

MANGROVES OF GUJARAT

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INTRODUCTION

The term 'mangrove' is derived from the word 'mangal' and Portuguese word for mangrove is 'mangue'. According to Chapman (1976) 'Mangal' — means the forest formation and Mangrove - indicates intertidal plants. But in Portuguese and French the term 'Mangal', 'Mangue', 'Paletuvier' and 'Manglier' used for forest community and the individual plant species. The term Mangrove forest is nothing but the synonym of the tidal forest (Mephram & Mephram, 1984).

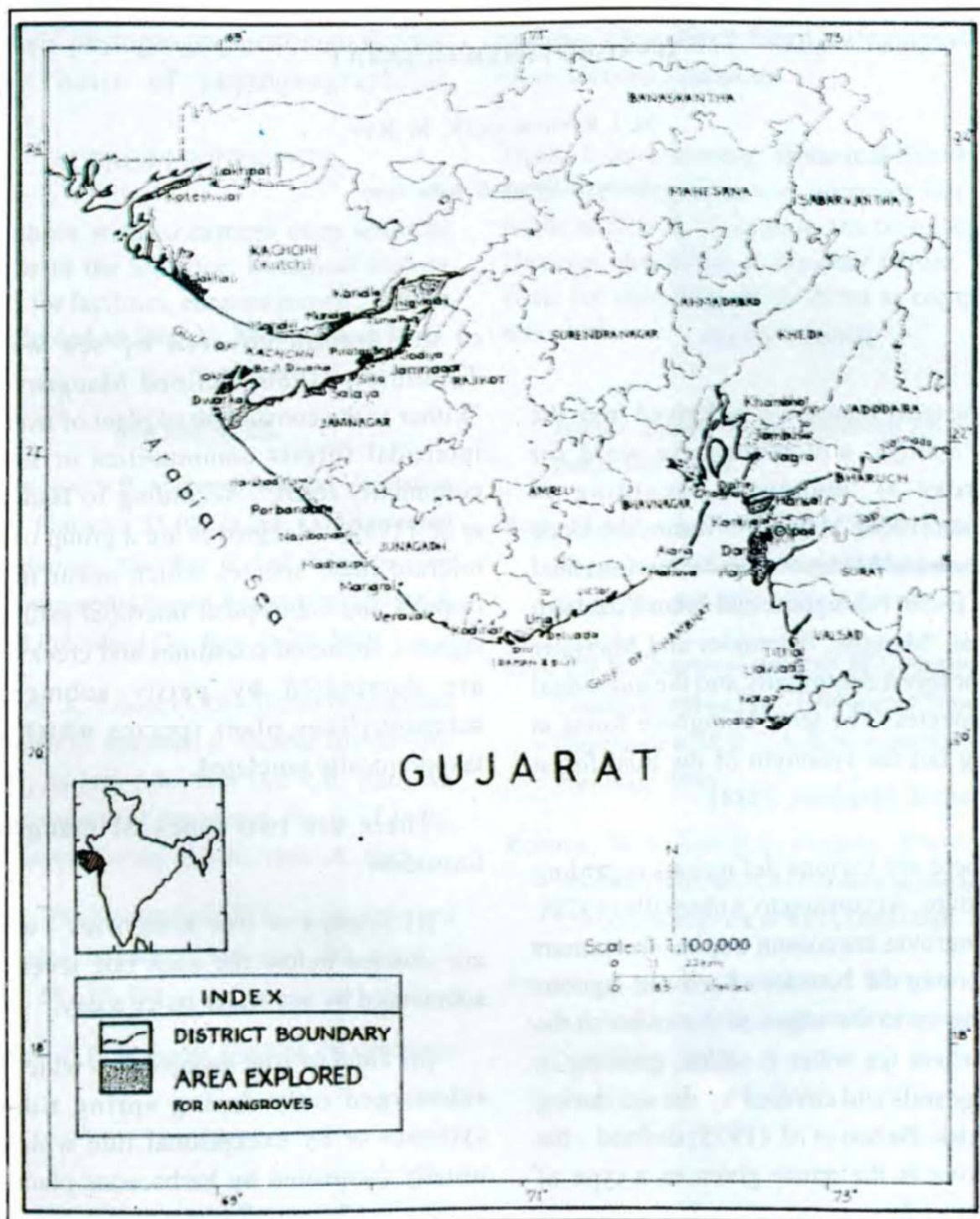
There are various definitions regarding mangroves. According to Aubreville (1970), the mangroves are coastal tropical formations found along the boarder of sea and lagoons reaching up to the edges of the rivers to the point where the water is saline, growing in swampy soils and covered by the sea during high tides. Balsco *et al.* (1975) defined - the mangrove is the name given to a type of coastal woody vegetation that fringes muddy saline shores and estuaries in tropical and subtropical regions and at a high tide much

of the ground covered by sea water. Tomlinson (1986) defined Mangroves "Either to the constituent of plant of tropical intertidal forests communities or to the community itself." According to Banerjee *et al.* (1989). Mangroves are a group of salt tolerant plant species which occur in the tropical and subtropical intertidal estuarine regions, sheltered coastlines and creeks and are dominated by partly submerged sclerophyllous plant species which are taxonomically unrelated.

There are two types of mangrove formation :

(i) *Swampy or true mangroves* which are situated below the high tide level and submerged by sea water twice a day.

(ii) *Tidal or true mangroves* - which are submerged only during spring tide or cyclones or by exceptional tide which is usually dominated by herbaceous plants of the family Chenopodiaceae (eg. *SUAEDA* spp.) and Aizoaceae (eg. *Sesuvium portulacastrum*).



Though Puri (1960) has considered Beach forests of *CASUARINA* sp., *THESPESIA* sp. etc. as a subdivision of the Mangrove forests of India, the mangroves may be differentiated from them as there is no tidal flow like that of pure mangrove formations.

Floristic studies in Gujarat is done by a number of workers. To mention a few, Cooke (1901-08) has recorded *ca* 450 species in his "Flora of Presidency of Bombay." Shah (1978) has described 1800 species in his "Flora of Gujarat State". Raghavan *et al.* (1981) have enumerated 1964 species. Other noteworthy books are Forest Flora of Gujarat State (Patel R. I., 1971), Checklist of Saurashtra (Santapau and Janardhanan, 1966), Plants of Kutch & their utility (Thaker, J. I., 1926) etc. Coastal vegetation of Kutch in particular is known through the works of Blatter (1908-09), Jain *et al.* (1960 a., b., 1968) etc., while Saurashtra coast from ecological point of view is studied by Rao *et al.* (1963, 1964, 1966, 1967, 1971, 1974). Accounts of Gujarat coast (south of river Narmada) is known through the works of Toor (1958), Rao (1965) etc. Kulkarni (1959) and Blasco (1975) have given data on ecological characters and utilisation of mangrove forests in Saurashtra and Kutch. The Mangroves of Gujarat coast in particular have been studied by different workers *viz.* Waheed Khan (1959), Qureshi (1959), Anonymous (1978, 1992), Untawale (1986), Untawale & Wafer (1988), Nayak *et al.* (1989), Banerjee *et al.* (1989), Bahuguna

et al. (1990), Kothari (1991, 1995), Kothari & Rao (1991, 1994 a, b ; 1995), Kothari & Singh (1995, 1998), Nayak *et al.* (1996), Naskar & Mandal (1999). However, a detailed information on Mangroves of Gujarat is not available. Therefore, Botanical Survey of India, Western Circle, Pune has taken up the project and an attempt is made here by the present authors to fulfil the gap.

In India, *ca* 59 species under 41 genera and 29 families comprise the major and significant part of Indian mangrove flora. Of these, 34 species of mangroves are present along the east coast and 25 species along the west coast of India (Banerjee *et al.* 1989).

However, Tomlinson (1986) has critically analysed and stated that these mangroves of the cosmopolitan basis are basically two types, *i.e.* (a) 'the major elements of mangals' and (b) 'the minor elements of mangals', (c) the third category is 'mangal associates' or 'mangrove associates', including the coastal species, like 'back mangal', salt marsh flora. 'wet coastal communities', beach or coastal communities, 'low land swamps', coastal swamps' and swamp forests'.

Tomlinson (1986) has characterised these 'major elements of mangal' or the 'true mangroves' as follows :

(i) These have complete fidelity to the mangrove environment ; *i.e.*, only grow in the mangal and do not exit in the terrestrial communities.

(ii) These form the pure strands in the mangal community and play major role.

(iii) Their morphological specialization are fitted with the environment or habitat, where they grow ; viz. aerial roots for gas exchange and viviparous germination.

(iv) They have the salt tolerance and salt exclusion mechanisms and able to grow in the sea water inundated zones ; and

(v) Taxonomic isolation from the terrestrial at their generic level or often in the family of sub-family level.

Regarding the 'minor elements of mangals or mangroves' he has also mentioned that.

(i) These species do not grow as conspicuous element of the vegetation.

(ii) They may occupy the peripheral habitats and very occasionally form pure strand, e.g. *Excoecaria agallocha* and *Aegiceras corniculatum*.

Based on recent literature and publication, ca 19 core mangroves species have been recorded on the western coast of India including Gujarat (Naskar & Mandal, 1999), out of which ca 11 species have been reported from W.Coast of India (Chawan 1985 ; Kothari & Rao, 1991). Recently Kothari & Singh, (1998) recorded ca 17

species from N.W. Coast. While Singh, H. S. (1999) could record only eight species in Gujarat as *Rhizophora apiculata*, *Bruguiera gymnorrhiza* and *B. cylindrica* were not encountered in his two year study.

However, at present there are about 18 species of mangroves could be recorded from Gujarat viz. *Acrostichum aureum**, *Aegiceras corniculatum**, *Avicennia alba*, *A. marina* var. *acutissima*, *A. marina* var. *marina*, *A. officianalis*, *Bruguiera cylindrica*, *B. gymnorrhiza*, *B. parviflora*, *Ceriops decandra*, *C. tagal*, *Excoecaria agallocha**, *Rhizophora apiculata*, *R. mucronata*, *Sonneratia alba*, *S. apetala*, *S. caseolaris*, *Xylocarpus granatum**. Out of which, 4 species marked with asterix * are semi or minor mangroves (Tansley & Fristch, 1905 ; Tomlinson, 1986).

Mangrove Associates or non mangrove halophytes of salt pans are species which are not strictly mangroves but are usually associated with mangroves and grow along the banks of creeks and salt marshes are ca 60 in the world. Out of which ca 33 species are recorded. *Acanthus ilicifolius*, *Aeluropus lagopoides*, *Canavalia maritima*, *Cenchrus biflorus*, *C. ciliaris*, *C. setigerus*, *Clerodendrum inerme*, *Cynometra ramiflora*, *Cyperus bulbosus*, *C. rotundus*, *Derris trifoliata*, *Fimbristylis spp.*, *Halopyrum mucronatum*, *Heliotropium curassavicum*, *Hydrophylax maritima*, *Juncus maritimus*, *Myriostachya wightiana*, *Peplidium*

maritimum, *Porteresia coarctata*, *Salicornia brachiata*, *Salvadora persica*, *Salsola baryosma*, *Scirpus littoralis*, *Sesuvium portulacastrum*, *Sporobolus marginatus*, *S. virginatus*, *Suaeda fruticosa*, *S. nudiflora*, *S. maritima*, *S. monoica*, *Tamarix troupii*, *Urochondra setulosa*, *Viscum orientale* etc.

Other plants collected in coastal regions of Gujarat are *ca* 102 species spread over among 36 families represented in tabular form. Over and above *ca* 10 species of marine algae and a lichen (*Rocella belangeriana*) closely associated with a mangrove were also collected. Results of the observations are supported by 10 coloured photographic plates (A—J), 9 line drawings and 5 tables.

MATERIALS AND METHODS

Two plant exploration tours to Gujarat were undertaken in months of May and September 1990 for study and survey of Mangroves of Gujarat. Collection of Mangroves usually depends upon tidal time of sea water. Particularly to approach the areas like Pirotan Island (near Jamnagar) in the gulf of Kutch, authors had to go there during odd hours (*i.e.* at 1.00 a.m.) of the day in a motor boat. To avoid leaf abscission, succulent plants were poisoned on the same day. Habit, habitat, colour of the flower, vernacular names, associated plants etc. were noted. Necessary close up and habitat photographs of mangroves and associated plants were also taken. Plants collected were processed in customary way, identified and

deposited in the herbarium, Botanical Survey of India, Western Circle, Pune.

For the sake of convenience, the text of Mangroves of Gujarat is presented under nine chapters/headings *viz.* Introduction, Materials and methods Topography & physiognomy, Vegetation pattern of Gujarat coast. Factors affecting the vegetation, Regeneration, utilisation of Mangroves, Conclusion & conservation, Enumeration of plants and Bibliography for references cited & photographic evidences in the form of ten plates A-J and a map of Gujarat showing its location, district boundaries and areas explored for the Mangroves. Some line drawings are presented along with the text.

Enumeration of plants includes key to families, genera and species for the Mangroves ; for a species, correct name with citation, basionym, synonym, vernacular name, description, flowering & fruiting time, localities in Gujarat, notes regarding habitat, abundance, associated plants and uses if any also provided. A comprehensive list of other plants (*ca* 102) collected along the coastal region of Gujarat is also appended in tabular form mentioning its families, habit with ecological notes for a ready reference.

TOPOGRAPHY AND PHYSIOGNOMY

Gujarat State is situated on the west coast of India between 20° to 25° north latitude and 68° to 75° east longitude. It is surrounded by Arabian sea on the west, Rajasthan on the

north-east, Madhya Pradesh on the east, Maharashtra on the south east and south, Pakistan on the north western fringe.

Topographically, hills of Sahyadri are located to the extreme south-east. Further north, the Satpura range separates the State from Khandesh tract of Maharashtra. In the north, the plains are broken by irregularly shaped hills which form a part of Satpura and Vindhya hills. Between these irregularly shaped hills are the alluvial valleys built up by Tapi, Narmada, Mahi, Sabarmati and Saraswati rivers draining in to Arabian sea.

There are famous hills of Gir, Girnar, Barda and Shetrunjaya. Kutch is undulating rocky area with many small hills and with the Rann of Kutch lying on the northern and consisting of expanded tidal mud flats.

Geomorphologically, the State can be divided into three divisions *i.e.* 1) Gujarat main land is a rich alluvial terrain, rises from the estuarine tracts between Narmada and Tapi rivers and extends about 400 kms. Northwards merging into the desert of Rajasthan and Rann of Kutch.

The eastern border is bounded by Aravalli, Vindhya, Satpura and Sahyadri hills. The Gulf of Kutch and the Rann of Kutch were perhaps once connected and Nal sarovar near Ahmedabad is probably a part of the sea (R. I. Patel, 1971). Now also Gulf of Cambay meets Bhogav river at Nal sarovar

(Ahmedabad). Though local people say Mangroves do not grow there, but as per our field observations at Goa, Mangroves grow profusely in swampy areas where sea and river water mixes. It is suggested that Mangroves can be introduced at Nal sarovar area where tidal flow of sea water mixes with river water.

2) Saurashtra peninsula, the central part forms an elevated tableland. Total Saurashtra coast line has 512 kms, coastline facing Arabian sea from Okha to Diu Island exhibits sandy beaches, often intercepted by exposed rocky shores directly facing sea. Coastline within the Gulf of Cambay and Kutch bordered by distinct muddy flats, always under tidal effect often giving rise to Mangroves and saline flats. Coastal areas of Saurashtra may be sandy, rocky or muddy.

3) Kutch peninsula is isolated Great Rann on the north and the Little Rann on the south-east. The Rann is a dry bed of the remnant of an arm of the sea which once connected the Narmada rift with Sindh and separated Kutch from the main land.

However, according to Anonymous (1992) Gujarat coast may be divided into 5 regions *viz.* 1) Rann of Kachchh, 2) The Gulf of Kachchh, 3) The Gulf of Cambay, 4) Saurashtra coast and 5) S. Gujarat coast. Out of which two Gulfs constitute the major mangroves zones of Gujarat coast, with some more details as under.

1. *Rann of Kachchh* : It is divided into 2 regions i.e. *Great Rann*, covers ca 10,500 km² & *Little Rann*. covers ca 3000 km². These Indus delta inundate with the upstream fresh water flow, alongwith tidal ingress from several minor creeks, waterways, canals etc. The 'Kori creek' inundate minor areas where few sparsely mangroves grow in patches within the height of 2 m. e.g. *Avicennia marina*, *A. officinalis*, *Rhizophora mucronata* etc. (Anonymous, 1992).

