Mangrove Plants of Tamil Nadu

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Preface

The present publication on the Mangrove plants of Tamil Nadu is a timely publication, since there is growing public and political awareness of the importance of mangrove wetlands in preserving the ecological security of coastal areas and the livelihood security of coastal communities. The publication has been prepared in a user-friendly manner, particularly for the benefit of scholars and extension workers. An understanding of the facts mentioned in the publication will facilitate effective joint mangrove forest management by forest departments and local communities. The book will help to sensitize all concerned about the rich biodiversity associated with mangrove ecosystems. I hope it will be widely used by members of forest departments, scholars and students and by all interested in the conservation and sustainable and equitable management of mangrove bio-resources.

M S Swaminathan

Content

Mangrove Plants of Tamil Nadu

1.0 Introduction

Mangroves are woody trees and shrubs that grow in the intertidal zones of tropical and sub-tropical regions. Duke (1992) defined a mangrove plant as " a tree, shrub, palm or ground fern, generally exceeding one and half metre in height, and which normally grows about mean sea level in the intertidal zones of marine coastal environments, or estuarine margins". Kathiresan and Bingham (2001) who reviewed biology of mangroves and mangrove ecosystems opined "this definition is acceptable except that ferns should probably considered mangrove associates rather than true mangroves".

True mangrove species

In general, flora of mangrove wetlands are divided into two groups namely, a) true or exclusive mangrove and b) associate mangrove species. According to Tomlinson (1986) following are the characteristic features of true mangrove species:

a) they grow only in mangrove environment and do not extend into terrestrial plant communities

b) they play a major role in determining the structure of plant community and ability to form pure stands

c) they are morphologically adapted to live in waterlogged condition – e.g. aerial roots associated with gas exchange

d) they are physiologically adapted to live in saline environment

e) they have viviparous reproduction

f) they are taxonomically isolated from terrestrial relatives

By reconciling common features from Banerjee and Rao (1990), Duke (1992) and Kathiresan and Bingham (2001), 69 species in 27 genera, belonging to 20 families can be considered as true mangrove species (Table 1). Families namely, Aegialitidaceae, Avicenniaceae, Nypaceae and Pellicieraceae contain only mangrove species. Two orders, Myrtales and Rhizophorales contain 25% of all mangrove families.

Table 1: Flora found exclusively in the mangrove environment (true mangrove species)

Order	Family	Genus	Species
Division POLYPODIOPHYTA			
	Pteridaceae	*Acrostichum*	*danaeifolium*
			aureum
			spceciosum
Division MAGNOLIPHYTA			
Plumbaginales	Plumbaginaceae	*Aegialitis*	*rotundifolia*
			annulata
Theales	Pellicieraceae	*Pelliciera*	*rhizophorae*
Malvaes	Bombacaceae	*Camptostemon*	*philippensis*
			schultzii
	Sterculiaceae	*Heritiera*	*littoralis*
			fomes
			globosa
			kanikensis
Ebenales	Ebenaceae	*Diospyros*	*ferra*
Primulales	Myrsinaceae	*Aegiceras*	*corniculatum*
			floridum
Fabales	Caesalpiniaceae	*Cynometra*	*iripa*
		Mora	*oleifera*
Myrtales	Combretaceae	*Conocarpus*	*erectus*
		Laguncularia	*racemosa*
		Lumnitzera	*racemosa*
			x rosea[1]
			littorea
	Lythraceae	*Pemphis*	*acidula*
	Myrtaceae	*Osbornia*	*octodonta*
	Sonneratiaceae	*Sonneratia*	*apetala*
			griffithii
			alba
			x sp[2]*.*
			ovata
			x gulngai
			caseolaris
			x merauke[3]
			lanceolata

Order	Family	Genus	Species
Rhizophorales	Rhizophoraceae	*Bruguiera*	*gymnorrhiza*
			sexangula
			exaristata
			hainesii
			parviflora
			cylindrica
		Ceriops	*tagal*
			decandra
			australis
		Kandelia	*candel*
		Rhizophora	*racemosa*
			x harrisonii
			mangle
			samoensis
			x selala
		Rhizophora	*stylosa*
			x lamarckii
			apiculata
			mucronata
Euphorbiales	Euphorbiaceae	*Excoecaria*	*agallocha*
			indica
Sapindales	Meliaceae	*Aglaia*	*cucullata*
		Xylocarpus	*granatum*
			mekongensis
Lamiales	Avicenniaceae	*Avicennia*	*germinas*
			bicolor
			schayeriana
			marina
			alba
			rumphiana
			officinalis
			integra
Scrophulariales	Acanthaceae	*Acanthus*	*ebracteatus*
			ilicifolius
Rubiales	Rubiaceae	*Scyphiphora*	*hydrophyllacea*
Arecales	Arecaceae	*Nypa*	*fruticans*

Taxonomic uncertainties still exist with mangrove plants despite their familiarity. This is mainly because they have wide distributions and few fieldworkers had the opportunity to explore species throughout their range. Often the characters that separate species are also not very obvious. The geographical limits of several of *Avicennia* taxa are still uncertain, even though this is the most constant genus in mangroves and the names for its species are not always reliable. Knowledge of the geographic range of mangrove species is often incomplete, so checklist of mangrove species for a given area is constantly in need of revision.

Mangrove associates

Some of the plant species that grow in the terrestrial environment and pure halophytes (that grow only in saline areas) are also found within or in the peripheral areas of mangrove wetlands. These species are called as associate mangroves. The terrestrial species that found associate with mangroves are unable to tolerate high salts and therefore do not penetrate deep into the mangrove wetlands. They normally found in elevated lands present within the mangrove ecosystem. On the other hand, halophytes such as *Salicornia, Sesuvium* and *Suaeda* are able to grow along with mangroves. In hypersaline areas, these halophytes grow monospecifically.

2.0 Mangrove plants of India

A comparative analysis of the list of species given in Untawale (1984), Banerjee and Rao, (1990), Deshmukh and Mahalingam (1991), Chaudhuri and Choudhury, (1994), Satyanarayana *et al* (2002) and Ramasubramanian *et al* (2003) indicates that a total number of 34 true mangrove species are present in the mangroves of India, including both east and west coasts and Andaman and Nicorbar islands (Table 2). The mangrove wetlands of Orissa has the highest number of species (31) followed by Sunderbans of West Bengal (27) and Andaman and Nicobar Islands (24). Along the east coast, the least number of species is present in Tamil Nadu mangroves (14). Analysis of the distribution of true mangrove species in different Indian mangrove wetlands indicates that *Acanthus ilicifolius, Aegiceras corniculatum, Avicennia marina, Bruguiera cylindrica, Ceriops decandra, Excoecaria agallocha, Lumnitzera racemosa, Rhizophora apiculata, R. mucronata* are common to all the mangroves of India. On the other hand, species such as *Pemphis acidula* is endemic to islands of Gulf of Mannar of Tamil Nadu, *Scyphiphora hydrophyllacea* to Godavari mangroves of Andhra Pradesh. Similarly, *Nypa fruticans* has been reported to be present only in Sunderbans of West Bengal. The Tamil Nadu mangrove is also characterised by the presence of a natural hybrid of *Rhizophora* species.

