines and New Guinea.

**Ecological Notes** : Frequent in sandy scrubs along the coast and sand bars in between mangrove forests at Krishna delta.

**Uses** : Used for fuel and fodder.

## 16. C H E N O P O D I A C E A E

### Key to the Genera

- 1a. Stems jointed, fleshy; leaves absent;  
embryo horse-shoe shaped.
  - 2a. Flowers in the scales of cone-like spikes;  
albumin fleshy .....1.*Arthrocnemum*
  - 2b. Flowerin cavity of joints; albume absent.....2.*Salicornia*
- 1b. Stems not jointed;  
leaves present; embryo spiral .....3.*Suaeda*

### 1. ARTHROCNEMUM Moq.

Key to the species.

- 1a. Stems prostrate; utricle crustaceous .....*indicum*
- 1b. Stem erect; utricle membranous .....*glaucum*

*Arthrocnemum indicum* (Willd.) Moq., Chenop. Monog. Enum. 113. 1840; Gamble, Fl. Pres. Madras 2 : 828 (Repr. ed).

Prostrate, glaucous-green, fleshy under shrubs 10-30 cm high, opposite and alternate branches. Leaves 0. Flowers whitish, monoecious arranged in cylindric cone-like spikes, clustered in the cup of the joint. Fruits crustaceous utricles, enclosed in spongy-shaped embryo.

**Fl. & Fr.** : August-Oct.

**Distrib** : Throughout the salt marshes in India, E. & W. coast; Sri Lanka, Mediterranean, W. Asia and tropical Africa.

**Ecological Notes** : Common in salt marshes along the river mouth of Krishna and Godavari and salt pans of the coastal backwater flows at Kothapalem and Dindipalem.

**Uses** : Often used as vegetable during flood hazards.



*Arthrocnemum glaucum* (Del.) Ung. Sternb., Atti. Bot. Congr. Firenze 283. 1874; Gamble, Fl. Pres. Madras 2:828. 1957 (Repr. ed).

Erect, fleshy shrubs 10-30 cm high with much branched jointed stems. Leaves 0 Flowers whitish in spikes; male flowers in threes with 3 stamens, each in a membranous perianth; female flowers obscurely 2-lipped. Utricles enclosed in a ovoid membranous perianth with an apical aperture for stigma. Seeds orbicular, with black, thin testa; embryo same as *A. indicum*

**Fl. & Fr.** : August-Oct.

**Distrib** : India, Sri Lanka, Mediterranean, W.Asia and tropical Africa.

**Ecological Notes** : Frequent in salt marshes along the coastal salt pans and estuarine salt marshes of the river Krishna.

**Uses** : It produces sodium carbonate, some times used as vegetables during cyclonic hazards.

## 2. SALICORNIA L.

*Salicornia brachiata* Roxb., Fl. Ind. ed. Carey 28. 1832; Gamble, Fl. Pres. Madras 2: 828. 1957 (Repr. ed).

Erect or decumbent fleshy herbs; stems jointed, much branched; cup-shaped jointed segments with short teeth embracing the base of next segment. Flowers minute, whitish, usually in groups of 3, each group sunken on either side of each segments forming cylindric spikes; sterile segments 5-10 mm. long. Fruits ovoid, utricles membranous. Seeds laterally compressed, whitish, hispid.

**Fl. & Fr.** : Through out the year.

**Distrib** : India and Sri Lanka.

**Ecological Notes** : Common in salt marshes along the coastal back water flows and salt pans, often gregarious in the estuarine islands near Krishna river.

**Uses** : Produces Sodium carbonate.

## 3. SUAEDA Frosk. ex Scop.

Key to species.

1a. Perennials; stigma more than 2; seeds erect.

2a. Flowers hermaphrodite; stigma 3; bracteoles not entire.

- 3a. Tall, erect shrubs; flowers 1-3 nate;  
bracteoles slightly toothed margins .....*fruticosa*
- 3b. Small, diffusely branched herbs or shrubs;  
flowers many, clustered; bracteoles  
pectinate margins .....*nudiflora*
- 2b. Flower polygamous; stigma 3-5;  
bracteoles entire margins .....*monoica*
- 1b. Annuals; stigma 2; seeds horizontal .....*maritima*

*Suaeda fruticosa* (L.) Forsk. ex Gmel. Syst. Nat. ed. 13. 2(1): 502. 1791; Gamble, Fl. Pres. Madras 5:13 1957 (Repr. ed).

Much branched shrubs upto 3 m tall with glabrous branches. Leaves variable, 0.6-1.5 cm long, linear-oblong, ellipsoid or obovate, obtuse at apex, narrowed at base. Flowers hermaphrodite, axillary, 1-3 nate; bracteoles slightly toothed margin. Utricle 2.5 mm long, obovoid with short spreading stigmas. Seeds ovoid, compressed, black.

Fl. & Fr. : Aug.- Sept.

Distrib : India, Africa and America.

Ecological Notes : Common and restricted in salt marshes near the Krishna delta.

Uses : used for crude soda, fodder and soil binder.

NOTE : First time recorded from the Krishna delta.

*Suaeda nudiflora* (Willd.) Moq., Ann. Sc. Nat. Ser. 23 : 316. 1831; Gamble, Fl. Pres. Madras 2: 829 1957 (Repr. ed).

Diffusely branched woody perennials upto 1.5 m. tall with glabrous, yellowish or often reddish stems. Leaves 7-12 mm. long, linear, fleshy, terete. Flowers 1.5-2 mm. across, clustered in terminal spikes; bracteoles 1-2 mm. long, ovate, acute, pectinate. Utricle ovoid with membranous pericarp and black, shining seeds 1-1.2 mm in diam.

Fl. & Fr. : July-Sept.

Distrib : Throughout the coastal provinces in India and Sri Lanka.

Ecological Notes : Common in salt marshes and saline embankments near the coast and coastal backwaters swamps, more frequent towards estuarine islands of Krishna and Godavari deltas.

Uses : Used as vegetables during flood hazards.

*Suaeda monoica* Forsk. ex Gmel., Syst. Nat. ed. 13. 2(1): 503. 1971; Gamble, Fl. Pres. Madras 2:829. 1957 (Repr. ed).

Small erect bush upto 0.8 m. tall with much branched, glabrous stems marked with tuberulate leaf-scars. Leaves 10-18 x 2-2.5 mm, alternatively crowded, linear-oblong or spatulate, obtuse or rounded at apex, narrowed at base. Flowers 2-3 mm. across greenish-white, polygamous, axillary, 1-3 nate arranged in clusters to the subtending leaves; bracteoles ovate-acute, entire. Utricles globose; seeds 1-1.3 mm in diam. horizontally arranged, black.

**Fl. & Fr. :** July-Sept.

**Distrib :** In both E. & W. coast of India; Sri Lanka, Arabia, Egpt and Portugal.

**Ecological Notes :** Frequent along the intertidal banks of creeks and channels in mangrove swamps of the Krishna at Soroligunta.

**Uses :** Used as vegetables during flood hazards.

*Suaeda maritima* (L.) Dum., Fl. Belg. 22. 1827; Gamble, Fl. Pres. Madras 2: 829. 1957 (Repr. ed).

Erect or ascending annuals with glabrous, much branched stems. Leaves 11-35 mm. long, linear-oblong, crowded, often purple coloured. Flowers 1 mm or less across, whitish in axillary clusters or on elongated lax spikes; bracteoles ovate, membranous, entire. Utricles ovoid. Seeds 0.8-1 mm in diam., brown, shining.

**Fl. & Fr. :** Dec-March.

**Distrib :** In Asia, Europe, N. America, Australia and N.Africa.

**Ecological Notes :** Common in salt marshes and saline embankments near the coast and estuarine islands of the Godavari and Krishna deltas, sometimes forms pure stand or in association with *S. nudiflora*, frequently found within the mangrove forests where the areas are devoid of regular tidal flows.

**Uses :** Extraction of oil, used as vegetables during flood hazards.

## 17. C O M B R E T A C E A E

## LUMNITZERA Willd.

*Lumnitzera racemosa* Willd., Neue. Schr. Ges. Naturf. Fr. Berl. 4:287. 1803; Gamble, Fl. Pres. Madras 1:331. 1957 (Repr. ed.).

Trees or shrubs 2-8 m tall without pneumatophores; barks reddish brown, lenticellate. Leaves 4-8.5 x 1.5-3.5 cm, obovate, coriaceous, entire, emarginate at apex, cuneate at base. Flowers 9-11 mm long, white, sessile in axillary spike. Fruits 8-10 x 4-6 mm woody, ellipsoid, compressed, 1-seeded drupes.

Fl. & Fr. : May July.

Distrib : Throughout the Indian Coast; Malaysia, Tropical E. Africa and N.Australia.

Ecological Notes : Frequent on sandy or muddy areas along the intertidal regions of backward mangrove fringes and coastal back water forests; common as a secondary forest formation along the estuarine islands of Godavari and Krishna deltas.

Uses : Potentially useful for fuel wood, tannin and boat building materials.

## 18. C O N V O L V U L A C E A E

## Key to Genera

- 1a. Parasitic leafless herbs.....1.*Cuscuta*
- 1b. Non parasitic leafy herbs.
  - 2a. Style 2, free
    - 3a. Corolla imbricate; stamens exerted .....2.*Cressa*.
    - 3b. Corolla induplicate, contorted,  
stamens included .....3. *Evolvulus*
  - 2b. Style 1.
    - 4a. Pollen grain smooth .....4. *Merremia*
    - 4b. Pollen grain spinulose .....5. *Ipomoea*

## 1. CUSCUTA L.

*Cuscuta reflexa* Roxb., Pl. Corom. 2 : 3. t. 104. 1798; Gamble, Fl. Pres. Madras 2 : 654. 1957 (Repr. ed.).

Parasitic, leafless, twining herbs with golden yellow stems Flowers 6-10 mm long, white, sessile in compact cymose clusters. Capsules ellipsoid, pale-brown, circumscissile at base.

**Fl. & Fr. :** Aug. Nov.

**Distrib :** Throughout India; Sri Lanka, Malaysia, Indonesia and China.

**Ecological Notes :** Frequent in sandy scrubs, coastal thickets and river banks at Nachugunta, Lankavani-dibba and Kothapalem.

**Uses :** Plants contains cuscotaline and cuscutin, useful medicinal chemicals.

## 2. CRESSA L.

*Cressa cretica* L., Sp. Pl. 223. 1753; Gamble, Fl. Pres. Madras 2 : 647. 1957 (Repr. ed.).

Erect, grey-pubescent, branched herbs, 8-30 cm high. Leaves small, 4-10 mm long, numerous, ovate, densely silky-tomentose, acute at apex. Flowers white, 2 mm long, clustered in the axils of upper leaves. Capsules, 4 mm long, ovoid, pubescent at apex; seeds solitary.

**Fl. & Fr. :** Nov. Jan.

**Distrib :** Mainly throughout the E.Coast in India; Sri Lanka.

**Ecological Notes :** Common in sandy plains, saline embankment, fallow fields and moist saline muds near the estuarine islands of the Godavari and Krishna deltas, often common on dry salt pans near coastal back water flow.

## 3. EVOLVULUS L.

*Evolvulus alsinoides* (L.) L., Sp. Pl. ed. 2 : 392. 1762; Gamble, Fl. Pres. Madras 2 : 648. 1957 (Repr. ed.).

Perennial, ascending herbs with woody root and spreading, wiry, branches, pubescent. Leaves 8-26 mm long, elliptic-oblong, sub-sessile, acute at apex, narrowed at base. Flowers blue, rarely white, axillary, solitary. Capsule 3-4 mm in diam., globose, 2-loculed, 4-valved. Seeds pale-brown, 4.

**Fl. & Fr. :** July-Sept.

**Distrib :** Tropical and sub-tropical regions of both the hemispheres.

**Ecological Notes :** Frequent along sea shores, river banks, road sides and dry plains.

**Uses :** As bitter tonic and febrifuge.

4. *MERREMIA* Dennst. ex Hallier.f.

*Merremia tridentata* (L.) Hall.f., E.J. 16: 552. 1893; Gamble, Fl. Pres. Madras 2 : 652. 1957 (Repr. ed.).

Twining, pubescent or glabrous herbs with woody root-stock. Leaves 2-10 cm long, variable, lanceolate or ovate-oblong, acuminate, emarginate or mucronulate at apex, truncate, hastate or auriculate at base, often toothed or lobed towards base. Flowers yellow in axillary cymes. Capsules globose 4-9 mm diam., 4-valved, 4-seeded, 2-3mm long.

Fl. & Fr. : July-Dec.

Distrib : India, Malaysia, Australia, S.Africa and China.

Ecological Notes : Frequent in sandy scrubs, coastal thickets and backward mangrove fringes at Krishna Delta.

5. *IPOMOEA* L.

## Key to species

- 1a. Twining herbs; leaves entire .....*tuba*  
 1b. Creeping herbs; leaves bilobed .....*pes-caprae*

*Ipomoea tuba* (Schlechtend.) G. Don, Gen. Syst. 4:271. 1838; Hook. f., Fl. Brit. India 4 : 212. 1890.

Perennial, glabrous twiners. Leaves 7.5-15.0 cm diam., broadly ovate or orbicular, cordate at base, acuminate at apex. Flowers white, axillary, solitary or rarely in 2-flowered cymes. Fruits globose with 4 seeds. Seeds hairy along the margin.

Fl. & Fr. : Aug. Oct.

Distrib : India, Malaysia, Sri Lanka, Tropical E.Africa and Tropical America.

Ecological Notes : Frequent along intertidal banks of creeks at Coringa estuary with mangroves.

Uses : Medicine for rheumatism and laxative.

*Ipomoea pes-caprae* (L.) Sweet., Hort. Suburb. 35. 1818; Gamble, Fl. Pres. Madras 2: 664. 1957.

Prostrate, glabrous runner, rooting from the nodes. Leaves 2-4.5 x 3.5-5.5 cm, deeply bilobed, coriaceous with parallel veins. Flowers rose-purple, solitary, axillary. Fruits 1.2-1.4 cm long ovoid, glabrous. Seeds villous.

**Fl. & Fr.** : Through out the year.

**Distrib** : The sandy shores of both the hemisphere.

**Ecological Notes** : Common sandbinder along the sea shores and open sandy places near the river banks and estuarine islands of the Godavari and Krishna deltas.

**Uses** : leaves and seeds are used for rheumatism, laxative and astringent.

## 19. C U C U R B I T A C E A E

### Key to Genera

- 1a. Seeds compressed; margins raised.
  - 2a. Petals entire; stylar disc cup-shaped .....1. *Mukia*
  - 2b. Petals fimbriate; stylar disc absent .....2. *Trichosanthes*
- 1b. Seeds not compressed; margins not raised.
  - 3a. Tendrils simple;
    - anther connectives prolonged .....3. *Cucumis*
  - 3b. Tendrils 2-3 fid;
    - anther connectives not prolonged .....4. *Citrullus*

### 1. MUKIA Arn.

*Mukia maderaspatana* (L.) M.J.Roem., Syn. Monogr. 2 : 47. 1896; Gamble, Pres. Madras 1 : 384. 1957.