2. *Gulf of Kachchh* : The Gulf of Kachchh lies between latitudes 29° 15' N to 23° 40' N and longitudes 60° 20' E to 70° 40' E. Kulkarni (1957) has reported ca 2,483 h. and 12,800 h. mangrove zones in the Northern coastal and southern coastal zones respectively. This extensive Gulf of Kutchchh contains both mud flats and cliffed ca 42 rocky islands with coral reefs and scattered mangroves, scrub forests, algal beds and permanent water zone. Hence the Govt. of India has accepted as a part of conservation strategy to protect such important marine habitat & declared an area of 457.92 sq. km as marine sanctuary from Okha to Jodia. To enhance the protection of some area, 162.89 sq.km. has been notified as Marine National Park in 1982. Ecologically this park is very important with its unique coral reefs, mangroves and other interesting flora & fauna. This is supposed to be first Marine National Park in India (Nayak *et al.* 1989; Singh, H. S. 1994, 2000; Naskar & Mandal, 1999).

3. *Gulf of Khambhat* (Cambay) (Between latitudes 20° 30' N and 21° 30' N and longitude 70° E & 73° E) characterised by the estuary like Sabarmati Mahi, Narmada, Kim, Dhadhar & Tapti; extensive mud flats, dunes and scattered sandy beaches, turned this gulf very much diverse ecotype. Moreover high tidal ranges are also much remarkable features here. For the diverse nature and number of estuaries these zones are also known as estuarine delta (Nayak & Sahani 1984, 1985).

4. *South Gujarat Coast* : Comparatively this coast land is uniform but broken by several small tidal creeks and few minor estuaries like Mindhola, Purna, Aurang, Daman Ganga etc.

Soil : Soils in southern districts of west Valsad, Surat and Bharuch are deep black. Along the coast, there is some alluvium, while in some parts soil is saline. In the east, Valsad & Dangs the soil varies from red, grey to nearly black. In the northern district, soil is poor, shallow derived from granites.

In the Saurashtra and Kutch, the soils are formed from sheets of Deccan Lava. Kutch has a good deal of alluvium. Along the coast-line, saline alluvium is found.

Regarding physiochemical properties of the soils of Gujarat, there are very few reports. Rao *et al.* (1966) has published some interesting results on Peram Islands. Saurashtra soils are sandy loamy to silty loam

with moderately alkaline reaction over 7.8-8.6 pH. Organic matter is higher and ranges from 1.41 to 2.59 p.c. NaCl is 1-3.84 p.c. & total dissolved solids are 1.72-3.98 p.c. showing the intense residual effect of sea water on soils. CaCO_3 varies from 7 to 21 p.c.

and exceptionally higher contrast of 82 p.c. with *Urochondra setulosa* and 53 p.c. with *Avicennia marina* var. *acutissima* are typically indicating the calcareous nature of plants (Rao & Shanware, 1967 ; Blasco, 1975).

Table I : Showing soil analysis of Mangrove areas of Gujarat Coast.

S. No.	Soil samples collected	pH water	Mechanical analysis and exchangeable cations meg/100 gm.			
			Salinity	Organic matters	Sulphur (S)	Potassium (K)
1.	Hajira	7.1	7.80	0.42	4	11.20
2.	Victor Fort	7.2	10.00	0.84	9	11.20
3.	Jodia bandar	7.3	4.30	0.24	9	14.20
4.	Pirotan Island	7.0	10.00	0.45	4	11.20
5.	Navlakhi coast	7.1	9.50	0.52	9	11.20
Mean Value		7.1	8.3	0.52	7	11.20

To confirm the present ecological data, soil samples *ca* 1kg per sample from different mangrove areas of Gujarat coast were collected and analysed at soil testing section, Agriculture College, Pune as shown in the Table I. Mean value of chemical parameters for mechanical analysis and exchangeable cations mg/100 gms in soil of mangrove areas of Gujarat comprises pH in water -7.1, salinity-8.3, organic matter-0.52, Sulphur -7 and Potassium-11.20. This analysis confirms that mangroves require soil with more salinity, necessary organic matters, sulphur and

potassium elements for their growth and development.

India has *ca* 5,700 km long coast line which can be divided into west coast, east coast and island chains. Among them, Mangrove area of India is about 6,740 sq.km, which is about 7% Mangrove area of the world (Gupta & Sastry, 1991). The present satellite based estimate of mangroves is 4460 sq.km which indicates loss of about 2,280 sq.km (Nayak *et al.* 1996). In the areawise ranking, Indonesia ranks first followed by Australia, Malaysia, Bangladesh and India.

Gujarat state has notified a total area of 1,324 sq.km in Kutch, Jamnagar and Rajkot district. Sidhu (1963), Blasco (1975, 1977), Untawale (1980, 1985). Govt. of India publication (1987) and Untawale & Jagtap (1991) have reported the mangrove areas in the Gujarat coast as 526 km², 200 km², 400 km², 260 km², 370 km² respectively. But through satellite imagery (Anonymous, 1992), the mangrove cover area in Gujarat coast has estimated about 1051.5 km²; out of which the 'dense mangrove' cover area is estimated about 892.7 km². Naked mud areas or coastal lands with sparse mangroves have also included. Hence actual mangrove regions may be 158.8 km² (Anonymous, 1992). The Forest Survey of India (FSI), Dehra Dun in 1997 and 1999 estimates a mangrove cover about 991 and 1,031 sq. km respectively in Gujarat based on Remote Sensing Technology. The Gujarat Ecological Education & Research (GEER) Foundation Gandhinagar made an independent study in 1999 using IRS LISS-III data of 1998 and interpreted forest cover on a scale of 1 : 50,000. This provided accurate estimate of 938.4 sq. km (874.4 sq.km in the Gulf of Kutch.) mangrove cover. Western mangroves in Abdasa and Lakhpat taluka, known as 'deltaic mangroves' are the largest tidal forests in Gujarat (Singh H.S., 2000).

Climate and Rainfall : Three distinct sea-

sons viz., winter, summer and monsoon are visible. Winters are severe and summers are oppressively hot in the northern border of Gujarat except in coastal tract. Average rainfall in south Gujarat is generally more than other parts of the State, the lowest in Kutch. The monsoon months are June to September in the State.

It is estimated that the mangroves cover an area of about 7,000 sq. km (7000,000 hectares) in the Indian territory (Sidhu, 1963). Out of 6,81,976 hectares of India, Mangroves of Saurashtra and Kutch cover a vast area of ca 52,616 hectares. Physiognomically they are open scrubby mangroves (Waheedkhan, 1959, p. 97). As they are developed under extremely arid climate, their bioclimates are hot with a rather cold season, subdesertic with a very strong average annual temperature *i.e.* ca 12° C. As the gulf of Kutch falling beyond 23° N, an absolute minimum temperature is observed 16° C. The duration of dryseason exceeds 7 months all over the coastal regions. In Jamnagar average rainfall is ca 470 mm. The gulf of Cambay is comparatively less arid. The gulf of Kutch has the largest ligneous halophytic formations of the region. Inland, the commonest spontaneous vegetation is thicker and generally low and is discontinuous with floral dominance of thorny shrubs with species of *Acacia*, *Prosopis*, *Ziziphus* etc.

VEGETATION PATTERN OF GUJARAT COAST

Champion & Seth (1968) classified coastal vegetation of India into group 4 *i.e.* Littoral and Tidal swamp forests. This is further divided into two sub divisions *viz.* 4A. Littoral forests *i.e.* strand vegetation, 4B. Tidal swamp forests *i.e.* Estuarine vegetation (Rao & Sastry, 1972). According to Rao & Sastry (1974), Estuarine vegetation categorised under two soil vegetation types *i.e.* estuarine and pro-estuarine.

I. Type 4B/EE Estuarine : Here the indicator plants grow on muddy habitat which is under constant influence of tides and fresh water, *e.g.* *Urochondra setulosa* (Trin.) Hubb.

The plant is known from Kutch and Saurashtra coast. During recent visit, it was collected from Victor port in Saurashtra (Pl. I. fig. 4.).

II. Type 4B/PE pro-estuarine : This composite type is further divided into 3 sub - types based on the nature of the relief and tidal influence as follows :

i) Subtype 4B/PE/TM : Tidal mangrove: This includes abundantly growing shrubs and tree species of the mangroves *e.g.* *Avicennia* ssp. , *Rhizophora* ssp. etc.

ii) Subtype 4B/PE/P : prohyline : Here

mixing of salt water from sea, fresh water from rivers resulting in salt tolerant fresh water plants *e.g.* *Salvadora persica* L., *Tamarix troupii* Hole (cf. Pl. H. fig.1).

iii) Subtype PE/E : Euhyline : Here the highly salt tolerant plants grow under conditions of apparent wetness or dryness *e.g.* *Atriplex stocksii*, *SUAEDA* spp. Rao (1971) in his distributional resume of maritime strand flora of India has recorded plants from Kutch coast are *Astragalus prolixus*, *Spinifex littoreus*, *Scaevola taccada*, *Peganum harmala*, *Tamarix articulata* etc. Shah (1978) classified Gujarat vegetation along the sea shores and saline ground into two *viz.* i) under the influence of tides ii) permanently saline soil as in some parts of South Gujarat.

Banerjee *et al.* (1989 p. 11) have also mentioned Gujarat mangroves on salt marshes, along tidal creeks and muddy banks. About 260 sq. km of area is covered under mangrove vegetation which presents an open mangrove scrubs (Waheedkhan, 1959).

The major mangroves & its associates from the Gujarat coast reported in the Government of India publication "The Status of Mangroves in India (1987) are *Rhizophora mucronata*, *R. apiculata*, *Ceriops decandra*, *C. tagal*, *Avicennia marina* var. *acutissima*, *Salvadora persica*, *Suaeda maritima*, *Salicornia brachiata*, *Atriplex stocksii*, *Urochondra setulosa* etc.

In the muddy banks and salt marshes, particularly Rann of Kachchh the herbaceous flora viz. *Suaeda fruticosa*, *Aeluropus lagopoides*, *Cenchrus setigerus*, *C. ciliaris*, *Sporobolus marginatus*, *Cyperus rotundus*, *Salsola baryosma*, *Haloxylon salicornicum* were reported by Blasco (1977). The xerophytic flora viz. *Acacia nilotica*, *Salvadora persica*, *Prosopis chilensis*, *Tamarix dioica* were also reported from the high tidal marshes. Besides these, scattered vegetated zones were also identified by Gupta & Naik (1987).

In Gulf of Cambay, the mangrove species like *Avicennia marina* is stunted and sparsely distributed along the coast near the river Mahi, Dhadh, Narmada, Kim & Sena. Dense mangrove associated species are also reported as intertidal flats flora like *Aeluropus lagopoides*, *Salicornia brachiata*, *SUAEDA* species etc. The high tidal flats are dominated by the xerophytic scrubs e.g. species of *ACACIA*, *PROSOPIS*, *ZIZIPHUS* etc. Similarly, mud flats and marsh vegetation are present in S. Gujarat coast. The sandy beach flora are scarce. Mangrove species like *Avicennia officinalis* is in patches on the mouth of Kolak estuaries and small creeks at Umbergaon and the south of Kolak river. A luxuriant growth of *Rhizophora* sp. is also present (Anonymous, 1992).

Besides these estuarine mouths, these coastal areas may be categorised as coastal

dunes, terrace, ox-bow lake, Paleo-mud flats, reclaimed mud flats, relict, alluvium paleocanal, Paleo-meanders and cliffs etc. (Anonymous, 1992).

There are 'Inland Mangroves' at "Shravan Kavadia" located at the distance of 42 km from Bhuj, in N.E on the fringe of Banni grassland is a place of religious importance. In this grove, a small Mangrove patch covering an area less than a hectare (ca 0.7 ha.) where about 64 trees of *Avicennia* were growing in 1994 (Solanki, 1997). Its survival in arid environment is nature's wonder and a matter of scientific investigation (Singh, 2001).

I. Tidal swamp Forests : Based on the literature and present survey during 1989-90, mangroves of Gujarat can be placed under 'tidal swamp forests as observed mainly along the tidal creeks' found along the Arabian sea near Umbergaon—a southernmost end of Valsad, Udwada, Olpad, Hajira (Surat), Jambusar, Dahej, Hansot, Kantiyajal, Aliabeyt (Bharuch), Ghogha, Bhavnagar, Victor port, Jaffrabad, Pirotan islands, Jodiya bandar (Jamnagar) and coastline bordering Gulf of Cambay and Kutch (Jakhau, Mundra, Lakhpat etc.) ; salt marshes which are characterised by its zonations i.e. mangroves from a distinct belt followed by sandy flat areas and salt pans-such areas were observed at Paniadra in Vaghra taluka (Bharuch dist.). Khijadia (Jambudi creek), Sikka (Jamnagar) etc. and occasionally the mangroves also

occur on muddy banks of rivers e.g. "Vanki nadi near Tithal coast (Valsad)". The mangrove vegetation is chiefly dominated by *Avicennia marina* and *A. officinalis*. Blasco (1975, p. 135) has also noted that the only arborescent species in Saurashtra coast where the mangrove cover theoretically 97 sq. miles is *Avicennia marina* var. *acutissima*. Other members in the mangrove community are *Acanthus ilicifolius*, *Aegiceras corniculatum*, *Bruguiera cylindrica*, *B. gymnorrhiza*, *Ceriops tagal*, *Rhizophora apiculata*, *R. mucronata* and *Sonneratia apetala*. Areas rich with various mangroves are limited as observed in Pirotan islands near Jamnagar and Umbergaon creek in Valsad district. Tree species of *Avicennia* i.e. *Avicennia alba*, *A. marina* var. *acutissima*, *A. officinalis* were noted and collected near sea coast bordering Gulf of Kutch particularly at Jakhau, Mundra, Pirotan island and also Umbergaon creeks in Arabian sea. The stem parasite, *Cassytha filiformis* growing on *Avicennia marina* and symbiotic epiphytic fruticose lichen *Rocella belangeriana* (Pl. I, fig. 1) on branches of *Ceriops tagal* were also noted and collected. *Avicennia marina* is predominant species throughout Gujarat coast. Since Gujarat has a limited mangrove areas as compared to the other rich mangrove areas of India like Sunderbans (Bengal), physiognomically particularly the Saurashtra mangrove were considered as the most degraded one (Blasco, 1975).

II. Littoral forests or strand vegetation :

The coastal areas of Saurashtra particularly from Okhamandal to Diu and Diu to Gopnath is sandy. Often it is intercepted by rocky cliffs e.g. (Okha, Dwarka, Mahuva, Gogha, Mangrol, Veraval, Somnath etc.). Similarly, the coastline south of Narmada up to Daman is marshy but intercepted by sandy shores e.g. (Danti Hajira, Tithal, Ubhrat etc.) These littoral or beach forests constitute strand vegetation. Though in beach forests there is no tidal flow like that of pure mangrove formations, Puri (1960) has considered these beach forests as subdivision of mangrove forests in India. Hence a short account of beach forests of Gujarat is also appended here.

Tree species as observed are *Acacia nilotica*, *Adansonia digitata* (Pl. J. fig. 3), *Borassus flabellifer* (Pl. J. fig. 6), *Casuarina equisetifolia*, *Cocos nucifera*, *Delonix elata*, *Melia azadiracta*, *Phoenix sylvestris*, *Prosopis chilensis*, *P. juliflora*, *Salvadora oleoides*, *Thespesia populnea*, *Ziziphus mauritiana*. The doum palm *Hyphaene dichotoma* (Wight) Furtado, an endemic species on west coast of India was found frequently on coastal sands at Daman, Diu, Kodinar, Veraval and also as an avenue tree on road sides from Una to Delwada in Gujarat coast (Pl. J. fig. 7.). It is a psamophyte which regenerates very well on the coastal sands (Rao, 1964). A little interior, the soil is less sandy but saline where number of herbaceous plants occur e.g. *Capparis decidua*, *Cenchrus biflorus*, *Clerodendrum inerme*, *Cressa*

PLATE - A (Figs. 1-5)



Fig.1: A fruiting twig of *Avicennia marina* (Forssk.) Vierh.; note associated marine algae-*Sargassum* sp : Jodia bandar, Jamnagar.



Fig. 2 : Habit photograph of *Avicennia marina* (Forssk.) Vierh. var. *acutissima* Stapf & Mold. ex Mold ; note pneumatophores, acuminate leaves and fruits ; Pirotan island, Jamnagar.



Fig. 3 : A close up of *Avicennia marina* (Forssk.) Vierh. with a flower and fruits ; note texture on, adaxial & abaxial surface of leaflets ; Victor port near Jafrabad.



Fig. 4 : A community of *Avicennia marina* (Forssk.) Vierh. background *Cocos nucifera* L. ; Udvada (Valsad).

Fig. 5 : A pure community of *Avicennia marina* (Forssk.) Vierh. ; Victor port near Jafrabad.

PLATE - B (Figs. 1-5)



Figs. 1,2,4 & 5 : *Avicennia marina* (Forssk.) Vierh. var. *acutissima* Stapf & Mold. ex Mold. ; note a gigantic tree in fig. 1 & pure colony in fig. 4, close up of flowering branch in fig.2 and fruiting branch of seedling in fig. 5 ; Pirotan island (Jamnagar) & Umbergaon creek (Valsad).