Table 2: List of true mangrove species occuring in different mangrove wetlands India

Sl. No.	Species	East Coast				Andaman and Nicobar islands	West Coast
		West Bengal	Orissa	Andhra Pradesh	Tamil Nadu		
1	*Acanthus ilicifolius* L.	✓	✓	✓	✓	✓	✓
2	*Acrostichum aureum* L.	✓	✓	-	-	✓	✓
3	*Aegialitis rotundifolia* Roxb.	✓	✓	-	-	✓	-
4	*Aegiceras corniculatum* (L.) Blanco	✓	✓	✓	✓	✓	✓
5	*Aglaia cucullata* (Roxb.) Pellegrin	-	✓	-	-	-	-
6	*Avicennia alba* Blume	✓	✓	✓	-	✓	✓
7	*A. officinalis* L.	✓	✓	✓	✓	✓	-
8	*A. marina* (Forsk.) Vierh.	✓	✓	✓	✓	✓	✓
9	*Bruguiera cylindrica* (L.) Blume	✓	✓	✓	✓	✓	✓
10	*B. gymnorrhiza* (L.) Savigny	✓	✓	✓	-	✓	✓
11	*B. parviflora* (Roxb.) W.& A.	✓	✓	-	-	✓	✓
12	*B. sexangula* (Lour.) Poir.	✓	✓	-	-	✓	-
13	*Ceriops decandra* (Griff.) Ding Hou	✓	✓	✓	✓	✓	✓
14	*C. tagal* (Perr.) Robins.	✓	✓	-	✓	✓	✓
15	*Cynometra iripa* Kostel	-	✓	-	-	-	-
16	*Excoecaria agallocha* L.	✓	✓	✓	✓	✓	✓
17	*Heritiera fomes* Buch.-Ham.	✓	✓	-	-	-	-
18	*H. littoralis* Aitonex Dryander	-	✓	-	-	✓	-
19	*H. kanikensis* Mj.et Ban.	-	✓	-	-	-	-
20	*Kandelia candel* (L.) Druce	✓	✓	-	-	✓	✓
21	*Lumnitzera racemosa* Willd.	✓	✓	✓	✓	✓	✓

Sl. No.	Species	East Coast				Andaman and Nicobar islands	West Coast
		West Bengal	Orissa	Andhra Pradesh	Tamil Nadu		
22	*Nypa fruticans* Van Wurmb.	✓	-	-	-	-	-
23	*Pemphis acidula* Forster	-	-	-	✓	-	-
24	*Rhizophora apiculata* Blume	✓	✓	✓	✓	✓	✓
25	*R. mucronata* Poir.	✓	✓	✓	✓	✓	✓
26	*R. stylosa* Griff.	-	✓	-	-	-	-
27	*R. x lamarckii**	-	-	-	✓	-	-
28	*Scyphiphora hydrophyllacea* Gaetn. f.	-	-	✓	-	-	-
29	*Sonneratia apetala* Buch.-Ham.	✓	✓	✓	-	✓	✓
30	*Sonneratia caseolaris* (L.) Engl.	✓	✓	-	-	✓	✓
31	*S. alba* J.Smith	✓	✓	✓	-	✓	✓
32	*S. griffithii* Kurz	✓	✓	-	-	✓	-
33	*Xylocarpus granatum* Koenig	✓	✓	✓	-	✓	✓
34	*X. mekongensis* Pierre.	✓	✓	✓	✓	-	-
35	*X. moluccensis* (Lam.) Roem.	-	-	✓	-	-	-
	Total	**27**	**31**	**18**	**14**	**24**	**19**

✓ = **Present;** - = **Absent**

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3.0 Mangrove plants of Tamil Nadu

Tamil Nadu has a coastline of about 950 km. Along the coastline major mangrove wetlands are present in two areas: one at Pichavaram in Cuddalore District and the other in the Muthupet region in Thiruvarur-Thanjavur Districts. Small patches of mangroves are also present along the Palk Bay, particularly in the Devipattinam region and also in some of the islands of the Gulf of Mannar in Ramanathapuram District.

Pichavaram: Pichavaram mangrove wetland consists of three Reserve Forests (RF), namely Killai RF, Pichavaram RF and Pichavaram Extension RF. According to the remote sensing data, in 1986 the total area of these RFs was about 1,474 ha (area in 1897 when this mangrove wetland was declared as Reserve Forest was about 1,358 ha). According to recent botanical survey conducted by M.S.Swaminathan Research Foundation, a total number of 12 true mangrove plant species are present in this mangrove wetland.

Muthupet: The total area of the Muthupet mangrove wetland is about 12,000 ha and for administrative purpose it is divided into six Reserve Forests. Presence of two large lagoons, which are contiguous and about 1,700 ha in area, is one of the characteristic features of the Muthupet mangrove wetlands. A recent botanical survey indicates a total number of 8 true mangrove species are present in the Muthupet mangroves, out of which 3 species namely *Ceriops decandra, Rhizophora apiculata* and *Rhizophora mucronata* have been reintroduced recently.

Table 3 True mangrove species present in Tamil Nadu mangrove ecosystems

Species	Pichavaram	Muthupet	Gulf of Mannar
Acanthus ilicifolius	✓	✓	-
Aegiceras corniculatum	✓	✓	✓
Avicennia marina	✓	✓	✓
A. officinalis	✓	-	-
Bruguiera cylindrica	✓	-	✓
Ceriops decandra	✓	✓	✓
C. tagal	-	-	✓
Excoecaria agallocha	✓	✓	✓
Lumnitzera racemosa	✓	✓	✓
Pemphis acidula	-	-	✓
Rhizophora apiculata	✓	✓	✓
R. mucronata	✓	✓	✓
R. x lamarckii	✓	-	-
Xylocarpus mekongensis	✓	-	-
Total	**12**	**8**	**9**

Gulf of Mannar: In the islands of Gulf of Mannar small patches of mangroves are present in which 9 true mangrove species have been recorded. *Pemphis acidula* is endemic to these islands. Table 3 shows the true mangrove species present in Pichavaram, Muthupet and Gulf of Mannar mangroves.