Scabrous climber with slender, hispid branches. Leaves 1.5-5.0 x 1.5-4.5 cm, ovate, hastate, 3-5 lobed, sinuate-toothed, acute at apex, narrowed at base. Flowers yellow, male and female flowers in separate clusters. Fruits 1 cm in diam., globose, smooth, scarlet coloured. Seeds compressed, ovate.

**Fl. & Fr.** : April-July.

**Distrib** : Throughout India; Malaysia, China, Australia and Tropical South Africa.

**Ecological Notes** : Frequent in coastal thicket and riverine scrub along the Krishna delta.

**Uses** : Fruits are used for various medicinal purpose.

## 2. TRICHOSANTHES L.

*Trichosanthes cucumerina* L., Sp. Pl. 1008. 1753; Gamble, Fl. Pres. Madras 1 : 373. 1957 (Repr. ed.).

Slender, scabrid-pubescent climbers. Leaves 8-10 x 8-11 cm, reniform or orbicular, deeply lobed, cordate at base. Flowers white, male flowers solitary, female flowers 2-3, in clusters. Fruits 6x4 cm, ovoid, conical with white stripes. Seeds 11 x 6 mm, compressed, tuberculate.

Fl. & Fr. : August-Oct.

Distrib : India, Australia and Polynesia.

Ecological Notes : Frequent on hedges and bushes on coastal scrubs at Kothapalem.

Uses : Leaves and fruits are used for bitter tonic and vegetable.

## 3. CUCUMIS L.

*Cucumis callosus* (Rottl.) Cogn., Engl. Pflerich. IV. 275. 11.129. 1924; Gamble., Fl. Pres. Madras 1 : 378. 1957 (Repr. ed.).

Annual climbers or trailers with rigid, angular branches. Leaves 3-6 cm long, palmately lobed, sinuate-dentate, rounded at apex. Flowers yellow; male flowers fasciated in axillary racemes; female flowers solitary, axillary. Fruits trigonous, smooth. Seeds 5 x 2 mm, many.

Fl. & Fr. : March July.

Distrib : India, Malaysia, China, Australia and N.Africa.

Ecological Notes : Frequent along dry sandy scrubs near the coast and back mangrove fringes; (Nizampatanam).

## 4. CITRULLUS Neck.

*Citrullus colocynthis* (L.) Schr., Linnaea 12 : 414. 1838; Gamble, Fl. Pres. Madras 1 : 378. 1957 (Repr. ed.).

Perennial trailing herbs with woody root stock; stems scabrid. Leaves 7.5 x 5.0 cm, deeply pinnatifid, 3-5 lobed, scabrid below. Flowers yellow, villose, unisexual, axillary, solitary. Fruits ovoid or sub-globose, longitudinally striped. Seeds 4-6 mm, smooth, ovoid.

Fl. & Fr. : Sept- Dec.



**Distrib :** Throughout India; Malaysia, China, Afghanistan, Europe and N.Africa.

**Ecological Notes :** Frequent in sandy waste lands along the sea shore and river banks of the Krishna delta.

**Uses :** Pulp of the fruits affords important purgative.

## 20. C Y P E R A C E A E

### Key to Genera

- 1a. Flowering glumes spirally imbricate or lower only distichous.
  - 2a. Hypogynous bristles or scales absent;  
styler base swollen .....1 *Fimbristylis*
  - 2b. Hypogynous bristles or scales present;  
styler base not swollen .....2 *Scirpus*
- 1b. Flowering glumes all distichous .....3 *Cyperus*

### 1. FIMBRISTYLIS Vahl.

#### Key to species

- 1a. Spikelets not compressed or trigonous; leaves not flat.
  - 2a. Spikelets solitary, rarely 2-3; nuts yellow,  
dotted with white spots .....*polytrichodes*
  - 2b. Spikelets umbellate or capitate;  
nuts not with whitish-yellow spots.
    - 3a. Leaves 0, or very short; stamens 2-3 .....*ferruginea*
    - 3b. Leaves many; stamens 1-2.
      - 4a. Rhizome present; nuts smooth,  
brown .....*sericea*
      - 4b. Rhizome absent; nuts tuberculate,  
ribbed .....*dichotoma*
- 1b. Spikelets compressed or trigonous; leaves flat.
  - 5a. Style glabrous .....*complanata*
  - 5b. Style pubescent .....*falcata*

*Fimbristylis polytrichoides* (Retz.) Vahl., Enum. 2:248. 1806; Gamble, Fl. Pers. Madras 3 : 1150. 1957 (Repr. ed.).

Glabrous, perennial sedge 4-20 cm high, with fibrous, slender roots. Leaves 2-10 cm long, wiry, acute, terete or teigonus. Flowers many; spikelets solitary, oblong-ellipsoid. Nuts turbinate, sessile, biconvex with acute margins.

Fl. & Fr. : Sept. Oct.

Distrib : throughout India, sea-level; Sri Lanka; Malacca and old world tropics.

Ecological Notes : Frequent on wet lands, embankments and river beds.

Uses : A good fodder.

*Fimbristylis ferruginea* (L.) Vahl, Enu. Pl. 2:291. 1806; Gamble, Fl. Pres. madras 3 : 1151. 1957 (Repr. ed.).

Perennial, leaf-less sedges 20-65 cm high, with stout, fibrous roots. Spikelets 5.5-4 mm long ellipsoid, pale-reddish or brown, pubescent. Nuts 2 mm long, obovoid, smooth, straw coloured, reticulate.

Fl. & Fr. : Sept. Dec.

Distrib : throughout the mangrove forests in India; Malaysia, Japan, Australia and Polinesea.

Ecological Notes : Common in tidal forests along the banks of creeks with mangroves.

Uses : Fodder.

*Fimbristylis sericea* R.Br., Prodr. 228. 1810; Gamble, Fl. Pres. Madras 3 : 1151. 1957 (Repr. ed.).

Thick, woody, rhizomatous sedge up to 7.5 cm long with rigid, terete, 4 angled, stems. Leaves 3-10 cm long, closely imbricate, ligulate, brown-silky. Spikelets clustered in umbel with silky bracts. Nuts obovate, smooth, pale-brown.

Fl. & Fr. : August Oct.

Distrib : in E.Asia; Malaysia and Australia.

Ecological Notes : Frequent along the sea shore and moist sandy places near the estuarine mouth the river Krishna.

Uses : A good sand binder.

*Fimbristylis complanata* (Retz.) Link., Hort. Berol. 1:292. 1827; Gamble, Fl. Pres. Madras 3 : 1152. 1957 (Repr. ed.).

Creeping sedge 0.2-1 m high with wiry, fibrous roots. Leaves 10-50 cm x 3-5 mm crowded at the stem base, flattened, 2-edged, coriaceous. Umbels decomposed with flattened rays. Nuts 0.7-1.2 x 0.5-1.0 mm obovoid, trigonous, straw coloured.

**Fl. & Fr. :** Sept. Dec.

**Distrib :** in India; Sri Lanka; Indo-China; Africa and Oceania.

**Ecological Notes :** Frequent along the margin of ponds, rivers and lakes away from the true mangrove habitat.

*Fimbristylis dichotoma* (L.) Vahl., Enum. Pl. 2 : 287. 1806; Gamble, Fl. Pres. Madras 3 : 1151. 1957 (Repr. ed.).

Annual, tufted sedge 1 cm-80 cm high, with long fibrous roots. Leaves 5cm-50cm long, 1.5-5mm broad, narrowed, recurved, pointed towards apex. Spikelets 5-7 x 2 mm, solitary or 2-5 in an irregular umbel, sessile or in a slender pedicel. Nuts 0.9-1.2 x 0.7-0.9 mm smooth, turbinate, compressed, rounded at apex.

**Fl. & Fr. :** Sept. Oct.

**Distrib :** India; Mediterranean regions of old world and tropics of N.S.Wales.

**Ecological Notes :** Common along the sandy sea shores and in wards sandy places of the mangrove forests.

**Uses :** Used as a good sandbinder.

*Fimbristylis falcata* (Vahl.) Kunth. Enum. Pl. 2 : 239. 1837; Gamble, Fl. Pres. Madras 3 : 1152. 1957 (Repr. ed.).

Glabrous, creeping, woody rhizomatous sedge 10-40 cm high, with fibrous roots. Leaves 5-30 cm x 2-4 mm crowded at the base of the stems, flat, recurved, coriaceous. Umbels compound with few slender rays, clustered in chestnut-brown spikelets. Nuts 0.8-1.0 x 0.8 mm obovoid, trigonous, ribbed.

**Fl. & Fr. :** Nov. Dec.

**Distrib :** Throughout India; Sri Lanka; Madagascar and Philippines.

**Ecological Notes :** Frequent on sandy areas along the back mangroves and estuarine islands.

## 2. SCIRPUS L.

## Key to species

1. Bristles 4 or more, ligulate, plumose. ....*littoralis*  
 1. Bristles 2-3, rigid, scabrous.. ....*triqueter*

*Scirpus littoralis* Schrad. Fl. Germ. 1.142. t. 5. 1806; Gamble, Fl. Pres. Madras 3:156. 1957 (Repr. ed.).

Perennial sedge 45-75 cm tall, with hard root-stock and fibrous roots. Leaves 2.5-5 cm long, hollow, sheath-like, acuminate. Spikelets 1.5 x 0.5 cm, pale-brown, congested near the top of the stems. Nuts obovoid, planoconvex, smooth with apiculation.

Fl. & Fr. : August Nov.

Distrib : India; Sri Lanka; Persia; Central Asia and Africa.

Ecological Notes : Frequent along the waste-lands and water-logged areas near the river banks and back mangrove swamps.

*Scirpus triqueter* L. var. *segregata* Clarke, Hook. f. Fl. Brit. India 6:658. 1893.

Stout club-rush up to 1 m tall. Spikelets umbellate, solitary on the ultimate rays of the lateral umbel.

Fl. & Fr. : Oct. Dec.

Distrib : mainly from the E.Coast in India; Sri Lanka and Malaysia.

Ecological Notes : Rarely found restricted on the banks of the Krishna river at Soroligunta.

## 3. CYPERUS L.

## Key to species

- 1a. Rhachilla deciduous as a whole; keel crested .....*kyllingia*  
 1b. Rhachilla persistent; keel not crested.  
     2a. Nut compressed, radially to the rhachilla; glumes cuspidate;  
         apex retuse .....*pumilus*  
     2b. Nut compressed at right angle to the rhachilla;  
         glumes obovate; rounded at apex.....*difformis*  
     3a. Inflorescence in a single head.

- 4a. Stems rigid, terete, creeping with glabrous rootlets;  
nuts trigonous black .....*arenarius*
- 4b. Stems robust, trigonous, erect with wooly rootlets;  
nuts ovoid, brown .....*pachyrrhizus*
- 3b. Inflorescence umbellate or corymbose.
- 5a. Rhachilla of spikelets distinctly 2-winged;  
plant with fragrant, stoloniferous  
rhizomes .....*rotundus*
- 5b. Rhachilla of spikelets simple;  
plants without fragrant stoloniferous rhizomes.
- 6a. Umbels simple with sessile head;  
glumes cuspidate. ....*compressus*
- 6b. Umbels decomound with many rays;  
glumes ovate, obtuse .....*malaccensis*

*Cyperus kyllingia* Endl., Cat. Hort. Ac. Vindob. 1 : 94. 1842; Gamble, Fl. Pres. Madras 3 : 1130. 1957 (Repr. ed.).

Erect, glabrous sedge 8-30 cm high with elongated creeping rhizome. Leaves 1.5-3.5 mm broad shorter than stem. Spikes solitary with deciduous rhachilla; spikelets 1-flowered with 3-4 floral bracts, similar to leaves. Nuts 1.2-1.5 x 0.5 mm obovoid, compressed, reddish-brown.

Fl. & Fr. : Sept. Oct.

Distrib : Pantropic.

Ecological Notes : Common along the wet lands near the river banks, roadsides and waste places near the sea at Dindipalem, Kandiduppa and Nizampatanam.

*Cyperus plumilus* L., Cent. Pl. 2:6. 1756; Gamble, Fl. Pres. Madras 3:1132. 1957 (Repr. ed.).

Slender annuals with tufted stems 1-25 cm high. Leaves 1-2 mm broad, one-nerved, acute. Spikes clustered or umbellate with 1-6 rays, spikelets many flowered, rhachilla not winged. Nuts 0.5 mm ellipsoid-oblong, brown.

Fl. & Fr. : Aug. Sept.

Distrib : India; E. & W.Coast; Sri Lanka; Malaysia; China; Tropical Africa and Australia.

**Ecological Notes :** Frequent along moist, sandy sea shore and river banks at Sorolagundi, and Yellichelladibba.

*Cyperus difformis* L., Cent. Pl. 2 : 6. 1756; Gamble, Fl. Pres. Madras 3 : 1139. 1957 (Repr. ed.).

Annual with fibrous roots and tufted stems 6-65 cm high, triquetrous at the top. Leaves 1.5-5.0 mm broad, linear, acuminate, flaccid. Spikes in simple or in compound umbel with 3-6 rays; spikelets many in dense head, brown. Nuts ellipsoid, trigonous, apiculate at apex.

**Fl. & Fr. :** Oct. Nov.

**Distrib :** India and warmer parts of the old world.

**Ecological Notes :** Frequent in marshy fields at sea level and river banks.

*Cyperus arenarius* Retz., Obs. Bot. 4 : 9. 1786; Gambel Fl. Pres. Madras 1140. 1957 (Repr. ed.).

Wiry, much-branched, creeping sedge 10-40 cm running deep down the sand. Rhizomes covered with chestnut brown sheaths; rootlets thick, glabrous. Leaves 2-4 mm broad linear, recurved. Head solitary on the summit of the stems, globose with many sessile radiating spikelets. Nuts obovoid, rounded, trigonous, black.

**Fl. & Fr. :** Oct. Nov.

**Distrib :** throughout the Indian coast; Sri Lanka; Persia and Arabia.

**Ecological Notes :** Common along sandy beaches as a pioneer sand binder and forms a first carpet in the intertidal coastal zone.

**Uses :** Useful sand stabilizer in the intertidal zone.

*Cyperus pachyrrhizus* (Nees) Kukenth, Pflanz. Jahrb. 101 : 275. 1956; Gamble, Fl. Pres. Madras 3 : 1140. 1957 (Repr. ed.).