Fig. 3 : Close up of a flowering branch of *Avicennia marina* (Forssk.) Vierh. ; Mamalia beyt, Navlakhi.

PLATE - C (Figs. 1-6)



Figs. 1 - 4 : *Avicennia officinalis* L. ; note flowering and fruiting branch in Fig. 1 & 3 ; pure colony of mature plants in fig. 2 and a young plant in fig. 4 ; Jakhau (Kutch) and Udwada (Valsad).

Figs. 5 & 6 : *Avicennia alba* Bl. ; close up of a mature and young branch in fruiting ; Jambusar (Bharuch).

PLATE - D (Figs. 1-6)



Fig. 1 : A flowering twig of *Sonneratia apetala* Buch. -Ham. ; Umbergaon creek (Valsad).

Fig. 2 : *Acanthus ilicifolius* L. in terminal flowers; Umbergaon creek (Valsad).

Figs. 3,4 & 6. : *Ceriops tagal* (Perr.) C.E. Robin, in viviparous fruits, habit photograph and in flowers respectively; Pirotan island (Jamnagar).

Fig. 5 : *Aegiceras corniculatum* (L.) Blanco with falcate hypocotyles. Pirotan island (Jamnagar).

PLATE - E (Figs. 1-4)



Fig. 1 : A general view of mangrove vegetation with predominance of *Avicennia marina* (Forssk.) Vierh. var. *acutissima* Stapf & Mold. ex Mold. and occasional *Ceriops tagal* (Perr.) C.E. Robin; Umbergaon creek (Valsad).



Fig. 2. : *Rhizophora mucronata* Lam. with white flowers and a viviparous fruit ; Pirotan island (Jamnagar).



Figs. 3 & 4 : *Bruguiera cylindrica* (L.) Bl. with habit and flowering twig; Umbergaon creek (Valsad).

PLATE - F (Figs. 1-5)



Fig. 1. : *Rhizophora apiculata* Bl. - fruiting twig ; Pirotan island (Jamnagar).

Fig. 2. : *Rhizophora mucronata* Lam. - in fruits; note viviparous germination of fruits; Pirotan island (Jamnagar).

Fig. 3-5. : Artificial germination of mangrove fruits in pots; note *Avicennia marina* (Forssk.) Vierh. - with 2, 4 & 6 leaflets in fig. 4 ; *Ceriops tagal* (Perr.) C. Robin with 2 leaflets in fig. 5; B.S.I. Nursery, Pune.

PLATE - G (Figs. 1-4)



Fig. 1. : A community of *Avicennia marina* (Forssk.) Vierh. affected by chemicals ; Marine National Park, Dwaraka.



Fig. 2. : Camel browsing in *Avicennia* forests ; Gogva near Sikka (Jamnagar).



Fig. 3. : Over-exploitation of leaves and fruits of *Avicennia marina* (Forssk.) Vierh. by human beings ; Jambusar (Bharuch).



Fig. 4. : Over-exploitation of wood of *Avicennia* species ; Salaya port (Jamnagar).

PLATE - H (Figs. 1-2)



Fig. 1. : *Tamarix troupis* Hole along with *Salvadora persica* L. and *Avicennia marina* (Forssk.) Vierh. on left side ; Mamalia beyt, Navalakhi.



Fig. 2. : A pure community of *Aeluropus lagopoides* (L.) Trin. ; background *Avicennia marina* (Forssk.) Vierh. ; Jambusar creek (Bharuch).

PLATE - H (Figs. 3-7)



Fig. 3. : Young plants of *Arthrocnemum indicum* (Willd.) Moq. with jointed fleshy stems ; Victor port (Saurashtra).



Fig. 4. : *Suaeda fruticosa* (L.) Forssk. ex Gmel. with terminal flowers; Ghogha sea coast (Bhavnagar).



Fig. 7. : A pure community of *Cressa critica* L. on sandy coast on way to Porbandar.



Fig. 5. : *Suaeda nudiflora* (Willd.) Moq. A close up of a flowering branch; Victor port (Saurashtra).



Fig. 6. : *Halopyrum mucronatum* (L.) Stapf in swampy habitat; Ghogha sea coast (Bhavnagar).

PLATE - I (Figs. 1-4)



Fig. 1. : *Ceriops tagal* (Perr.) C.E. Robin with symbiotic, epiphytic lichen (*Rocella belangeriana*) on a stem branch; Pirotan island (Jamnagar).



Fig. 2. : *Halophila ovalis* (R. Br.) Hook. f. - a rare grass in carpellary flowers; Triveni creek, Somnath.



Fig. 3. : *Portresia coarctata* (Roxb.) Tateoka - a rare grass; Dwarka coast.



Fig. 4. : *Urochondra setulosa* (Trin.) Hubb. - a frequent grass; Victor port (Saurashtra).

PLATE - J (Figs. 1,2 & 5)



Fig. 1. : *Pedalium murex* L. - in flowers;
Udwada coast (Valsad).



Fig. 2. : *Ipomoea pescaprae* Sw. - in
flowers ; Tithal sea coast (Valsad).



Fig. 5. : *Fagonia cretica* L. in flower ; Porbandar sea-coast.

PLATE - J (Figs. 3 & 4)



Fig. 3. : *Adansonia digitata* L. in fruits; Umbergaon creek (Valsad).



Fig. 4. : *Sesuvium portulacastrum* (L.) L. in flowers ; Mamalia beyt, Navlakhi.

PLATE - J (Figs. 6 & 7)



Fig. 6. : *Borassus flabellifer* L. intermixed with *Cocos nucifera* L. ; Hajira coast (Surat).



Fig. 7. : *Hyphaene dichotoma* (Wight) Furtado - an endemic plant planted as an avenue tree ; Una to Delwada.

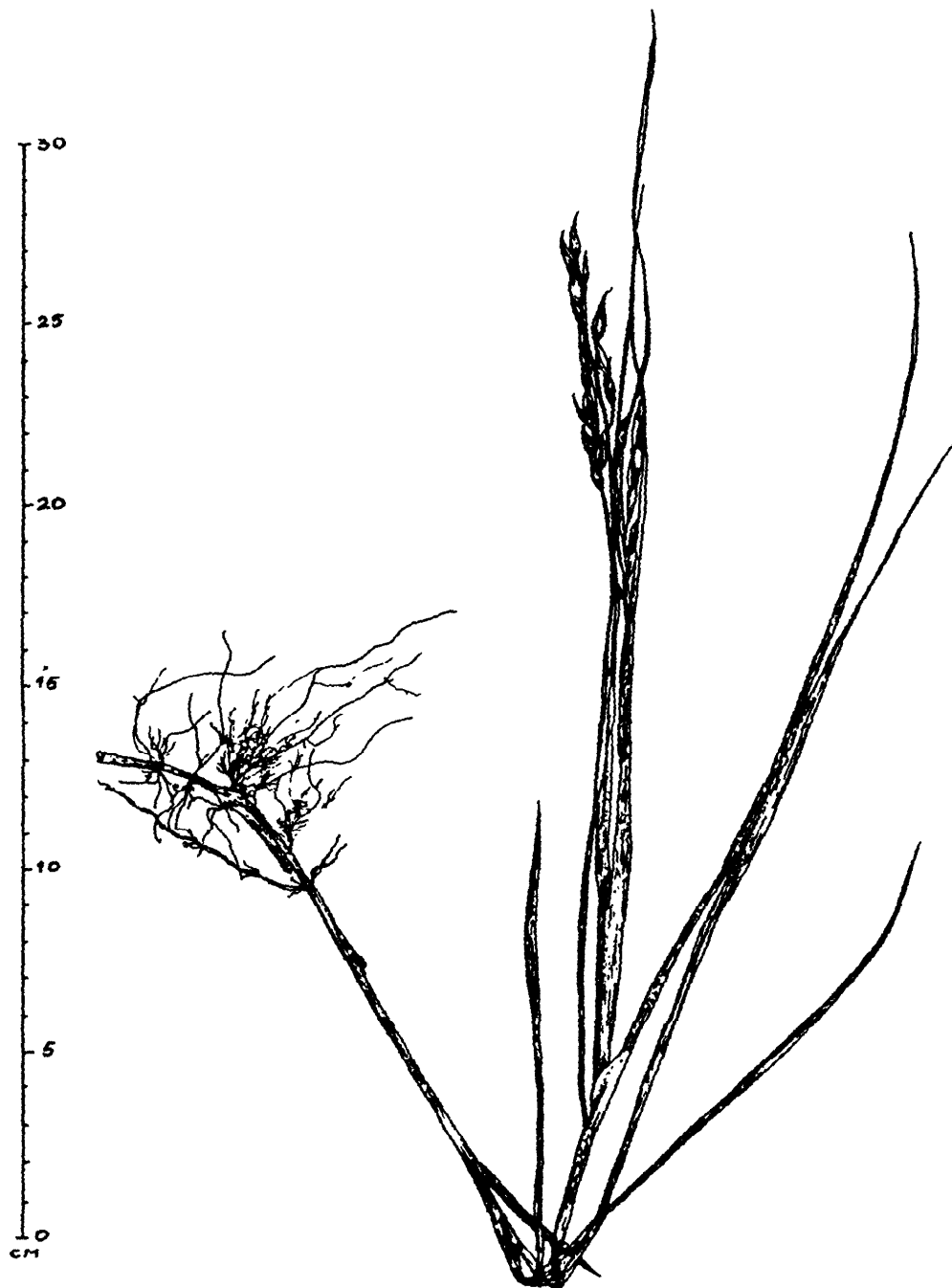


Fig. 1 : *Porterasia coarctata* Takeoka

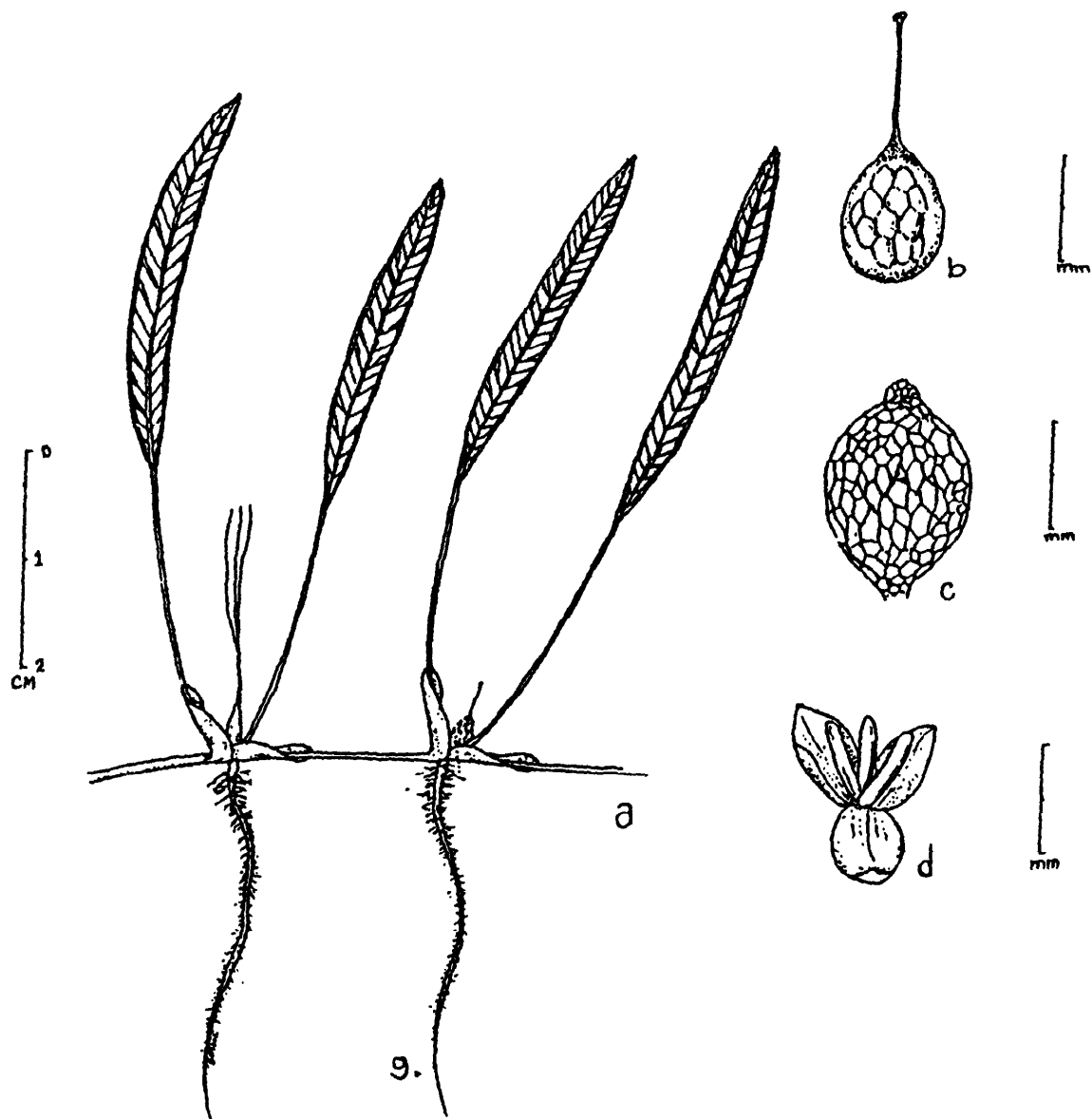


Fig. 2. : *Halophila ovalis* (R. Br.) Hook. f. ssp. *ramanurthiana* Ravikumar et Ganesan.
a. Habit. b. A mature carpel. c. Seed. d. Male flower.

cretica, *Cyperus bulbosus*, *C. pachyrhizus*, *Juncus maritimus*, *Urochondra setulosa* etc. A number of sand binder plants are also found on coastal sand in colonial form. They are *Cassia italica*, *Crotalaria burhia*, *Cyperus arenarius*, *Evolvulus alsinoides*, *Ipomoea pes-caprae* (Pl. J. fig. 2), *Indigofera cordifolia*, *Launaea sarmentosa*, *Pedaliium murex* (Pl. J. fig. 1), *Spinifex littoreus* etc. A number of other species are observed and collected on sands scattered in small or large patches viz. *Alhagi pseudalhagi*, *Astragalus prolixus*, *Canavalia maritima*, *Heliotropium marifolium*, *Limonium stocksii*, *Helichrysum cutchicum*, *Hydrophylax maritima*, *Opunita elatior*, *Peganum harmala*, *Psilostachys sericea*, *Scaevola taccada*, *Tephrosia uniflora* subsp. *petrosa*, *Tribulus elatus*, *Aristida adscensionis*, *Cenchrus biflorus*, *Chloris villosa*, *Cynodon dactylon*, *Perotis indica* and *Zoysia matrella*. Srinivasan (1969) has reported ca 55 marine algae from Okha and Dwarka coast of which ca 10 marine algae viz. *AMPHIROA* spp., *Caulerpa peltata*, *C. racemosa*, *C. taxifolia*, *Chaetomorpha media*, *CODIUM* spp., *Ulva* spp. etc. were also collected. Some of them e.g. *Sargassum* sp. were associated with *Avicennia marina* (see Pl. A, fig.1). Some medicinal plants like *Commiphora wightii* (Guggal) were also collected in rocky habitat along sea shores of Diu and Dwarka (Beyt Island and Marine National Park). Some non mangrove halophytes or salt tolerant species as observed on saline ground, salt pans or mud flats along

the sea shores of Gujarat are *Aeluropus lagopoides* (Pl. H. fig. 2), *Arthrocnemum indicum* (Pl. H. fig. 3), *Halopyrum mucronatum* (Pl. H. fig. 6), *Atriplex stocksii*, *Cressa cretica* (Pl. H. fig. 7), *Salicornia brachiata*, *Salsola baryosma*, *Salvadora persica*, *Sesuvium portulacastrum* (Pl. J. fig. 4), *Suaeda fruticosa* (Pl. H. fig. 4), *S. maritima*, *S. monoica*, *S. nudiflora* (Pl. H. fig. 5), *Tamarix aphylla*, *T. troupii* (Pl. H. fig. 1) etc. Rao *et al.* (1966) reported a seagrass viz. *Enhalus acoroides* (L.f.) H. Rich. ex Steud. from Piram island near Ghogha coast in Bhavnagar along the Saurashtra coast. An another seagrass *Halophila ovalis* (R. Br.) Hook. f. subsp. *ramamurthiana* Ravik. & Ganes. (Pl. fig. 2) was collected for the first time from Triveni creek near Somnath from Saurashtra coast (Kothari & Rao, 1994). Similarly, *Porteresia coarctata* (Roxb.) Tateoka is an addition to Gujarat Flora from Dwarka coast (Kothari & Rao, 1991) (see Pl. I figs. 2 & 3). In succulent mangroves, *Bruguiera cylindrica* Bl. is also a new record for Gujarat coast collected from Umbergaon creek, Valsad (see Pl. E, figs. 3 & 4). Similarly, *Roccella belangeriana* Awas, a lichen was recorded for the first time from Pirotan Island, Gujarat, West Coast of India (Kothari & Rao, 1994) (see Pl. I., fig.1). The type specimen was collected by Awasthy on stilt roots of *RHIZOPHORA* sp. from Pondicherry, E. coast, on 20 June, 1979. After the lapse of 11 years, the same lichen was recollected from above Pirotan Island locality

in W. coast on another mangrove viz. *CERIOPS* sp. by present authors in 1990.