In the Pichavaram mangrove wetland, apart from the 12 species currently present, species such as *Aegiceras floridum*, *Bruguiera gymnorrhiza*, *Cynometra ramiflora*, *Kandelia candel*, *Xylocarpus granatum* and *Sonneratia apetala* were present in large numbers in the past and now they have become locally extinct (Venkatramani, 1954; Tissot, 1987 and Kathiresan 2000 and Selvam *et al* 2002). Specimens of *Aegiceras floridum* collected from Pichavaram mangrove wetland are present in the collections of the Botanical Survey of India. Similarly, specimens of *Bruguiera gymnorrhiza* and *Sonneratia apetala* are present in the herbarium of the French Institute, Pondicherry. All these indicate that the mangrove wetlands of Tamil Nadu were once richer in diversity of true mangrove species. According to Selvam (2003) and Selvam *et al* (2004) reduction in freshwater flow is one of the main reasons for extinction of these species in Tamil Nadu mangroves.

4.0 About this manual

In this manual basic information to identify 14 true mangrove species that are present in the mangrove wetlands of Tamil Nadu is given along with information on how to identify some of the mangrove associate species. The information provided will be useful to identify the species in the field easily. For each species general characters such as shape, size, surface and colour of bark, nature of the root system is given along with information on leaves, flowers and fruits. In addition, information on flowering and fruiting periods and when the mature propagules/seeds can be collected is also presented. The characteristics of plants are described using simple language. However, many morphological terms are also used and meanings of these morphological terms are given below.

Explanation for morphological terms

Aerial roots: Most of the mangrove species produce aerial roots. Aerial roots are the roots that are exposed to air at least during part of the day or sometimes all day in relating to the tide Aerial roots are one of the important characters in identifying mangrove species in the field (Kitamura *et al* 1997). The following four different types of aerial roots are found in the mangrove species of Tamil Nadu.

Stilt roots: In species like *Rhizophora* roots diverge from the tree trunk as much as 2 to 3 m above ground and penetrate the soil some distance away from the main stem. Because of their appearance and as they provide main physical support of the trunk, the aerial roots of

Rhizophora are often called as stilt roots. On reaching the soil, absorptive roots grow from the stilt roots vertically downwards into the soil. Stilt roots also develop from lower branches of the tree.

Fig. 1 Stilt root

Pneumatophores: In species like *Avicennia* shallow horizontal roots radiate outwards, often for a distance of many meters. At intervals of 15 to 30 cm, vertical structures known as pneumatophores emerge as lateral branches from horizontal roots and stand erect, up to 30 cm above the soil.

Fig. 2 Pneumatophores

Buttress: In species like *Xylocarpus granatum* horizontal root becomes extended vertically by eccentric cambial activity throughout its length. These roots are laterally sinuous in their course, so the result in the mature tree is a series of wavy, plank like structures growing away from the base of the trunk. Similar buttress roots can also be seen in *Heritiera* as narrow surface outgrowths of the base of the trunks. Buttress roots are also present in *Bruguiera* species.

Fig.3 Buttress roots

Knee-roots: In species like *Bruguiera cylindrica,* horizontal roots reorient upward through the soil and tip of the upward extension form pronounced loop. At the site of the loop, secondary thickening occurs mainly on the upper side so that a blunt, knoblike structure is raised above the soil surface and these roots are called as knee roots.

Fig.4 Knee-roots

Leaves:

Simple leaf : only one definite segment present between the stem and the end of the blade, although sometimes lobed or toothed

Compound : Having two or more leaflets from the stem to the apex (formed of similar parts grouped in a whole or leaves when composed of more than one separate leaflet); compound leaves can be recognised by the absence of a bud at the base of the leaflet

Opposite : Two leaves inserted opposite to each other on the stem,

Alternate : Only one leaf is inserted at a node, i.e. single leaf at each node.

Simple

Compound

Opposite

Alternate

Leaf blade shape:

Lanceolate : Leaves are shaped like a lance; they have a broad base and taper to a point; length of the leaves is several times longer than width

Elliptical : Leaves are broadest at the middle; both ends rather equal; the length of the leaves is at least twice the width

Ovate : Leaves shaped like the longitudinal section of an egg, with the broad basal end The leaf is widest below the middle

Obovate : Leaves are egg shaped, with the narrower end at the base

Cordate : Leaves are heart shaped (i.e. more or less deeply notched at the base and in form like a conventional heart)

Lanceolate

Elliptical

Ovate

Obovate

Cordate

Apex of the leaf

Acute : Leaf tip sharply pointed, but not drawn out

Acuminate : Leaf tip gradually tapering to the apex, long pointed

Apiculate : Leaves furnished with a short sharp, but not stiff, point

Obtuse : Leaf tip blunt

Rounded : Leaf tip rounded

Emarginate : A shallow notch present on the rounded apex

Acute *Acuminate* *Apiculate* *Obtuse* *Rounded* *Emarginate*

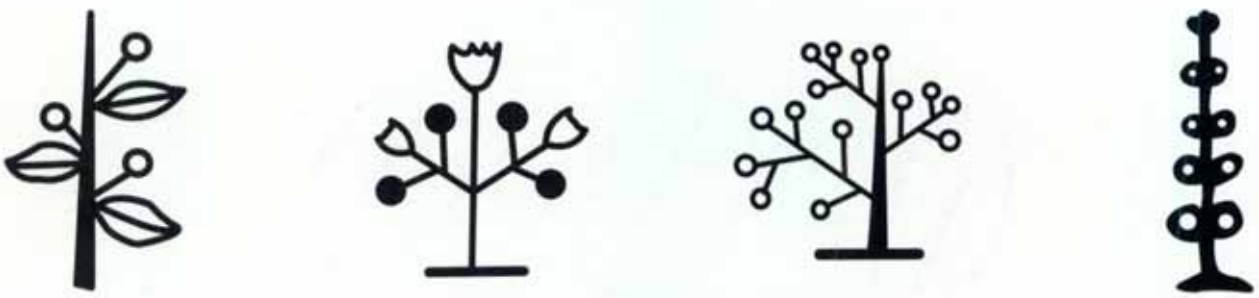
***Inflorescence*:** (the disposition of the flowers on the floral axis; the flower clusters as a whole)

Single : flowers borne singly, at nodes or stem, not in clusters

Cyme : a flat-topped loose flower cluster, flowers with stalks (a centrifugal inflorescence in which the secondary or lateral branches continue to grow and may extend beyond the main axis)

Panicle : a compound raceme (a repeatedly branched inflorescence)

Spike : a simple inflorescence of sessile flowers arranged on a common, elongated axis



Single *Cyme* *Panicle* *Spike*

Raceme : a simple inflorescence of stalked flowers on a more or less elongated axis

Catkin : A spike consisting usually of unisexual flowers without petals, solitary or twin in the axils of bracts, usually pendulous inflorescence

Umbel : inflorescence of stalked flowers all arising from same point, indeterminate type (an inflorescence in which a cluster of pedicels springs from the same point)

Thyrse : Compact panicle, more accurately a complex group of dichasia recembling a panicle

Terminal : arising from the end of the stem

Axillary : arising from the angle formed by the upper side of a leaf and the stem

Receme *Caikin* *Umbel* *Terminal* *Axillary*

Acanthus ilicifolius

5.0 True Mangrove species of Tamil Nadu

Scientific name : *Acanthus ilicifolius* L.