Creeping, rhizomatous perennial herbs 30-45 cm long roots densely woolly clothed with chestnut coloured scales. Stems trigonous with single head. Inflorescence 2.5 cm in diam., consisting of many congested spikelets. Nut obovoid, trigonous, black.

**Fl. & Fr. :** August Oct.

**Distrib :** In coastal regions from Orissa to Krusadi islands; Sri Lanka and N. Africa.

**Ecological Notes** : Frequent along sandy sea shores near the Krishna river mouth.

**Uses** : Useful sand binder due to the woolly rootlets.

*Cyperus rotundus* L., Sp. Pl. 45. 1753; Gamble, Fl. Pres. Madras 3:1140. 1957 (Repr. ed.).

Glabrous, stoloniferous herbs 10-40 cm, with hard, tunicate, fragrant tubers; roots clothed with flexuous hairs. Leaves 2-4 mm broad, flat, 1-nerved, narrowly acuminate. Spikes in umbel, simple or compound with 2-8 rays; spikelets reddish-brown, contracted into a head. Nuts 1.5-1.7 mm long, obovoid, trigonous, greyish-black.

**Fl. & Fr.** : Sept. Nov.

**Distrib** : India and other tropical parts of the world.

**Ecological Notes** : Frequent from the sea shore to inland moist places, river banks and newly formed estuarine islands.

**Uses** : Potentially used for soil binder, tubers for medicines, aroma and fabrics, powder of the tuber is used for 'Agarbati'.

*Cyperus malaccensis* Lamk., Illustr. 1 : 146. 1791; Gamble, Fl. Pres. Madras 3 : 1140. 1957 (Repr. ed.).

Rhizomatous sedge 45-90 cm long; rhizome thick, creeping, clothed with dark-brown scales. Leaves 5-15 cm long, few, shortly caudate. Spikes in umbel, 5-15 cm in diam., simple or compound, congested. Nuts narrowly oblong, obtusely trigonous, compressed and apiculate.

**Fl. & Fr.** : Sept. Nov.

**Distrib** : Throughout India; Australia and Polynesia.

**Ecological Notes** : Frequent in swampy areas along the river banks, coastal sandy waste places and canal sides.

*Cyperus compressus* L., Sp. Pl. 1 : 46. 1753; Gamble, Fl. Pres. Madras 3 : 1140. 1957 (Repr. ed.).

Annuals with tufted stems 3-40 cm high, and fibrous roots. Leaves 1.5-4.0 mm broad, 1-nerved. Spikes in umbel with sessile head; rays 3-6 bearing 4-8 terminal spikelets. Nuts 1.5-1.7 mm long obovoid, triquetrous.

**Fl. & Fr.** : Sept. Nov.

**Distrib :** throughout the tropics of the world.

**Ecological Notes :** Frequent in sandy sea shore, estuarine banks and road-side swamps in the sea leves.

## 21. E U P H O R B I A C E A E

### EXCOECARIA L.

*Excoecaria agallocha* L., Syst. Nat. ed. 10. 1288. 1759; Gambel Fl. Pres; Madras 2 : 941. 1957 (Repr. ed.).

Trees with milky acrid juice 4-20 m tall, 10-80 cm in diam.; barks greyish, lenticillate; wood soft, light; tap roots insignificant, lateral roots intermingled with each other and spreading like snakes; elbow-shaped pegs are produced instead of pneumatophores from the lateral roots. Leaves 2-8 x 1.5-3 cm, ovate-elliptic or oblong, coriaceous, acute at apex, narrowed at base; turning yellowish-red before shedding. Flowers unisexual, male flowers 2-3 mm across yellow, sessile in axillary many-flowered catkin-like spikes 3-7 cm long; female flowers 2.5-3.5 mm across pedicellate in axillary few-flowered racemes 1-2.5 cm long. Fruits 1-1.5 cm across, globose, 3-lobed with sub-globose seeds.

**Fl. & Fr. :** March Oct.

**Distrib :** Throughout the tidal bands of mangrove forests in India; Sri Lanka, Java, Tropical Asia, N.Australia and New Caledonia.

**Ecological Notes :** Common along the intertidal banks of creeks and channels in mangrove swamps; costal backwaters and estuarine islands of the Godavari and Krishna deltas.

**Uses :** Potentially useful for soft wood, fuel and paper pulp. Milky acrid juices is poisonous.

## 22. F A B A C E A E

### A. CAESALPINIACEAE

#### Key to Genera

- 1a. Leaves with distinct main rachis;  
 pods not moniliform .....1 *Caesalpinia*
- 1b. Leaves without main rachis,  
 pods moniliform .....2 *Parkinsonia*



## 1. CAESALPINIA L.

## Key to species

- 1a. Pods prickly .....*bonduc*  
 1b. Pods not prickly .....*crista*

*Caesalpinia bonduc* (L.) Roxb., Fl. Ind. 2 : 362. 1832 *quoad besion*; Gamble, Fl. Pres.; Madras 1 : 279. 1957 (Repr. ed.).

Prickly, scrambling shrubs. Leaves bipinnate, armed with prickles; pinnae 4-16 jugate; leaflets 1.5-4 x 1-2 cm, ovate, acute at apex, oblique at base. Flowers 5-10 mm long, yellow in supra-axillary racemes. Pods 4-6 cm, elliptic-oblong, densely covered with prickles. Seeds 2 cm across, globose, shining.

Fl. & Fr. : Aug. Nov.

Distrib : pantropically, from coast towards in islands.

Ecological Notes : Frequent in hedges, scrubs and coastal thickets near the sea, rarely in sandy areas on back mangroves.

Uses : Seed oil is used for cosmetic and antipyretic.

*Caesalpinia crista* L., Sp. Pl. 380. 1753; Gamble, Fl. Pres. Madras 1 : 278. 1957 (Repr. ed.).

Large climbers or lianas, armed with hooked prickles. Leaves 18-30 cm long decomposed; pinnae 2-6 pairs; leaflets ovate, glaucous beneath, acute at apex, obtuse at base. Flowers 1.5-2 cm long, deep yellow in axillary branched racemes. Pods 4-5 x 3-3.5 cm, ellipsoid, compressed, glabrous, beaked. Seeds 1, flat, smooth.

Fl. & Fr. : Jan. May.

Distrib : pantropical.

Ecological Notes : Frequent in the intertidal regions of creeks and channels in the mangrove forests, usually restricted to the littoral zone.

## 2. PARKINSONIA L.

*Parkinsonia aculeata* L., Sp. Pl. 375. 1753; Gamble, Fl. Pres. Madras 1 : 281. 1957 (Repr. ed.).

Small trees 4-7 m high, with pinnately compound leaves. Flowers yellow in lax racemes with corrugated petals. Pods 7.5-10 cm long, moniliform, turgid, dehiscent.

Fl. & Fr. : March April.

Distrib : A native of tropical America.

Ecological Notes : Frequently planted along the saline bunds and road sides near the sea shore.

Uses : Introduced for good soil binding and ornamental plant.

## B-M I M O S A C E A E

## PROSOPIS L.

*Prosopis cineraria* (L.) Druce, Rep. Bot. Soc. Exch. Cl. Brit. Isles (3) : 422. 1913; Gamble, Fl. Pres. Madras 1 : 297. 1957 (Repr. ed.).

Bushy, straggling, spiny shrubs or small trees up to 4 m high with long, sermentose branches. Leaves 2.5-8 cm long 1-3 at each node, bipinnate. Flowers white or yellowish-white in axillary spike; calyx companulate, 5, toothed; petals 5, free, tomentose along the inner margin; stamens 10, exserted. Pods 10-20 seeded.

Fl. & Fr. : Throughout the year.

Distrib : A native of Mexico and arid parts of central America.

Ecological Notes : Very common in this delta along the river banks of the Godavari and Krishna even extended up to the estuarine mouth. Field observation revealed that this species spreads automatically from the inland towards the lowlying areas of the estuarine islands and coastal beaches up to a certain range of tidal salinity conditions.

Uses : Largely used for fuel woods, a soil binder.

## C. P A P I L I O N A C E A E

## Key to Genera

## 1a. Trees

2a. Leaflets opposite; pods thin, kidney-shaped.....1. *Dalbergia*

- 2b. Leaflets opposite; pods thick, flattened.....2. *Pongamia*  
 1b. Climbing or twining herbs or shrubs.  
 3a. Pods thick covered with irritant bristles .....3. *Mucuna*  
 3b. Pods thin, without bristles, glabrous.....4. *Derris*

### 1. DALBERGIA L. f.

*Dalbergia spinosa* Roxb., Fl. Ind. ed. Carey 3 : 233. 1832; Gamble, Fl. Pres. Madras 1 : 269. 1957 (Repr. ed.).

Shrubs or small bushy trees 4-10 m tall; branchlets many, horizontal, ending in a hard spine. Leaves 6-9 cm long, crowded at the nodes of spinous branches; leaflets 9-11, alternate, each 1-2.5 x 0.5-1 cm, elliptic or ovate-lanceolate, glabrous, obtuse or emarginate at apex, rounded or cuneate at base. Flowers 2-3 m across, whitish-purple in axillary lateral raceme. Pods 2.5-3 cm, thin, kidney-shaped, 1-2 seeded.

Fl. & Fr. : April Oct.

Distrib : India; Bangladesh.

Ecological Notes : common along the intertidal banks of creeks and channels in the mangrove forests and estuarine islands of the Godavari and Krishna delta.

Uses : Used for fodder, fuel and fish food.

### 2. PONGAMIA Vent.

*Pongamia pinnata* (L.) Pierre, Fl. For. Cochinch. Sub. t. 385. 1899; Gamble, Fl. Pres. Madras 1 : 272. 1957 (Repr. ed.).

Trees up to 20 m tall; barks greyish-white; woods yellow. Leaves 20-30 cm long, 5-7 foliolate; leaflets 6-10 x 4-8 cm, ovate-elliptic or oblong, glabrous, acute or acuminate at apex, obtuse at base. Flowers 7-8 mm across, lilac or purple in axillary racemes. Pods 4-8 x 2-3.5 cm, flat, oblong-ovoid, woody, ridged along the suture, mucronate at apex, narrowed at base. Seed one, smooth.

Fl. & Fr. : May Oct.

Distrib : India; Malaysia; N.Australia and Polynesia.

Ecological Notes : Frequent throughout the coastal regions along the sandy beaches, coastal thickets and back water mangrove areas, sometimes planted along the road side at Sanjoy nagar, Kothapalem and Nizampatanam.

Uses : Potentially used for 'Pongam' oil for tannin industries and soap making; woods for cottage industries and root juice for the treatment of Gonorrhoea.

### 3. MUCUNA Adans.

*Mucuna pruriens* (L.) DC. Prodr. 2 : 405. 1825; Gamble, Fl. Pres. Madras 1 : 251. 1957 (Repr. ed.).

Pubescent, large twiners. Leaves trifoliolate; leaflets 5-15 x 3-12 cm ovate-elliptic, pubescent, oblique at base, acute or acuminate at apex. Flowers 25-40 mm long dark purple in axillary, drooping racemes. Pods 5-7.5 cm long 'S' -shaped, covered with irritant bristles.

Fl. & Fr. : Oct. Jan.

Distrib : Throughout Indian coast; Sri Lanka; Malaysia and Burma.

Ecological Notes : Frequent on coastal thickets and back mangrove areas.

### 4. DERRIS Lour.

#### Key to species

1a. Pods strap-shaped, narrow .....*scandens*

1b. Pods rounded, papery, flat.....*heterophylla*

*Derris scandens* (Roxb.) Benth., J. Linn. Soc. 4(Suppl.) : 103. 1860; Gamble, Fl. Pres. Madras 1 : 273. 1957 (Repr. ed.).

Scandent shrubs; stems brownish, lenticellate. Leaves imparipinnate 6-12 cm long, leaflets 9-13, opposite, 4-8x 1-1.8 cm, each ovate-oblong, sub-coriaceous, acute at apex, obtuse at base. Flowers 4-6 mm whitish-pink clustered in axillary racemes. Pods 6-8 cm long, strap-shaped, narrow, winged along the upper suture. Seeds 1-3.

Fl. & Fr. : August Dec.

Distrib : Throughout the tidal forest of India; Sri Lanka, Malaysia, China and N.Australia.

Ecological Notes : Common in the tidal banks of creeks and channels of the mangrove forests in the Godavari and Krishna deltas.

Uses : Roots are used for fish toxicant.

*Derris heterophylla* (Willd.) Back. & Bakh., Fl. Java 1 : 619. 1963; Gamble, Fl. Pres. Madras 1 : 273. 1957 (Repr. ed.).

Large twining or creeping shrubs; branches woody, glabrous with scattered lenticels. Leaves 6-15 cm long, imparipinnate; leaflets 5-10 x 2-3.5 cm, ovate or ovate-oblong, coriaceous, shortly acuminate at apex, obtuse or rounded at base. Flowers 4-6 mm across, lilac, purple or pale-white in axillary panicles. Pods roundish, flat, papery, narrowly winged along the upper suture. Seed-one.

Fl. & Fr. : May Sept.

Distrib : Coastal India; Malaysia, Java, China, N.Australia, Polynesia and Madagascar.

Ecological Notes : Frequent along the banks of creeks and channels in the mangrove forest of the Krishna delta.

Uses : Barks serve as fodder, entire plant is used as stimulant, antispasmodic and root powder for insecticide.

## 23. FLACOURTIACEAE

### FLACOURTIA L' Heritier

*Flacourtia indica* (Burm. f.) Merrill, Interpret. Rumph. Herb. Amb. 377. 1917; Gamble, Fl. Pres. Madras 1 : 39. 1957 (Repr. ed.).

Bushy, spiny shrubs with many branches. Leaves 3-7 cm long obovate, orbicular, crenate, obtuse at apex, cuneate at base. Flowers greenish-yellow in few-flowered racemes. Fruits globose 1-1.2 cm in diam., scarlet-red when ripe. Seeds 1.5-2 mm long, 8-16, ellipsoid.

Fl. & Fr. : Feb. June.

Distrib : India; tropical Africa, S.E. Asia, Malaysia, Java and Polynesia.

Ecological Notes : Frequent along the riverine scrubs, coastal thickets and sand bars on back mangroves at Machilipatanam, Nizampatanam and Kothapalem.

Uses : Used as good fodder, fruits are edible.

## 24. H I P P O C R A T E A C E A E

## SALACIA L.

*Salacia chinensis* L., Mant. 3 : 293. 1767; Gamble, Fl. Pres. Madras 1 : 154. 1957(Repr. ed.).

Straggling shrubs with divaricate branches and angular twigs. Leaves 4.5 8.5 x 2.5 3.5 cm, elliptic lanceolate, acuminate at apex. Flowers yellow, fleshy, solitary. Fruits 1.2 cm in diam., subglobose, fleshy, apiculate, red when ripe. Seed one.

