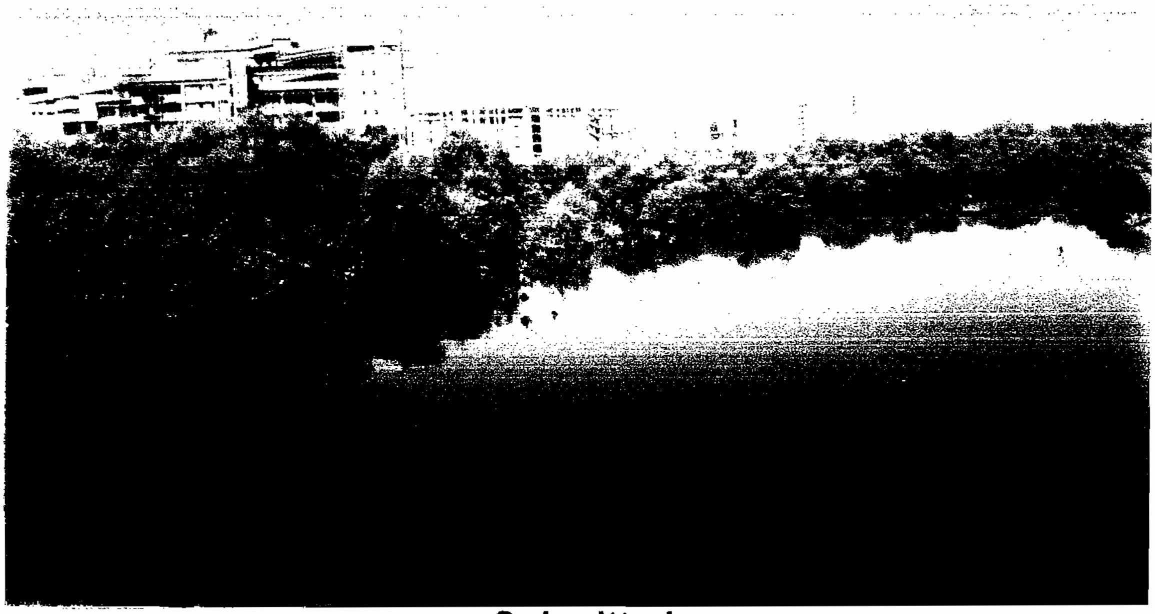
FINAL REPORT

on

The Project Titled

"MORPHOLOGICAL AND ANATOMICAL FEATURES FAVOURING LUXURIANT GROWTH OF MANGROVES IN MUMBAI METROPOLITAN REGION"



Submitted

To

MMR ENVIRONMENT IMPROVEMENT SOCIETY

Mumbai

By

Dr. B.Sasikumar

Dr. Suhasini Sasikumar

Dr. Ranjana Jaiswal

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Biology Department
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Mumbai
16.1.2001

Dr. B.Sasikumar
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Dr. Ranjana Jaiswal

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INTRODUCTION

WHAT ARE MANGROVES ?

The plants which complete their life cycles exclusively in saline environments which border the sea, deltas and estuaries are called **halophytes.** They have developed the property of resisting saline conditions (Mishra, 1967). A typical halophytic formation is represented by mangroves.

Mangroves are the characteristic littoral plant formations of sheltered, low-lying tropical and subtropical coasts (Global Biodiversity, 1992). The mangrove species can be divided into two groups, the exclusive species found only in the mangrove habitats and the non-exclusive species which may be important in the mangrove community, but are not restricted to it. Saenger *et. al.* (1983) listed 60 species in the former group and 23 species in the non-exclusive group.

Mangroves are found growing luxuriantly in the intertidal regions along the estuaries, backwaters, islands and other sheltered areas of sea coast, against high waves and wind. They generally prefer soft clay mud for their growth (Untawale, 1985).

The word **"mangrove"** is derived from a combination of the Portuguese word for tree **(mangue)** and the English word for a stand of tree **(grove)**. The term is ecological, and is used to include both shrubs and trees that occur in the intertidal and shallow subtidal zones of tropical and subtropical tidal marsh.

A mangrove forest is called **mangale**. Every mangale is composed of two classes of plants :

a) Genera and higher taxa which are found only in mangrove habitat.
b) Species that belong to genera of inland plants which are adapted for life in the swamp forest (Walsh, 1974).