Family : Acanthaceae

Local Name : *Neermulli* in Pichavaram
Athumulli in Muthupet

General : *Acanthus ilicifolius* is typically a low woody sprawling herb and has ability to spread by its reclining stems. Height varies from 0.5 to 1.2 m.. Leaves simple and opposite, 5 to 15 cm long and deep green in colour, glossy and stiff. Decussate in arrangement with a pair of spines at the insertion of each leaf. Leaf blade is either broadly lanceolate with an entire margin, apex rounded or mucronate or more usually with a sinuous spiny margin. Trunks, when visible, have a yellowish complexion.

Root : No prominent aerial root. Sometimes develop small stilt-like roots.

Flower : Inflorescence simple or branched, spike terminal. Flowers large, showy, blue with a purple hue, about 4 to 5 cm long. Bisexual. Flowering period: March to December.

Fruit : Fruit a capsule 2 to 3 cm long and 1 cm wide, slightly flattened, usually with 4 seeds of about 1 cm long; fruits are glossy, green in colour. Embryo is partly developed within the fruit (crytovivipary).

Distribution : In the reserve forest areas of Pichavaram, *Acanthus ilicifolius* was once found in large numbers along the banks in the upstream region of the river till 1992. But now this species has become almost extinct within the reserve forest area due to increase in salinity but a few patches are present in the freshwater region outside the reserve forest area. In Muthupet mangroves, small bushes can be seen in the upstream area of the Koraiyar river.

Aegiceras corniculatum

Scientific name : *Aegiceras corniculatum* (L.) Blanco

Family : Myrsinaceae

Local Name : *Narikandal* in Pichavaram
Kanna in Muthupet

General : Shrub of about 2 to 3m tall with low spreading branches. Leaves simple, alternate and spirally arranged, stipules absent; petiole is frequently pink-red in colour merging with a yellow or red-tinted. Leaf blade is obovote to elliptical, cuneate at the base and notched at the tip. Leaves are about 5 to 7 cm long and 3 to 4 cm wide. Mid rib is prominent on the lower side of the leaf. Salt crystals can be seen on the upper surface of the leaf, secreted by salt glands. Bark is smooth, whitish to dark gray.

Root : No prominent aerial root.

Flower : Inflorescence simple umbel, flowers on first order of branches. 1.5 to 2 cm long, white in colour. The corolla has 5 white petals, pointed, contorted and always twisted to the left, calyx 5 green, lobed. Flowers are fragrant (honey smell). Flowering period: March to May

Fruit : 5-8 cm long, cylindrical, strongly curved with persistent calyx and sharply pointed, green to reddish in colour on maturation. Cryptoviviparous propagules with membranous epicarp and spongy mesocarp. Furiting period: July to September.

Distribution : In Pichavaram region, *Aegiceras corniculatum* can be seen growing among the roots of *Rhizophora* species (i.e within the *Rhizophora* zone), along tidal creeks and canals. In Muthupet individual plant or groups can be seen growing luxuriantly along the banks of the Korayar estuary.

Avicennia marina

Scientific name : *Avicennia marina* (Forsk.) Vierh.

Family : Avicenniaceae

Local name : *Venkandal* in Pichavaram
Alayathi in Muthupet

General : Growth form varies from tall trees with broad trunk to shrubby stunted individuals. It can be easily differentiated from *Avicennia officinalis* by its smooth and brilliant white bark. Leaves simple and opposite, leaf blade is mostly elliptical and leaf apex is acute or obtuse (*Avicennia officinalis* – rounded apex). Leaves are yellowish green on the upper side and lower side of the leaf is yellowish white in colour with numerous minute hairs (pubescence). Salt secreted from salt glands may be seen on both sides of the leaf. Bark chalky white in colour when dry (*Avicennia officinalis* bark is grey-brown), mostly smooth but sometimes flaky.

Root : Needle like pneumatophores are similar to *A. officinalis.*

Flower : Flowers are orange-yellow in colour, 2-4 mm in diameter and crowded in terminal cymes or axillary on distal shoots. Peduncles trichotomously branched. Petals, 4 yellow to orange in colour and calyx is 5 lobed. Flowering period: August to October.

Fruit : Fruit is heart-shaped, rounded or sometimes shortly beaked; pericarp is finely hairy and green in colour; colour of the viviparous seedling (cryptoviviparous) is radiant green or russet brown or dark green. The fruit of *A. marina* is smaller than that of *A. officinalis.* Fruiting period: November to January.

Distribution : *Avicennia marina* is the dominant species both in Pichavaram and Muthupet. In Pichavaram mangroves pure stands of *A. marina* can be seen just behind *Rhizophora* zone whereas in Muthupet mangroves, tall *A. marina* trees can be seen along the banks of canals and creeks.

Avicennia officinalis

Scientific name : *Avicennia officinalis* L.

Family : Avicenniaceae

Local name : *Karungkandal* in Pichavaram
Absent in Muthupet

General : Growth form varies from tall trees with broad trunk to shrubby stunted individuals. It can be easily distinguished from *A. marina* by its smooth, gray to brown coloured bark and rounded leaves. Leaves simple and opposite, leaf blade is obovote to elliptical, apex is rounded and 8-10 cm long. Lower side of the leaf is greenish yellow. Young leaves are normally hairy.

Roots : Needles like pneumatophores are similar to *A. marina.* Bark grey-brown in colour.

Flower : Inflorescence 1 to 1.5 cm long, more or less globular with 7-10 flowers, orange-yellow in colour, dense spike, terminal or axillary on distal shoots. Petals 4, yellow coloured and calyx is 5 lobed. Size of the flower varies from 10 to 12 cm in diameter, larger than that of *A. marina*. Flowering period: August to October.

Fruit : Fruit is heart-shaped and larger in size than that of *A. marina.* It is rounded at apex or with a short beak. Surface is hairy. Cryptoviviparous, pericarp is green in colour. Like *A. marina,* colour of the viviparous seedling is radiant green or russet brown or dark green. Furiting period: November to January.

