CHAPTER 9: FLORAL DIVERSITY OF THE STUDY AREA AND PHYTO-SOCIOLOGICAL STATUS OF MANGROVES

9.1 FLORAL DIVERSITY

The marine floral components of the gulf are most varied and range from mangroves to marine algae. An inventory of higher plants found in the different microhabitats of the study area has been made. The vegetational components encountered in the study area have been listed under the following major categories

1. True mangroves
2. Mangrove associate and salt marsh halophytes
3. Sand beach vegetation
4. Island vegetation

9.1.1 TRUE MANGROVES

Mangroves are the most conspicuous vegetation of the region. Plants that have complete fidelity to the mangrove environment have been considered true mangroves. The classification given by Tomlinson (1986) has been followed except for the presence of one variety (*Avicennia marina* (Forsk.) Vierh. var. *acutissima* Stapf & Mold.). The list of mangrove species located in the study area has been given in the table 9.1.

Table 9.1 Mangrove species located in the study area

Sr. No.	Family / Mangrove Species
	RHIZOPHORACEAE
1.	*Ceriops tagal* (Perr.) C. E. Robin.
2.	*Rhizophora mucronata* Lamk.
	MYRSINACEAE
3.	*Aegiceras corniculatum* Blanco
	AVICENNIACEAE
4.	*Avicennia alba* Bl.
5.	*Avicennia marina* (Forsk.) Vierh. var. *acutissima* Stapf & Mold.
6.	*Avicennia marina* (Forsk.) Vierh. var. *marina*
7.	*Avicennia officinalis* Linn.

9.1.1.1 *AVICENNIA*

Avicennia is the dominant genus present in the area and the most dominant species is *Avicennia marina* var. *marina* accounting for almost 60 percent of the total area covered by mangrove vegetation. It is commonly known in the area as '***Cher***'. It can be easily identified from the other species of *Avicennia* by its elliptic-oblong leaves and apiculate fruits. It is generally present on the seaward margins of the mangrove vegetation. It grows to an average height of about 2 m but towards the edge of the creeks its growth may reach up to 3.5 m.

Avicennia marina var. *acutissima* is the second most common species in the area. Locally known as '***Murari***' it mostly occupies the landward side of the habitat. The height of the plant rarely reaches above 1.6 m and the average height of the plant is about 90 cm. The species can be identified by its shiny sessile to sub-sessile leaves and acuminate apex. It is also characterized by a distinct yellowish tinge. At several places, the leaves of the plant curved towards the lower margin. It generally has an open canopy and is mostly associated with the back mangrove elements at the landward margins.

Avicennia alba is found in small patches all over the study area. Commonly known as '***Pat-cher***', it is distinguished from other species by its acute apex and the pale greenish tinge on the upper surface. Among all the species of *Avicennia* it appears the most pale-green in colour. Another characteristic feature of the plant is that the bark is light brown to whitish in colour. It has a very short height averaging around 60 cm and the maximum height reached 1 m.

Avicennia officinalis is present in very few numbers in the area. Locally known as '***Tiwar***', it is usually found on the edges of creeks. It does not form conspicuous patches, occurring more as individual plants.

9.1.1.2 *CERIOPS*

Ceriops is the second most common genus within the area, with the species *Ceriops tagal*, locally known as '***Kundari***'. It generally grows in almost pure continuous patches, however it has also been seen growing scattered among the other mangrove species. Located mostly on the islands it is usually found at a comparatively higher elevation than the other species. The plants grow on firm

soil and in such dense patches that it is almost impossible to walk through without physically damaging them. It grows to a maximum height of 2 m and the average height is about 1.2 m. A narrow yellow band just below the stalk characterizes the ripe fruits.

9.1.1.3 *RHIZOPHORA*

Rhizophora with its characteristic stilt roots is the most easily distinguishable genus in the area. The genus is represented by a single species, *Rhizophora mucronata*. It is commonly known in the area as '***Karod***'. The plant usually grows in pure patches and very few scattered individuals have been located. It has an average height of about 2.5 m but at Baga belan it reached a height of more than 5 m. It grows on very soft substratum and in most cases surrounding small creeks.

9.1.1.4 *AEGICERAS*

Aegiceras corniculatum does not form continuous patches and is mostly found scattered among the other mangrove plants. Locally known as '***Agirops***' or '***Chawario***' it is generally found on islands, except the sites opposite Chiriya Bet and Pathe Pir ka bela on the mainland. It inhabits a group of islands to the east of Dide ka bet i.e. on Bhains bid, Chiriya Bet and Pathe Pir ka bela. It grows to an average height of about 1.5 m and the tallest plant located had a height of 2.5 m.

Plates 9.1 to 9.3 depict the vegetative as well as the reproductive stages of the true mangrove species found in the area. In addition to the true mangroves other plants also inhabit the study area. They are broadly divided into mangrove associates, salt marsh halophytes, sand dune vegetation and island vegetation.