David (1940) describes mangroves as a term applied to plants which live in muddy, loose, wet soils in tropical tide-waters. According to Macnae (1968), mangroves are trees or shrubs that grow between the high water mark of spring tides and a level close to, but above sea levels. The mangroves are angiosperms, with about 45 species in India. They have special characters like viviparous germination, pneumatophores, prop or knee roots and salt glands. These trees form a thick forest belt on the deltas, along the major estuaries, and fringe the estuarine banks, as well as back waters. (Untawale, 1985).

VALUE OF MANGROVES :

This unique tree resource is used for various purposes like tannin extraction, paper and pulp, fire wood, timber, charcoal, alcohol, fodder and several other by-products. The mangrove swamps are rich in the larvae of many economically important fishes, prawns, crabs and bivalves. These are the most suitable areas for feeding, breeding and nursery grounds of these marine organisms, and hence important for aquaculture purpose (Untawale, 1985).

The uses and values of mangroves to humans are many and varied. The wood from mangrove trees is used by local people for building materials for houses, fence poles, materials for fish traps, etc. Thus, it is harvested on a large scale by international companies, particularly for pulp and particle board. Mangroves are also a significant source of fuel, both fire wood and charcoal. The most important species for this purpose are those belonging to the genus *Rhizophora* as this wood is heavy and clean burning. Another potential source of fuel in the mangrove habitat is the Nypa palm *(Nypa fruticans),* which produces sugar that can be converted into alcohol (Saenger *et. al.* 1983).

Other products from the mangrove habitat includes shellfish, crustaceans, and fish. These are harvested both on a subsistence basis and for commercial purpose. For instance, in the mangroves of Sierpe, Costa Rica, the million shellfish (Anadara sp.) harvested annually are worth US $ 85,000 to the local communities which collect them (Lahmann, 1989). Most of the larger commercial shrimps and prawns are major sources of export earnings in many tropical countries. In addition to providing habitat for adult fish, the mangroves are essential spawning and nursery areas for many species of marine fish.

Domestic animals feed on mangrove foliage in many countries. In Pakistan, camels are herded down to the coast to feed on the mangroves in the dry season. water buffalo graze them in parts of Asia & Australia, while in Africa goats and cattle feed on the foliage (Dugan, 1990).

Mangroves stabilize shorelines and decrease coastal erosion by reducing the energy of waves and currents and by holding the bottom sediment in place with plant roots. They also act as wind breaks and provide protection from coastal storms, forming a cost-free, self-repairing barrier.

Mangrove habitats can be used for tourism, education and scientific study. For instance, the Bengal Tiger *Panthera tiger* population in Sunderbans mangrove is focus for tourism in Bangladesh and thousands of visitors go to see it.

THREATS TO MANGROVE HABITATS :

The anthropogenic activities have affected the coastal environment due to discharge of man - made hazardous materials, thus disturbing its elemental cycles of C, N, & P. Uncontrolled discharge of sewage, throwing of garbage (Fig.1) indiscriminate reclamation and many other man-made invasions are hastening the decay.

The major threats to mangroves are deforestation, reclamation and lately pollution also. The influx of population from other states and commercial activities have encroached upon the mangrove marshy land in Mumbai. In the process, a large number of mangroves are being chopped off for pitching tenaments of house dwellings overnight on a day to day basis.

In many areas, the demand for fuel wood from mangroves is well above a sustainable level and it is increasing as the human population increases. In addition, the commercial use of the wood, for pulp in particular, results in some areas being more or less clear-felled. Natural regeneration frequently does not occur and often the area is converted to other forms of land use such as agriculture or aquaculture.

The conversion of mangrove areas to aquaculture gives rise to a number of problems. Much of the mangroves and its associated flora and fauna in the areas surrounding the ponds are destroyed because of major changes in drainage conditions, nutrient availability and frequency of tidal inundation. The acid sulphate soils that have an adverse effect on crops also inhibit algae growth, which the fishes feed on, and may kill the prawns or fish directly by poisoning them. Conversion to aquaculture ponds is a particular threat in the Asian region, although in the Indo-Pacific area it was estimated, in 1977 that 1.2 million ha of mangrove forests had already been converted to aquaculture ponds (Saenger *et. al.* 1983).