Fl.& Fr. : Dec March.

Distrib. : India ; Java and Philipines.

Ecological Notes : Rare along the sand bars and coastal thickets at Dindipalem.

Uses : Roots are used as antidiabetic, fruits are edible.

## 25. L A U R A C E A E

## CASSYTHA L.

*Cassytha filiformis* L., Sp. Pl. 35. 1753; Gamble, Fl. Pres. Madras 1 : 868. 1957 (Repr. ed.).

Leafless, twining herbs with slender, greenish branches. Flowers yellowish white, sessile in lax lateral spikes. Fruits 5-6 mm diam., white, globose, enclosed in fleshy perianth tube.

Fl.& Fr. : Sept. Dec.

Distrib. : India, Arabia, Tropical Asia, & Australia, Polynesia, Tropical Africa and America.

Ecological Notes : Frequent in costal thicket and sandy beaches at Nizampatnam

Uses : Medicinal.

## 26. L E C Y T H I D A C E A E

## BARRINGTONIA Forster

*Barringtonia acutangula* (L.) Gaertn., Fruct. 2 : 97. pl. 101. 1991; Gamble, Fl. Pres. Madras 1 : 344. 1957(Repr. ed.).

Trees up to 15 m tall with greyish barks. Leaves 6-15 x 2-6 cm, membranous, acuminate at apex, obtuse at base. Flowers 2-3 cm across, whitish in pendulous racemes. Fruits 2-6 x 1-2.5 cm, triangular, ovoid ellipsoid, 1-seeded.

**Fl. & Fr.** : April - Oct.

**Distrib.** : India through out the coastal regions; Sri Lanka, Malaysia, and Polynesia.

**Ecological Notes** : Frequent on river banks near sea levels at Nagylanka, Sarcemento and Yanam.

**Uses** : Fruit juice is used for remedy of Asthma, jaundice, colic pains and skin diseases.

## 27. L O R A N T H A C E A E

### Key to Genera

- 1a. Branches dichotomous; flowers unisexual.....1. *Viscum*  
 1b. Branches not dichotomous; flowers bisexual .....2. *Dendrophthoe*

### 1. VISCUM L.

*Viscum ovalifolium* Wall. ex DC., Prodr. 4 : 278. 1830; Gamble, Fl. Pres. Madras 1 : 880. 1957(Repr. ed.).

Semi-parasitic, much branched herbs; branches angular, flattened at internodes. Leaves 1.5-5.5 x 0.5-2.5 cm, ovate-elliptic, coriaceous, obtuse or rounded at apex, narrowed at base. Flowers greenish-yellow in axillary 2-3 flowered clusters; female in centre surrounding the male. Fruits 5-6 mm across, oblong-ellipsoid, narrowed at both the ends.

**Fl. & Fr.** : April - August.

**Distrib.** : India, China, Java, New Guinea and Australia.

**Ecological Notes** : Frequent on *Excoecaria agallocha* in the mangrove forests and on *Pongamia pinnata* in the back mangrove zones at Nachugunta.

**Uses** : Potentially useful for various herbal medicine.

## 2. DENDROPTHOE Mart.

*Dendroptoe falcata* (L.f.) Etting., Denkschr. Akad. Wiss. Math. Naturw. Cl. 32 : 52-58. 1872; Gamble, Fl. Pres. Madras 1 : 877. 1957(Repr. ed.).

Semi-parasitic woody shrubs. Leaves 7-15 x 2.5-10 cm, variable, ovate-elliptic or lanceolate, often fulcate, glabrous, obtuse at apex, rounded at base. Flowers 3-4 cm long, bright-red in unilateral racemes. Berries globose, purple when ripe.

Fl. & Fr. : Dec. March.

Distrib. : India; Sri Lanka, Malaysia and Australia.

Ecological Notes : Frequent on tree species in coastal scrubs and back mangroves.

## 28. M A L V A C E A E

## Key to Genera

- 1a. Tree with yellow latex;  
young parts with peltate scales ..... 1. *Thespesia*
- 1b. Shrubs or herbs without latex; young parts without peltate scales.
  - 2a. Shrubs or small trees; young parts covered  
with stellate hairs fruits capsular ..... 2. *Hibiscus*
  - 2b. Mostly herbs; young parts without stellate hairs;  
fruits a schizocarp.
    - 3a. Ovules solitary ..... 3. *Sida*
    - 3b. Ovules 2-many ..... 3. *Abutilon*

## 1. THESPESIA Soland ex. Corr.

## Key to Species

- 1a. Capsules dehiscent; exocarp separated from  
endocarp by a fibrous, spongy mesocarp ..... *populneoides*
- 1b. Capsules indehiscent; exocarp not  
separated from endo carp; mesocarp absent ..... *populnea*



*Thespesia populneoides* (Roxb.) Kostel., Allg. Med. Pharm. Fosberg & Sachet in Smith. Cont. Bot. 7. 1972; Roxb. Fl. Ind. ed. Carey 3 : 81. 1832.

Tree 3-6 m tall, with yellow latex and bronze-coloured lepidots on young twigs. Leaves 7-10 x 5-8 cm, cordate, acuminate at apex, sinued at base. Flowers 3-5 cm across, yellow. Fruit globose, at maturity separating from the spongy, reticulated endocarp. Seeds 6-8 mm across, ovoid with rough clavate hairs along the angles.

**Fl. & Fr.** : Through out the year.

**Distrib.** : India Coastal Bengal, Orissa, Andhra Pradesh, Malaysia, Combodia, Laos and Australia.

**Ecological Notes** : Frequent along the estuarine islands at Coringa and Krishna river mouth.

**Uses** : Used for yellow dye and skin disease.

*Thespesia populnea* (L.) Sol. ex Corr., Ann. Mus. Nat. Paris 9 : 290. 1907; Gamble, Fl. Pres. Madras 1 : 72. 1957 (Repr. ed.).

Trees 6-9 m tall, with yellow latex and brown lepidotes on young twigs. Leaves 6-15 x 4-13 cm, deltoid, orbicular or cordate, acuminate at apex, narrowed at base. Flowers 4-6 cm across, yellow solitary. Capsules 4-5 cm across globose indehiscent. Seeds 1-1.3 mm across, ovoid with long silky hairs along the angles.

**Fl. & Fr.** : Through out the year.

**Distrib.** : Pantropic.

**Ecological Notes** : Frequent on sea shore, river and roadsides, often planted as shade tree.

## 2. HIBISCUS Medik.

*Hibiscus tiliaceus* L., Sp.Pl. 694 1753; Gamble, Fl. Pres. Madras 1 : 70 1957 (Repr. ed.).

Shrub 3-6 m tall or lianas with many branches close to the ground. Leaves 5-16 x 4-18 cm orbicular, crenulate, stellate beneath, acute at apex, cordate at base. Flowers 7-10 cm across, campanulate, yellow with crimson eye in the centre, turning purple when old. Capsules 3-5 across, ovoid, tomentose; Seeds black with pale dots.

**Fl. & Fr.** : Feb. Sept.

**Distrib. :** Pantropic.

**Ecological Notes :** Common along Orissa, Bengal and Kerala back mangroves. Though its occurrence has been recorded in the Godavari delta but we failed to collect it in the Godavari or in the Krishna delta.

**Uses :** Potentially used for fibres and fuel.

### 3. SIDA L.

*Sida cordifolia* L., Sp.Pl. 684. 1753; Gamble, Fl. Pres. Madras 1 : 64. 1957 (Repr. ed.).

Erect herbs 0.5-1 m high, with much-branched, tomentose stems. Leaves 1-6 cm, long ovate, obtuse or acute at apex, truncate at base. Flowers 12-15 mm across, yellow, axillary corymbose. Carpels 10 with two awns exceeding the calyx lobes.

**Fl.& Fr. :** May August.

**Distrib. :** Through out the tropics.

**Ecological Notes :** Common along the river banks, seashores and road sides.

**Uses :** Medicinal herbs.

### 4. ABUTILON Gaert.

*Abutilon indicus* (L.) Sweet, Hort.Bit. 1 : 54. 1886; Gamble, Fl. Pres. Madras 1 : 65. 1957 (Repr. ed.).

Erect annual or perennial herbs or undershrubs, 0.3-3 m high, velutinous. Leaves 2-7 cm long ovate or sub-orbicular, crenate, acute at apex, cordate at base. Flower 25-30 mm across, yellow, solitary. Fruits globose separating into 20-25 mericarps.

**Fl.& Fr. :** May - Sept.

**Distrib. :** Throughout the tropics and sub tropics of both the hemispheres.

**Ecological Notes :** Rare along the sea shore, common along the roadsides and wasteland.

## 29. M E L I A C E A E

## Key to Genera

- 1a. Fruits drupes.  
 2a. Drupes 1-celled ..... 1. *Cipadesa*  
 2b. Drupes 5-celled ..... 2. *Azadirachta*  
 1b. Fruits capsules ..... 3. *Xylocarpus*

## 1. CIPADESA Blume

*Cipadesa bacciferra* (Roth.) Miq., Ann. Mus. Lugd. Bot. 4 : 6. 1868; Gamble, Fl. Pres. Madras 1 : 126. 1957 (Repr. ed.).

Trees with lenticellate barks. Leaves up to 30 cm long, imperipinnate; leaflets 5-10 cm ovate-elliptic, glabrous, crenate, oblique at base. Flowers 3 mm across, white, polygamous, in axillary panicles. Fruits 4 mm in diam., globular drupe with 5 pyrenes. Seeds elongated, membranous.

Fl. & Fr. : May Sept.

Distrib. : Mostly in Indo-Malayan regions.

Ecological Notes : Frequent in coastal scrubs and river banks.

Uses : For soft wood and medicinal.

## 2. AZADIRACHTA A.Juss

*Azadirachta indica* A.Juss., Mem. Hist. Nat. Par. 19 : 220. 1830; Gamble, Fl. Pres. Madras 1 : 126. 1957 (Repr. ed.).

Trees. Leaves imperipinnate about 30 cm long; leaflets 3-7 x 1-3 cm, ovate-lanceolate, oblique at base. Flowers 10 mm across, white, polygamous in axillary many flowered panicles up to 30 cm long. Fruits ovoid, 1-seeded.

Fl. & Fr. : March June.

Distrib. : India, Sri Lanka, Burma and Malaysia.

Ecological Notes : Frequent along the coastal thickets and lee side of the coastal dunes.

Uses : Potentially useful for timber, oils, soap and various medicines.

## 3. XYLOCARPUS Koen.

*Xylocarpus granatum* Koen., Naturf. 20 : 2. 1784; Gamble, Fl. Pres. Madras 1 : 132. 1957(Repr. ed.).

Trees 10-15 m tall with thin yellowish barks and buttresses. Leaves unijugate or bijugate; leaflets 6-10 x 3-5 cm, obovate, entire, coriaceous, rounded at apex tapering at base. Flowers 5-7 mm across, white, reddish glandular within arranged on short axillary thyrses. Fruits 30-40 cm across, spherical, septifragal capsule. Seeds 10-15, pyramidal or triangular with corky testa.

Fl.& Fr. : Throughout the seasons.

Distrib. : In both E & W costal mangroves in India; Sri Lanka, Malaysia, Tropical Africa and N. Australia.

Ecological Notes : Frequent along the intertidal banks of creeks and channels on mangrove forests at Kandikuppa, Nachugunta, Lankavanidibba of the Godavari and Krishna delta.

Uses : Timber wood, fruit paste is often applied for remedy of breast tumours.

## 30. MYRSINACEAE

## AEGICERAS Gaertn.

*Aegiceras corniculatum* (L.) Blanco., Fl. Filip. 79.1878; Gamble, Fl. Pres. Madras 2 : 532. 1957 (Repr. ed.).

Small evergreen trees 3-4 m tall or shrubs; stem much branched with broom shaped stilt roots arising from the base. Leaves ovate or ovate-oblong, coriaceous, retuse or emarginate at apex, cuneate at base. Flowers 1.5-2 cm long, white, fragrant in leaf opposed umbels. Fruit 6-8 cm long, falcate, hypocotyle 3-4 cm. curved.

Fl.& Fr. : April Sept.

Distrib. : Throughout the tropical shores of the world.

Ecological Notes : Common along the inter tidal zones of several creeks and channels in Godavari and Krishna deltas.

Uses : Fuel woods and best quality honey combs culture.

## 31. MYRTACEAE

## SYZYGIUM Gaertn

*Syzygium ruscifolium* (Willd.) Santapau & Wagh., Bull. Bot Survey India 5 : 109. 1963; Gamble, Fl. Pres. Madras 1 : 342. 1957 (Repr. ed.).

Shrubs; young branches rusty-pubescent. Leaves ovate or elliptic ovate, sub-coriaceous, acute at apex, obtuse at base. Flowers white fragrant, in axillary, solitary or 2-4 flowered fascicles. Fruit globose berries, red when ripe.

**Fl. & Fr.** : Throughout the year.

**Distrib.** : India and Sri Lanka.

**Ecological Notes** : Frequent along the coastal thickets, riverine scrubs and sea shores in the Godavari and Krishna deltas.

### 32. P A N D A N A C E A E

#### PANDANUS L.f.

*Pandanus tectorius* Soland ex Park., J. Voy. H.M.S. Endeavour. 46.1773; Gamble, Fl. Pres. Madras 3 : 1095. 1957 (Repr. ed.).

Much-branched trees 3-6 m tall, with many prop roots. Leaves 1-2.5 m long ensiform, coriaceous, spinous, pointed, gradually tapering into a long, triquetrous acumen. Male spadix yellowish, fragrant with many cylindric spikes enclosed within the caudate acuminate spathes. Female spadix 5-8 cm, solitary yellow. Fruits 10-20 cm long, oblong, symcarpids yellow, red when ripe. Carpels fragrant, convex, depressed at apex; mesocarp of pyrenes fibrous.

**Fl. & Fr.** : April Sept.

**Distrib.** : Throughout the coast of India; Burma, Malaysia, Java, China and Polynesia.

**Ecological Notes** : Frequent along the sea shore sand, coastal thickets and sand bars in between the mangrove fringes at Kothapalem, Nizampatanam and Dindi.

**Uses** : Preparation of scents, fruits are edible.

### 33. P L U M B A G I N A C E A E

#### AEGIALITIS R.Br.

*Aegialitis rotundifolia* Roxb., Fl. Ind. 2 : 111. 1832; Clarke in Hook.f., Fl. Brit. India 3 : 479. 1880.