Distribution : Huge trees, more than 15 m in height and 40-50 cm in diameter at breast height can be seen in the Pichavaram Extension area. It seems that this species grow well only in areas where the annual average salinity is low. Inside the core mangrove areas of Pichavaram Reserve Forest only lean trees could be seen just adjacent to *Rhizophora* zone. According to the local community *A. officinalis* was one of the dominant species of the Pichavaram mangrove forest about 60 to 80 years ago. Selective felling of the trees in coupe by government agencies for revenue generation coupled with reduction in freshwater flow decreased its population and also affected the growth.

Bruguiera cylindrica

Scientific name : *Bruguiera cylindrica* (L.) Blume

Family : Rhizophoraceae

Local name : *Pannukuchi* in Pichavaram
Absent in Muthupet

General : Grows mostly as a shrub of about 2 m tall; in some places where there is sufficient freshwater inflow, it grows as a tree of about 4 to 5 m height but with slender trunk and branches. It normally grows in the *Rhizophora* zone, just behind *Rhizophora* trees or mixed with *Rhizophora* and *Ceriops*. Leaves opposite and simple; leaf blade oblanceolate or elliptical, apex acuminate and varies from 8 to 10 cm in length. Bark is pale pink in colour, scaly at the bottom of the trunk.

Root : Develops buttress roots, which originate as stilt like roots. Knee roots are also present, slightly away from the trunk.

Flower : Inflorescence, 3 flowered in axillary pedunculate cymes. Flowers are white in colour, small in size. Calyx 8-10 lobed, yellowish in colour and persistent, forming a "cap" above the hypocotyl. Flowering period: June to October

Fruit : Viviparous; green to purple green in colour, immature fruits (hypocotyl) is slightly curved, mature fruits well curved, detaches with calyx. Hypocotyl is 0.5-1.0 cm in diameter and 6 to 13 cm in length. Fruiting period: August to November.

Distribution : Available only in Pichavaram in the Rhizophora zone under shade.

Ceriops decandra

Scientific name : *Ceriops decandra* (Griff.) Ding Hou

Family : Rhizophoraceae

Local name : *Cirukandal in* Pichavaram

General : *Ceriops decandra* mostly grows as a shrub of about 1.5 to 2 m tall. In some places grows to a height of about 4m with lean stem and branches. Leaves simple and opposite, leaf blade obovote, apex rounded. Bark pale yellowish gray with patches of dark brown.

Root : Develops small buttress roots, which originate as stilt-like roots and display flaky bark.

Flower : Inflorescence condensed cyme, axillary on short, thick stalks. Flowers small, 5 mm, enclosed in cup shaped partially fused bracteoles. Petals, 5 to 6 free, white brown in colour. Calyx, 5-6 pointed, lobed and green. Flowering period: August to October.

Fruit : Hypocotyl clearly ribbed from top to bottom, about 15 cm long, green to brown in colour and erect. Cotyledonary collar dark red when mature. Calyx tube warty and persistent. Furiting period: September to November

Distribution : It grows along with *Bruguiera cylindrica*, just adjacent to *Rhizophora* species. Reintroduced in Muthupet mangroves *Ceriops decandra* was reintroduced in small numbers by the Tamil Nadu Forest Department in 2001 under Biodiversity Enrichment Programme (Baruah, 2004)

Ceriops tagal, which is similar to *Ceriops decandra* has long peduncle, with a hanging fruit and longer hypocotyls.

Ceriops tagal

Scientific name : *Ceriops tagal* (Perr.) Robins.

Family : Rhizophoraceae

Local name : *Kanna* in Gulf of Mannar

General : *Ceriops tagal* grows as a small tree / shrub of about 2.5 to 3.0 m tall. Maximum height of the tree is about 6.0 m in some places. Leaves resemble *C. decandra*, simple, opposite, leaf blade obovote, apex rounded.

Root : Develops buttress roots, originating stilt-like roots, sometimes develops knee-roots or knobby pnuematorphores.

Flower : Inflorescence hanging cyme, axillary on longer and slender stalks compared to *C. decandra*. Flowers are small, 5mm, white, in pairs in axils of the leaves and with red anthers on longish filaments. Petals, 5 white and brown. Calyx 5 lobed, green.

Fruit : Hypocotyls is slender, typically longer than *C. decandra*. The ripened fruit is a reddish purple tint towards the tip. The hypocotyls of *C. tagal* hangs down one of the identifying keys. Fruiting period: October – December.

Distribution : Distribution of this species is exclusively restricted to a few islands of Gulf of Mannar region in Tamil Nadu, where it grows in association with other mangrove species such as *Rhizophora mucronata, Lumnitzera racemosa*, *Bruguiera cylindrica* and *Avicennia marina*.

Excoecaria agallocha

Scientific name : *Excoecaria agallocha* L.

Family : Euphorbiaceae

Local name : *Thillai* in Pichavaram
Thillai in Muthupet

General : Tree, about 5 to 8 m tall, branched from base. In some areas it grows as a shrub. Unisexual, male and female plants are separate. Leaves simple and alternate, elliptical in shape and apex is acute. Both in the male and female plants, leaves are green in young but become red and yellow tinted when mature, notched margin. Leaves of female plants are larger than that of male plants and dark green in colour. Generally, leaves are shed during the summer and fresh foliage can be seen during October-November (northeast monsoon season). Bark is gray in colour and smooth, sometimes lenticellate and with white latex. Lichens, variously coloured and shaped can be seen on the bark.

Root : No prominent aerial roots.

Flower : Flowers unisexual. Inflorescence axillary, pale green in colour, 3-7 cm long and catkin like. Male inflorescence appears yellow with glandular bracts. Petal green and white, calyx, yellowish green. Flowering period: August to December

Fruit : Look like 3 balls combined (three lobbed) but small in size, green in colour and surface is leathery. Fruits turn back in colour when mature. No vivipary or crytovivipary. Normal seeds. Fruiting period: November to January.

Distribution : In landward portion, where salinity is low or in sandy areas which are not inundated by tidal water but with slightly saline ground water, gregarious monospecific stands of *E. agallocha* can be seen with trees of large trunk and profuse branches (e.g. east of T.S.Pettai village in Pichavaram). On the other hand, trees with lean stems and limited branches can be seen in areas of high salinity. All parts of the plant release white latex when wounded, which can be very irritating to skin and eyes and hence, it is called as "blinding tree". Not grazed by animals. In Muthupet tall trees, more that 12 m height were once reported in Sethukuda region but now only small trees are present along the tidal creeks and canals.