The building of ponds for extraction of salt water can, especially in arid and semi-arid areas, causes extensive damage to mangroves. In this process the land has to be cleared of all trees and shrubs thus destroying it. For purpose of levelling and dyking, a canal system is built and the soil surface compacted. Thus, the ponds are later abandoned; the chemical & physical properties of the soil have been so changed that recolonization by mangroves is impossible. Mangrove habitats are also being converted for urban and industrial development, commonly for housing, tourist facilities, airports and small ports. Many of the mangroves that are not directly destroyed by fresh water and by pollution from numerous different sources, rubbish and solid wastes are often deliberately dumped in mangrove habitats. Mining within the mangrove system completely destroys the habitat. Mining in the adjacent areas causes variable adverse effects, foremost among these being excessive silt deposition in the mangrove system causing tree loss or reduced productivity.

Chemical wastes from mines are also frequently carried into coastal areas where mangroves occur, with similar effects. Industries are known to produce potentially toxic hazardous wastes such as pesticides, dyes and pigments, organic chemicals, fertilizers, non-ferrous metals, steel and chlor-alkali manufacturing plants.

Drilling activities for oil in some mangrove habitats and both spillage and the associated pipelines and roads which alter the drainage of the area can also be very destructive to the mangrove ecosystem.

The construction and road widening activities along the coastal areas bring about changes in the existing mangrove flora due to changes in the top soil, as a result of movement of heavy construction equipment and material, vehicles, personnel etc. (Fig. 2). Though the adverse impacts are restricted to the areas bordering the mangrove belt, its effects are also extending from the immediate vicinity farther into the high tide line disturbing and often uprooting the mangrove ecosystem.

The dust and fine rock particles produced due to these activities in the land as well as intertidal area will mix with sea water and get suspended in the water environment which thus become environmentally hazardous.

Another threat to mangroves is the diversion of the fresh water flow away from them. Rivers are often dammed or diverted so that their water can be used on land. Changes in land use upstream such as the logging of a forest can also affect the fresh water flow into the mangroves. This leads to the gradual replacement of useful mangroves species with more silt- tolerant and possibly less useful species. Mammals within the mangrove system are affected by the lack of fresh water, while fishery resources may be depleted by the higher salinity and reduced nutrients (Global Biodiversity, 1992).

Mangroves are sensitive to changes in sea levels, as well as to changes in water salinity, and sedimentation rates which are inevitable with rising sea levels and anthropogenic activities. When this happened in the past, there was time for natural adjustment and the development of new mangrove swamps. But in only a few decades, this would be impossible in most areas (Gerald Foley, 1991). Some species of mangroves will perish and the modified species will superseed the others. Thus the biodiversity will be lost.

STRESS TOLERANCE:

Salinity stress :

The luxuriant vegetation of mangroves, which is a conglomeration of plants of diverse form and origin, growing in tidal swamp areas under adverse conditions such as high levels of humidity, temperature, salinity and water-logged substrate have been an enigma to scientists. They show a common characteristic of withstanding high salt concentration.

The species of mangroves show different salinity tolerance limits (Untawale, 1985). The phenomenon of salt tolerance was the greatest attraction to various research workers. The effect of increasing or decreasing salt concentration on morphology (Greenway, 1968), growth (Black, 1956, 1960; Brownell and Wood, 1957), metabolic pathways (Joshi *et. al.* 1962; Polijakoff –Mayer and Gale, 1975) and enzymes (Karmarkar and Amonkar, 1974; Weimberg, 1975) of mangrove have been studied earlier.

Soil salinity is a major factor controlling soil water potential which vary considerably, both seasonally and spatially due to difference in frequency of tidal flooding, water salinity, precipitation and evapo-transpiration (Susan *et. al.* 1982).

Saline habitats form an extreme group of special environment characterised by the presence of high level of salts. It imposes various ways of stress on the plants which occupy them.

Salinity stress induced changes in growth and mineral constituents of *Acanthus ilicifolius* L., a halophyte, has been reported by *Ravindran et. al.* (1999).

Pollution Stress :

Plants are known to represent characteristics of the environment which they occupy differently (Treshow, 1980).

Pollution is an important environmental variable that may adversely affect plant health. The different effects it has on specific plants has been used as a measure of environmental quality (Manning and Feder, 1976).