9.1.2 MANGROVE ASSOCIATES AND SALT MARSH PLANTS

Mangrove associates do not form large conspicuous patches and are found growing in the mangrove region as well as the terrestrial region. These plants are usually found near the landward margin of mangrove. Salt marsh plants are differentiated from the mangrove plants by the fact that the former form large continuous patches while the latter are found as a few scattered plants here and

Avicennia alba

Avicennia marina var. *marina*

Avicennia marina var. *acutissma*

Plate 9.1 Major Mangroves Of The Study Area

Ceriops tagal

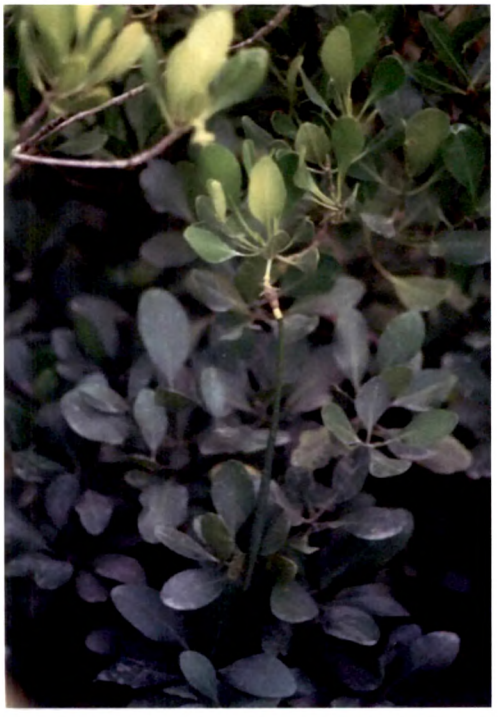
Aegiceras corniculatum

Plate 9.2 Flowering And Fruiting Of Major Mangrove Species - I

Rhizophora mucronata

Avicennia alba

FRUITING OF MAJOR MANGROVE SPECIES



Ceriops tagal

Rhizophora mucronata

Plate 9.3 Flowering And Fruiting Of Major Mangrove Species - II

there. Within the study area large patches of salt marsh that are dominated by one or two species of halophytes have been located. At a few places theses patches covered an area a few hectares in size. The major mangrove associates and salt marsh plants of the study area are detailed in the table 9.2 and a few of them have been shown on plate 9.4

Table 9.2 Mangrove associates and salt marsh plants in the study area

Sr. No.	Mangrove Associate and Salt Marsh Species
	AIZOACEAE
1.	*Sesuvium portulacastrum* (L.) L. (Syn. *Portulaca portulacastrum* L.)
	CHENOPODIACEAE
2.	*Atriplex stocksii* Boiss.
3.	*Salicornia brachiata* Roxb.
4.	*Suaeda fruticosa* (L.) Forsk. ex Gmel.
5.	*Suaeda nudiflora* (Willd.) Moq.
6.	*Suaeda maritima* (L.) Dumort.
	POACEAE
7.	*Aeluropus lagopoides* (L.) Trin. ex Thw.

Sesuvium portulacastrum has been found in large numbers on the mainland region as well as the islands of the study area intermixed with the true mangrove species. It is a prostrate plant and rarely grows to a height of more than 15 cm. It is usually intermixed with *Aeluropus lagopoides,* which grows in dense tufts. At a few places very small patches of *Atriplex stocksii* have been located. Small patches of *Salicornia barchiata* have been found towards the landward margins of creeks. The young plants are bright green in colour while most of the old plants are reddish in colour. It does not grow beyond 40 cm in height.

The salt marsh community is usually found in the high tidal areas. They occur towards the margin of the vegetation along the mudflats. On an average they reach a height of 25 cm, however, at a few localities they have been found reaching a height of 60 cm. These plants are also found scattered within the

Suaeda maritima and *S. fruticosa*

Sesuvium portulacastrum and *Aleuropus lagopoides*

Plate 9.4 Mangrove Associates And Salt Marsh Halophytes

mangrove community but there they do not form large patches. These patches are dominated by different species of *Suaeda*.

9.1.3 VEGETATION ON SAND

Sand beaches are found on all the big islands of the study area including Bhains Bid, Pirotan, Jindra, Chhad, Dide ka bet and Munde ka bet. The smaller islands do not have a beach except the island of Bada bela. The beaches are usually found on the Northern and Western side of the islands. The plant species located on the sand beaches/patches have been listed in table 9.3 below.

Table 9.3 Plant specimens located on sand beaches in the study area

Sr. No.	Beach Vegetation Species/Families
	CAPPARACEAE
1.	*Capparis decidua* (Forsk.) Edgew.
	FABACEAE
2.	*Indigofera astragallina* DC.
	SALVADORACEAE
3.	*Salvadora persica* L.
	BORAGINACEAE
4.	*Heliotropium curassavicum* L.
5.	*Heliotropium bacciferum* Forsk.
6	CONVOLVULACEAE
7.	*Cressa cretica* L.
8.	*Ipomoea pes-carpea* (L.) Sw. (Syn. *Ipomoea biloba* Forsk.)
	OROBANCHACEAE
9.	*Cistanche tubulosa* Wt.
	CYPERACEAE
10.	*Cyperus compressus* L.
11.	*Cyperus pangorei* Rottb.
12.	*Fimbristylis* sp.

The most prominent species on the sand is *Salvadora persica*. It is present on all the beaches in the study area except on Bada bela. They usually have a shrubby

form growing to a mazimum height of 2.5 m. The other prominent sand species is *Ipomoea pes-carpae*, which is also found at almost all places. *Cypersus compressus and Fimbristylis* are also common in the area along with *Helitropium* and *Cressa cretica* in small patches. *Capparis* is found on the islands of Pirotan and Dide ka bet while *Indigofera astragalina* was found growing on Pirotan only. In Pirotan, a parasitic plant, *Cistanche tubulosa* was found growing among *Salvaroda* and *Cyperus*. The major sand vegetation components are shown in plate 9.5

9.1.4 ISLAND VEGETATION

All the islands in the study area are intertidal. There however, occur patches on them that are above the high tide mark. Such patches though still influenced by the sea have a different plant diversity compared to their surroundings. The islands of Pirotan and Munde ka bet have such patches that have vegetation not usually found on the other islands. Except for a few species, which have been also been located on Jindra Island, the species listed below (Table 9.4) have been located at these two islands.