Lumnitzera racemosa

Scientific name : *Lumnitzera racemosa* Willd.

Family : Combretaceae

Local name : *Thipparathi* in Pichavaram
Kaandaa in Muthupet

General : Evergreen plant, about 3 to 4 m tall, grows within the *Rhizophora* zone. Leaves small, thick, succulent, simple and alternate, obovate blade, apex rounded to emerginate. Conspicuous pair of glands can be seen on the distal adaxial part of the petiole. Upper and lower surface of the leaf are almost the same. Bark is gray and may be fissured, especially in old trunks.

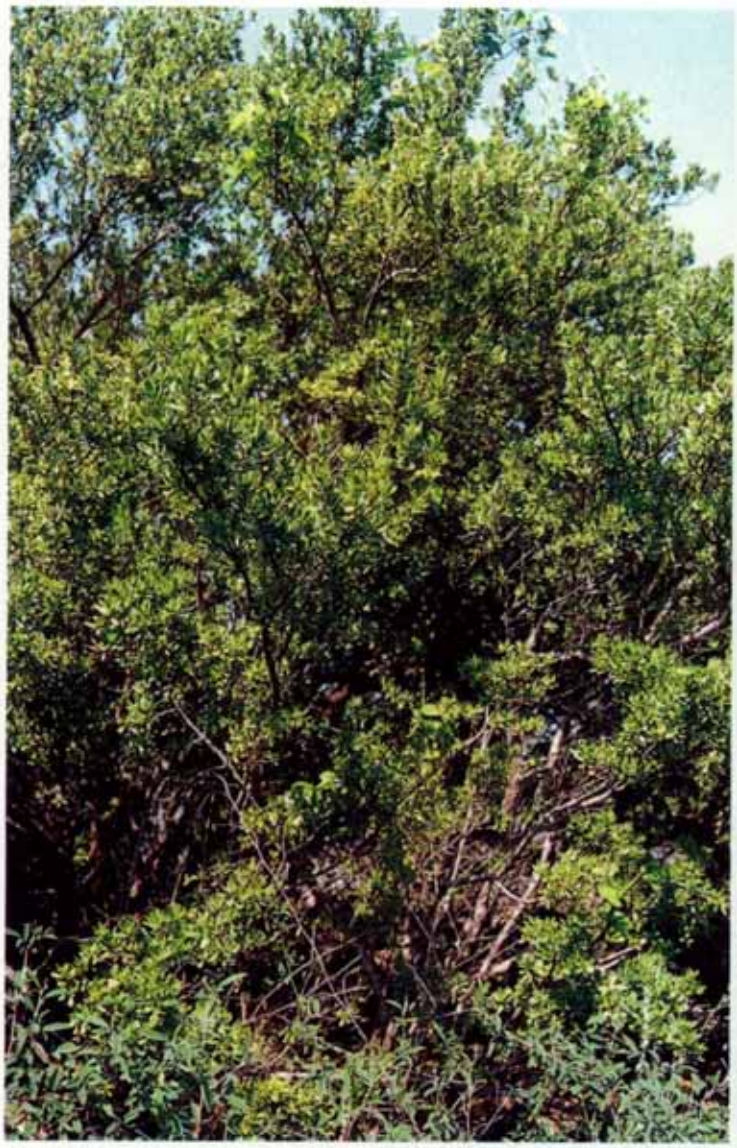
Root : No pneumatophores but small buttress can be seen.

Flower : Inflorescence, spike, 1-5 cm long and axillary. Petal 5, white in colour. Calyx 5 lobed, green. Flowering period: August to November.

Fruit : Small, vase-shaped, drupe like, becomes harder when mature but buoyant in tidal water. No vivipary or crytovivipary, normal seeds. Fruiting period: November to December.

Distribution : In Muthupet mangroves distribution of *L. racemosa* is restricted to northern part of the Thamarankottai and Palanjur Reserve Forest.

Pemphis acidula



Scientific name : *Pemphis acidula* Forster

Family : Lythraceae

Local Name : *Keeri chedi* in Gulf of Mannar

General : Shrub, upto 3 m in height. Leaves simple, opposite, 1-3 cm long, fleshy, 1.5 to 2 mm thick; leaf blade, elliptic to obovate; apex rounded to bluntly acute. Decussate in arrangement. Bark light gray to brown in colour, deeply fissured, young twigs densely hairy.

Roots : No prominent aerial roots

Flower : Inflorescence axillary, solitary, or a few flowered sessile cyme. Flowers hexamerous, distylous. Calyx, 12 lobed, greenish red in colour, persistent in fruit. 6 petals, white in colour, inserted on the mouth of the calyx cu, shortly clawed.

Fruit : Fruit enclosed in calyx, spherical capsule 4-5 mm with persistent style, densely haired, seeds normal, small in size, numerous 20-30 per fruit and flattened.

Distribution : Endemic to Gulf of Mannar; Not present in other mangrove wetlands of India

Rhizophora apiculata

Scientific name : *Rhizophora apiculata* Blume

Family : Rhizophoraceae

Local name : *Surapunnai* in Pichavaram

General : *Rhizophora apiculata* is typically found growing along the banks of tidal creeks and canals, which are flushed by daily tides and where the salinity is moderate {20 to 45ppt (parts per thousand)}. Tree, 5 to 7m. Leaves simple, normally elliptic oblong, or ovate-lanceolate, dicussate, entire, curioceaous, acute, apiculate at apex, smaller than other *Rhizophora* species. Leaf upper surface dark glossy green, lower surface yellowish green, small black dots scattered. The bark of the *Rhizophora apiculata* is distinctive, being rather dark in color and smooth in texture. Internally the bark is red or orange red in color.

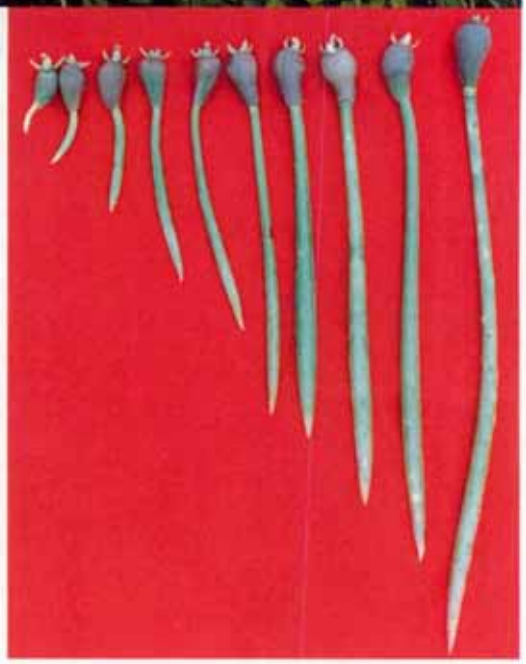
Root : *Rhizophora apiculata* and also other *Rhizophora* spp such as *Rhizophora mucronata* and *Rhizophora lamarckii* can be easily recognized by their stilt roots. These roots are arising from the main trunk, grow downward and penetrate deep in the mud and thereby provide additional support to the tree. The presence of stilt roots help *Rhizophora* spp to withstand the fury of cyclones. Stilt roots contains a large number of lenticels, function as breathing roots.