Pollutants may enter the body of mangrove plant systems by primary and secondary pathways. The primary pathway is analogous to human inhalation. The leaf having both the surfaces covered by cuticularised epidermal layers prevent evapo-transpiration and thus help in moisture retention. Between the two epidermal layers are the water storage parenchyma and the mesophyll tissue-palisade and spongy parenchyma. The leaf also possess vascular strands which conduct water, minerals and carbohydrates throughout the plant body. Two important components are the minute openings in the epidermal layers called stomata, whose opening and closing are controlled by guard cells; and the air spaces which are intercellular. The leaf structure has been so well defined to perform several important functions like photosynthesis, transpiration and respiration. Photosynthesis is accomplished by chloroplasts in the leaf, which by utilising water and CO_2 in the presence of sunlight form carbohydrates and release O_2 to the atmosphere.

With the diffusion of gases into and out of the leaf, pollution gases have a direct pathway into the cellular system. Direct deposition of particulate matter also occurs on the outer surfaces of the leaf.

The indirect pathway by which pollutants interact with plants is through the root system. The deposition of pollutants on soil and surface waters can bring about alteration of the nutrient content of soil in the vicinity of the plant. This change in soil condition can lead to indirect or secondary effects of pollutants in plants, as they absorb these pollutants from the soil through the root system. The accumulation of NO_2-N in the system is indicative of an environment under high pollution stress (Zingde and Govindan, 2000).

Pollution stress leads to complex physiological effects such as reduced water uptake, stunted growth and stomatal closure (Hall and Went, 1952). Pollutants appear to be relatively nonspecific agents which have many sites of action. They inhibit many enzyme systems and metabolic processes. The effect of pollutant depends on its concentration in a cell as well as metabolic patterns in cells.

Growing plants are specifically susceptible to pollution stress, with reduction in photosynthesis and growth. Some of the polluting chemicals inhibit photosynthesis by clogging stomata or causing changes in the optical properties of leaves, leaf metabolism, anatomy of leaf and stem or by combinations of them. These chemicals also reduce rate of photosynthesis by causing lesions on leaf, chlorosis or even abscission or leaf-fall (Kozlowski and Keller, 1966).

AFFORESTATION OF MANGROVES - Need for selection of species :

Mumbai is located on the Western Sea Coast of India at 18^0 53' North to 19^0 16' North latitude and 72^0 E to 72^0 59' E longitude. It occupies an area of 437 sq. km. which is 0.14% of the total area of the state of Maharashtra. Its maximum width is 17 km (East to West) and length is 42 kms (North to South). Mumbai experiences tropical savana climate. It receives heavy south west monsoon rainfall, in the range of 1850 mm-2000 mm per year. On an average, the temperature ranges from 17^0 C to 35^0 C, with marginal difference between summer and winter months, whereas relative humidity ranges between 50% and 75%.

The city is blessed with natural resources like lakes, coastal water, forests, wetlands and mangroves. Mumbai has 26 kms of coast line along its western edge. This coast line is indented at a number of places, giving rise to many larger and smaller creeks. While the wetland along the coast line proper consist of sandy beaches, rock-on slopes escarpments etc., the wetlands along the creeks consist of mud planes and marshy land. The other kind of wet line, the mud plane of marshes – along the creeks through their rich flora consisting of mangroves provide the necessary lungs to the city (Environment Status of Brihanmumbai , 1998-99).

In India, the study of mangrove vegetation of Mumbai has been subject of investigation from the beginning of the last century. Blatter (1905) studied morphological and anatomical features of the mangroves. Cooke (1908) described the flora of mangroves. Bharucha (1932) stressed the importance of the study of physical and chemical properties of mangrove soil. Ecology of mangroves was systematically detailed by Navalkar (1942, 1951,1953,1956, 1959) and Navalkar and Bharucha (1948,1949,1950) .

In Mumbai, the major mangroves forest is seen along the Thane Creek in the east and Malad and Manori Creek in the western suburbs. Degraded patches of mangroves are also found in the Mahim and Mahul creeks. Mangrove vegetation which is found in abundance in the city is *Avicennia marina*. Many species of mangroves like *Bruguiera parviflora*, *Carapa oborata, Rhizophora conjugate*, *Rhizophora mucronata*, *Kandela candel* have either become very rare or totally disappeared from the region due to indiscriminate land reclamation (Environment Status of Brihanmumbai, 1998-99).

The mangrove vegetation supports and harbours some of the rare flora and fauna along with its ecosystem.

The present status of mangrove vegetation in Mumbai has been studied in the form of an indexing of mangroves and associated species found at various locations in MMR. (Sanjay Deshmukh *et. al*. 2000).