Table 9.4 Island vegetation species located in the study area

Sr. No.	Island Vegetation Species/Families
	MENISPERMACEAE
1.	*Cocculus hirsutus* (L.) Diels
2.	*Cocculus pendulus* (Forst.) Diels
	CLEOMACEAE
3.	*Cleome gynandra* L.
4.	*Cleome viscosa* L.
	PORTULACACEAE
5.	*Portulaca oleracea* L.
	ELATINACEAE
6.	*Bergia suffruticosa* (Del.) Fenzl. (Syn: *Bergia odorata* Edgew.)

	MALVACEAE
7.	*Abutilon glaucum* (Cav.) Sw.
	ZYGOPHYLLACEAE
8.	*Tribulus terrestris* L.
	OXALIDACEAE
9.	*Biophytum sensitivum* (L.) DC.
	BALANITACEAE
10.	*Balanites aegyptiaca* (L.) Del.
	BURSERACEAE
11.	*Commiphora wightii* (Arn.) Bhandari (Syn. *Commiphora mukul* Engl.)
	MELIACEAE
12.	*Azadirachta indica* A. Juss.
	RHAMNACEAE
13.	*Zizyphus mauritiana* Lam.
14.	*Zizyphus nummularia* (Burm. f.) W. & A.
	FABACEAE
15.	*Crotalaria medicaginea* Lam.
16.	*Desmodium triflorum* (L.) DC.
17.	*Tephrosia purpurea* (L.) Pers.
	MIMOSACEAE
18.	*Acacia nilotica* (L.) Del.
19.	*Prosopis chilensis* (Molina) Stuntz. (Syn. *Prosopis juliflora* (Sw.) DC.)
	LYTHRACEAE
20.	*Ammannia baccifera* L.
	CUCURBITACEAE
21.	*Melothria maderaspatana* Cogn. (Syn. *Mukia maderaspatana* (L.) M. Roem.)
	MOLLUGINACEAE
22.	*Glinus lotoides* L.
	AIZOACEAE
23.	*Sesuvium sesuvioides* (Fenzl.) Verd. (Syn. *Trianthema hydaspica* Edgew.)

	ASTERACEAE
24.	*Eclipta prostrata* (L.) L.
25.	*Launaea sarmentosa* (Willd.) Alst.
26.	*Parthenium hysterophorus* L.
27.	*Vernonia cinerea* (L.) Less.
	ASCLEPIADACEAE
28.	*Pentatropis spiralis* (Forsk.) Decne.
	CONVOLVULACEAE
29.	*Convolvulus microphyllus* (Roth) Sieb. ex Spr.
	SOLANACEAE
30.	*Datura innoxia* Mill.
31.	*Physalis minima* L.
	PEDALIACEAE
32.	*Pedalium murex* L.
	EUPHORBIACEAE
33.	*Euphorbia hirta* L.
34.	*Euphorbia neriifolia* Linn.
35.	*Euphorbia tirucalli* L.
	CYPERACEAE
36.	*Cyperus compressus* L.
37.	*Cyperus conglomeratus* Rottb.
38.	*Fimbristylis* sp.
39.	*Scirpus littoralis* Schr.
	POACEAE
40.	*Chloris barbata* Sw.
41.	*Digitaria adscendens* (H. B. & K.) Henr. (Syn. *Digitaria ciliaris* (Retz.) Koel.)
42.	*Eragrostis ciliaris* (Linn.) R. Br.
43.	*Eragrostis pilosa* (L.) P. Beauv.
44.	*Sporobolus* sp.
45.	*Urochondra setulosa* (Trin.) Hubb.

Salvadora persica

Ipomoea pes-carpea

Cistanche tubulosa

Plate 9.5 Sand Vegetation

The island of Pirotan has a dargah (a muslim religious place) due to which a large number of people visit it. Plants such as *Azadirachta indica* and *Tribulus terrestris* on Pirotan Island can be explained only if we take into consideration the above fact. *Urochondra setulosa*, a grass species endemic to India was found in a small patch on Pirotan Island. Few individuals were also found scattered on the mainland as well as on Dide ka bet. Along with *Commiphora*, it has been shown on plate 9.6.

9.2 PHYTO-SOCIOLOGY OF THE TRUE MANGROVE SPECIES

A total of seventeen transects were randomly laid on different islands as well as the mainland to collect data on the phyto-sociology aspect of the true mangroves of the region. Occurrence of mangrove associates and other halophytes was noted. The lengths of transects were variable and dependent on the specific condition of the mangroves of the area starting from the landward or seaward margin and extending till a creek or very dense vegetation did not allow moving further. The details of transects have been given in table 9.5 and their locations have been shown in plate 9.7. Transects numbers 2, 4, 8 and 11 has to be terminated at the indicated points as the *Ceriops* plants were growing so close together that it was not possible to move further without damaging the plants.