Evergreen shrubs 1-7 m tall, stems 5-20 cm in diam. straight, unbranched, conically swollen at the base, supported by stilt roots; barks thin, brownish, lenticellate

with numerous leaf scars. Leaves 2.5-9.5 x 3-9 cm, alternate, rotund, broadly ovate or orbicular, entire, coriaceous, reticulovenous, rounded or cuneate at base, acute, obtuse or shortly protruding at apex. Petiols thick, glandular, dilated, amplexicaul. Flowers 17-22 mm long white, bracteate in axillary leafy panicles dichotomously branched; calyx tubular, barrel-shaped, 5-ribbed, 5-lobed, persistent; corolla white, united below forming a connate-compact tube with staminal base; petals 5, imbricate 10-14 x 2-3.5 mm, spatulate, circumscissile from the top of the connate tube; stamens 5, 13-17 mm long, flat, plate-like, adnate to the corolla tube; anthers basi fixed; ovary ovoid conical, angled, 5-ribbed, one loculed, one ovuled; ovule pendulous, suspended from a basal persistent funiculus; funicles enlarged at time of dehiscence of fruit; style 5, 10-12 mm long free at apex, adnate towards base; stigma capitate. Capsules linear, curved, 5-ribbed, splitting finally along the ribs from the apex, often tipped with staminal tube. Hypocotyle curved, whitish, with plumular cap and long funiculus.

Fl. & Fr. : March July.

Distrib. : India Bengal, and Orissa Burma and Siam.

**Ecological Notes :** This species is restricted inside the mangrove swamps and along the banks of a creeks in association with *Bruguiera gymnorrhiza* and *Bruguiera cylindrica* near the estuarine region of the Nachgunta forest block in the Krishna delta.

**Uses :** Stems are useful for poles in house building and boats, fine salt are prepared from the ash of its burnt stem and leaves, medicinal.

**NOTE :** This is not found in the Godavari delta. Collection from Nachgunta is the first time record from the Krishna delta in Andhra Pradesh.

### 34. P O A C E A E

#### Key to Genera.

- 1a. Dioceous herbs; leaves rigid, spiny;  
inflorescence globose heads ..... 1. *Spinifex*
- 1b. Monoecious herbs; leaves not rigid, spiny;  
inflorescence not in globose head.
  - 2a. Mature spikelets separating entirely from their pedicels.
    - 3a. Spikelets 2-flowered; not thickened ..... 2. *Paspalum*
    - 3b. Spikelets 1-flowered; thickened.
      - 4a. Spikelets articulate; glumes 4,  
cartaceous awned ..... 3. *Porteresia*

- 4b. Spikelets not articulated; glumes 1.  
     coriaceous, not awned .....4.*Zoysia*
- 2b. Mature spikelets breaking up leaving  
     persistent glume on the pedicel.
  - 5a. Spikelets with penicillate silky hairs on the  
     flowering glumes .....5.*Phragmitis*
  - 5b. Spikelets without penicillate silky hairs, on the flowering  
     glume.
    - 6a. Spikelets distichously racemed;  
     lemma entire; glumes coriaceous,  
     awned .....6.*Myriostachya*
    - 6b. Spikelets capitate; lemma 2-3 lobed;  
     glumes membranous villose, not  
     awned .....7.*Aeluropus*

1. SPINIFEX L.

*Spinifex littoreus* (Burm.f.) Merr., Philp. J. Sci. Bot. 7 : 229. 1912; Gamble, Fl. Pres. Madras 3 : 1183. 1957 (Repr. ed.).

Much branched, woody, polygamo-dioceous, spiny shrubs 20-60 cm high, rooting at the nodes. Leaves 3-20 x 0.1-0.6 cm, rigid, cartaceous, involute, spreading and recurved, ending into a sharp spine. Inflorescence dioceous in terminal globose, bracteate heads with radiating spiciform racemes. Spikelets 8-12 x 1-2 mm, articulated; male flowered several, distichous in each raceme; female solitary, one flowered. Grains clavate, tipped with rigid stilar base, free within lemma and palea.

Fl.& Fr. : Jan July.

Distrib. : Throughout the Indian coast; Burma, Sri Lanka, Java and China.

Ecological Notes : Common along the sandy sea shore at Machlipatanam and Nizampatanam, frequent on the raised sand bars within the mangrove forest at Kothapalem.

Uses : Potentially useful as a good sand binder and controls the movement of the wind blown sands.

## 2. PASPALUM

*Paspalum distichum* L., Syst. Nat. (ed.10.) 11 : 855. 1759; Gamble, Fl. Pres. Madras 3 : 1227. 1957 (Repr. ed.).

Erect perennials 10-90 cm long creeping base, compressed below. Leaves 1-20 x 0.1-0.8 cm, narrow, distichous, stiff, flat or involute, hairy towards the flattened sheath. Spikelets 2.5-4 mm long, solitary or in pairs, pale green arranged in racemes. Grains ellipsoid.

Fl.& Fr. : June Oct.

Distrib. : India estuarine and coastal areas; tropical and temperate America.

Ecological Notes : Frequent along the river banks in saline conditions and moist sandy places near the shore at Kothapalem and Morlagunta.

Uses : Good fodder.

## 3. PORTERASIA Takeoka.

*Porterasia coarctata* (Roxb.) Takeoka, Bull. Nat. Sci. Muss. Tokyo 8 : 406. 1965; Gamble, Fl. Pres. Madras 3 : 1276. 1957(Repr. ed.).

Perennial herbs with erect culms from a stout creeping rhizome, 50-70 cm tall. Leaves unequal sided, rigid, scaberulous with short ligule. Panicle 9-12 cm long spiciform, branched, few-flowered; rachis trigonous, stiff; spikelets imbricate, chartaceous; glumes three, narrowed, ending into a rigid awn. Grains cylindrical, longitudinally striated.

Fl.& Fr. : May Sept.

Distrib. : All over the deltas in India; Burma and Tenasserim.

Ecological Notes : Common on newly deposited silts along the intertidal creeks, channels and estuarine island in both the Krishna and Godavari delta.

Uses : Very effective as soil binder in the formation of estuarine islands, good fodder; known as wild rice.

## 4. ZOYSIA Willd.

*Zoysia matrella* (L.) Merr. Philip. J. Sci. Bot. 7 : 230. 1912; Gamble, Fl. Pres. Madras 3 : 1257 1957 (Repr. ed.).



Small, glabrous herbs 5-30 cm high with wiry, creeping rootstock. Leaves 1-8 x 1-0.3 cm rigid, convolute. Inflorescences spiciform 1-5 cm long, in terminal racemes; spikelets 2-3 mm long, ovoid, 1-flowered, imbricate, grains oblong, free within the glume and lemma.

**Fl. & Fr. :** Jan June.

**Distrib. :** India, Malacca, Sri Lanka, tropical Asia, Australia and Mauritius.

**Ecological Notes :** Common and wide spread from the sea shore to inland low lying areas.

**Uses :** Good sandbinder and fodder.

### 5. PHRAGMITES Trin.

*Phragmites karka* (Retz.) Trin. ex Steud., Nom. (ed.2.) 2 : 324. 1814; Gamble, Fl. Pres. Madras 3 : 1251. 1957(Repr. ed.).

Stout, perennial shrubs 50-300 cm high with creeping rhizome and hollow woody culms. Leaves 10-60 x 0.5-2 cm stiff, flat, lanceolate with a row of short hairs at ligule. Inflorescence 15-50 cm long, lax panicles, silky hairy at the base. Spikelets 8-16 mm long bisexual, 3-4 fid; rachilla penicillate and jointed below the flowering glumes. Grains oblong, semi terete, loosely enclosed by the lemma and palea.

**Fl. & Fr. :** Nov April.

**Distrib. :** Throughout India; Afghanistan, Japan, tropical Africa, Asia and Australia.

**Ecological Notes :** Frequent along the river banks under the fresh water conditions and marshy areas, often gregarious near running water.

**Uses :** Paper pulp, baskets and for long sticks.

### 6. MYRIOSTACHYA Hook.f.

*Myriostachya wightiana* (Nees ex Steud.) Hook.f., Fl. Brit. India 7 : 237. 1896; Gamble, Fl. Pres. Madras 3 : 1259. 1957 (Repr. ed.).

Stout perennial grass 0.6-3 m tall, with thick, spongy root stock; roots flexible, sheathed, smooth, spreading simple or branched to a long distance. Leaves linear

1.5 cm broad flat, finely acuminate, smooth. Spikelets many, laterally compressed, golden yellow, arranged in elongated panicles 30-60 x 60-90 cm, rachilla very short. Grains obliquely ovoid with long, elongated embryo.

## 7. AELUROPUS

*Aeluropus lagopoides* (L.) Trin. ex Thw., Enum. Pl. Zeyl. 374. 1864; Gamble, Fl. Pres. Madras 3 : 1276. 1957 (Repr. ed.).

Prostrate, much branched, rigid, perennial grass, 5-40 cm long, with distichous, coriaceous, convolute leaves 0.2-5 x 0.1-0.3 cm. Spikelets 3-4 mm long, white, sessile, many-flowered in terminal crowded heads. Grains obovoid, free within the lemma.

Fl. & Fr. : Jan July.

Distrib. : India throughout the coasts, probably a native to the Mediterranean and Arabia extended up to Baluchistan.

Ecological Notes : Common in salt marshes and coastal alkaline sands on both the Krishna and Godavari deltas.

Uses : A good sand binder.

## 35. RHIZOPHORACEAE

### Key to Genera

- 1a. Flowers ebracteolate;  
calyx 8-13 lobed; petal 2-lobed.....1. *Bruguiera*.
- 1b. Flowers bracteolate; calyx 4-6 lobed; petals not lobed.
  - 2a. Calyx 4-lobed; petals without apical appendages;  
anthers opening with a ventral valve .....2. *Rhizophora*
  - 2b. Calyx 5-lobed; petals with apical appendages;  
anthers not opening by ventral valve .....3. *Ceriops*.

### 1. BRUGUIERA Lamark

#### Key to species

- 1a. Flowers solitary; red .....*gymnorrhiza*
- 1b. Flowers 2-5 flowered; white .....*cylindrica*

*Bruguiera gymnorrhiza* (L.) Savigny, Lamark Encl. 4 : 696.1796; Gamble, Fl. Pres. Madras 1 : 324.1957(Repr. ed.).

Trees 6-20 m tall with rough, fissured, brown corky barks; stem base shortly buttressed with many geniculate pneumatophores. Leaves 12.5-20.5 x 5.5-7.5 cm. ovate-elliptic or elliptic-oblong, coriaceous, acute at apex, obtuse at base. Flowers scarlet 3.5-4 cm. calyx tube ribbed, petals as many as the calyx lobes, caducous, sinuated at apex and embracing a pair of stamens 9-12mm. long, sinus of the petal with one straight bristle; petal apex having 1-4 cilia and petal margin covered with hairs; sinus bristle, apical cilia and marginal hairs very variable in numbers and sizes. Hypocotyl angular, cigar shaped 15-17x1.5-2.5 cm. narrowed at apex.

Fl.& Fr. : Throughout the year.

Distrib : India, Sri Lanka, Malaysia, tropical Africa & Australia.

Ecological Notes : Common along the intertidal banks of several creeks and channels in the mangrove forest; more common in the Krishna delta than that of the Godavari.

Uses : Potentially useful for poles and house building materials and tanin.

*Bruguiera cylindrica* (L.) Bl., En. Pl. Java 1 : 93. 1827; (*quoad basionym*) Gamble, Fl. Pres. Madras 1 : 325.1957 (Repr. ed.).

Small trees 10-12m tall, with buttresses and knee roots; twigs yellowish-bronze with many stipular scars. Leaves elliptic or oblanceolate, coriaceous, acute at apex, cuneate at base. Flowers white 1-1.3mm across, 3 in axillary pedunculate cymes; calyx tube cup-shaped, smooth, not ribbed with 8-10 reflexed lobes; petals bilobed with apical cilia, sinus bristle and marginal hairs. Hypocotyles cylindrical, straight.

Fl.& Fr. : March-August.

Distrib : India, Sri Lanka, Malaysia and Australia.

Ecological Notes : More common along the bank of creeks and channels towards estuarine proper of Sorligunta, Nuchgunta, Kandikuppa and Lankavanidibba of Krishna and Godavari delta.

Uses : Used for fuel wood, boat building, charcoal and scent from pneumatophores and tanin extraction.

## CERIOPS Arn.

*Ceriops decandra* (Griff.) Ding Hou, Fl. Thailand 2 : 11. 1970; Gamble, Fl. Pres. Madras 1 : 324.1957 (Repr. ed.).

Bushy shrubs or small trees 4-10m tall. Stem base pyramidal with many stilt roots; bark light-grey, lenticular fissures, peeling in thin flakes. Leaves 5-14 x 4-10cm. obovate or elliptic-oblong, coriaceous, rounded or emarginate at apex, cuneate at base. Flowers white 3-4mm. across, 8-14 flowered condensed cymes, arranged in the axils of nodes or in upper branchlets; petals fringed at apex. Hypocotyles 12-14 cm. angular, sulcate.

Fl. & Fr. : Almost throughout the year.

Distrib : India, Burma, Srilanka, Thailand, S.Vietnam, Malaysia, Java and New Guinea.

Ecological Notes : Common along the edges of mangrove swamps and along the banks of creeks and channels at Sarcomento, Kandikuppa, Nuchgunta, Lankavani dibba, Morlagunta, Nizampatanam, Dindipalem and Kothapalem of the Godavari and Krishna deltas.

Uses : Used for good charcoal, maximum quantity of tanin, building accessory and country boats.

## 2. RHIZOPHORA L.

## Key to species

- 1a. Leaves apiculate at apex; inflorescences 2-flowered;  
petal glabrous inside; stamens 8 .....*apiculata*
- 1b. Leaves mucronate at apex; inflorescences more than 2-flowered;  
petals hairy inside; stamens 12 .....*mucronata*

*Rhizophora apiculata* Bl., En. Pl. Java 1 : 91.1827; Gamble, Fl. Pres. Madras 1 : 323.1957 (Repr. ed.).

Trees 15-20 m tall with many sympodial branches and many supporting aerial roots or stilt roots, dichotomously branched forming natural tide breaker. Leaves 10-20 x 5-9 cm, ovate-lanceolate or elliptic-oblong, decussate, coriaceous, acute or apiculate at apex, cuneate at base. Flowers yellowish-white, sessile, paired in upper axils from cupular involucre. Fruits obpyriform, solid, brown; hypocotyles smooth, solid, pointed.

**Fl. & Fr. :** April-August

**Distrib :** India, Malaysia, E. Africa and Australia.

**Ecological Notes :** Common along intertidal banks of creeks and channels of mangrove forest in both the Godavari and Krishna delta at Kandikuppa Nuchgunta, Morlagunta and Kothapalem.

**Uses :** Used as tide breaker, charcoal, tanin, fire wood and prawn culture.

*Rhizophora mucronata* Poir., Lam. Tab. Encycl. (Text) 2 : 517.1794; Gamble, Fl. Pres. Madras 1 : 323.1957 (Repr. ed.).