FACTORS AFFECTING THE VEGETATION

Mangroves of Gujarat are affected by both biotic and abiotic factors.

I. Biotic factors : Biotically mangroves are affected by over grazing, over exploitation by human beings, chemical hazards, industrialization and urbanization in port area, Fishing, Recreation & Tourism etc.

a) Overgrazing : Overgrazing of green leaves by animals like camels, buffaloes etc. in coastal areas have affected growth and development of mangroves. According to Kulkarni (1959) and Blasco (1975), over 2500 camels of Rabaris are dependent on browsing of mangroves in Saurashtra and Kutch. Through nominal fees is charged from Rabaris by Government authorities, this has resulted in stunted growth of *AVICENNIA* species (Pl. G, fig. 2).

b) Over exploitation of green leaves, fruits and wood of mangroves : Lopping of green leaves and fruits in head loads for cattle fodder and cutting of green branches for firewood have largely affected the mangroves. Over 10,000 persons (mostly "Wagher community in the parts of Kutch and Saurashtra are dependent on mangroves for firewood (Kulkarni, 1959). He has also given an official yearwise estimate from

1951-56, regarding exploitation of wood (*i.e.* green wood, dry wood, fodder leaves, fruits, head loads, tanning bark in mounds/tons) in tabular form, between Navlakhi and Okha coast. Untawale & Wafer (1980) also reported the utility of these mangroves of Kachchh as signal trees during navigation, produce tan bark for fishermen nets, fishing stakes ; mangrove woods are also used for toy making, match box industries, fodder for cattle, goats, camels, firewood & overall nursery beds for prawn, shrimp & fish species. Anonymous (1978) has also reported more than 1,10,000 tons mangrove woods were exploited during the period 1948-1978. Recently, the over exploitation of leaves and woods were observed at Jambusar and Salaya (Pl. G. figs. 3 & 4).

c) Chemical hazards : Tata chemical works Ltd., Mithapur company manufactures soda ash, sodium bicarbonate, caustic soda, fusite, liquid chloride, bromine & other chemicals. Lime stone, salt, ammonia, sulphur etc. are used for preparation of soda ash as major product. The 'effluents' (about 8000m³) for ammonia recovery, containing NaCl and CaCl₂ etc. is discharged constantly by the factory through a grand pipe line in sea near Marine National Park, Dwarka etc. which effect mangroves and other marine habitat. So far, because of this number of *Avicennia* spp. and other wild plants have been destroyed (Pl. G. f. 1). To prevent long chronic effect, the effluent must be

dechlorinated before discharging into the gulf. Similarly, Gujarat State Fertilizer Corporation Ltd. (GSFC), Sikka, The GSFC Motikhavdi near Sikka, producing Di Ammonium Phosphate (DAP). To Produce DAP, Phosphoric acid & Liquid Ammonia are raw materials. Any leakage of Ammonia or Phosphoric acid would prove to be catastrophic to the aquatic life in the park and sanctuary area. Disposal rate of these two liquids is faster and therefore risk factor is also more. Therefore small leakage of Phosphoric acid or ammonia could effect mangroves and water birds around the storage tanks.

Singh, H. S. (1994) reported *ca* 21 salt work industries along the coast of Jamnagar and total 10,325 ha. (10,211 ha. forest + 114 ha. Revenue) area are leased out for this purpose. Especially from Jodia to Okha, many of the leased out area had very good mangrove forests in the past but disappeared after the beginning of salt production.

It is estimated that in every one lakh tonne of salt production *ca* 944 lit. of bittern is produced (CSMCRI, 1984). In Gulf of Kachchh adjoining park & sanctuary area *ca* 15 to 20 lakh tonnes of salt is produced in 10,325 ha. salt work area and *ca* 1700 lit. bittern is discharged in the sea, polluting marine ecosystem. The 'Bittern' is toxic to certain species of mangroves.

d) Industrialization and Urbanization: In port areas of Gujarat e.g. Jafrabad and Alang (Saurashtra) where once upon a time *AVICENNIA* species were growing profusely but now due to ship breaking and urban developing for commerce and rehabilitation, the growth of mangroves is reduced.

Vadinar off shore oil terminal Co.Ltd. is a great threat to Marine National Parks & Sanctuary (MNP&S) as it handles crude oil in terminal within the Gulf itself. This terminal handles 12 M tonnes crude oil per annum & pump to Madhura Koyli Refineries. Reliance group of Industries ESSAR, Petroleum Refineries & Bharat Petroleum Corp. Ltd. have proposed oil terminals near Vadinar to handle 24 M tonnes of crude oil would generate large amount of pollution in the Gulf, which are harmful to both Corals & Mangroves. Petroleum products & oil cause burning, yellowing, wilting of leaves & damage to roots cause retardation of growth (Jagtap & Untawale, 1980). The proposed multinational Reliance Refinery Project could also destroy the Gujarat's Marine National Park at Motikhavdi, about 25 km east Jamnagar in the western region of Gujarat (WWF report October-December, 1993).

Harbour & Ship Breaking Yards : About 2000 ships & vessels visit Kandla, five intermediate and seven minor ports every year. They create a major problem of garbage

and oil discharge. Along 'Vadinar', oil terminal is a great threat to the MNP&S, as it handles crude oil in a terminal within the sea itself. Minor oil spills took place many times in past and caused extensive damage to Mangroves and marine life. Ship breaking yard at "Sachana" is another major threat to MNP. Dense mangrove forests near Sachana have been destroyed by ship breaking works. Oil spills from the breaking of ship and oil tank damage marine life and their ecosystem (Singh, H. S. 1994). It was observed that steamers of Salaya-Madhura pipe lines throw its waste oil near Pirotan island at Jamnagar. Due to this oil, growth and development of mangroves is affected and number of mangrove species are destroyed also.

Calcareous Sand Mining (Cement Industry) : Gujarat Govt. leased out M/s Digvijay Cement Co. Sikka before declaration of Sanctuary. The Company has ruthlessly exploited Narara & Pirotan coral reef. Removal of calcareous sands from the above areas, play an important role in rising sedimentation, leading thereby, to decrease in Precious marine lives from Gulf of Kachchh.

e) Fishing : This should not be allowed in MNP & S (as per Wildlife Protection Act. 1972 & its amendment in 1991) but this practice cannot be stopped in the protected area also. Local fisherman fix their nets across creeks, on the islands for prawn fishery. They

cut mangroves for firewood and fixing tanning nets.

f) Recreation and Tourism : Pirotan island is famous for its scenic beauty and rich marine life. Scientists, students and nature lovers are permitted to visit islands and coral reefs. Local fishermen and muslim communities also regularly visit for their religious 'Pirs' located in the islands. All these movements of people cause some damage to marine life and ecosystems.

II. Abiotic factors : Mangroves of Gujarat are also affected abiotically by following environmental factors viz. climate, edaphic, geomorphological and geological factors.

1. Climate : Climate of any intertidal region is an important factor for growth, development and succession of mangroves. Among these, the temperature fluctuation-between 20°C to 35°C, humidity, annual rainfall (above 100 mm), regular wind flow, frost free, radiation and sedimentation along with upstream water supply are important for growth and viability of mangroves. Naskar & Guha Bakshi (1987) have reported that the typical mangrove flora require tidal inundation, typical tropical climate, temperature between 20°C 40°C, torrential rainfall between 1400-2000 mm per annum, with coastal aridity, silty-clayey sedimented soil and protected shallow shelter bays or

beach areas. Mangroves are very much sensitive to forest. The humid climate is better for physiological function of mangroves than the arid climate (Naskar & Guha Bakshi, 1987).

2. Edaphic and Geomorphological factors : Beyond these climate factors, the edaphic and hydric factors are also predominant, Mangroves develop best in tropical estuary, occasionally in subtropical wet zone and rarely in subtropical dry zone (Walter, 1977). The edaphic and geomorphological influence are as decisive as the climatic factors for growth and development of mangroves. The tidal fluctuations has the major role for mangrove habitats. Mangroves grow well in between Mean High Water Spring Tide (MHWST) and Mean Sea Level (MSL). Oliver (1982) has reported that the mangroves always grow in the tropical ecosystem is not always true. The mangrove areas are restricted in the lagoons, deltas, estuaries, tidal inlets, areas on the leeward sides of Shielding headlands or Islands or coastal orientation. These zones have dominant wind flow, which blow parallel and are favourable for mangroves (Naskar & Mandal, 1999). Soil salinity determines the slow growth of mangroves but Walter (1977) has reported that frequent rainfalls have direct effect in the well growth if mangroves in the tidal region. Shade is also an important factor in the degeneration of mangroves. Seedlings of different mangrove

species have different preference of shade in their early period of establishment (Wells, 1983).

3. Geological Factors : According to Zennings (1975) change in relative altitudes between land and sea, tectonism, sea level fluctuation, changes in tidal range, compactness in sediment, erosion or deposition of silt, would have effect on mangrove ecosystem. Modest change of climatic or geomorphological features have major effect on the mangroves. The soil structure, soil salinity and the hydrobiological conditions are the main agents controlling the distribution of mangroves.

It is reported that in gulf of Kachchh sea level rises presumably at the rate of 1 to 1.3 cm per year as a result of holocene transgression of the sea, affected the mangroves by way of increased sediment movements. Similarly, the climate in the Gulf region is dry with temperature ranging from a average minimum of 7.8°C in January to a average maximum of 44.8°C in May. The average rainfall is about 400 mm.

Sometimes natural forces like high velocity of wind brings cyclones and high tides in sea water uproots the mangrove species and affects its growth. The part of the Mangroves in and around Kori creek were also destroyed by the cyclone that hit Gujarat and the coast of Pakistan in May 1999 (Singh,

H. S., 2000). Recently on 26th January 2001, due to massive earth-quake in Kutch & Saurashtra, mangroves and other coastal vegetation are also affected. Constant drought or famine especially in Kutch and Saurashtra during 1973 to 1975 and 1984 to 1987 have also affected the growth and development of mangroves e.g. an area like Navlakhi coast where *Bruguiera gymnorhiza* (L.) Lam. and other tree species of mangroves were abundant (ef. Santapau, 1962 ; Shah, 1978). As per local information and personal visit of the area, now tree species of mangroves are not available due to constant drought. The species have been vanished or cut off during the scarcity period.

REGENERATION

In nature, the seeds of *AVICENNIA* spp., *BRUGUIERA* spp., *CERIOPS* spp., *RHIZOPHORA* spp., show vivipary *i.e.* the seeds germinate on parent trees before falling on the ground. These germinated seeds can develop roots from hypocotyle region as soon as they fall on suitable muddy substrata and complete plant is formed. It was observed that camels play an important role indirectly in natural regeneration of *AVICENNIA* spp. While browsing its leaves by camels, the seeds are pushed sufficiently deep into the mud by their foot. This creates favourable condition for germination due to successful establishment of seeds in the pits created by the foot marks of camels (Kulkarni, 1959). Artificially, Macnae (1968) studied the growth pattern in

AVICENNIA spp. in which the fallen seeds first absorb water and split the testa and seedlings come out of the testa. Kulkarni (1959) also mentioned that the germinated seeds of *AVICENNIA* spp. can be collected by net and planted in site immediately at the desired spacing e.g. 1" to 2" below the surface of the ground with the receding water. After getting maximum land exposure from new moon and especially from latter part of fortnight, the newly regenerated plants get established and able to catch the floating seeds brought by the tides which may augment the future mangroves. The recent scheme was prepared for N. W. Saurashtra for restocking the muddy saline banks below the mangrove zone. In Kutch also attempts were made to fill up the blanks artificially by removing the dead stumps from debris transplanting the embryos of *AVICENNIA* spp. or its seedlings in lowered level pits of the size 1' × 1' × 1' were dug out 6' × 6' spacing.

The degree of success in the first technique is too early to say but likely to be achieved thereby. Similarly in the second method results were not satisfactory and varied. Failure were due to heavy encroachment of sea algae on the young seedlings, attack of small sea shells covering the stems etc. (Kulkarni, 1959). The present authors have also tried to cultivate mangroves in the nursery of Botanical Survey of India, Western Circle, Pune sowing germinated fruits of *Avicennia marina*, *Ceriops tagal* and *Rhizophora mucronata* with hypocotyle in

pots. The attempt was successful up to seedlings with 2, 4 & 6 leaflets (see Pl. F., figs. 3-5). As the mangroves require characteristic environmental conditions *i.e.* swampy muddy habitat and tidal waves of sea water for their growth and developments, they hardly survive in other habitats. Therefore, the forest department of Goa have developed nurseries of Mangroves *in situ i.e.* natural habitat at Chorao Islands, Panaji (Kothari and Rao, 1990). In Gujarat also certain mangrove areas e.g. Kudchali area at Dwarka and Pirotan islands at Jamnagar are protected in the form of Marine National Park by forest department (see Pl. G, fig. 1 ; Pl. B, fig. 1 ; Pl. D, fig. 4).

UTILIZATION OF MANGROVE FORESTS IN GUJARAT :

Mangroves of Gujarat are used for fodder, fuel, tanning, fishing, furniture, native

medicines etc. They play an important role in soil conservation and to maintain ecological balance.

I. Economic uses

a) *As a fodder* : Green leaves and fruits of *Avicennia marina*, *A. alba* and *A. officinalis* are only the major source of food for animals in costal areas of Kutch and Saurashtra. Chemical composition and nutritive value in leaves of *Avicennia officinalis* and certain coastal grasses analysed by Shukla & Shukla (1986). Accordingly based on mineral contents as shown in the Table III, it was suggested that 'Cher' leaves (*Avicennia officinalis*) have definite use in famine condition and can be used as a filler material by cattle feed factors located near coastal regions.

Table II : Mineral content of certain coastal vegetation of Gujarat :

(%) ON DM BASIS							
Name	Ca	P	Salt as NaCl	Iodine KI	Fe ppm.	Cu ppm.	Mn ppm.
'Cher' <i>Avicennia officinalis</i>	0.77	0.17	16.6	0.0141	1012	17	52
'Moras' <i>Sueda nudiflora</i>	0.66	0.17	16.5	—	1382	11	69
'Aal' <i>Halopyrum mucronatum</i>	0.13	0.12	7.4	—	1843	10	291
'Ganthiu' <i>Spermacoce hispida</i>	0.45	0.21	6.0	—	1499	12	66

Table III : Nutritive Elements (Dry weight in %)

Nutritive elements	Leaves ('Cher') <i>Avicennia officinalis</i>	'Ranjako' <i>Medicago sativa</i>	'Cher' Fruit (<i>A. officinalis</i>)	Maize Grains
Proteins	20.63	19.90	19.10	10.40
Fatty substances	4.15	2.90	1.93	4.20
Fibrous substances	12.07	22.90	2.96	1.80
Carbohydrates	47.20	43.40	77.46	81.90
Ash	25.95	10.70	8.55	1.80
Silica	0.53	0.80	1.98	0.30
Phosphorus	0.22	0.43	0.24	0.35
Calcium	0.38	1.59	0.10	0.08

(Based on a letter No. GVC/ANRS/21642 dated 2-6-88 from Animal Nutrition Station, Anand, Gujarat.)

Table —III shows that fruits of *Avicennia officinalis* ('Cher') is having nearly similar nutritive elements of maize grains. Therefore during scarcity 'Cher' leaves can also be used as substitute for leaves of leguminous plants (e.g. *Medicago sativa*). It is suggested that proper planning and management of *Avicennia* forests covering a vast area of about 52,000 hectares can save cattle of Gujarat during scarcity period.

b) *Only source of fire-wood* : Kulkarni (1959) states over 10,000 persons mostly 'Wagher' community live by selling the mangrove as firewood in the ports such as

Jamnagar, Khambhalia, Sikka, Salaya, Navlakhi, Kandla, Mundra, Navinal, Jakhau etc.

The population at these places largely depened upon the mangrove forests as the only source of firewood. Blasco (1975) also support this statement and also mentions a total population probably exceeding 2 lakh persons of Gujarat coast receive no other firewood than these from the mangroves.

c) *Tanning* : Stem bark of mangroves are rich in tannin and used to dye fishing nets and in leather industries.

Table IV : Showing frequently and tannin percentages of mangroves from Gujarat
(See Narayana Murthy & Rao, 1959).