Table 9.5 Details of transects laid in the study area

Tr. No.	Location	Start Long. / Lat.	End Long. / Lat.	Length (m)
1.	Dide ka bet - Chankhdi Creek	69.901813 °E 22.529310 °N	69.904235 °E 22.530094 °N	200
2.	Dide ka bet - North of Chankhdi Creek	69.903685 °E 22.533411 °N	69.904270 °E 22.532415 °N	70
3.	Dide ka bet – North East I	69.930135 °E 22.544060 °N	69.927535 °E 22.540440 °N	220
4.	Dide ka bet – North East II	69.931085 °E 22.543328 °N	69.930135 °E 22.542978 °N	90
5	Pathe Pir ka Bela – East	69.934060 °E 22.524056 °N	69.931011 °E 22.525353 °N	400
6.	Pathe Pir ka Bela – North	69.935988 °E 22.530768 °N	69.934387 °E 22.531764 °N	200

Commiphora wightii

Urochondra setulosa

Plate 9.6 Island Vegetation

Plate 9.7 Location of Transects in study area

Tr. No.	Location	Start Long. / Lat.	End Long. / Lat.	Length (m)
7.	Chiriya Tapu – West	69.934377 °E 22.521617 °N	69.636890 °E 22.519505 °N	400
8.	Bhains Bid	69.956262 °E 22.545787 °N	69.954435 °E 22.544601 °N	220
9.	Chhad – South West	69.964023 °E 22.548117 °N	69.964697 °E 22.546985 °N	150
10.	Amudi Bela	70.011033 °E 22.551998 °N	70.011682 °E 22.551022 °N	60
11.	Jindra Gusanga Creek I	70.012372 °E 22.560569 °N	70.013820 °E 22.560348 °N	150
12.	Jindra Gusanga Creek II	70.013018 °E 22.565967 °N	70.014737 °E 22.566148 °N	200
13.	Pirotan – South	69.954747 °E 22.569444 °N	69.654789 °E 22.598863 °N	300
14.	Pirotan – South West	69.951073 °E 22.596730 °N	69.951812 °E 22.597078 °N	60
15.	Mainland I	69.680240 °E 22.508749 °N	69.967007 °E 22.515144 °N	2000
16.	Mainland II	69.675466 °E 22.514758 °N	69.973575 °E 22.517157 °N	300
17.	Mainland III	69.989299 °E 22.544108 °N	69.990559 °E 22.540934 °N	400

The condition of the mangroves in the different regions of the area has been depicted graphically in the cross-sections given on plates 9.8 to 9.11. The plates are indicative of the condition of the mangroves along transects 1, 5, 12 and 17 respectively. These four transects have been chosen as they represent different microhabitat setting in the area. Transect 1 represents an almost pure patch of *Avicennia marina* while transect 5 represents the area with the highest species diversity. Transect 12 is characteristic of the thick vegetation of *Ceriops* in the study area while transect 17 represents the mainland fringing mangroves.

9.2.1 Species Diversity and distribution in the area

The species of mangroves found in the area are compared for their distribution in the area. The species present in each transect have been given in table 9.6. *Avicennia marina* var. *marina* was found in all transects while *Ceriops tagal* was found in 11 of the 17 transects. *Avicennia marina* var. *acutissima* was found in 10