Tree 10-20 m tall with many sympodial branches; stem base with numerous stilt roots; stilt roots lenticellate. Leaves 10-18x4-9 cm., decussate, broadly elliptic oblong or ovate, coriaceous, acute, blunt or with a fine mucro at apex, obtuse or cuneate at base. Flowers 1.5-2 cm. long, cream-white, fleshy, fragrant, arranged in axillary cymes; peduncles 2-5 cm. long, 2-3 times forked; calyx 12-15 mm. long, deeply lobed; petals 7-8 mm. long hairy inside. Hypocotyles 20-50 cm. long, cylindric, warty pointed towards the end.

**Fl. & Fr. :** April-August.

**Distrib :** Throughout the mangrove forests of the old world tropics.

**Ecological Notes :** Gregarious along the intertidal banks of several creeks and channels in the mangrove forests of Godavari and Krishna deltas at Sarcomento, Kandikuppa, Coringa, Nuch gunta, Morlagunta, Kothapalem and Nizampatanam.

**Uses :** Used for charcoal, tanin, adhesive, decoction of bark is used for remedy of leprosy and neck inflammation.

### 36. R U B I A C E A E

#### Key of Genera

- 1a. Small, erect trees; stipules interpetiolar,  
not connate, entire .....1. *scyphiphora*
- 1b. Creeping herbs; stipules connate  
with the petioles, toothed .....2. *Hydrophylax*

## 1. SCYPHIPHORA Gaertn.f.

*Scyphiphora hydrophyllacea* Gaertn.f., Fruct. iii. 91.t.196.1805; Gamble, Fl. Pres. Madras 2 : 438. 1957 (Repr. ed.).

Glabrous trees up to 3 m. tall with many branches, swollen at the nodes. Leaves obovate, thick, coriaceous, rounded at apex, narrowed or cuneate at base; stipules obovate, entire, minutely hairy at the apex. Flowers white, arranged in axillary pedunculate cymes. Calyx tube elongated cupular, truncate, toothed; corolla tube cylindrical, 4-5 lobed, recurved and twisted; styles filiform bifid. Fruits cylindrical, grooved drupe with 2 connate pyrenes. Seeds membranous with scanty albumen.

Fl.& Fr. : May Sept.

Distrib. : Only in the Godavari delta and in Andamans from India; Malaysia, Phillipines, N. Australia and New Caledonia

Ecological Notes : Restricted along the estuarine mouth of the river Gautami-Godavari at Sarcamento Light house areas and in Kandikuppa mangrove forest; it is not found even in the Krishna delta; grows in association with *Lumnitzera racemosa* and resembles very much with this species.

NOTE : Very rare species in Indian mangroves which needs careful protection.

## 2. HYDROPHYLAX L.f.

*Hydrophylax maritima* L.f., Suppl. 126.1781; Gamble, Fl. Pres. Madras 2 : 460. 1957 (Repr. ed.).

Succulent, creeping perennials with long tap roots; stems 30 cm. much-branched, 4-angled, glabrous, rooting at the nodes. Leaves 1.2-2.5x0.6-1.2 cm., sessile, coriaceous, acute or acuminate at apex; stipules membranous, toothed, connate with the petiolar leaf base. Flowers purple or pinkish-purple, funnel-shaped, sessile, solitary, axillary. Fruits 1.2-1.6 cm. long ellipsoid, compressed, corky, crowned with calyx-teeth. Seeds ovoid, grooved, two, one of them is usually ill-developed.

Fl.& Fr. : June-Oct.

Distrib : India and Sri Lanka.

Ecological Notes : Common along the sea shore sand and frequently on the sandy heaps near the estuarine areas and sand dunes at Kothapalem, Nizampatanam and Machlipatanam.

Uses : An useful sand binder.

## 37. S A L V A D O R A C E A E

## SALVADORA L.

*Salvadora persica* L., Sp. Pl. 122. 1753; Gamble, Fl. Pres. Madras 1957 (Repr. ed.).

Much-branched, evergreen trees 6-8 m tall with white, corky barks and drooping branchlets; wood soft, yellow. Leaves 3.5-8 x 1.7-3.5 cm. ovate-oblong or elliptic-lanceolate, thick, coriaceous, acute or obtusely rounded at apex, cuneate at base. Flowers 2-3 mm. long white, fragrant arranged in terminal panicles. Fruits 4-6 mm. across globose, smooth, 1-seeded drupe with pungent smell.

Fl.& Fr. : Feb. June.

Distrib : India, Sri Lanka, W.Asia, Egypt, Abyssinia, Arabia and E.Africa.

Ecological Notes : Frequent on back mangroves on saline lands at Nuchgunta near the Krishna estuary.

Uses : Leaves are used to remove leeches from the body of Camels, twigs are used as tooth cleaner.

## 38. S O N N E R A T I A C E A E

## SONNERATIA L.f.

*Sonneratia apetala* Buch. Ham., Symes, Embassy Ava 3 : 477. 1800; Gamble, Fl. Pres. Madras 2 : 363. 1957 (Repr. ed.).

Evergreen trees 10-40 m tall with dense crown; stems brown, irregularly fissured, base provided with peg-like, corky pneu-matophores; branches articulated, pale-green, drooping. Leaves 5-14 x 2-3.5 cm. or oblanceolate, coriaceous, tapering towards apex, attenuate at base. Flowers 1.5-2 cm. across apetalous, cream-coloured in axillary solitary or 3-flowered dichasia or 7-flowered cymes at the branch axils. Fruits 2-2.5 cm. across, globose, many seeded berries shortly pointed at apex.

Fl.& Fr. : March July.

Distrib : Only in India (E.Coast) and Sri Lanka.

Ecological Notes : Frequent along the banks of creeks and channels in the mangrove forests of Godavari delta, Kothapalem, Morlagunta and Nuchgunta at

the Krishna delta, also invariably present in the places affected with fresh and brackish water mixture in association with *Excoecaria agallocha* and *Cerriops decandra*.

Uses : Used for fuel, soft woods, paper pulp, fodder and edible fruits.

### 39. T A M A R I C A C E A E

#### TAMARIX L.

##### Key to species

- 1a. Leaves not sheathing; flowers bisexual .....*troupii*  
 1b. Leaves sheathing; flowers unisexual .....*dioica*

*Tamarix troupii* Hole, Ind. For. 45 : 247. 1919; Gamble, Fl. Pres. Madras 1 : 48. 1957 (Repr. ed.).

Bushy shrubs. Leaves 2-3 mm. long subulate, semi-amplexicaule at base, adpressed to the young twigs. Flowers 3-4 mm. across white or pink, bisexual, in lateral or terminal pendulous racemes. Capsules 4-5 mm. across 3-4 valved, tapering towards apex. Seeds 8-10, tufted with silky hairs at apex.

Fl. & Fr. : August Dec.

Distrib : India, Burma, Sri Lanka, South Asia, Tropical Africa and North shore of Europe.

Ecological Notes : Frequent along the river banks, back mangroves and sea shores at Coringa river mouth in the Godavari delta.

Uses : Used as fuel.

*Tamarix dioica* Roxb., Fl. Ind. ed. Carey 101. 1832; Gamble, Fl. Pres. Madras 1 : 48. 1957 (Repr. ed.).

Bushy dioecious trees 3-4 m tall or shrubs. Leaves 2-3 mm. long subulate, sheathing at base. Flowers 3-4 mm. across, purple in lateral and terminal racemes; male flowers; stamens 5; female flowers with 3-4 staminodes. Capsules 4.5 mm. long, conical, 4-valved. Seeds many with silky hairs at apex.



**Fl. & Fr. :** August Dec.

**Distrib :** India, Burma, Sri Lanka and Afganistan.

**Ecological Notes :** Rare in moist sandy river beds and saline lands of back mangroves at Coringa river mouth in the Godavari delta and Yellichetladibba in the Krishna delta.

**Uses :** Used for fuel and tannin.

#### 40. V E R B E N A C E A E

##### CLERODENDRUM L.

*Clerodendrum inerme* (L.) Gaertn., Fruct. 1 : 271. 1788; Gamble, Fl. Pres. Madras 2 : 769. 1957 (Repr. ed.).

Straggling, much branched shrubs 1-3 m tall, with adpressed pubescent young branches. Leaves 1.5-6 x 1-3 cm., ovate-elliptic or oblong-lanceolate, thick, coriaceous, obtuse or shallowly retuse at apex, narrowed at base. Flowers 3-3.5 cm. long white, tubular in terminal or axillary, 3-flowered pedunculate cymes. Drupes 1.5-2 cm. long, obovoid, 4-lobed, breaking into 4-pyrenes.

**Fl. & Fr. :** April August.

**Distrib :** Throughout India, Burma, Sri Lanka, Malaysia, Java and Australia.

**Ecological Notes :** Common along the intertidal banks of creeks and channels towards brackish water zones, more common in coastal back water in association with *Acanthus ilicifolius* L; sporadic towards back mangroves in the Godavari and Krishna deltas and shows capacity for tolerating various ecological parameters.

**Uses :** Often planted as garden hedges and so perhaps run wild inland.

## PHENOLOGY, FIELD CHARACTERS AND REGENERATION OF MANGROVES IN THE DELTAS

**Phenology** Phenological data of the mangrove species is an important event, to understand the functioning of the mangrove ecosystem. Some important works on the line of phenology have already been attempted recently in India for the mangroves of Maharashtra (Mullick and Bhosle, 1969) and mangroves of Karnatak Coast (Rao and Suresh, 1988;1989). However, no attempt has been made to record the phenology of mangrove of the Godavari and Krishna delta in Andhra Pradesh.

Like other Indian deltas, mangroves of the Godavari and Krishna areas are also under the severe pressure of increased human activities and natural cyclonic devastation, which have resulted in the reduction of mangrove areas and mangrove species. Some important species are becoming rare in these areas. Therefore, it would be useful to have a permanent information of the mangrove phenology. This information would be helpful in the field of regeneration, afforestation, mangrove floral biology, management, reproductivity and honey culture,

The starting of flowering and fruiting in most of the mangrove species usually commences during summer months. (Jones 1971; Graham *et al.* 1975). The months from March to September appear to be a favourable physiological period for pheno phases of mangrove species. It was observed that some mangrove species have a seasonal features of flowering and fruiting time and others seem to have a non-seasonal effect in the flowering and fruiting. The non-seasonal species exhibit wider ecological amplitude compared to seasonal ones (Rao and Suresh, 1990). Phenological rhythms varies from one species to another in a given locality (Blasco, 1984). Some are found to flower during spring and other are during winter. but majority of them are found to start their flowering and fruiting during summer months (March - September). This indicates that flowering and fruiting in the mangrove species are perhaps controlled by high temperature and long photoperiods.

**Field identifying characters** Mangroves are taxonomically unrelated and derived from a variety of plant families. They are capable of living under a special environmental condition in the tropical and subtropical littoral habitat, with the development of some adaptive morphological characteristics befitting with the physiological process, to that particular environmental condition. Identification of important and common mangroves is the prerequisite for research,

forest management and proper planning for conservation and protection. Some major field characters for mangrove species for easy identification would therefore, be an useful data for interested naturalist and common people to identify the plants in the field without much difficulty.

**Regeneration** Regeneration of mangrove species is a peculiar feature as majority of them are adapted in various ways to withstand the most hazardous natural conditions associated with the saline tidal environment. It appears that they always search the opportunity for suitable natural condition for their regeneration process and accordingly modify their fruiting and seed forming pattern. The species with viviparous embryos need the help of tidal water flow for the dispersal of their seedlings and those without vivipary are found to modify their fruits and seeds in various ways. Either their fruit covers become spongy, corky, leathery or fibrous in nature to enable the fruits and seeds for easy floating along the river water for dispersal. In most of the cases salt concentration of the embryonic tissue remain lower compared to the salt concentration of the mature mother tissue (Chapman, 1976). Therefore, all types of adaptation in the fruits and seeds while floating along the saline river water flow or in the sea water are supposed to be preventive measure against the entry of high saline water within the embryonic tissue.

Vivipary is a common phenomenon in almost all the species of *Rhizophoraceae* in mangroves. This peculiar character is nothing but probably an expression of uniform environment condition of the early geological period (Watson 1928). Degrees of vivipary among mangroves differ in different species such as, in the genera of *Rhizophora*, *Bruguiera*, *Ceriops* and *Kandelia* the embryos grow out of the seeds and fruits and project in the form of green seedlings known as hypocotyles with a zone of plumules and radicles. The cotyledons serve here as a haustorium sucking food from the mother plants. Finally, when the hypocotyle becomes loose from the cotyledon, falls into the mud or in shallow water where the pointed root end pierces the mud. During low tide, hypocotyles stick directly into the mud and the incipient adventitious roots emerge out for anchoring the seedling. If the hypocotyles drop during high tide and float in the river water current, development of adventitious roots do not take place until it comes in contact with the soil.

In the case of *Aegiolitis* and *Aegiceras* the embryos emerge from the seeds but remain inside the fruit. Fruits are floating along the river current with the help of spongy mesocarp and as soon as they happen to come in contact with the soft mud each fruit splits longitudinally from the apical part and the narrow pointed

radicles pierce the mud for development of roots and leaves from the green plumules. In the case of *Avicennia*, the endosperm and the embryo emerge out from the seed and lie uncovered within the ovary chamber. Here embryo consist of two fleshy, green, conduplicate cotyledons which obtain food from the mother plant by means of long, repeatedly branched hypha like haustorial cells which traverse the placenta. This green conduplicate cotyledonary embryos are found floating along the river current with densely hairy radicles and green plumules. As soon as they come in contact with the mud, establish roots and leaves from the the radicles and plumules.

In other cases like *Sonneratia*, *Xylocarpus* and *Excoecaria* etc. the septifragal capsules split and seeds with corky or spongy testa spread along the water current for establishing the seedling in the adjoining mud.

It is found that none of the genera of *Rhizophoraceae* are able to regenerate themselves by coppice shoot(Watson 1928). Field observation reveals that regeneration by coppice shoot in case of *Aegiolitis* and *Aegiceras* is very difficult but to some extent regeneration by coppice for *Sonneratia*, *Xylocarpus*, *Excoecaria* and *Avicennia* may be possible with constant care in the field.