S. No.	Name of species	Frequency	Average tannin %
1.	<i>Aegiceras corniculatum</i>	Frequent	6.6
2.	<i>Bruguiera cylindrica</i>	Occasional	18.9
3.	<i>B.gymnorrhiza</i>	Occasional	18.9
4.	<i>Ceriops tagal</i>	Frequent	29.0
5.	<i>Rhizophora apiculata</i>	Occasional	33.8
6.	<i>R. mucronata</i>	Frequent	38.0
7.	<i>Sonneratia apetala</i>	Occasional	11.3

d) *Fishing* : Fishes, crabs, prawns, lobsters etc. get shelter on root system of mangroves. Their proteinous food products obtained are useful economically indirectly e.g. areas of Jakhau (Kutch) etc.

e) *Furniture* : Timber obtained from the wood *Bruguiera gymnorrhiza*, *Rhizophora* spp., *Sonneratia apetala* etc. are used for house construction purpose, telegraph poles, furniture etc.

f) *Medicines* : Decoction of *ceriops tagal* leaves used as substitute for quinine while *Acanthus ilicifolius* useful for asthma, rheumatism etc.

g) *Gums and resins* : These are obtained from the bark of some mangroves like *Aegiceras corniculatum*.

II. Soil conservation : Pneumatophores, stilt roots etc. bind soil and mud particles to

prevent soil erosion. e.g. *AVICENNIA* spp., *BRUGUIERA* spp., *CERIOPS* sp., *RHIZOPHORA* spp. *ACANTHUS* sp. etc. On the sandy coasts of Danti, Mahuva, Veraval etc, *Ipomoea pescaprae*, *Perotis indica*, *Psilostachys serices*, *Spinifex littoreus*, *Hyphaene dichotoma* etc. colonise sand particles and help in the fixation of silt or recently deposited sand. Rao (1959) has stated that the mangroves act as wind breakers, the vast block of forest act as buffer and reduce the severity of gales. Where the spill area of the river has been reduced by the reclamation of land etc. Thus mangroves also protect the coastal area against wind and conserve soil.

CONCLUSION AND CONSERVATION

Mangroves have assumed world wide importance due to their ecological and scientific values. Hence efforts are being made by the UNESCO and other UNO

to protect these valuable ecosystems. From all above mentioned biotic and abiotic factors it may be concluded that the mangrove flora are suffering and its areas are reclaiming or denuding continuously due to overgrazing, developing harbours, industrialization and consequent pollutants discharges. Reclamation of these mangrove lands for agricultural purposes are not practised due to scanty rainfall & higher salinity in soil (Untawale, 1985). Hence the mangroves of the Gujarat coast are seen very much degraded (Blasco, 1975). Based on work of Milliora & Inery, Naskar & Mandal have also reported the sea level rises up on the Gujarat coast at the rate of 1.0-1.03 cm per annum, as a result of *Holocine Transgression* the continuous increase of sediment movement. Waheed Khan (1959) has also reported these mangals of Gujarat as open scrubby Mangroves and according to Qureshi (1959) large mangrove areas at Gujarat coast are transferred to the Port Trust Authority for development of port. Caratine *et al.* (1980) have also reported that Gujarat coast are barren without any plant cover and called it "Pseudo-Steppe-Vegetation". As such the coastal lands gradually converted into naked & barren lands with few visible Pneumatophores (Anon., 1992). However, these mangroves are patchy but occasionally densely present at "Patre creek, Dinde-ka-bet, Valsura, Navlakhi, Kandla though wide spread near Mundra Jetty & sparse at Okha, Poshitra, Pindara, Dhani, Narara, Sikka, Jindra, Pirotan Island & near Jakhau Port.

Chawan (1985) has also reported more than 30 salt factories were set up between Okha & Navlakhi and for these salt manufacturing activities mangroves are cleared from the intertidal areas, which was essential for salt pans. Besides these, 50 other salt works between Sachna and Hanshital are kept pending for getting permission for establishing salt factories (Chawan 1985). Thus from above all facts, it can be summarized that "the Mangroves in the Gujarat coasts are highly degraded which need early protection and conservation". Though the mangroves in the Gulf of Kutch are degraded consistently as a result of cutting, grazing & lopping but scenerio is now changed after implementation of afforestation and conservation measures (Singh, 2001). Till 1998, the Gujarat Forest Dept. afforested an area of about 13,200 ha. As per an estimate, about 600-700 km² area of the barren mudflat in intertidal zone mainly located in the two gulfs, is potential area suitable for Mangrove regeneration in order to expand the existing mangrove cover from *ca* 1000 km² to *ca* 1600 km² in future, it requires a planned strategy of regeneration. Therefore to protect the above important fragile ecosystem, necessary measures for conservation are also essential. To conserve mangroves in particular, Dept. of Science and Technology. Govt. of India constituted a panel of experts and published State of the Art Report on Mangrove Ecosystems in 1979. Later the Ministry of Environment & Forests, New Delhi revised the Status Reports on

Mangroves of India in June 1989 with extensive information. At present 10 Mangrove Steering Committees in different States and Union Territories are functioning. *ca* 15 Mangrove areas have been selected for conservation. National Committee is also reconstituted in December, 1988-with the Secretary of Ministry of Environment & Forests as its chairman to advise Government to take appropriate measures for conservation and Management of Mangroves (Banerjee *et al.* 1989). To classify and identify the Mangroves of India, Botanical Survey of India has published a book also (Banerjee *et al.* 1989). Ministry of Environment & Forests have also initiated mapping of Mangrove Wealth of India with the help of experts alongwith regeneration, plantation and other conservation programmes. Establishment of Marine National Parks in Gujarat at Pirotan Island (Jamnagar), Jakhau & Mundra (Kutch); Pichvaram in Tamil Nadu and Sunderbans in West Bengal are good examples for action taken by Govt. of India in this direction for *in situ* conservation of Mangroves. Similarly for regeneration and multiplication of Mangroves nurseries are also developed in various parts of India e.g. Nayachar Island in West Bengal & Pirotan Island in Gujarat. Govt. of Goa has already declared Mangroves as protected species and their felling is completely banned. Govt. of India has also classified Mangroves in Coastal Regulation Zone (CRZ) - I category. At Sunderbans, Mangrove Interpretation

Centre was also opened in 1991 and complete area is declared as Ecological Park for growth and development of Mangroves and to protect Tortoise, Fishes, Dolphins and Crocodiles etc. [Gupta, 1995]. In India, Ministry of Env. & Forests is the nodal agency for planning, promoting and co-ordinating environmental programmes. There is enough legislative, institutional and political support to ensure development without destruction (Atri, 1996). Among these a few legislative measures include —

1. Wildlife (Protection) Act, 1972.
2. Forest (Conservation) Act, 1980—amended in 1988.
3. Environment (Protection) Act, 1986.
4. Notification on Coastal Regulation Zone, 1991.
5. Hazardous Waste (Management Handling) Rules, 1989.

Environment Impact Assessment (E I A) has been made compulsory under the Environment (Protection) Act 1986. In the same Act, the Govt. of India has declared the Coastal stretches of seas, bays, estuaries, creeks, rivers and back waters - which are influenced by tidal action in landward side up to 500 m from High Tide Line (H T L) and the land between the Low Tide Line (LTL) and HTL as the Coastal Regulation Zone (C R Z). Certain activities prohibited in the C R Z are :—

1. Setting up of new industries or expansion of existing ones.

2. Manufacturing, handling, storage or disposal of hazardous substances.

3. Dumping of city or town waste.

4. Mining of sand rocks and other substrate materials.

5. Construction activities in ecologically sensitive areas.

In Kerala state, the major problems concerning the destruction of Mangroves are lack of awareness among public, injudicial tourism and Pollution from Industrial effluents

(Thomas & Radhakrishnan, 1999). Therefore still more efforts needs are to be done to involve public participation and Non-Governmental Organisations (N G O) in this direction. Environmental education and mass awareness among lay men, school children etc. are also important, as started at Chorao Bird Sanctuary, Panaji, Goa. Recently it is declared that in Kerala, Mangrove area 'Mangala vanam' (Kochi) also will be converted into a bird sanctuary, consisting about 70,000 hectares of Mangrove forests for protection, development of mangrove wealth and environmental awareness among people.

ENUMERATION OF PLANTS

Key to the families

1a. Flowering plants :

2a. Plants with either stilt roots, knee roots or pneumatophores and vivipary ; acrid milky juice absent :

3a. Plants without pneumatophores; stilt roots, knee roots and vivipary present :

4a. Ovary superior ; stamens less than 6 ; hypocotyle falcate, cinnamon brown

... Myrsinaceae
(*Aegiceras corniculatum*)

4b. Ovary inferior ; stamens more than 6 ; hypocotyle not as above

... Rhizophoraceae

3b. Plants either with large buttressus or pneumatophores ; stilt roots, knee roots and

vivipary absent (except for incipient vivipary
in Avicenniaceae) :

5a. Buttresses present ; pneumatophores
woody ; stamens more or
less united

.... Meliaceae
(*Xylocarpus granatum*)

5b. Buttresses absent ; pneumatophores
not woody ; stamens free :

6a. Pneumatophores corkey ; stamens
many ; fruits turgid, large, many seeded

.... Sonneratiaceae

6b. Pneumatophores Spongy ; stamens
4-5, fruits compressed,
small, 1-seed

... Avicenniaceae

2b. Plants without stilt roots, Knee roots and
vivipary ; acrid milky juice present

... Euphorbiaceae
(*Excoecaria agallocha*)

1b. Non-flowering plants

... Pteridaceae
(*Acrostichum aureum*)

ACANTHACEAE

ACANTHUS L.

purple, sessile in opposite pairs, in terminal
crowded or pseudo axillary spikes. Capsules
ovoid-oblong, apiculate brown, shining.

Acanthus ilicifolius L. Sp. Pl. 639. 1753.
(Pl. D, fig.2).

Fl. & Fr. : April May.

Locality : South Gujarat : Tithal, Udvada
and Umbergaon creek in Valsad District.

Erect shrubs 1-2 m high ; stems several,
stout, cylindric, base with stilt roots. Leaves
shining, 4.6-10 × 2.5-7.2 cm, ovate-oblong,
elliptic, pinnatifid or toothed, acute or
truncate at apex, sharp spinous teeth on
margins. Flowers blue, pink or pinkish

Notes : Frequent along the tidal muddy
creeks in association with AVICENNIA species.
This mud binding plant is used for blood
purification, dyspepsia and rheumatism.

AVICENNIACEAE

AVICENNIA L.

Key to the species

- 1a. Leaves lanceolate ; inflorescence spicate ;
capsules ellipsoid ... *A. alba*
- 1b. Leaves obovate or elliptic ; inflorescence
Umbellate ; capsules ovoid :
 - 2a. Trees, 10-30 m tall ; leaves obovate ;
capsules ovoid, beaked ... *A. officinalis*
 - 2b. Shrubs or small trees, 0.5-0.6 m tall ;
leaves elliptic ; capsules apiculate :
 - 3a. Leaves sessile or sub-sessile,
acuminate at apex ... *A. marina*
var. *acutissima*
 - 3b. Leaves petiolate, acute at apex ... *A. marina*
var. *marina*

Avicennia alba Bl. Bijdr. Fl. Ned. Ind.
14 : 821. 1826. *A. officinalis* L. var. *alba* C.
B. Cl. (Pl. C, figs. 5,6).

Local names : 'Tavar', 'Tivar'.

Evergreen large shrubs or small trees,
3-5 m high with dark brown, lenticelled bark.
Leaves 5.2 - 7.4 × 1.6 - 3.2 cm, glaucous green
above, whitish tomentose beneath, acute at
apex, cuneate at base. Flowers yellow in
axillary or terminal, long spikes. Capsules
slightly acuminate and curved at apex, bright
yellow and smooth when ripe.

Fl. & Fr. : February - August.

Locality : Kutch : Mundra, Jakhau.
Saurashtra : Dwarka, Pirotan islands near
Jamnagar. South Gujarat : Jambusar
(Bharuch), Umbergaon creek in Valsad.

Notes : Common along the tidal creeks.
Leaves are used for cattle fodder and fish
food. Wood is exploited for fuel.

A. marina (Forssk.) Vierh. var. **acutissima**
Stapf & Mold. ex Mold. in Phytologia
1 : 411. 1940 & 7 : 225. 1960. *Pl. A*, fig.
1; *Pl. B*, figs. 1,2,4,5. (Pl. E, fig. 1).

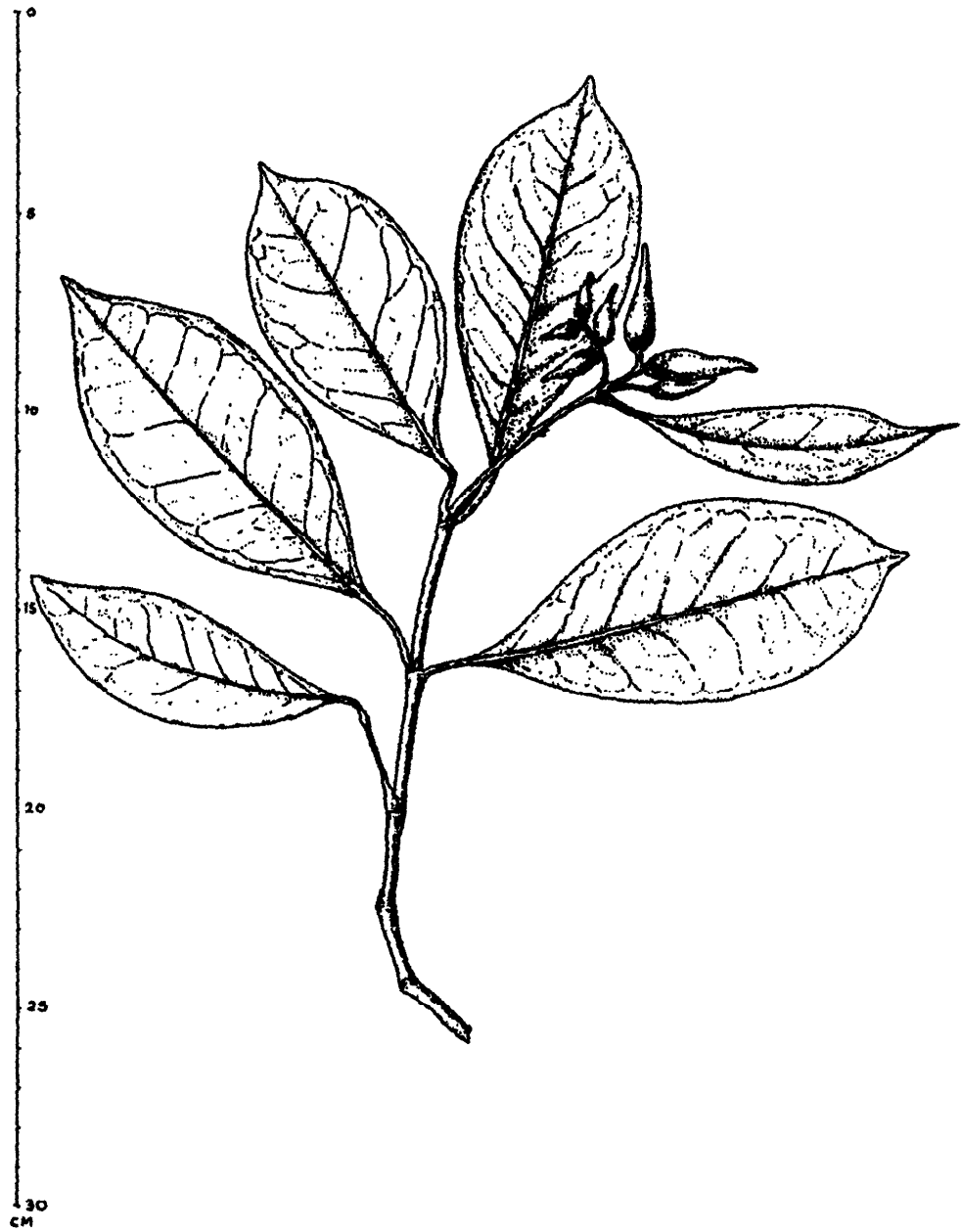


Fig. 3 : *Avicennia alba* Bl.