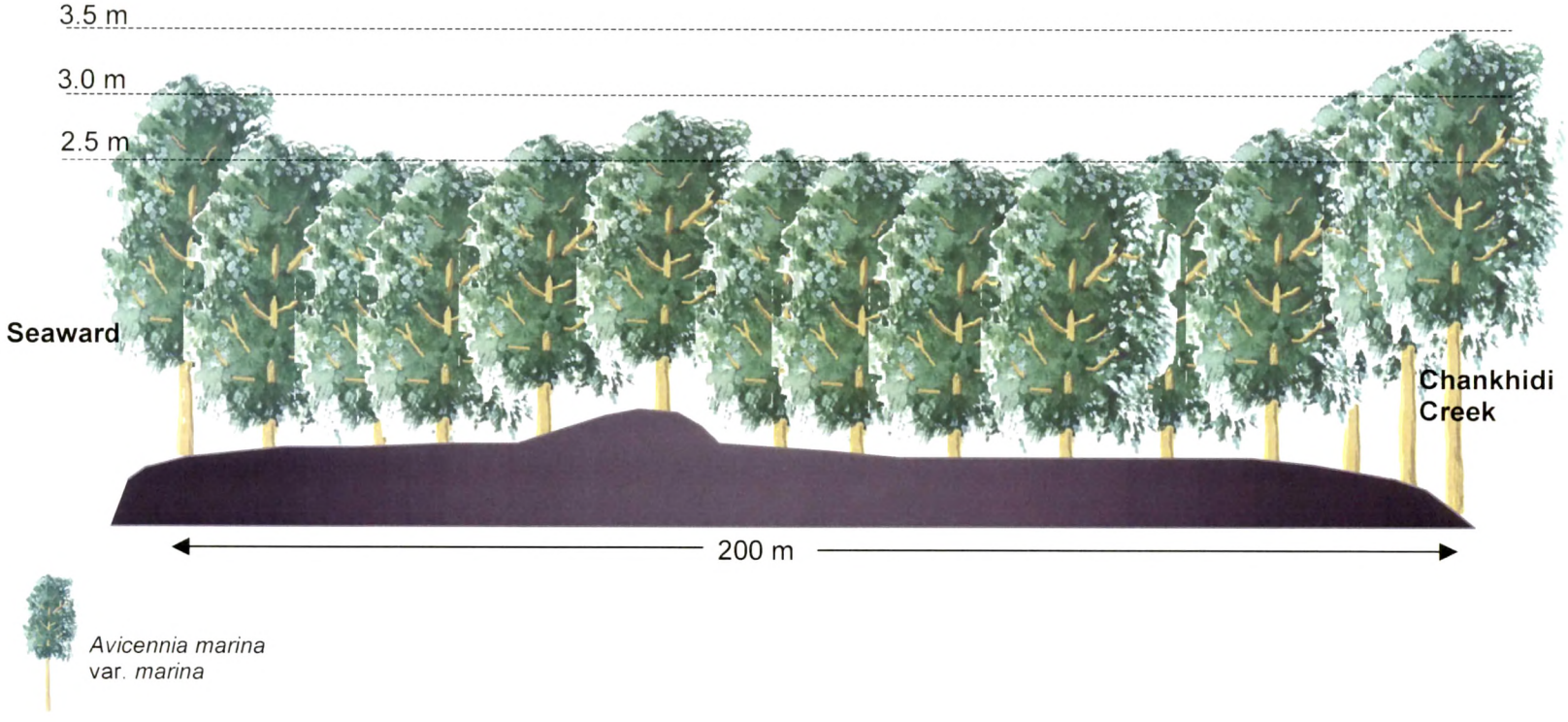


Plate 9.8 Diagrammatic representation of mangroves at transect 1 (Dide ka Bet-Chankhdi Creek)

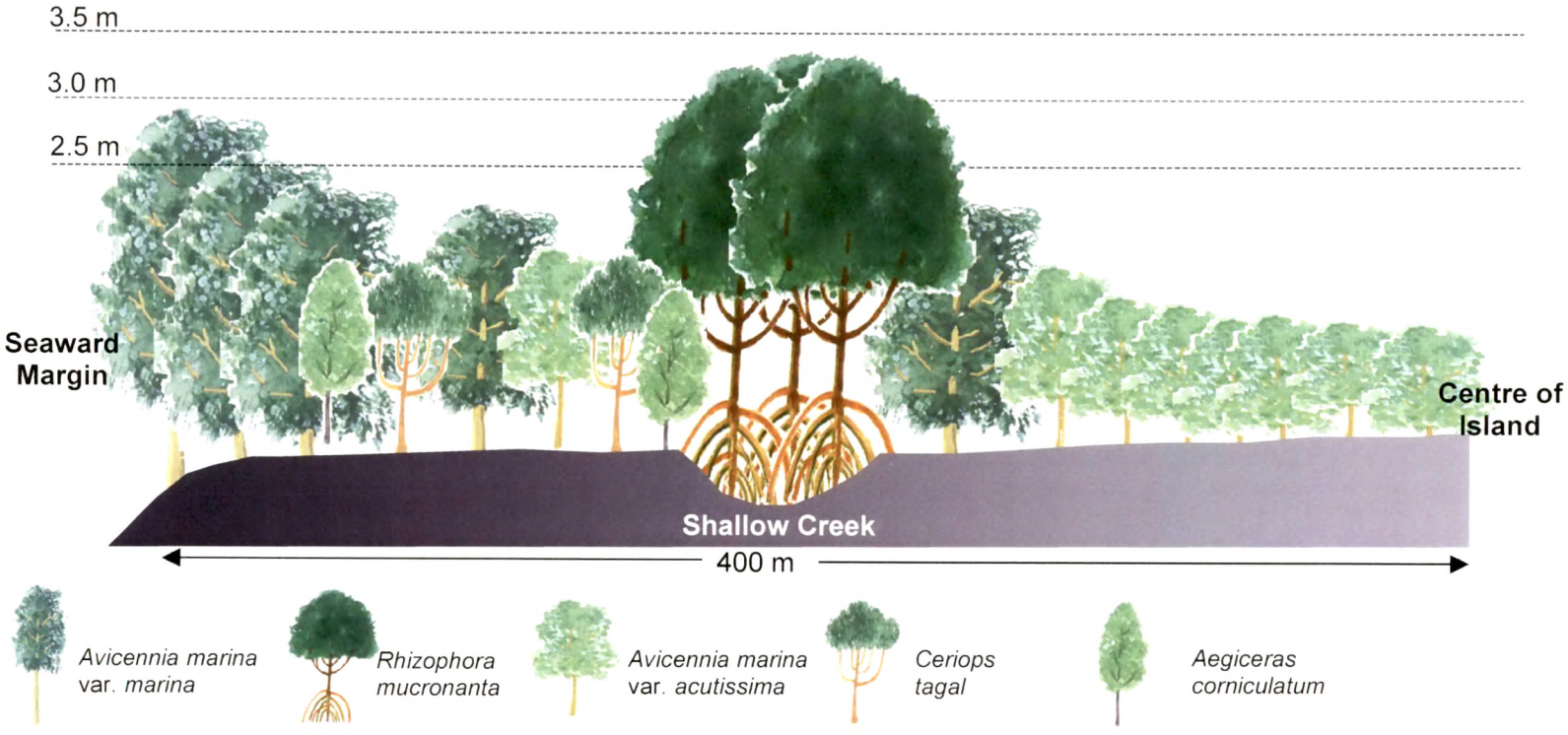


Plate 9.9 Diagrammatic representation of mangroves at transect 5 (Pathe Pir Ka Bela)