**THE TABLE SHOWS PHENOLOGICAL DATA, FIELD CHARACTERS AND REGENERATION OF  
MANGROVE IN THE DELTAS**

<b>Name of Mangrove Species</b>	<b>Flowering &amp; Fruiting</b>	<b>Field Charecters</b>	<b>Regeneration</b>	
<b>Acanthus ilicifolius</b>	Mar. - Aug,	May-Aug.	Erect or Scandent shrub, Leaves ovate, elliptic with spiny teeth. Flowers bluish.	By seeds. Seeds are released by dehiscence of capsule on the plant.
<b>Acgiceras corniculatum</b>	Jan.- April & Sep.- Nov.	Feb. - June & Oct. - Dec.	Fragrant white flower and crescent shaped fruits.	Vivipary, embryo comes out from the seed but remain inside the fruit.
<b>Aegialitis rotundifolia</b>	April - Aug.	May - Sept.	Orbicular leathery leaves, petioles clasping stems. Stem base conical in shape. Flowers white.	-do-
<b>Avicennia alba</b>	June-Aug.	July-Sept.	Stem black, leaves lanceolate. fruits narrowly ellipsoid.	Incipient vivipary. Cotyledonary embryo floats in water with densely hairy radicle.
<b>A. officinalis</b>	June-Aug.	July-Sept.	Lustrous, Stem grey, leaves obovate, coriaceous, and almond shaped fruits.	-do-
<b>A. marina</b>	April-June	June-Sept.	Stem yellowish grey, leaves elliptic ovate, fruits almond shaped, apiculatę.	-do-
<b>Bruguiera gymnorhiza</b>	Throughout the Year.		Plants with knee roots Petioles and flowers scarlet red.	Vivipary. embryo emerges out from the seeds and fruits.
<b>B. cylindrica</b>	Throughout the Year.		Plants with oval shaped knee bent; twigs and leaves bronze coloured; flowers white.	Vivipary. Embryo emerges out of the seeds and fruits.

Name of Mangrove Species	Flowering & Fruiting	Field Characters	Regeneration
<i>Ceriops decandra</i>	Throughout the Year.	Stem base pyramidal with stilt roots; barks peeling off into flakes; flowers white with cillius at the petal apex.	Vivipary. Embryo emerge, out of the seeds and fruits.
<i>Dalbergia spinosa</i>	April-July      Aug.-Dec.	Bushy shrubs; branchlets ending into sharp spines; pods kidney shaped.	By seeds.
<i>Derris scandens</i>	June-Aug.      Aug.-Dec.	Scandent shrub, flowers pinkish; pods strap shaped.	-do-
<i>Excoecaria agallocha</i>	April-June.      July- Sept.	Soft wooded trees with milky acrid juice and snake like spreading roots. Plant dioecious. Male flowers yellow, in catkin like spike.	Septifragal capsules break into seeds.
<i>Lumnitzera racemosa</i>	Feb.-May      March-Sept.	Stem with reddish brown bark. leaves obvate, thick flowers white; fruits woody compressed.	-do-
<i>Rhizophora apiculata</i>	May-Aug.      July-Oct.	Stem base with numerous stilt roots; leaves apiculate; flowers - 2, white; hypocotyles clavate, cylindric.	Vivipary, embryo emerges out from seeds and fruits.
<i>R. mucronata</i>	July-Oct.      Aug. -Dec.	Stem base with stilt roots; leaves mucronate; flowers	-do-

<b>Name of Mangrove Species</b>	<b>Flowering &amp; Fruiting</b>	<b>Field Charecters</b>	<b>Regeneration</b>
<b>Scyphiphora hydrophyllacea</b>	June-Aug July-Oct.	Plant resembles <i>Lumnitzera</i> but differs in having obovate rounded leaf and hairy, connate stipules at interpetiolar region. Fruits cylindric, grooved.	By seeds.
<b>Sonneratia apetala</b>	March-May June-July	Large tree with peg like, corky pneumatophores. Leaves narrowly elliptic flowers apetalous.	By seeds.
<b>Xylocarpus granatum</b>	March-Sept. June-Dec.	Stem buttressed without pneumatophores. Leaves obovate, unijugate or bijugate; Flowers white with red glands; Fruits large spherical or globose.	By seeds.

## CONSERVATION AND MANAGEMENT OF ANDHRA PRADESH MANGALS

Though many people living along the coastal districts of Andhra Pradesh are indiscriminately using the mangrove flora and fauna for various purpose of their livelyhood yet the proper planning for conservation and management of mangroves for developing the State's economy appears to have been neglected.

The mangals of the Godavari-Krishna delta and other backwaters of the Andhra Pradesh are also facing some major ecological threats like other Indian mangroves. Some of the natural and man made threats to the mangrove ecosystem are as follows :

Presence of low lands along the coast and vast low lying areas interconnected with several creeks and canals of the deltas, geographic location of the deltas in the northern hemisphere, funnel shaped configuration of the river mouth, shallow nature of the sea water depth and enormous flow of fresh water from the rivers are some of the characteristics reasons in these deltas causing regular cyclonic floods which bring severe damage to the mangrove communities and many lives in the ecosystem. In 1977 the damaging cyclonic floods in the Divi taluk of Krishna District uprooted the mature mangrove forests. The cyclonic floods during 1989 damaged greatly the mangrove forests of Repalle taluk in Guntur district.

The branches of *Avicennia* and *Sonneratia* are frequently covered with a black rust. The extruded radicles of *Rhizophora mucronata* Poir., are often infected with a fungal species of *Cryptospora*. The symptoms are characterised by a brown discolouration and dying of tissues, starting in the middle and extending upwards and downwards until the whole length is affected.

The larvae of a cerambycid beetle have been found in burrows immediately beneath the over mature trees of *Bruguiera parviflora* and are found instrumental in their demise. Species of *Avicennia* is occasionally found defoliated and even killed by the attack of lepidopterous.

Though crabs are main source of inorganic minerals in the mangroves but some time they damage mangrove seedlings. *Rhizophora apiculata* Bl. seedlings are particularly susceptible to their attack. It takes the form of devouring the bark of young seedlings until they are completely girded or even bitten right through.



Before 1977 mangrove forests of these deltas were exploited only to meet fuel woods and charcoal requirement to the local people and local people without having adequate knowledge regarding other uses of mangrove forests exploited at their will. Moreover the private state owners of the mangrove forests used to have clear felling system which hampered regeneration and resulted a very low graded forest cover.

Reclamation of mangrove lands for resettlement agriculture and prawn culture is the most usual practice in these deltas due to increased population pressure. Recently some mangrove lands are also been allotted to ex-military personnel for agriculture and fish culture in the Divitaluk of the Krishna delta.

Rapid deforestation for fire woods, house building and boat building materials and some developmental activities such as establishment of fertilizer factory adjacent to the mangrove forest zone are also threatenning to the mangals of Andhra Pradesh.

In the past, management of mangrove forests was to depend on several factors. The most important of them being the economic improvement of the crop for timber and fuel and quantum of regeneration. Mostly, the mangroves of Andhra Pradesh contain maximum species of *Avicennia* and some species of *Rhizophora*, *Ceriops* & *Bruguiera*. Clear felling system was in practice with a rotation of 25 years in Coringa and 15 years in Kandikuppa.(both in East.Godavari Dist.). Similarly, Krishna mangroves were also managed in 25 years rotation with a clear felling system. Working plan in the mangrove forests have always had their main objectives for production of high percentage of fire wood by the simplest and cheapest possible methods. The requirements of fishermen in the way of stakes for their traps, building materials for their houses and tannin for their nets have also been well conserved.

Before the Governmental control, mangrove forests of the East Godavari district and Krishna district were owned by private estate forestry and were heavily exploited due to continuous grazing, removal of firewoods, timbers, house and boat building materials and others. Government forestry provided much better protection and conservation practices and accorded systematic working plan to meet fuel demand and other accessories to the local people. After the cyclone in 1977 all mangrove forests in Krishna deltas have been closed for working. Similarly, in the East Godavari District extraction of firewoods and timbers from

mangrove forests have been stopped completely from 1978 - 1980. Establishment of biosphere reserve and national park for total conservation of mangrove ecosystem have been prescribed. Out of the 332.66 Sq Km of mangrove forests existing in the Godavari estuaries, an area of 235.70 Sq Km has been declared as Coringa Wild Life Sanctuary in the East Godavari District and an area of 249.53 Sq Km in the Krishna delta has been declared as Wildlife Sanctuary, in the districts of Krishna and Guntur.

Some of the important points are to be given more weight in respect of proper conservation of the valuable mangrove resources of Andhra Pradesh.

**Demarcation** - For proper control and to avoid encroachments, it is proposed to demarcate all the mangrove forests in the state with clear demarcation line and by erecting pillars, boards etc. Similarly the sanctuaries both declared and proposed to be declared are also to be demarcated clearly on ground with pillars indicating core areas where higher level of protection and total ban on human interference will be implemented for preservation of mangrove flora and fauna.

**Protection** Since significant areas of the mangrove forests of these deltas have been declared as sanctuaries, appropriate protection measures have to be undertaken. At present, the Forest Guards and Beat Officers have to depend on fishing boats and private boats for patrolling these forest blocks. Mangrove forests are such that it is impossible to keep watch over them without proper mechanised boats. For patrolling the creeks and onshore areas along the coast proper motorised boats should be provided to the forest staff. In addition to a network of wireless station and check post to check smuggling and poaching.

**Welfare Measure** The villagers living around the mangrove are as should be provided with sufficient welfare measures to reduce their dependence only on the mangrove forests for their livelihood. Removal of fuelwood is one of the major causes for degradation of forests. The villagers are to be provided with alternate energy sources, Large tracts of barren lands in these deltas approaching the mangrove forests should be suitably afforested with firewood species to keep villagers away from the Mangrove swamps. Transport facilities both land and water and employment should be improved considerably so that they may develop alternate source of employment other than their traditional fishing in the mangrove creeks.

**Environmental Education** Education centres to aware local people regarding the fragile ecosystem should be set up. It is necessary that the people living in and around the mangroves are to be educated by mangrove ecosystem development camps for conserving the mangrove forests for better future.

**Endangered species** *Schyphiphora hydrophyllacea* Gartn.f. whose distribution is limited only in a small area near Sacramento light house in Kandi kuppa forest should be well protected and may be introduced in other areas to increase its distribution. Due to the absence of coppicing and pollarding power, species of *Rhizophoraceae* has been greatly reduced in these swamps. Special propagation and protection should be carried out for these species. Many animal species which occur in these swamps have become highly endangered due to reduction of their habitat and other illegal activities such as poaching etc. To rehabilitate these species captive breeding and later release into the wild should be done. The rehabilitation programmes of Mugger crocodiles which was taken up by the state has been found highly successful.

## REFERENCES

- Arora, R.K. and K.R. Agarwal (1960). Observation on the vegetation of Malpe Coast and neighbouring islands. *J. Indian Bot. Soc.*, 44: 314-324.
- Banerjee, L.K. (1984). Vegetation of the Bhitarkanika Sanctuary, Orissa State, *J. Econ. Tax. Bot.*, 6:1065-1079.
- Banerjee, L.K. (1987). Ecological studies on the mangals of Mahanadi estuarine delta, Orissa. *Trop. Ecol.*, 82:117-125.
- Banerjee, L.K. and G.C. Das (1975). New distributional records from Orissa. *Bull. Bot. Surv. India*, 14 (1-4) :184-186.
- Banerjee, L.K. and T.A. Rao (1985). Mangals of Mahanadi Delta, Cuttack Dist., Orissa State, India. All India Symp. Mar. plants, Dona Paula, Goa, India : 137-152.
- Banerjee, L.K., A.R.K. Sastry and M.P. Nayar (1989). Mangroves in India, Identification Manual, Bot. Surv. India Publ.
- Bharucha, F.R. and B.S. Navalkar (1950). Studies in Ecology of Mangroves, *J. Univ. Bombay*, 18: 7-16.
- Blasco, C.J. (1973). Status and Problem of Coastal Aquaculture in the Philippine. *FAO Fishing News Ltd. England*, 60-65.
- Blasco, F. (1975). Mangroves of India, *Inst. Fr. Pondicherry. Trav. Sect. Sci. Tech.*, 14:180.
- Blasco, F. and C. Caratini (1973). Mangroves De Pichavaram, *Trans. Doc. Cent. Etudes. Geogr. Trop.*, 8: 164-185.
- Caratini, C., G. Thanikaimoni and C. Tissot (1980). Mangroves of India. Palynological Study and Recent History of Vegetation. *Proc. In. Palyno. Con., Lucknow.*
- Caratini, C. and F. Blasco (1980). Les Mangroves de L'inde. *Trav. Doc. Geogr. Tropicale*, 39: 91-106.
- Champion H.G. (1936). A preliminary Survey of the forest types of India and Burma. *Indian For. Rec.*, 1:365.
- Champion, H.G. and S.K. Seth (1969). A revised survey of the forest types of India. *Manager of Publ., Govt. of India*, 404.
- Chapman, V.J. (1976). Mangrove Vegetation., J. Cramer, Fl. 9490, Vaduz.

- Clarke, C.B. 1896). Presidential address to the Linnean Society on the Sunderbans of Bengal. Proc. Linn. Soc., London, 32: 14 29.
- Cooke, T. (1901 1908). The Flora of the Presidency of Bombay, London.
- Cornwell, R.B. (1937) Working Plan for the Godavari Lower Div., Forest department, Andhra Pradesh.
- Curtis, S.J. (1933). Working plan for Sunderbans Divison. Forest Department, W.Bengal.
- Danial, J.C. (1967). The Point Calimer Sanctuary, Madras State. J. Bombay Nat. Hist. Soc., 64: 514 523.
- Erlanson, E.W. (1936) Plant colonization on two new tropical islands. J. Ind. Bot. Soc., 15 : 193 214.
- Gamble J.S. (1915 1935). Flora of the Presidency of Madras. Rep. ed. Bot. Surv. India, Calcutta.
- Gogate, M.G. (1982) East Coast Mangroves : an Overview in Proc. Semi. res. Dev. 24-29. E. Ghats.
- Graham et. al (1975)
- Griffith, W. (1836). On the family of Rhizophoraceae. Trans. Med. Phys. Soc., Calcutta, Vol -8.
- Haines, H.H. (1922 1925). The Botany of Bihar and Orissa. Rep. ed., Bot. Surv. India, Calcutta, 1961.
- Hooker, J.D. (1875 -1897). The Flora of British India, L.Reeve and Co., Kent, London.
- Jain, S.K. (1960) The Vegetation and sucession of Plant Communities in Kutch, Gujarat. Bull. Bot. Surv., 2:186 292.
- Jain, S.K. (1961). The Vegetation and Succession of plant communities in Kutch, Gujarat. Proc. Symp. Recent. Adv. Trop. Ecol., 426 437.
- Jones (1971)
- Khan Waheed, M.A. (1959). Ecological Studies of the Mangrove Forests of India. Proc. of the Mangrove Symp., Calcutta.
- Marlange, M. and V.M. Meher-Homji (1965). A phyto sociological study of the Pondicherry region. J. Indian Bot. Soc., 44: 167 182.
- Mooney, H. (1950). Suppliment to the Botany of Bihar and Orissa. Govt. of Orissa.
- Mudaliar, C.R. and H.S. Kamath (1952). Back Water Flora of the West Coast of South India. J. Bombay Nat. Hist. Soc., 54: 69 89.