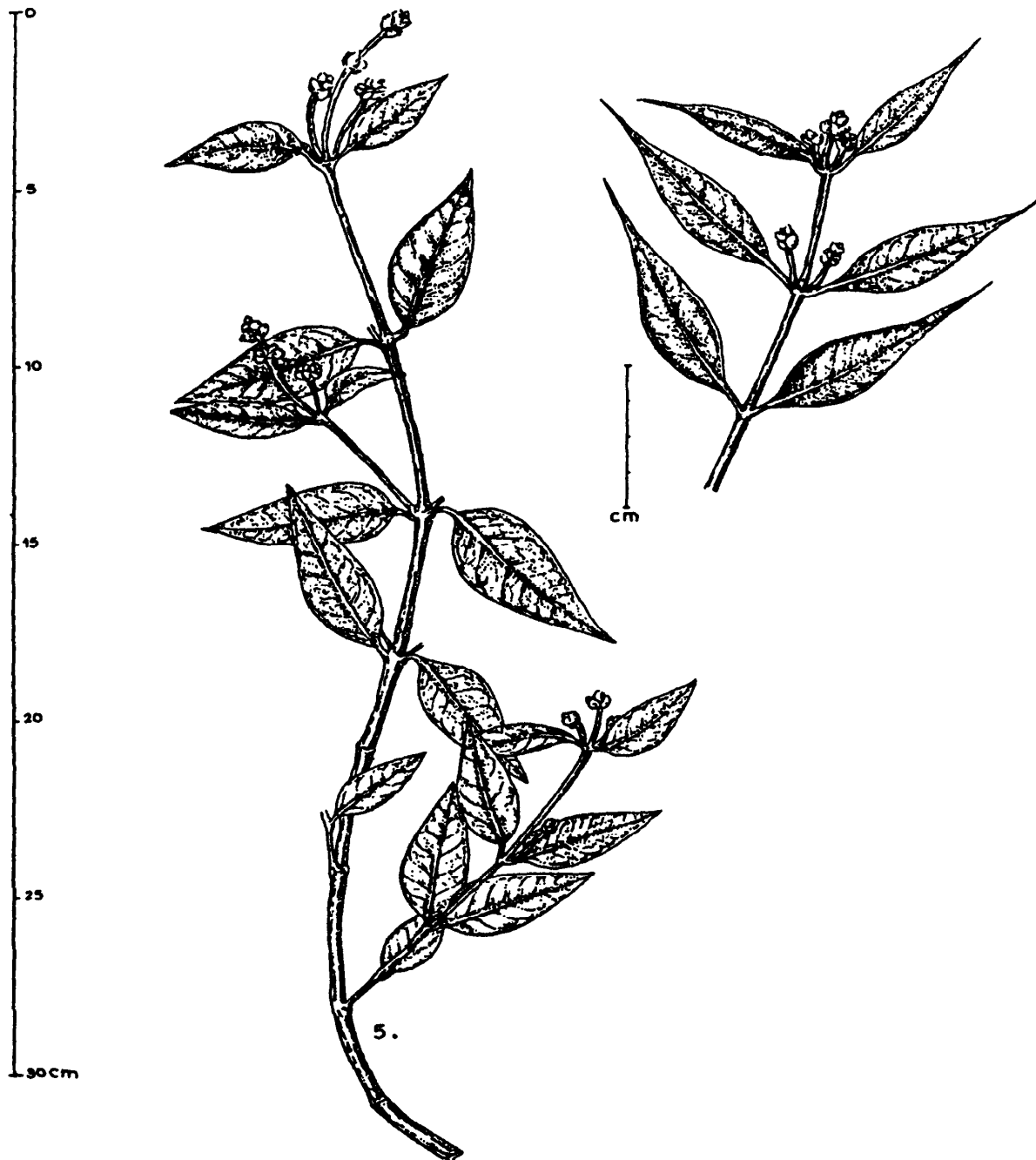


Fig. 4 : *Avicennia marina* (Forssk.) Vierh. Fig. 6 : *A. marina* var. *acutissima* Stapf & Mold. ex Mold.

Local names : 'Tavar', 'Tivar'.

Large shrubs or trees, 2-5 m high. Leaves 5.5 × 2.4 - 3.2 cm, elliptic lanceolate, tapering at base, shortly petiolate. Flowers in terminal and axillary cymes. Capsules ovoid, apiculate.

Fl. & Fr. : February - August.

Locality : Kutch : Jakhau, Mundra. Saurashtra : Bhavnagar, Gogha, Jodia bandar and Pirotan islands (Jamnagar district), Porbandar. South Gujarat : Jambusar, Kavi, Olpad, Tithal, Umbergaon.

Notes : Common along the muddy creeks. Extensively used for fodder and fuel purposes.

Avicennia marina var. **marina** (Forssk.) Vierh., Denkschr. Akad. Wiss. Wien Math. Nat. 71 : 435. 1907. (Pl. A, figs. 1, 3-5).

Local names : 'Tavar', 'Tavara'.

Shrubs or small trees, 1-3 m high ; bark yellowish brown, smooth. Leaves 2.5 - 6.2 × 1.8 - 2.6 cm, elliptic-oblong or elliptic-ovate, rarely oblong-lanceolate, glaucous green above, brown tomentose beneath, tapering at base. Flowers yellow - orange, in condensed, axillary and terminal cymes. Capsules 10 - 15 mm long, ovoid, apiculate.

Fl. & Fr. : February - August.

Locality : Kutch : Jakhau, Kandla, Koteswar, Mundra, Navinal. Saurashtra : Bhavnagar, Dwarka (Marine National Park),

Ghogha, Harsad, Jafrabad, Jodiyabandar (Jamnagar), Porbandar, Victor port ; Central Gujarat : Khambhat ; South Gujarat : Aliyabeyt, Dahej, Damen, Hajira, Hansot, Jambusar, Kantiyajal, Olpad, Paniandra, Udwada, Umbergaon.

Notes : Fairly common in muddy creeks and salt marshes. Occasionally a stem parasite *Cassytha filiformis* L. growing profusely on this plant at Hajira coast (Surat). Similarly, marine algae like SARGASSUM sp. was also found frequently in association with this species. (see-Pl. A, fig. 1)

A. officinalis L. Sp. Pl. 1 : 110. 1753. (Pl. C, figs. 1-4).

Local names : 'Cher', 'Tivar', 'Tavariya' (Gujarati), Timer, Cheria Jo jad, Bakaljo jad (Kutchi).

Trees with greyish-white bark. Leaves 3.5-8 × 2 - 4 cm, coriaceous, obtuse at apex, tapering at base, glabrous and shining above, pubescent beneath. Flowers yellow, in terminal and axillary, trichotomous, sessile heads. Capsules compressed.

Fl. & Fr. : March - August.

Locality : Kutch : Jakhau, Mandra; Saurashtra : Bhavnagar, Jamnagar, Navlakhi, Porbandar. South Gujarat : Aliyabeyt, Jambusar, Olpad, Udwada and Umbergaon.

Notes : Frequent along the muddy

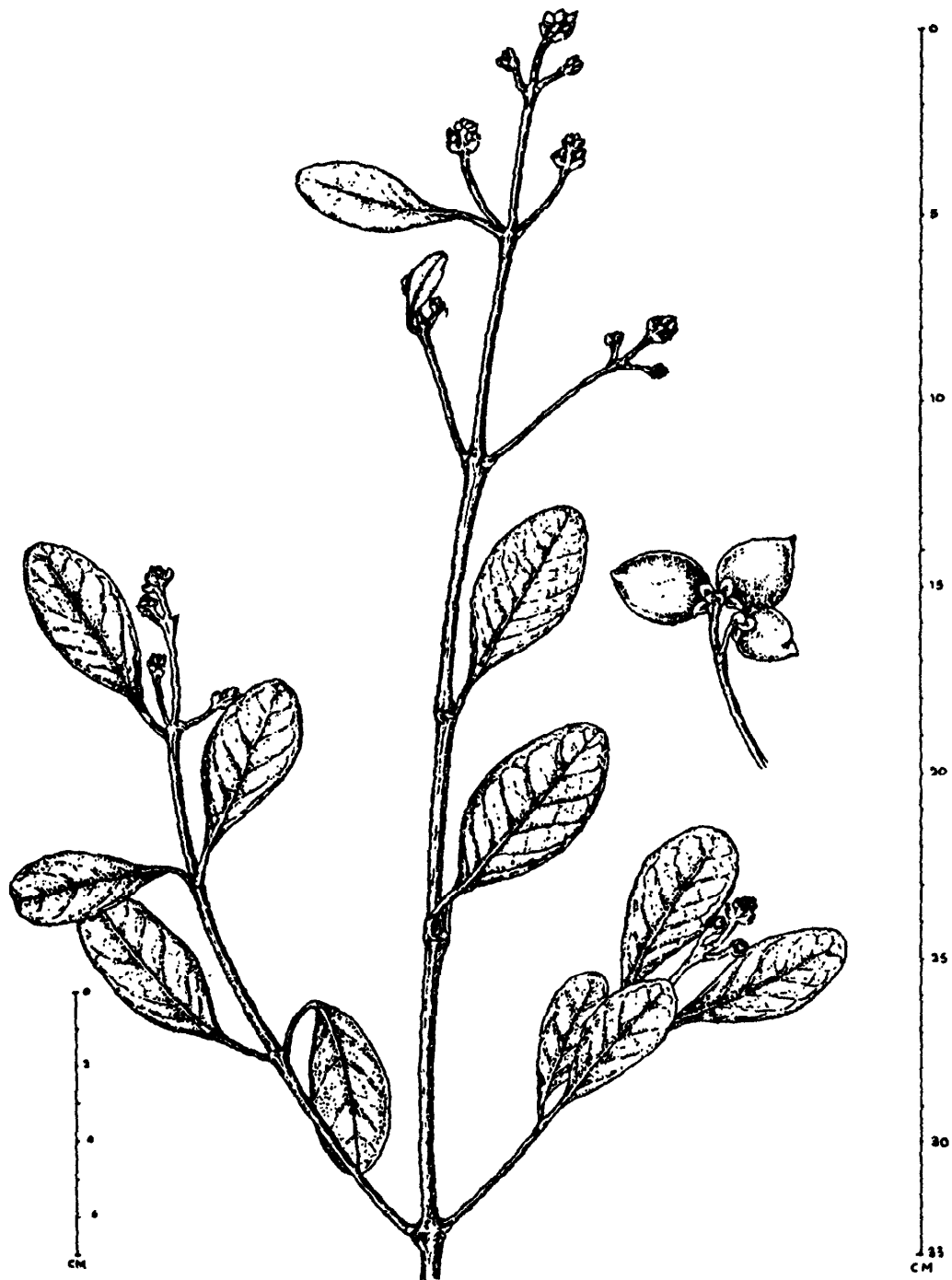


Fig. 5 : *Avicennia officinalis* L.

coastal creeks. Bark used for tanning material ; leaves and wood for fodder and fuel purposes respectively. Fruits are useful medicinally e.g. for intestinal worms, fever, diabetes, piles, liver trouble etc. (Thaker, 1926).

EUPHORBIACEAE

EXCOECARIA L.

Excoecaria agallocha L. Syst. Nat. [ed. 10] 1288. 1759.

Local name : 'Blind-your-Eye-Mangrove or Blinding tree'.

Evergreen trees or large shrubs, 15 - 20m high. Bark greyish, fissured, with poisonous milky latex. Leaves 3 - 8 × 1.4 - 3 cm, ovate, ovate elliptic or ovate oblong, spirally arranged, apex acute or obtuse, base narrowed. Inflorescence catkin-like spikes. Flowers unisexual, fragrant ; male flowers yellow, axillary ; female ones pedicellate, in axillary few flowered racemes. Capsules depressed globose, 3 lobed, dehiscent. Seeds blackish, sub-globose or 3-gonous.

Fl. & Fr. : March July.

Locality : Gujarat & Throughout India (Naskar & Mandal, 1999).

Notes : The milky juice of the plant is highly acrid and produces blisters on skin and causes blindness. Its woods are used for paper pulp and board packing boxes, fuel etc. (Banerjee et al., 1989).

MELIACEAE

XYLOCARPUS Koen.

Xylocarpus granatum Koen. Natruf. 20 : 2. 1784. *Carapa obovata* Bl.

Trees up to 20 m high ; trunk base with well developed buttresses. Leaves unijugate or bijugate, compound ; leaflets obovate, apex rounded, base tapering. Inflorescence mixed in axillary irregularly branched thyrses. Flowers white, with a reddish gland within, calyx 4 lobed ; petals 4, free. Fruits large, 30-40 cm across, globose in septafragal capsules, 4-valved. Seeds 10 - 15, pyramid shaped with a corky testa.

Fl. & Fr. : Throughout year.

Locality : Along East and West coast of India (Banerjee et al. 1989) ; Gujarat (Untawale, 1986) ; Naskar & Mandal, 1999).

MYRSINACEAE

AEGICERAS Gaertn.

Aegiceras corniculatum (L.) Blanco Fl. Filip. 79. 1837. *Rhizophora corniculata* L ; *Aegiceras majus* Gaertn. (Pl. D, fig. 5).

Local name : 'Chavariyo'.

Evergreen trees. 3 - 6 m high ; stem much branched with many stilt roots. Leaves 2.5 7.8 × 1.2 2.7 cm, obovate oblong, coriaceous, glabrous. Flowers white, fragrant in terminal, axillary or leaf opposed umbels. Fruits 1.5 6 cm long, cinnamon brown curved or falcate, tapering to a pointed apex.

Fl. & Fr. : December - July.

Locality : Kutch : Jakhau, Mundra.
Saurashtra : Pirotan islands, Jamnagar. South
Gujarat : Umbergaon creek (Valsad district).

Notes : Frequent along the muddy creeks in association with *AVICENNIA* and *CERIOPS* species. Bark is used as fish poison and also contains tannin / saponia (7.8 %) and some resin. A good quality of-honey and wax is extracted from its flowers. The wood is used for construction and as fuel.

PTERIDACEAE

ACROSTICHUM L.

Acrostichum aureum L., Sp. Pl. 2 : 1069.
1753.

Erect, terrestrial fern, 1 - 1.5 m high ;

stipes woody, glabrous arising from a stout rhizome. Fronds unipinnate ; pinnae 8 - 14, alternate, linear - oblong, apex rounded or retusely mucronate, base cuneate ; lower sterile, upper reddish - brown, soriferous. Sori densely aggregated along the undersurface, non-indusiate.

Sori : June - October.

Locality : Gujarat (Naskar & Mandal, 1999).

Notes : Common back mangal in estuarine of East and West coast in India and tropical coasts of the world. This is the only terrestrial fern that grown in mangrove situations (Banerjee *et al.* 1989). Tender frond leaves are edible as vegetables. Medicinally, rhizome - paste is said to be used for boils (Naskar & Mandal, 1999).

RHIZOPHORACEAE

Key to the genera

- | | | |
|---|-----|------------|
| 1a. Calyx 8 - 14 lobed ; petals 2 - lobed ; bracteoles absent | ... | BRUGUIERA |
| 1b. Calyx 4 - 6 lobed ; petals not lobed ; bracteoles present : | | |
| 2a. Calyx 4 -lobed ; petals without apical appendages ; ovary 2 -celled ; hypocotyle long, smooth | ... | RHIZOPHORA |
| 2b. Calyx 6-lobed ; petals with apical appendages ; ovary 3-celled ; hypocotyle short, ridged | ... | CERIOPS |

BRUGUIERA Lam.

Key to the species

- 1a. Flowers solitary, 3- 4 cm long ; mature calyx red to pinkish-red ; Calyx tube not reflexed ... *B. gymnorrhiza*
- 1b. Flowers more than, up to 1 cm long ; mature calyx not red ; calyx tube slightly or completely reflexed in fruits : ..
- 2a. Calyx tube smooth ... *B. cylindrica*
- 2b. Calyx tube ribbed ... *B. parviflora*

Bruguiera cylindrica (L.) Bl. Ency. Pl. Jav. 1 : 93. 1827. *Rhizophora cylindrica* L ; *Bruguiera caryophylloides* Bl. (Pl. E., figs. 3 & 4).

Local name : 'Chitleri'.

Trees up to 20 m high ; bark smooth, greyish. Leaves 4.2 - 10.6 × 2.4 - 4.5 cm, broadly lanceolate or oblanceolate, acute at apex, cuneate at base. Flowers white in axillary pedunculate cymes ; calyx tube smooth with 8 - 10 reflexed lobes ; petals bifid with a bristle in a sinus ; stamens 16, unequal, 2 in each petal. Fruits oblong - ovoid, hypocotyle cylindric, ribbed, 10 - 14 cm long.

Fl. & Fr. : May - August.

Locality : South Gujarat : Termora beyt near Umbergaon.

Notes : Rare along the tidal creeks. This species is not recorded by Shah (1978) and Banerjee *et al.* (1989) from Gujarat coast. So far known from Malabar (West coast) and

East coast of Indian Peninsula, Andaman Islands, Sri Lanka, S. E. Asia and Australia (Banerjee *et al.* 1989). This plant is used for timber, tannin and fuel.

B. gymnorrhiza (L.) Lamk. Encycl. Meth. Bot. 4 : 696. 1797. *Rhizophora gymnorrhiza* L.

Evergreen trees up to 30 m high ; stem base with knee like roots. Leaves 7 - 14 × 3 - 6 cm, elliptic - oblong, glabrous, coriaceous, acute at apex. Flowers scarlet, axillary. Fruits obconical with persistent calyx lobes ; hypocotyle 10 - 15 cm long, cigar shaped obscurely ribbed.