However, the mangroves in Mumbai continue to provide the necessary lungs to the city. But, its ever-increasing population mostly living in highly polluted environments warrants afforestation of mangroves as an urgent and befitting panacea.

Plants are known to get adapted, to some extent, to the environmental changes in their vicinity. During plantation the survival rates of mangrove seedlings vary with the species, plantation methods and environmental conditions. It would save a lot of precious time, labour and money, if such species of mangroves, which are better adapted, are selected for afforestation.

Since some of the species of mangroves are thriving well under the adverse conditions of pollution and salinity stress in the coastal areas of MMR, it was thought to undertake the present study to throw light on the morphological and anatomical features which make them better adapted.

MAJOR OBJECTIVES :

i. To evaluate the morphological and anatomical features of 6 different species of mangroves with respect to various stresses due to pollution and high salinity.

ii. To study the growth rate of these species of mangroves in the stress - affected areas of MMR.

iii. To assess the productivity of these mangroves with respect to photosynthetic activity.

iv. To select the species of mangroves with favourable growth habits under stress conditions, so that such species could be useful for afforestation in the stress - affected areas of MMR.

MATERIAL & METHODS

(I) SELECTION OF SITES

A visual survey of mangroves was conducted to assess the present status and source of pollution from surrounding locations, for the selection of suitable sites along the coastal areas of Brihanmumbai and Navi Mumbai.

Selection of polluted sites was done on the basis of visual observation, soil analyses and water analyses. The following 5 sites , at a distance of not less than 10 km from each other, were selected for the present investigation on mangroves :

a) Alibaug - Dharamtar Creek
b) Ghodbunder - Cheena Creek
c) Mahim Creek
   (i) Mahim - Khar Danda
   (ii) Mahim - Kurla
d) Mankhurd - Vashi Creek (towards Mankhurd)
e) Thane - Kalyan Bypass.

STANDARD / CONTROL SITE :
Vashi - Mankhurd (towards Vashi)

For the convenience of study, the whole year was divided into three seasons - Monsoon (June - September), Winter (October - February) and Summer (March - May).

(II) SELECTION OF MANGROVE SPECIES

The following mangrove species were selected at all the five sites :

	Sites	Plant species
A	**Alibaug - Dharamtar Creek**	*Acanthus ilicifolius* Linn. *Avicennia marina* Forsk. *Avicennia officinalis* Linn. *Salvadora persica* Linn. *Sonneratia apetala* Buch-Ham
B	**Ghodbunder - Cheena Creek**	*Acanthus ilicifolius* Linn. *Avicennia marina* Forsk. *Avicennia officinalis* Linn. *Rhizophora mucronata* Lam. *Salvadora persica* Linn. *Sonneratia apetala* Buch-Ham.
C	**Mahim Creek** **(i) Mahim - Khardanda** **(Carter Road Coast)**	*Acanthus ilicifolius* Linn. *Avicennia marina* Forsk. *Avicennia officinalis* Linn. *Rhizophora mucronata* Lam. *Salvadora persica* Linn. *Sonneratia apetala* Buch-Ham.
	ii) Mahim - Kurla	*Acanthus ilicifolius* Linn. *Avicennia marina* Forsk. *Avicennia officinalis* Linn. *Rhizophora mucronata* Lam. *Salvadora persica* Linn. *Sonneratia apetala* Buch-Ham.
D.	**Mankhurd - Vashi Creek** **(towards Mankhurd)**	*Acanthus ilicifolius* Linn. *Avicennia marina* Forsk. *Avicennia officinalis* Linn. *Rhizophora mucronata* Lam. *Salvadora persica* Linn. *Sonneratia apetala* Buch-Ham.
E.	**Thane - Kalyan Bypass**	*Acanthus ilicifolius* Linn. *Avicennia marina* Forsk. *Avicennia officinalis* Linn. *Rhizophora mucronata* Lam. *Salvadora persica* Linn. *Sonneratia apetala* Buch-Ham.

INDEXING OF MANGROVES & ASSOCIATED SPECIES FOUND AT VARIOUS LOCATIONS IN MMR

Table . Distribution of Mangroves and their Associates at Various Locations in Mumbai.