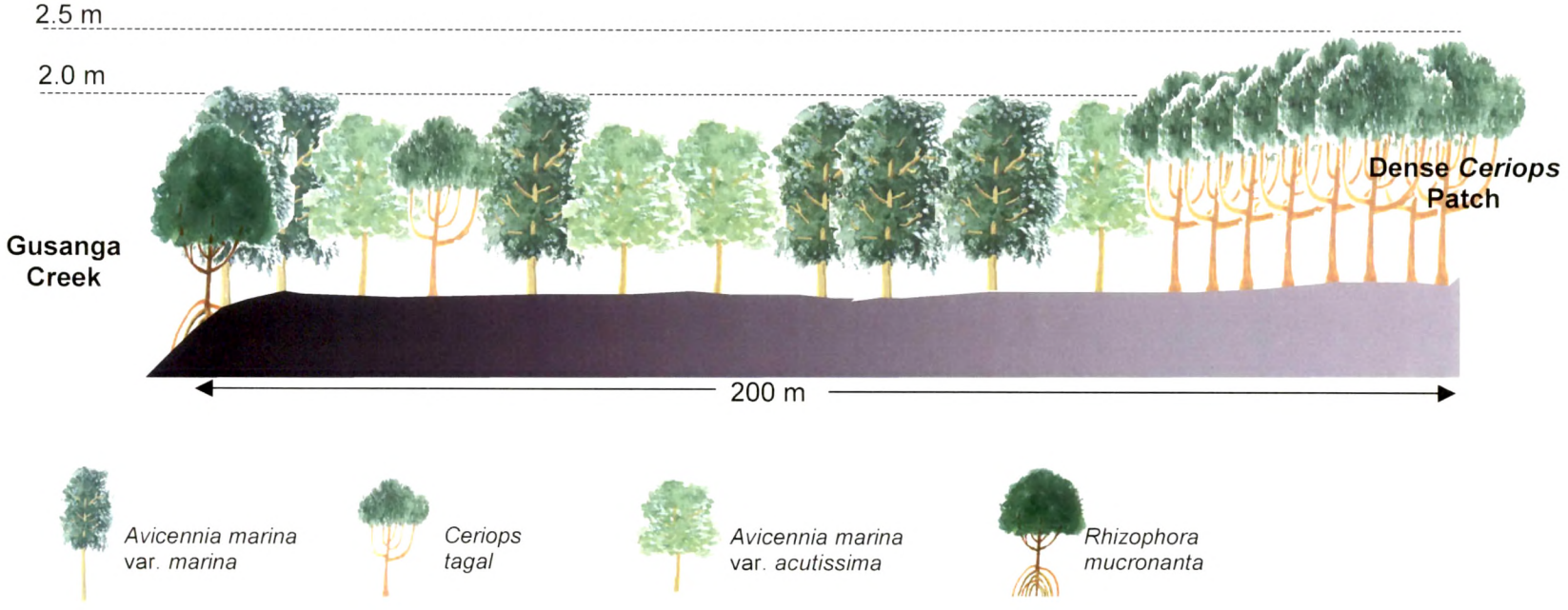


Plate 9.10 Diagrammatic representation of mangroves at transect 12 (Jindra-Gusanga Creek II)