Mukerjee, B.B. and J.Mukerjee (1978). Mangrove of Sunderbans, India Phytomorphology, 28(2): 217 229.

Mullick and Bhosle (1975)

Nairne, (1896). The Flowering plants of Western India. London.

Nasker, K. and D.N. Guhabakshi (1982). The World Mangrove Forest of the District 24 Parganas in West Bengal. J.Econ. Tax. Bot., 3: 883 913.

Navalkar, B.S. and F.R. Bharucha (1959). Studies in the Ecology of the Mangroves : Chemical Factors of the mangrove soil. J. Univ. Bombay, (N.S.) 18(3):17 35.

Nayer, M.P. (1969). Vegetation of Kanya Kumari. Dist. Bull. Bot. Surv. India, 1:122 126.

Prain, D. (1903). Flora of the Sunderbans. Rec. Bot. Surv. India, 2:231 370.

Prasad, S. Narendra (1992). An Ecological Reconnaissance of Mangals in Krishna Estuary: Plea for conservation.

Raja Gopalan, V.R. (1952). Ecological Adaptation of the Mangrove vegetation in Pichavaram. J. Annamalai Univ.

Rao, R.S. (1959). Observation on the Mangrove vegetation of the Godavari Estuary. Proc. Mangrove Symp., 36 44.

Rao, T.A. (1971). Distributional resume on Maritime strand Flora of India. Bull. Bot Surv. India, 13: 192 202.

Rao, T.A., K.R.Agarwal and A.K.Mukerjee (1963) Ecological studies on the soil and vegetation of Krusadi group of island in the Gulf of Manner. Bull. Bot. Surv. India, 5: 141 148.

Rao, T.A., A.K.Mukerjee and L.K. Banerjee (1965). Distribution of some plants along Midnapur coast in West Bengal State. Curr. Soc., 34: 599.

Rao, T.A., A.K.Mukerjee and L.K.Banerjee (1970). Some interesting plant records from the Orissa Coast. J. Bomb. Nat. Hist. Soc. 67 : 128.

Rao, T.A., and A.K.Mukerjee (1971). Ecological aspects along shore or Burabalanga tidal estuary, Orissa State, Proc. Indian Acad. Sci., 76(b): 201 206.

Rao, T.A. and A.R.K.Sastry (1972). An ecological approach towards classification of coastal vegetation in India, I.Strand vegetation. Indian Forester, 98: 594 607.

Rao, T.A. and A.R.K.Sastry (1974). An ecological approach towards classification of coastal vegetation of India. II Estuarine vegetation. Indian Forester, 100: 438 452.

- Rao, T.A. and A.R.K.Sastry (1977). An outline of the coastal vegetation of India. *Bull. Bot. India*. 16 (1-4): 101 -115.
- Rao, T.A. and P.V.Suresh (1990). Ecosystem of Karnatak Coast II: Mangroves. *My Forest*, 26(4): 399 - 442.
- Reddy, C.S. (1982). The Mangals of Godavari Estuary. Proceeding on the Seminar on Resource development and Environment in the Eastern Ghat. Andhra Univ. Waltair, 215 - 217.
- Roxburgh, W (1814). *Hortus Benglaensis*. Srirampur Misson Press, 105.
- Satyanarayan, Y (1958). Ecological studies of Bombay coastline vegetation. *J. Bio. L. Sci*, 1 : 53-55.
- Sanyal A. (1957). Additional notes on the Botany of Bihar and Orissa by H.H Haines and its suppliments by H.Mooney, *Indian For.*, 83: 230-234.
- Shah, G.L. (1962). The vegetation along the sea shore in Salsette island. *Bombay. Bull. Bot. Surv.*, 4:239-240.
- Sidhu, S.S. (1963). Studies on the Mangrove of India: I-East Godavari region. *Indian For.*, 89:337-351.
- Prasad, S. Narendra., Ed. Singh, K.P. and J.S. Singh. *Tropical Ecosystem: Ecology and Management*. 215 - 227. Wiley Eastern Lit. New Delhi.
- Thomas, K.J. (1962). A survey of vegetation of veli with special reference to ecological factors. *J. Indian Bot. Soc.*, 41: 104-130.
- Tvor, P.S. 1958). Studies in vegetation of Gujarat Coast W. India. *Proc. Indian Sci. Cong.*, Part III.
- Untwalle, A.G., S.N. Dwivedi and S. Y. S. Singbal (1973). Ecology of Mangroves in Mandovi and Zuari Estuaries and the interconnecting Cumbarja canal of Goa. *Indian J. Marine Sci.*, 2: 47 - 53.
- Venkateswaralu, J. (1944). The Estuarine Flora of Godavari. *J. Bombay Nat, Hist. Soc.* 44: 431-435..pa
- Venkateswaralu, J. (1972). The Flora of Visakhapatnam. *Andhra Pradesh Acad. Sci.*, Hyderabad. Watson, J.G. (1928). Mangrove Forests of Malay Peninsula. *Malayan Forest Records*, No:6.
- Watson J. G. (1928) Mangrove forest at Malaya pensula in *Malayan For. Rec.* 6 : 1-2-75

## INDEX TO BOTANICAL NAMES

<i>Abutilon indicus</i> (L.) Sweet.	96	<i>Blumea lacera</i> (Burm.f.)DC.	63
<b>Acanthaceae.</b>	49	<i>Borassus flabellifer</i> L.	56
<i>Acanthus ilicifolius</i> L.	49	<b>Boraginaceae</b>	67
<i>Achyranthes aspera</i> L.	53	<i>Bruguiera gymnorrhiza</i> (L.)	105
<i>Aegiceras corniculatum</i> (L.)	98	Savigny	
Blanco		<i>Bruguiera cylindrica</i> (L.) Bl.	106
<i>Aegialitis rotundifolia</i> Roxb.	99	<i>Caesalpinia bonduc</i> (L.) Roxb.	87
<i>Aeluropus lagopoides</i> (L.)	104	<i>Caesalpinia crista</i> L.	87
Trin. ex Thw.		<b>Cactaceae</b>	67
<i>Aerva lanata</i> (L.)	52	<i>Calotropis gigantea</i> (Willd.)	58
<b>Aizoaceae</b>	49	<b>Capparidaceae</b>	68
<i>Allmania nodiflora</i> (L.) R. Br	52	<i>Capparis brevispina</i> DC.	68
<i>Alternanthera sessilis</i> (L.) ex DC.	54	<b>Caryophyllaceae</b>	69
<b>Amaranthaceae</b>	51	<i>Carissa spinarum</i> L.	55
<i>Amaranthus spinosus</i> L.	51	<i>Cassythia filiformis</i> L.	92
<b>Amaryllidaceae</b>	54	<b>Celastraceae</b>	69
<b>Apocynaceae</b>	55	<i>Celosia argentea</i> L.	52
<b>Arecaceae</b>	56	<i>Ceriops decandra</i> (Griff.)	106
<b>Aristolochiaceae</b>	57	Ding Hou	
<i>Aristolochia indica</i> L.	57	<b>Chenopodiaceae</b>	70
<i>Arthrocnemum indicum</i> (Willd.)	70	<i>Cipadesa baccifera</i> (Roth.) Miq.	97
Moq.		<i>Citrullus colocynthis</i> (L.) Schr.	78
<i>Arthrocnemum glaucum</i> (Del.)	71	<i>Clerodendrum inerme</i> (L.)	111
Ung. Sternb.		Gaertn.	
<b>Asclepiadaceae</b>	58	<b>Combretaceae</b>	74
<b>Asteraceae</b>	60	<b>Convolvulaceae</b>	74
<b>Avicenniaceae</b>	64	<i>Crataeva adansonii</i> DC.	68
<i>Avicennia alba</i> Bl.	65	<i>Cressa cretica</i> L.	75
<i>Avicennia officinalis</i> L.	65	<i>Crinum asiaticum</i> L.	54
<i>Avicennia marina</i> (Forsk.) Vierh.	66	<i>Crinum defixum</i> Ker-Gawl.	54
<i>Avicennia marina</i> var. <i>tomentosa</i>	66	<i>Cucumis callosus</i> (Rottl.) Cogn.	78
Jacq.		<b>Cucurbitaceae</b>	77
<i>Azadirachta indica</i> A.Juss.	97	<i>Cuscuta reflexa</i> Roxb.,	74
<i>Barringtonia acutangula</i> (L.) Gaertn.	92	<i>Cyathocline purpurea</i> (Buch.-	62
		Ham. ex Don.) Kuntze.	



<b>Cyperaceae</b>	79	<b>Hippocrateaceae</b>	92
<i>Cyperus arenarius</i> Retz.	84	<i>Hydrophylax maritima</i> L.	109
<i>Cyperus compressus</i> L.	85	<i>Ichnocarpus frutescens</i> (L.) R.Br.	55
<i>Cyperus difformis</i> L.	84	<i>Ipomoea pes-caprae</i> (L.) Sweet	76
<i>Cyperus kyllingia</i> Endl.	83	<i>Ipomoea tuba</i> (Schlechtend.)	76
<i>Cyperus malaccensis</i> Lamk.	85	G. Don.	
<i>Cyperus plumilus</i> L. Cent.	83	<b>Lecythidaceae</b>	92
<i>Cyperus pachyrrhizus</i> (Nees.)	84	<i>Launaea sermentosa</i> (Willd.)	61
Kukenth		Sch.-Bip. ex Kuntze	
<i>Cyperus rotundus</i> L.	85	<b>Lauraceae</b>	92
<i>Dalbergia spinosa</i> Roxb.	89	<i>Lumnitzera racemosa</i> Willd.	74
<i>Dendrophoe falcata</i> (L.f.) Eting	94	<b>Loranthaceae</b>	93
<i>Derris heterophylla</i> (Willd.)		<b>Malvaceae</b>	94
Back. & Bakh..	91	<i>Maytenus emerginata</i> (Willd.)	69
<i>Derris scandens</i> (Roxb.) Benth.	90	Ding Hou	
<i>Eclipta prostata</i> (L.) L.	63	<b>Meliaceae</b>	97
<i>Eupatorium odoratum</i> L.	64	<i>Merremia tridentata</i> (L.)	76
<b>Euphorbiaceae</b>	86	<i>Mucuna pruriens</i> (L.) DC.	90
<i>Evolvulus alsinoides</i> (L.) L.	75	<i>Mukia maderaspatana</i> (L.)	77
<i>Excoecaria agallocha</i> L.	86	<i>Myriostachya wightiana</i>	103
<b>Fabaceae</b>	86	(Nees. ex Steud.) Hook. f.	
<i>Fimbristylis complanata</i> (Retz.)	80	<b>Myrsinaceae</b>	98
Link.		<b>Myrtaceae</b>	98
<i>Fimbristylis dichotoma</i> (L.) Vahl.	81	<i>Opuntia dillenii</i> (Ker-Gawler)	67
<i>Fimbristylis falcata</i> (Vahl.) Kunth.	81	Haw.	
<i>Fimbristylis ferruginea</i> (L.) Vahl.	80	<b>Pandanaceae</b>	99
<i>Fimbristylis polytrichoides</i> (Retz.)	80	<i>Pandanus tectorius</i> Sol. ex Park.	99
Vahl.		<i>Parkinsonia aculeata</i> L.	88
<i>Fimbristylis sericea</i> R.Br.	80	<i>Paspalum distichum</i> L.	102
<b>Flacourtiaceae</b>	91	<i>Pentatropis capensis</i> (L.f.)	58
<i>Flacourtia indica</i> (Burm.f.) Merrill.	91	<i>Phoenix farinifera</i> Roxb.	57
<i>Gnaphalium polycaulon</i> Pers.	63	<i>Phoenix sylvestris</i> (L.)Roxb.	56
<i>Grangea maderaspatana</i> (L.)Poir.	61	<i>Phragmites karka</i> (Retz.)	103
<i>Heliotropium curassavicum</i> L.	67	Trin. ex Steud.	
<i>Hibiscus tiliaceus</i> L.	95		

<b>Plumbaginaceae</b>	99	<i>Spinifex litoreus</i> (Burm.f.) Merr.	101
<b>Poaceae</b>	100		
<i>Polycarpaea corymbosa</i> (L.) Lamk.	69	<i>Suaeda fruticosa</i> (L.) Frosk. ex Gmel.	72
<i>Pongamia pinnata</i> (L.) Pierre	89	<i>Suaeda maritima</i> (L.) Dum.	73
<i>Porterasia coarctata</i> (Roxb.) Takeoka	102	<i>Suaeda monoica</i> Forsk. ex Gmel.	73
<i>Prosopis cineraria</i> (L.)	88	<i>Suaeda nudiflora</i> (Willd.) Moq.	72
<i>Pupalia lappacea</i> (L.) Juss.	53	<i>Syzygium ruscifolium</i> (Willd.) Santapau	98
<b>Rhizophoraceae</b>	105	<b>Tamaricaceae</b>	110
<i>Rhizophora apiculata</i> Bl.	107	<i>Tamarix dioica</i> Roxb.	111
<i>Rhizophora mucronata</i> Poir.	107	<i>Tamarix troupii</i> Hole.	110
<b>Rubiaceae</b>	108	<i>Thespesia populnea</i> (L.) Sol. ex Corr.	95
<i>Salacia chinensis</i> L.	92	<i>Thespesia populneoides</i> (Roxb.) Kostel.	95
<i>Salicornia brachiata</i> Roxb.,	71	<i>Trianthema protulacastrum</i> L.	50
<b>Salvadoraceae</b>	109	<i>Trianthema triquetra</i> Rottl. & Willd.	50
<i>Salvadora persica</i> L.	10	<i>Trichosanthes cucumerina</i> L.	78
<i>Sarcobolus carinatus</i> Wall.	59	<i>Tylophora indica</i> (Burm.f.) Merr.	60
<i>Sarcobolus globosus</i> Wall.	59	<b>Verbenaceae</b>	111
<i>Scirpus littoralis</i> Schrad.	82	<i>Vernonia cinerea</i> (L.) Less.	62
<i>Scirpus triquetra</i> L.	82	<i>Viscum ovalifolium</i> Wall.	93
var <i>segregata</i> Clarke		<i>Xylocarpus granatum</i> Koen.	98
<i>Scyphiphora hydrophyllacea</i> Gaertn. f.	108	<i>Zoysia matrella</i> (L.)	102
<i>Sesuvium portulacastrum</i> (L.) L.	49		
<i>Sida cordifolia</i> L.	96		
<i>Sonneratia apetala</i> Buch.-Ham	110		