Fl. & Fr. : January - June.

Locality : Saurashtra : Navlakhi.

Notes : Rare. Santapau (1962) has recorded this plant in sea creeks at Navlakhi. During a recent visit to the area, the plant was not found. This may be due to biotic

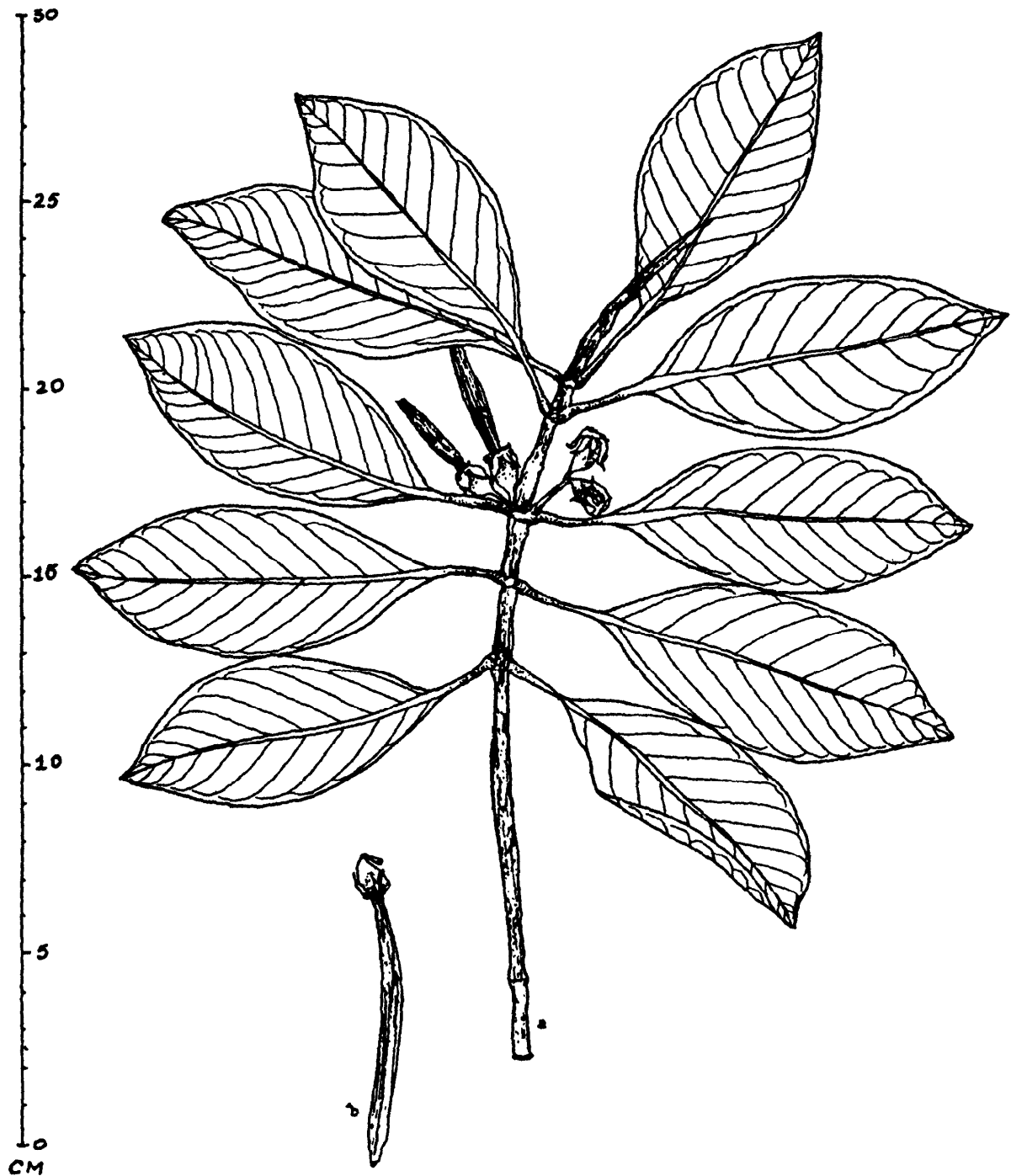


Fig. 6 : *Bruguiera cylindrica* Blume : a) Fruiting branch. b) Fruit with hypocotyl.

effects. The stem is used in building fishing boats, houses etc, and as a fuel. Its bark yields tannin.

B. parviflora (Roxb.) Wight & Arn. ex Griff.
Trans. Med. Phys. Soc. Cal.
8 : 10. 1936.

Trees, up to 15 m high, with many upright branches ; stem base buttressed with Knee roots. Leaves simple, opposite, decussate, elliptic - oblong, apex retuse, base attenuate, exstipulate, petiolate. Inflorescence axillary, pedunculate cymes. Flowers 2 - 3, greenish white ; calyx tube cylindrical, up to 2 cm long in fruit, narrow, ribbed ; sepals

8, yellowish - white, bilobed, terminal part with 3 long cilia, margin sparsely hairy. Stamens 16. Carpels 3, stigma 2, bifid. Fruits berry, pendulous ; hypocotyle 7 - 12 cm long, cylindrical, slightly curved in the middle.

Fl. & Fr. : April - September.

Locality : Gujarat.

Notes : In tidal forests. The species is included based on the authority of Untawale & Wafer (1988) ; Naskar & Mandal (1999). Fruits are used in medicine for eye diseases and its Knee-bent roots yield a perfume (Banerjee *et al.* 1989).

CERIOPS Arn.

Key to the species

- 1a. Petals with terminally 3-clavate appendages,
anthers shorter than filaments ; hypocotyle up to
25 cm long with sharp end

....

C. tagal

- 1b. Petals without clavate appendages, terminally
ciliated ; anthers longer than filaments ;
hypocotyle up to 12 cm long, apex blunt

....

C. decandra

Ceriops decandra (Griff.) Ding Hou, Fl.
Males. Ser. I. 5(4) : 471. 1958. *Bruguiera*
decandra Griff. ; *Ceriops roxburghiana*
Arn.

Shrubs or small trees, 2 - 5 m high ; stem
base pyramidal with many stilt roots. Leaves
opposite decussate, exstipulate, elliptic-ob-
long or obovate, apex emarginate, base
cuneate. Inflorescence *ca* 1 cm long in

condensed axillary cymes. Flowers 6 - 10,
white, axillary, calyx 5 - 6 merous, whitish
yellow, petals 5 - 6, oblong, apex tipped with
many ciliae. Stamens 20, free. Carpels 3,
united ; ovary inferior, style one, stigmas 3.
Fruits capsule. Hypocotyle angular, sulcate.

Fl. & Fr. : Almost throughout year.

Locality : Gujarat (Untawale, 1986).

C. tagal (Perr.), Robinson, Philipp. J. Sci. Bot. 3 : 306. 1908. *Rhizophora tagal* Perr. *Ceriops candolleana* Arn.

(Pl. D, figs. 3, 4 & 6 ; Pl. E, fig. 1).

Local name : 'Kanari'.

Large shrubs or small trees, 1-4 m high ; stem branched, buttressed and with stilt roots. Leaves 4 - 10.5 × 1.5 - 4.2 cm, obovate - oblong, ovate-oblong or spatulate, leathery, fleshy, emarginate or rounded at apex, cuneate at base, petiolate. Flowers white, sessile in axillary clustered cymes. Fruits 1.5 - 2 cm long, ovoid, conical with fleshy sepals; hypocotyle reddish brown, grooved and ribbed.

Fl. & Fr. : September - July.

Locality : Kutch : Mundra (Rao, 1970). Saurashtra : Bedibandar, Jodia bandar, Sosbari and Pirotan island (Jamnagar). South Gujarat : Udvada and Umbergaon creek (Valsad district).

Notes : Frequent along the tidal creeks in association with AEGICERAS, AVICENNIA and RHIZOPHORA species. Occasionally a symbiotic lichen (*Roccella belangeriana*) was found growing on stems of the species at Pirotan island (Pl. I, fig. 1). Stem bark is rich in tannin and used to dye fishing nets ; its wood used for boat building etc. Medicinally, root decoction is used as a substitute for quinine and to stop haemorrhage and applied on malignant ulcers.

RHIZOPHORA L.

Key to the species

- | | | |
|--|-----|---------------------|
| 1a. Leaves elliptic, mucronate at apex, flowers pedicellate
in group of 4 - 8, petals hairy | ... | <i>R. mucronata</i> |
| 1b. Leaves oblong lanceolate, acute at
apex, flowers 2, sessile ; petals glabrous | ... | <i>R. apiculata</i> |

Rhizophora apiculata Bl. En. Pl. Jav. 1: 91. 1827. *R. conjugata* Arn., auct. non L.
Local name : 'Karod'. (Pl. F, fig. 1).

Trees, 5 - 12 m high ; stem base with numerous stilt roots. Leaves 8.5 - 14 × 4.2 - 6.5 cm, tapering at base. Flowers creamy white, in pairs of upper leaf axils; stamens 12, 4 episepalous, paired ; 4 epipetalous.

Fruits ca 2.5 cm long, conical or obclavate at the base; hypocotyle cylindrical, 30 - 50 cm long.

Fl. & Fr. : May - September.

Locality : Saurashtra : Pirotan islands near Jamnagar.

Notes : Infrequent along the tidal creeks and islands. Stem-bark yields tannin and ply-

wood adhesive. Wood and leaves are also used as fuel and fodder respectively.

R. mucronata Lam. Encycl. 6:189. 1804.

(Pl. E, fig. 2 ; Pl. F, fig. 2,4.)

Local name : 'Kandel, Karod'.

Trees 5 - 15 m high, supported by branched stilt roots. Leaves 7.5 - 15 × 3.6 - 7.2 cm, coriaceous, cuneate at base. Flowers creamy white, in axillary cymes ; stamens 8, 4 episealous, 4 epipetalous. Fruits ovoid-conical with persistent calyx lobes ;

hypocotyle 30 - 60 cm long, cylindrical, smooth.

Fl. & Fr. : August - December.

Locality : Kutch : Kandla, Mundra. Saurashtra : Dwarks, Navalakhi ; Bedibandar, Pirotan islands and Sosbari in Jamnagar district. South Gujarat : Umbergaon creek in Valsad district.

Notes : Frequent along the tidal creeks in association with *AVICENNIA* and *CERIOPS* species. Fruits are edible. Other uses are similar to *R. apiculata*.

SONNERATIACEAE

SONNERATIA L.f.

Key to the species

- 1a. Petals absent ... *S. apetala*
- 1b. Petals present :
 - 2a. Leaves mucronate with apical nobs ; flowers reddish- purple with flattened calyx tube .. *S. caseolaris*

Sonneratia alba J. Sm. In Rees Cyclop 2 : 33. 1819.

Small trees up to 5 m high ; stem much branched, pneumatophores many, corky. Leaves glabrous, 5 - 7.4 × 4 - 6 cm, elliptic, oblong or suborbicular, apex obtuse, base narrowed. Flowers white ; calyx tube cup-shaped, 6 - 8 ; lobes lobed - obscure in flower, distinct in fruits ; petals white, small ; ovary depressed globose, style one, stigma capitate.

Fruits obconical *ca* 3 cm in diam., with persistent calyx and pointed style.

Fl. & Fr. : April - September.

Locality : Gujarat (Naskar & Mandal, 1999).

Sonneratia apetala Buch.-Ham. Syems, Embassy Ava 3 : 477. 1800.(Pl.D, fig 1).

Large trees, 15 - 30 m high ; branches

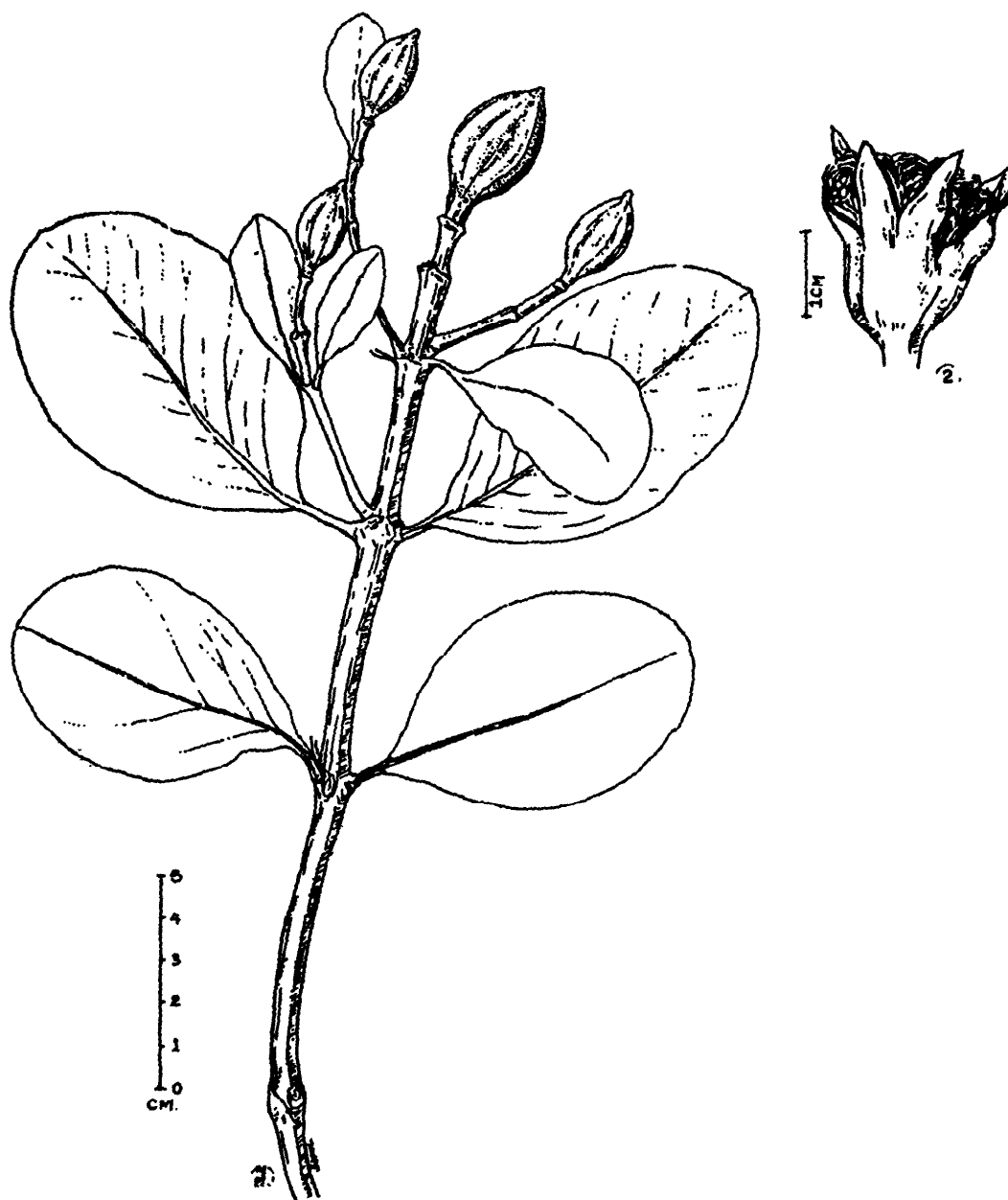


Fig. 7 : *Sonneratia alba* J. Sm. : 1. Habit. 2. Flower.