TRANSECT 17: MAINLAND III

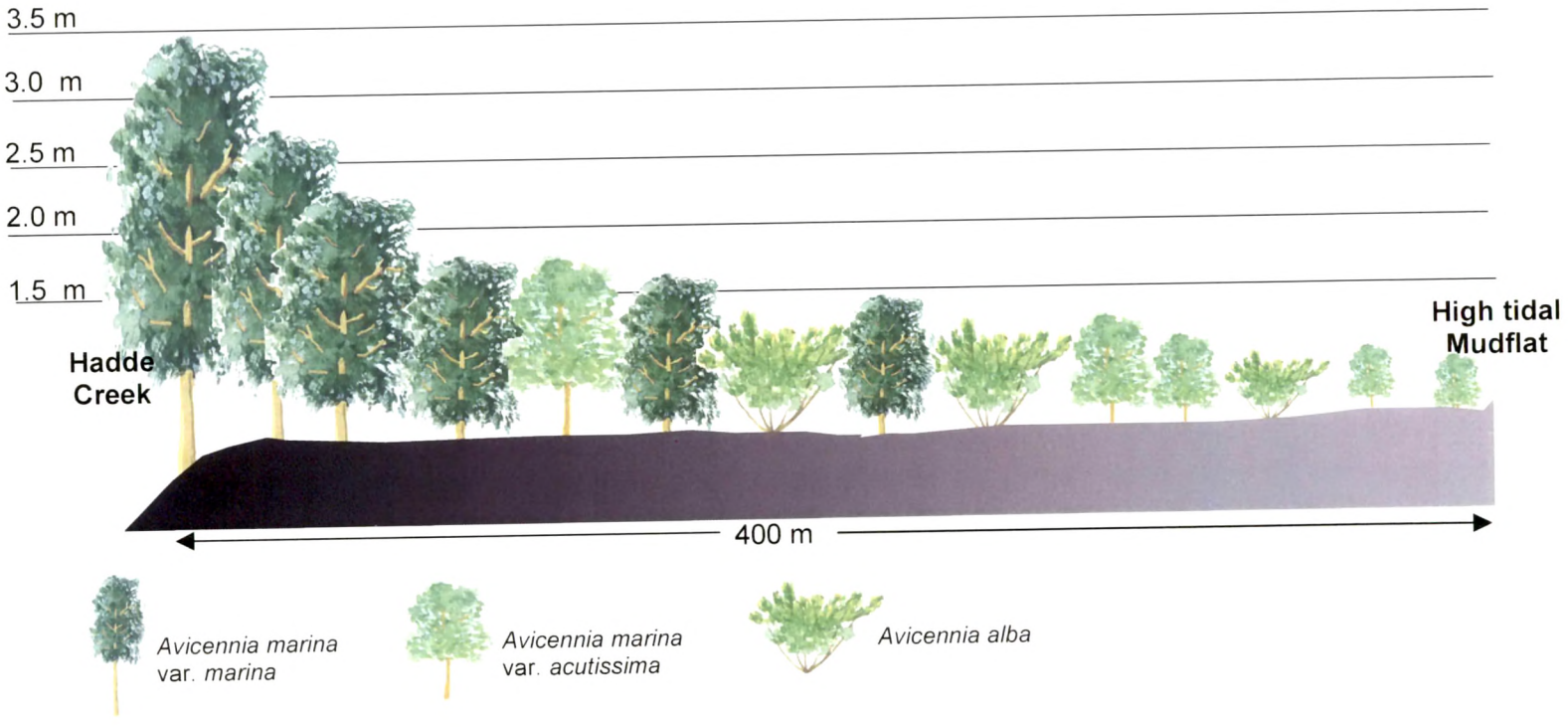


Plate 9.11 Diagrammatic representation of mangroves at transect 17 (Mainland III)

transects, *A. alba* and *R. mucronata* were both found in six transects each while *A. corniculatum* was found in only four transects. *Avicennia officinalis* did not fall into any transect. Transects 5 and 7 have the highest number of species present and are representative of regions of highest diversity in the area. The number of species in each transect and the number of transects in which each species occurs has been graphically depicted in fig 9.1 and 9.2 respectively.

Table 9.6 True Mangrove Species Present in each transect

Transect Number	Location	Species
1.	Dide ka bet - Chankhdi Creek	*Amm*
2.	Dide ka bet - North of Chankhdi Creek	*Amm, Ama, Ct*
3.	Dide ka bet - North East I	*Amm, Aa,*
4.	Dide ka bet - North East II	*Amm, Aa, Ama, Ct*
5.	Pathe Pir ka Bela – East	*Amm, Ct, Rm, Ama, Ac*
6.	Pathe Pir ka Bela – North	*Ct, Rm, Amm, Ac*
7.	Chiriya Tapu – West	*Amm, Ama, Ac, Rm, Ct*
8.	Bhains Bid	*Amm, Ac, Ct, Rm*
9.	Chhad - South West	*Amm, Aa, Ct*
10.	Amudi Bela	*Amm, Ct*
11.	Jindra Gusanga Creek I	*Amm, Ama, Ct*
12.	Jindra Gusanga Creek II	*Amm, Ama, Ct, Rm.*
13.	Pirotan – South	*Amm, Ama, Rm*
14.	Pirotan - South West	*Amm*
15.	Mainland I	*Ama, Amm,Aa, Ct*
16.	Mainland II	*Ama, Amm, Aa*
17.	Mainland III	*Amm, Ama, Aa*

(**Abbreviations used**: *Amm – Avicennia marina* var. *marina*, *Ama – A. marina* var. *acutissima*, *Aa – A. alba*, *Ct – Ceriops tagal*, *Rm – Rhizophora mucronata*, *Ac – Aegiceras corniculatum*)