Flower : Inflorescence 2-4 flowered, axillary cyme, mature flowers below the leafy clusters. Flowers 10-12 mm long, yellow, sessile, paired, peduncles stout and short. Petals 4, delicate, white or greenish white, glabrous. Calyx 4 lobed, greenish yellow, outside reddish green, persistent in hypocotyl. Flowering season: Throughout year.

Fruit : Viviparous fruits. Hypocotyl 30 to 60 cm long (shorter than that of *R. mucronata*), 2.5 to 3 cm in diameter, smooth, cylindrical and pointed. Fruiting period: October to January.

Distribution : Reintroduced in Muthupet mangroves *R. apiculata* was reintroduced in 2000 by the Tamil Nadu Forest Department in the Sethuguda region under Biodiversity Enrichment Programme (Baruah, 2004).

Rhizophora mucronata



Scientific name : *Rhizophora mucronata* Poir.

Family : Rhizophoraceae

Local name : *Surapunnai* in Pichavaram

General : Trees, 8 to 10m in height. It is easily distinguishable from *R. apiculata,* by its leaf shape, size, flower, bark color, etc. Leaves of *Rhizophora mucronata* is broadly elliptic, oblong or ovate and much larger than that of *R. apiculata.* Similarly, leaves of *Rhizophora mucronata* are pale green in color whereas those of *Rhizophora mucronata* are dark green. Apex is blunt or with fine mucro. Bark of the *Rhizophora mucronata* is yellow-orange inside with a large bark scale on the outside. *Rhizophora mucronata* is found growing in association with *Rhizophora apiculata* along the bank of tidal creeks and canals. It is taller than *R. apiculata.*

Root : Stilt roots are similar to those of *Rhizophora mucronata* but may be curved more as they reach the muddy substratum.

Flower : Inflorescence axillary, 4-8 flowered dichotomous cyme. Flowers small, creamy white, fleshy, fragrant, 2-3 cm long peduncle, 2-3 times forked. Petals white and hairy. Calyx deeply lobed, creamy yellow or yellowish green in colour. Flowering period: Throughout the year.

Fruit : Viviparous fruits. Hypocotyl 70 to 80 cm long (longer than that of *R. apiculata*), warty (smooth in *R. apiculata*), cylindrical, pointed, green to yellowish green. Cotyledonary collar yellow when mature. Fruiting period: October to January.

Distribution : M.S.Swaminathan Research Foundation reintroduced *R. mucronata* in 1992 in *Challimunai* area, near lagoon mouth. Survives well but growth is very much restricted. Tamil Nadu Forest Department reintroduced *R. mucronata* in many places of the Muthupet region under Biodiversity Enrichment Programme (Baruah, 2004)

Rhizophora sp (natural hybrid)

Scientific name : *Rhizophora* sp (natural hybrid)

Family : Rhizophoraceae

Local name : *Surapunnai* in Pichavaram

General : A natural hybrid of *Rhizophora apiculata* and *Rhizophora mucronata* exists in Pichavaram mangroves. It is found growing along with the above two species on the banks of tidal rivers and canals. *Rhizophora* hybrid can be easily recognized even from a long distance by its relatively taller trunk, dense canopy and larger root zone than that of *R. apiculata* and *R. mucronata*. Leaves broader than that of the above two species and dark green in color. Height of *Rhizophora* sp varies from 10 to 15m. At the tip of the leaves mucro is present. Flowers are white in color and the length of the peduncle is intermediate between that of *R. apiculata* and *R. mucronata*. Stilt roots are very long and well curved at the bottom. It is normally sterile but one or two propagules can be seen.

This species has been identified as a new species called *Rhizophora annamalayana* Kathir. (Kathiresan, K., 1995. *Rhizophora annamalayana:* A new species of Mangrove. *Environment and Ecology.* Vol. 13, 240-241p).

Xylocarpus mekongensis

Scientific name : *Xylocarpus mekongensis* Pierre

Family : Meliaceae

Local name : *Somundhiri* in Pichavaram

General : Tree, 3 to 5 m tall. It is rare and grows just behind or sometime in association with *Rhizophora* sp. along the banks of the tidal canals and creeks where the salinity is low. Leaves compound with 1 or 2 pairs of leaflets, elliptic or oblong in shape, obtuse at both ends. Leaves pale to dark green. Bark reddish brown with thick flakes and buttress present. The pneumatophores are stout, stumpy and finger like.

Flower : Inflorescence upto 8 cm or longer, with a distinct main axis and regular lateral cymes. Flowers 3-4 cm across, white in short-branched, axillary thyrse. Flowering season: July to September

Fruit : The fruits are ball shaped, about the size of an orange fruit and green in colour when young becoming brown on maturity. The fruit contains 8 to 12 semi-triangular seeds. No vivipary. Fruiting period: October to November.

Distribution : Very few trees are existing in the Rhizophora zone of Pichavaram mangroves. Compared to *X. mekongensis* fruits of *X. granatum* are very large (about 25 cm in diameter). *X. granatum* has no pneumatophores but the trunk base is often enlarged, with well-developed buttresses continued outward as narrow undulating ribbon like extensions of the surface root system. Similarly, compared to *X. mekongensis*, inflorescence of *X. granatum* is spreading type and irregularly branched, without a well-developed main axis.

Salicornia brachiata

Sesuvium portulacastrum

6.0 Mangrove Associates

Scientific name : *Salicornia brachiata* Roxb.

Family : Chenopodiaceae

Local name : *Kozhikal* in Pichavaram
Pavazhappoondu in Muthupet

General : Herb, head erect or decumbent of about 20 to 45 cm high. Stems succulent and much branched. Each segment of the stem from a lette cup at the apex. The "cup" has short teeth covering the base of the next segment. The stems are seemingly leafless. *Salicornia brachiata* is a pure halophyte capable of growing in very high saline soils. It is one of the important ground flora of hyper saline sandy mud flats associated with mangrove wetlands. It has been found that *S. brachiata* can be grown as a commercial species in seawater farming as vegetable salad as well as for seeds, which yields edible oil.