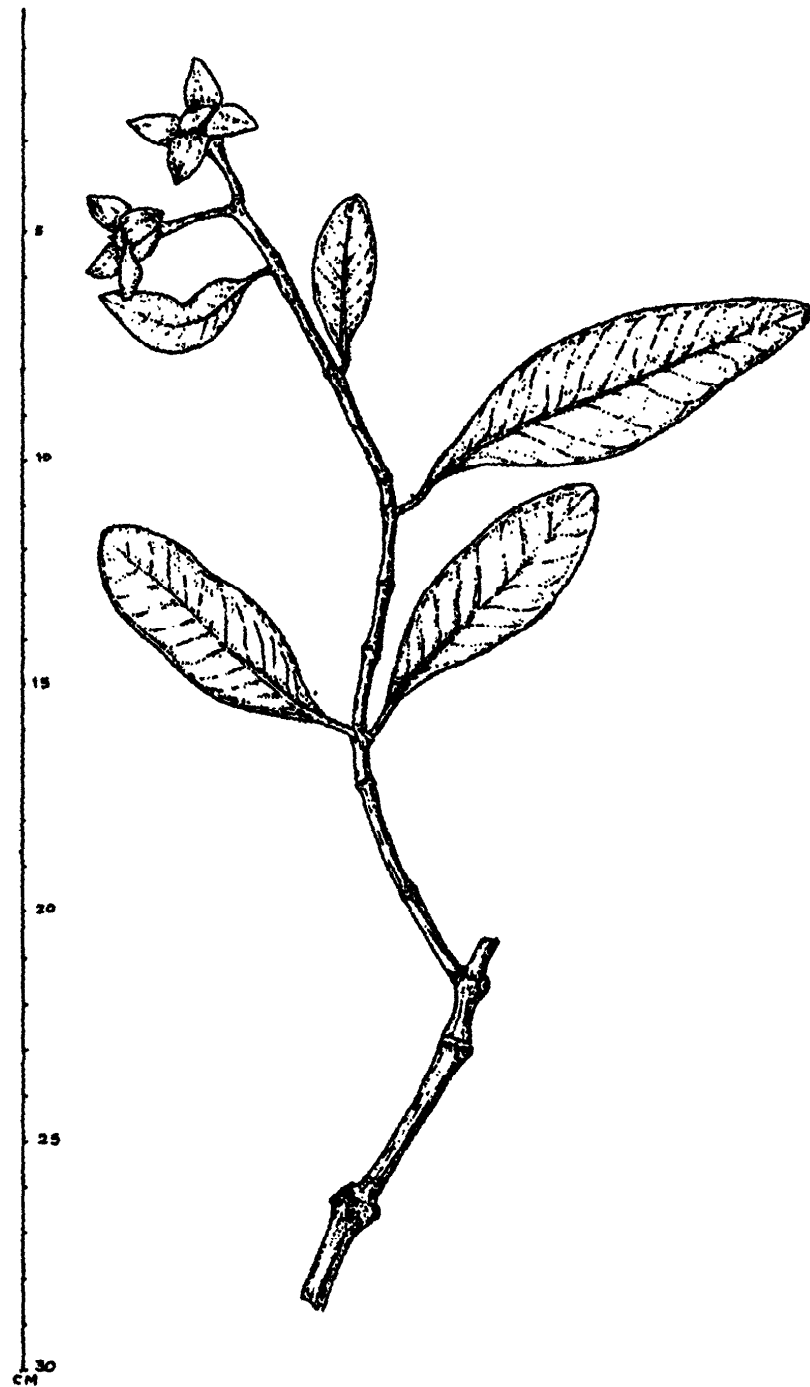


Fig. 8 : *Sonneratia apetala* Buch.-Ham.

many, slender, drooping, bark thin, brownish; pneumatophores, 50–100 cm long, forked. Leaves 4.5–10 × 2–3.5 cm, oblong-lanceolate or elliptic - oblong, obtuse at apex, tapering at base. Flowers apetalous, cream coloured, in 3-flowered dichasial cymes 4-merous, cup-shaped; stamens many, exserted. Capsules *ca* 2 cm across, 1 depressed, globose, tipped with style.

Fl. & Fr. : February - April.

Locality : South Gujarat : Khatalwada in Umbergaon creek (Valsad district).

Notes : Rare along the muddy creeks. The plant is reported from Daman near Valsad (Rao, 1986). Shah (1978) and Banerjee *et al.* (1989) have not mentioned its occurrence from Gujarat coast. Fruits are edible and used as vegetables. Leaves used as fodder and wood as fuel.

Sonneratia caseolaris (L.) Engl. in Engl. & Prant. Nachtr. 261. 1897. *S. acida* L.f.

Small trees up to 6 m high; bark white; pneumatophores many, corky. Leaves 5-10 × 3-5 cm, elliptic-oblong or obovate, apex mucronate, base attenuated. Flowers reddish-purple, solitary and terminal; calyx tube flattened, 6-lobed; petals 6, linear-oblong, membranous; ovary depressed globose; style one, stigma capitate. Fruits depressed globose with persistent calyx and pointed style.

Fl. & Fr. : March - July.

Locality : Gujarat (Naskar & Mandal, 1999); Both coast of Indian Peninsula (Banerjee *et al.*, 1989).

Notes : Common along intertidal banks of creeks and channels in mangrove forests.

Table V : List of other plants known/collected from Gujarat Coast.

S. No.	Species	Families	Habit	Ecological Notes
1.	<i>Acacia nilotica</i> (L.) Del. subsp. <i>indica</i> Bth. Brenan	Mimosaceae	Shrubs	Common on sandy soil.
2.	<i>Aeluropus lagopoides</i> (L.) Trin.	Poaceae	Herbs	Common on mud flats.
3.	<i>Aerva lanata</i> (L.) Juss.	Amaranthaceae	Herbs	Common on sandy soil.
4.	<i>Alhagi pseudalhagi</i> (M. Bieb.) Desv.	Fabaceae	Herbs	Common on sandy soil.

S. No.	Species	Families	Habit	Ecological Notes
5.	<i>Aloe barbadense</i> Mill.	Liliaceae	Shrubs	Frequent on sandy soil.
6.	<i>Alternanthera paronychioides</i>	Amaranthaceae	Prostrate herbs	Frequent on sandy soil.
7.	<i>Amaranthus spinosus</i> L.	„	Erect herbs	Common on sandy soil.
8.	<i>Apluda mutica</i> L.	Poaceae	Erect	Frequent on sandy soil.
9.	<i>Aristida adscensionis</i> L.	„	Erect herbs	Frequent on sandy soil.
10.	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Shrubs	Frequent on sandy soil.
11.	<i>Atriplex stocksii</i> (Wt.) Boiss.	Chenopodiaceae	Erect herbs	Frequent on salt pans.
12.	<i>Bergia ammanioides</i> Roxb.	Elatinaceae	Erect or sub-erect herbs	Frequent in salt marshes.
13.	<i>Blumea mollis</i> (D.Don) Merr.	Asteraceae	Erect herbs	Frequent on sandy soil.
14.	<i>Boerhavia diffusa</i> L.	Nyctaginaceae	Erect, diffuse herbs	Frequent on sandy coast.
15.	<i>Brachiaria ramosa</i> (L.) Stapf	Poaceae	Herbs	Frequent on sandy soil.
16.	<i>Caesulia axillaris</i> Roxb.	Asteraceae	Diffuse herbs	Frequent on mud flats.
17.	<i>Calotropis gigantea</i> (L.) R. Br.	Asclepiadaceae	Erect herbs	Frequent on sandy soil.

S. No.	Species	Families	Habit	Ecological Notes
18.	<i>Canavalia maritima</i> (Aubl.) Thouars.	Fabaceae	Climber	Occasionally on mangroves.
19.	<i>Capparis decidua</i> (Forssk.) Edgew.	Capparidaceae	Shrubs	Frequent on sandy soil.
20.	<i>C. spinosa</i> L. var. <i>galeata</i> Hook. f. & Thoms.	„	Shrubs	Frequent on sandy soil.
21.	<i>Cassia auriculata</i> L.	Caesalpiniaceae	Herbs	Frequent on sandy soil.
22.	<i>C. italica</i> (Mill.) Lam. ex F.W. Andrews.	„	Herbs	Frequent on sandy soil.
23.	<i>Cassytha filiformis</i> L.	Lauraceae	Stem parasite mangroves	Frequently climbing and spreading.
24.	<i>Casuarina equisetifolia</i> L.	Casuarinaceae	Shrubs or trees	Planted in coastal areas.
25.	<i>Cenchrus biflorus</i> Roxb.	Poaceae	Erect herbs	Frequent on sands.
26.	<i>C. ciliaris</i> L.	„	Erect herbs	Frequent on sands.
27.	<i>Chenopodium album</i> L.	Chenopodiaceae	Erect herbs	Frequent on sands.
28.	<i>Chloris virgata</i> Sw.	Poaceae	Erect herbs	Frequent on sands.
29.	<i>Cleome viscosa</i> L.	Cleomaceae	Erect herbs	Frequent on sands.

S. No.	Species	Families	Habit	Ecological Notes
30.	<i>Clerodendrum inerme</i> (L.f.) Gaertn.	Verbenaceae	Shrubs	Frequent on saline soil & associated with mangroves.
31.	<i>Cocos nucifera</i> L.	Arecaceae	Trees	Usually planted in coastal areas.
32.	<i>Commiphora wightii</i> (Arn.) Bhandari	Burseraceae	Shrubs	Frequent on sandy & stony soil.
33.	<i>Cressa cretica</i> L.	Convolvulaceae	Herbs in patches	Common on sandy & saline soil.
34.	<i>Crotalaria burthia</i> (Buch.-Ham.) ex Benth.	Fabaceae	Herbs	Frequent on sandy soil.
35.	<i>C. medicaginea</i> Lam.	„	Herbs	Frequent on sandy soil.
36.	<i>C. verrucosa</i> L.	„	Herbs	Frequent on sandy and in marshy soil areas.
37.	<i>Cyperus arenarius</i> Retz.	Cyperaceae	Tufted herbs	Frequent on sandy and in marshy soil areas.
38.	<i>C. bulbosus</i> Vahl.	„	Tufted herbs	Frequent on salt marshes.
39.	<i>C. pachyrhizus</i> Nees	„	Tufted herbs	Occasional on sandy shores.
40.	<i>C. rotundus</i> L.	„	Tufted herbs	Common along the coastal region.

S. No.	Species	Families	Habit	Ecological Notes
41.	<i>Datura metel</i> L.	Solanaceae	Under-shrubs	Frequent on sandy soil.
42.	<i>Delonix elata</i> (L.) Gamble	Caesalpiniaceae	Trees	Frequent on sandy soil.
43.	<i>Desmodium triflorum</i> (L.) DC.	Fabaceae	Prostrate herbs	Frequent on sandy soil.
44.	<i>Digera arvensis</i> Forssk.	Nyctaginaceae	Suberect herbs	Frequent on sandy soil.
45.	<i>Eclipta alba</i> (L.) Hassk.	Asteraceae	Erect herbs	Frequent on sandy soil.
46.	<i>Euphorbia nivulia</i> Butch.-Ham.	Euphorbiaceae	Shrubs	Frequent on sandy & muddy soil.
47.	<i>Evolvulus alsinoides</i> (L.) L.	Convolvulaceae	Prostrate herbs	Frequent on sandy soil.
48.	<i>Fagonia cretica</i> L.	Zygophylliaceae	Spiny undershrubs	Common on sandy and rocky soil.
49.	<i>Fimbristylis complanata</i> (Retz.) Link	Cyperaceae	Erect herbs	Frequent on marshy places.
50.	<i>F. tetragona</i> R.Br.	„	Erect herbs	Frequent on marshy places.
51.	<i>Geissaspis cristata</i> Wight & Arn.	Fabaceae	Erect herbs	Frequent on marshy places.
52.	<i>Glinus lotoides</i> L.	Molluginaceae	Tufted herbs	Frequent on sandy soil.

S. No.	Species	Families	Habit	Ecological Notes
53.	<i>Halopyrum mucronatum</i> (L.) Stapf	Poaceae	Tufted herbs	Frequent on saline soil.
54.	<i>Helichrysum cutchicum</i> (Cl.) Rolla Rao et Desh.	Asteraceae	Herbs	Infrequent on sandy soil.
55.	<i>Heliotropium curassavicum</i> L.	Boraginaceae	Prostrate herbs	Frequent on saline soil.
56.	<i>H.marifolium</i> Koen. ex Retz.	„	Herbs	Common on sandy soil.
57.	<i>H. subulatum</i> Hochst. ex DC.	Boraginaceae	Erect herbs	Common on sandy soil.
58.	<i>Hydrophylax maritima</i> L. f.	Rubiaceae	Prostrate herbs	Frerquent along sea coast
59.	<i>Indigofera cordifolia</i> Heyne ex Roth	Fabaceae	Prostrate herbs	Common on sandy coast.
60.	<i>I. tinctoria</i> L.	„	Shrubs	Common on sandy coast.
61.	<i>Juncus maritimus</i> L.	Cyperaceae	Shrubs	Occasional on salt pans.
62.	<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajagopal	Asteraceae	Creeping herbs	Common on sandy soil.
63.	<i>L. sarmentosa</i> Alst.	„	Creeping herbs	Common on sandy soil.
64.	<i>Opuntia elatior</i> Mill.	Euphorbiaceae	Spiny shrubs	Frequent on sandy coast.
65.	<i>Parkinsonia acutangula</i> L.	Mimosaceae	Shrubs	Introduced on sandy areas.

S. No.	Species	Families	Habit	Ecological Notes
66.	<i>Pedaliium murex</i> L.	Pedaliaceae	Herbs	Frequent on sandy soil.
67.	<i>Pentatropis capensis</i> (L.) Bullock	Asclepiadaceae	Climbers	Frequent on coastal areas
68.	<i>Peplidium maritimum</i> (L.f.) Wetst.	Scrophulariaceae	Herbs	Frequent on sandy soils.
69.	<i>Perotis indica</i> (L.) O. Ktze.	Poaceae	Herbs	Frequent on sandy soils.
70.	<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Trees	Frequent along sea coast.
71.	<i>Physalis minima</i> L.	Solanaceae	Diffuse herbs	Frequent on sandy soils.
72.	<i>Polycarpon prostratum</i> (Forssk.) Ach.-Schw.	Caryophyllaceae	Herbs	Frequent on sandy soils.
73.	<i>Porteresia coarctata</i> (Roxb.) Tataoka	Poaceae	Tufted herbs	Occasional on saline soil.
74.	<i>Portulaca oleracea</i> L.	Portulacaceae	Prostrate herbs	Common on moist sandy soil.
75.	<i>Prosopis chilensis</i> (Mol.) Stunty.	Mimosaceae	Trees	Common on sandy coast.
76.	<i>Salicornia brachiata</i> Roxb.	Chenopodiaceae	Erect herbs or under-shrubs	Frequent on salt marshes.
77.	<i>Salsola baryosma</i> (R. & S.) Dandy	„	Much branched under-shrubs	Frequent on saline soil.
78.	<i>Salvadora oleoides</i> Decne	Salvadoraceae	Trees	Frequent on sandy coast.

S. No.	Species	Families	Habit	Ecological Notes
79.	<i>S. persica</i> L.	„	Shrubs	Frequent on sandy soil & marshy areas.
80.	<i>Scaevola taccada</i> Roxb.	Goodeniaceae	Shrubs.	Along sundy coast.
81.	<i>Scirpus littoralis</i> Schrad.	Cyperaceae	Herbs	Frequent on sandy & marshy areas.
82.	<i>Sesuvium portulacastrum</i> (L.) L.	Aizoaceae	Prostrate succulent herbs	Common on muddy flats, salt pans etc.
83.	<i>Spinifex littoreus</i> (Burm.f.) Merr.	Poaceae	Creeping shrubs	Common on sandy coast.
84.	<i>Sporobolus tenuissimus</i> (Shrank.) O. Ktze.	„	Tufted herbs	Common on sandy coast.
85.	<i>Suaeda fruticosa</i> (L.) Forssk. ex Gmel.	Chenopodiaceae	Suberect or diffuse herbs	Frequent on mud flats.
86.	<i>S. maritima</i> (L.) Dum	„	Suberect or diffuse herbs	Frequent on mud flats.
87.	<i>S. monoica</i> Forssk.	„	Erect herbs	Infrequent on mud flats.
88.	<i>S. nudiflora</i> (Willd.) Moq.	„	Branched under-shrubs and puffed herbs	Common along sea-coast & mud flats.
89.	<i>Sporobolus virginicus</i> (L.) Kunth	„	Branched under-shrubs and puffed herbs	Common on sandy coast.
90.	<i>Tamarix aphylla</i> (L.) Karst.	Tamaricaceae	Shrubs	Frequent on sandy & loamy soil.
91.	<i>T. troupii</i> Hole	„	Shrubs	Frequent on muddy soil in association with <i>Avicennia</i> sp.

S. No.	Species	Families	Habit	Ecological Notes
92.	<i>Taverniera cuneifolia</i> (Roth) Arn.	Fabaceae	Prostrate or erect herbs	Frequent on sandy soil.
93.	<i>Tephrosia purpurea</i> (L.) Pers.	Fabaceae	Erect herbs or under shrubs	Frequent on sandy soil.
94.	<i>T. uniflora</i> Pers. subsp. <i>petrosa</i> (Blatt. & Hallb.) Gill.	„	Erect herbs or under-shrubs	Frequent on sandy soil.
95.	<i>Trianthema triquetra</i> Rottl. & Willd.	Aizoaceae	Prostrate herbs	Frequent on sandy soil.
96.	<i>Tribulus terrestris</i> L.	Zygophyllaceae	Prostrate herbs	Frequent on sandy coast.
97.	<i>Urena lobota</i> L.	Malvaceae	Herbs	Frequent on sandy coast.
98.	<i>Urochondra setulosa</i> (Trin.) Hubb.	Poaceae	Erect herbs	Frequent on salt marshes.
99.	<i>Vitex negundo</i> L.	Verbenaceae	Under-shrubs	Frequent on sandy soil.
100.	<i>V. trifolia</i> L.	„	Herbs	Frequent on sandy soil.
101.	<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	Trees	Frequent on sandy coast.
102.	<i>Zoysia matrella</i> (L.) Merr.	Poaceae	Creeping herbs	Frequent on sandy soil.

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