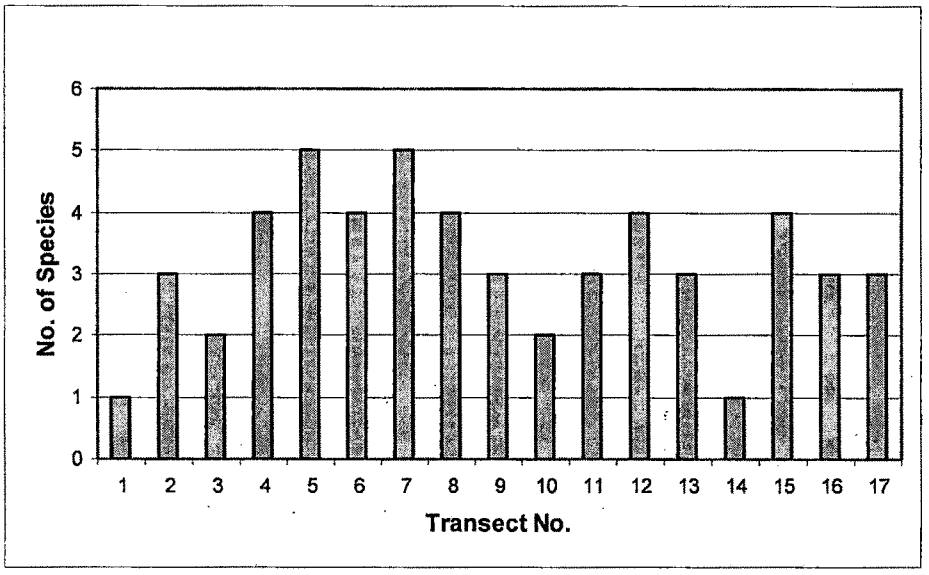


Fig 9.1 Number of true mangrove species present in each transect

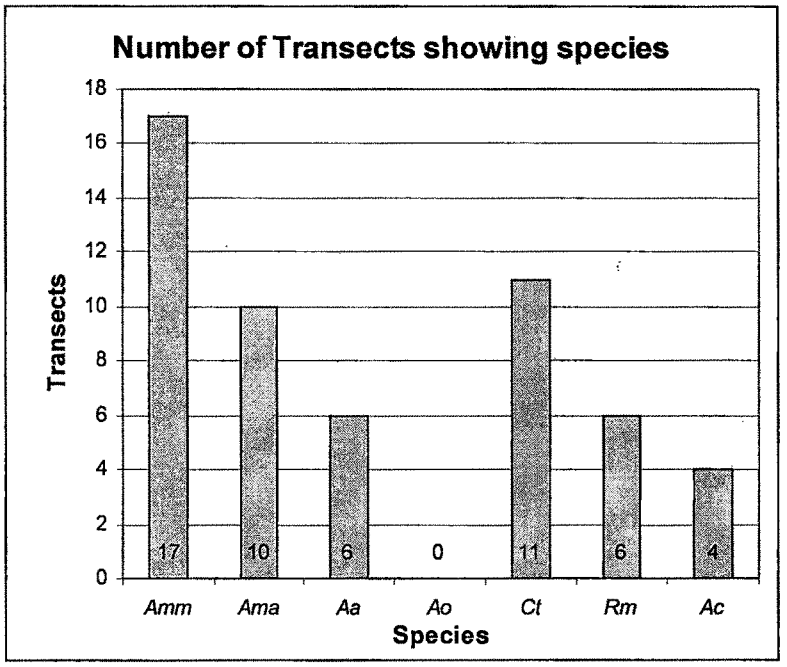


Fig 9.2 Occurrence of mangrove species

9.2.2. Height

The height of the mangrove plants was found to be quite variable. A constant feature however, was that the plants were taller near to the creek or the seaward margin and were the shortest towards the landward side. The tallest plants

encountered in transects were on Pirotan where they had reached a height of about 4.5 m. These mangroves represent an earlier plantation site of the forest department. Other tall mangroves plants that reached a height of 3.5 m were encountered in transects 1 and 17. All these tall mangroves belong to the species *Avicennia marina* var. *marina. Avicennia alba* had the shortest individuals whose average height stood at 0.62 m. The tallest *Rhizophora mucronata* plants which reached a height of about 3.3 m were encountered in transect 7. A comparison of the average and maximum heights of the plants found in the transect has been depicted in fig 9.3.

The tallest mangrove plants in the study area did not fall in any of the transects. These individuals of *R. mucronata* were located on the island Baga belan where they reached a height of more than 5 m.

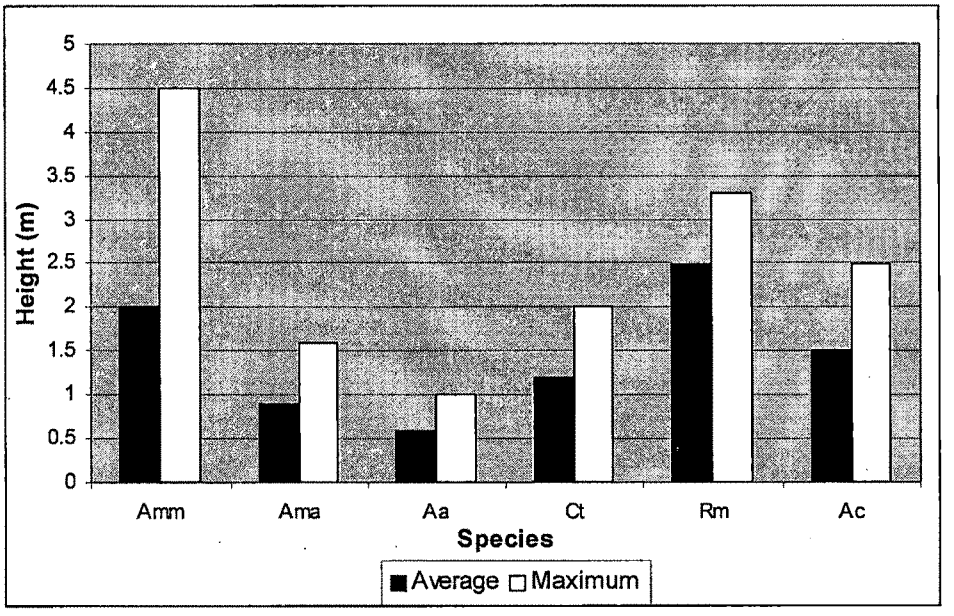


Fig 9.3 Average and maximum heights of the mangrove species (in transects)

9.2.3 Density

The density of the plants have been calculated as per the formula given by Cintron and Novelli (1984) which has been detailed in chapter 6. As the transects were taken on different Islands or different parts of the Islands, they point to the density of mangrove plants in that particular area. The highest density was obtained for transects 2 and 3 while the lowest density were obtained for transect

4 and 15. Transect 3 is a recent plantation site and the fact that the plants are planted near one another seems to be the main reason for its high density. Transect 15 is found on the mainland and is a disturbed patch and that has probably reflected in its low density. It was observed that the density of plants near the creek is slightly higher than towards the interior. The density of the various species found in the different transects have been enumerated in table 9.7 on the next page.

Table 9.7 Density of mangrove species in transects laid down

	Species	Density (individuals per hectare) in transects																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	*Avicennia marina* var. *marina*	2430	925	3908	256	624	1297	878	1004	1554	1787	1183	851	1800	2500	255	319	475
2.	*Avicennia marina* var. *acutissima*	-	2960	-	147	1035	-	594	-	-	-	921	543	926	-	301	701	332
3.	*Avicennia alba*	-	-	782	358	-	-	-	-	723	-	-	-	-	-	152	256	234
4.	*Ceriops tagal*	-	555	-	9	255	952	155	589	189	1277	526	449	-	-	4	-	-
5.	*Rhizophora mucronata*	-	-	-	-	198	433	232	381	-	-	-	47	360	-	-	-	-
6.	*Aegiceras corniculatum*	-	-	-	-	156	778	207	796	-	-	-	-	-	-	-	-	-
	Total	2430	4440	4690	770	2268	3460	2066	2770	2066	3064	2630	1890	3086	2500	712	1276	1041