Scientific name : *Sesuvium portulacastrum* (L.)

Family : Aizoaceae

Local name : *Vangaravaasi* in Pichavaram

General : Perennial vine, herbaceous plant with creeping stems, often buried in sand, stout and much branched, red in colour and glabrous. The leaves are opposite / linear or spathulate oblong, fleshy with short petiole. The flower is singular and light purple in color. It normally grows in dense masses in low saline, moist, sandy-clayey soils. The local people use *Sesuvium portulacastrum* as a pot herb.

Suaeda maritima



Suaeda monoica



Scientific Name : *Suaeda maritima* (Linn.) Dum

Family : Chenopodiaceae

Local name : *Umiri* in Pichavaram
Mottaumiri in Muthupet

General : Shrub of about 0.5 to 3cm height with numerous branches arising from the base. Stems glabrous, woody slightly whitish with green tint when young, black in color in old individuals. Leaves small, (10 to 20 mm in length) simple, linear oblong, succulent, crowded sometimes. Leaves green while young but become purple when mature. Inflorescence axillary clusters or elongated spikes. The flowers are very small in size. Ovoid seeds, 0.8 to 1 mm in diameter and shining brown in colour.

Suaeda maritima and its sister species *Suaeda monoica* are pure halophytes and dominant species in the hypersaline areas of the arid and semi-arid regions. Both the species are capable of tolerating high soil salinity ranging from 40 to 90 g/l; they are unable to grow in places where tidal flushing is regular or where low salinity condition exists for longer periods. Thus the presence of *Suaeda maritima* and *Suaeda monoica* can be taken as an indicator of hypersaline soil. Both in the Pichavaram and the Muthupet mangroves *Suaeda maritima* can be seen growing as monospecific patches in large areas in coup felled areas. In addition, it is also found growing in large numbers along with *Avicennia marina* in the places where *Avicennia marina* shows symptoms of shoot dieback due to salt stress.

Scientific Name : *Suaeda monoica* Forsk. ex J.F.Gmel.

Family : Chenopodiaceae

Local name : *Umiri* in Pichavaram
Pooumiri in Muthupet

General : *Suaeda monoica* is a pure halophyte, similar to *Suaeda maritima* in appearance, growing in hypersaline soils. Compared to *Suaeda maritima* its distribution is limited (reasons are not known). It is a shrub but much smaller in size (0.3 to 0.7). Leaves simple, succulent but compared to *S. maritima* slightly linear and longer. *Suaeda monoica* can be distinguished from *S. maritima* by the following morphological features; slender and young twigs of *S. monoica* are ribbed whereas young stems of *S. maritima* are smooth. Secondly, young stem of *S. monica* is pink in color where as that of *S. maritima* is green in color.

Azima tetracantha

Clerodendrum inerme

Scientific name : *Azima tetracantha*

Family : Salvadoraceae

Local name : *Sanguchedi*

General : Glabrous shrub, rigid, scrambling, armed with axillary spines. Leaves elliptic-obovate to lanceolate, apex acute, spine tipped. Flowers small, subsessile in axillary cluster or in short spikes. Calyx 4 lobed, unequal and toothed. Corolla cream coloured, free, oblong and glabrous. Fruit, glabose, berries, ripening fruit with white pulpy cover; single seeded.

Found in large number on the landward side of the Muthupet mangrove wetland, on sandy soil. Only a few individuals found in the Pichavaram mangroves.

Scientific name : *Clerodendrum inerme* (L.) Gaertn.

Family : Verbanaceae

Local name : *Peenchal* in Pichavaram
Peekalathi in Muthupet

General : Shrub, erect or straggling, about 2m tall. Leaves simple, opposite, leaf blade ovate-elliptic or oblong-lanceolate, glabrous, shallowly obtuse at apex. Inflorescence 3 flowered, pedunculate cyme, axillary. Flowers, tubular, 5 lobes, white in colour. Fruits egg shaped, about 2 cm long, obovoid, 4 segmented, green to brown and leathery.

Common in Pichavaram and Muthupet mangroves; found growing only on sandy soil in elevated places.

Derris trifoliata

Thespesia populneoides

Scientific name : *Derris trifoliata* Lour.

Family : Fabaceae

General : It grows as a vine in the areas where soil is sandy and less saline. Leaves alternate, compound, with 3 leaflets, ovate in the lower half and lanceolate in the upper portion; apex acute; size of the leaves varies but majority are about 10 cm in breadth. Inflorescence a spike, about 20 cm long. Flowers about 1 cm in length, white or pale pink in colour. Fruits flattened and rhomboid in shape with 2 to 3 seeds.

Common in Pichavaram and Muthupet mangroves; found associated with *Excoecaria agallocha.*

Scientific name : *Thespesia populneoides* (Roxb.) Kostel

Family : Malvaceae

Local name : Muthupet: *Poovarasu*

General : Tree, grows upto 5 m in height. Leaves simple, alternate, cordate to subcordate in shape with shallow sinus at bass, acuminate at apex with prominent yellow veins. Flowers solitary and axillary, 3-5 cm across, yellow in colour, red in centre, stout pedicel. Fruits round capsules, globose, exudes deep yellow latex when young; mature fruit dehiscing apically into two distinct layers.

Distribution : Found associated with mangroves only in Muthupet, especially in the Tamarankottai Reserve Forest, on the landward side. It is a common terrestrial plant of the coastal regions of Tamil Nadu. But it grows as a mangrove associate in Muthupet mangroves.

Tamarix troupii

Sarcolobus carinatus

Scientific name : *Tamarix troupii* Hole

Family : Tamaricaceae

Local Name : *Kattusavukkai* in Muthupet

General : Shrub, about 2 to 3 m tall. Leaves 2-3 mm long, needle like, not sheathing. Flowers small, 3-4 mm across, white or pink, bisexual, in lateral and terminal, pendulous racemose panicles. Capsules 4-5 mm across, 3-4 valved, tapering towards the apex. Seeds 8-10, silky hairy at apex.

Distribution : In Muthupet mangroves it is present in large numbers on the landward side of the Tamarankottai Reserve Forest. Absent in Pichavaram mangroves.

Scientific name : *Sarcolobus carinatus* Wall.

Family : Asclepiadaceae

General : Glabrous, twining shrubs with fleshy rhizome bearing roots. Leaves fleshy, variable in size,broadly elliptic or narrowly elliptic-oblong, entire coraiaceous, acute or abutse at apex, rounded at base. Flowers, small 2 to 3 mm across, yellowish-white, in axillary pedunculate cymes; corolla glabrous within. Follicles ellipsoid in shape, keeled along the dorsal suture. Seeds flattened, shortly winged.

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