Name of Species	Location
Acanthus ilicifolius	1,2,3,4,10,12,14,15,16
Aegiceras corniculatum	1,4,12
Aeluropus lagopoides	1,2,3,4,6,14,16
Avicennia marina	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16
Avicennia officinalis	1,2,5
Bruguiera cylindrica	4.12
Bruguiera gymnorrhiza	1
Ceriops tagal	1,4,12,16
Clerodendrum inerme	1,2,3,4,10,13,14,15,16
Cyperus rotundus	1,4
Derris heterophylla	2,3,4,10,15
Excoecaria agallocha	1,2,3,4,16
Kandellia candel	13
Rhizophora mucronata	1,6,8,15,16
Salicornia bracheata	1,7,13
Salvadora persica	1,2,3,4,9,10,16
Sesuvium portulacastrum	1,2,3,4,10,13,14
Sonneratia alba	8,10,15
Sonneratia apetala	1,2,3,4
Suaeda fructicosa	2,6,7,12,13,14,16

1: Ghodbunder; 2: Thane; 3: Mulund; 4: Vikhroli; 5: Chembur; :6: Trombay; 7: Sewri; 8: Colaba; 9 : Butcher island; 10 : Elephanta island; 11: Backbay; 12: Mahim; 13: Bandra; 14 : Madh; 15: Malad; 16: Manori.

As reported by * Sanjay Deshmukh (2000)

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*Deshmukh, Sanjay, *et.al.* (2000) : Conservation of Coastal Biodiversity of the Island city of Mumbai, *Environmental Problems of Coastal Areas in India*, (Ed) Vinod K. Sharma, Bookwell . Delhi, pp. 71-80.

(III) BIOLOGICAL PARAMETERS

A) i) **Morphology :** Length of fixed internodes of stem. Distance between the consecutive nodes from 1st to 5th measured in cm.

ii) **Laminar Area of Leaves** from 1st, 2nd and 5th nodes were measured in cm^2 on graph paper.

B) **Micro-Morphology / Anatomy :**

i) **Leaf :** Thin transections of leaves from 1st, 2nd and 5th nodes were studied under the research microscope for the following parameters, and various components were measured in mm, using stage micrometer and occular micrometer:

1. Total thickness of lamina.
2. Thickness of adaxial epidermis with cuticle and epicuticular wax.
3. Thickness of palisade parenchyma
4. Thickness of storage parenchyma.
5. Thickness of spongy parenchyma.
6. Thickness of abaxial epidermis with cuticle and epicuticular wax.
7. Presence of salt glands.
8. Presence of stomata /hydathode

Structures of **midrib** and **petiole** were studied from stained transections to ascertain the orientation of vascular bundles, the development of secondary vascular tissues therein and associated with the vascular bundles if any, and the sclerenchymatous mechanical tissues surrounding the vascular bundles.

ii) **Stomata :**

a) **Measurement of Stomata :** Epidermal peelings from the leaves of 5th node were taken. Following measurements were recorded in cm, using stage micrometer and occular micrometer, under the research microscope.

1. Length of stoma from adaxial / abaxial epidermis.
2. Breadth of stoma from adaxial / abaxial epidermis.

b) **Stomatal Index :** From the adaxial / abaxial epidermis of leaves from 5th node was calculated.

iii) **Palisade ratio :** The leaves from the 1st, 2nd and 5th nodes were subjected to this study, following chloral hydrate treatment, so as to decolourise the mesophyll tissue. The frequency of palisade parenchyma cells per adaxial epidermal cell was estimated.

iv) **Measurement of radius of stem :** Thin stained transections from the 4th internode of stem were studied under the research microscope for the following parameters, and the components were measured in mm, using stage micrometer and occular micrometer.

1. Total radius of stem.
2. Thickness of epidermis + periderm.
3. Thickness of hypodermis - collenchyma.
4. Thickness of aerenchymatous cortex.
5. Thickness of vascular cylinder.
6. Thickness of pith.
7. Number of xylem vessels per cm^2.
8. Diameter of xylem vessels (lumen).

For anatomical observations, transections of stem, leaf and petiole were differentially stained, following the techniques described by Sass (1967).

C) **Chlorophyll Content :**
500 mg of fresh leaf material was crushed in 80% acetone, with a pinch of Mg CO_3, filtered, and volume made to 10 ml.

This was then filtered, and then read on a Spectrophotometer at 663 and 645 wave lengths.

The total Chlorophyll was estimated by the formula given by Arnon (1949), whereas Chlorophyll a and Chlorophyll b were estimated by following the formula of Machlachlan and Zalik (1963) as follows:

$$\text{Total Chlorophyll} = \frac{20.2 \times D\,645 + 8.02 \times D\,663}{d \times 1000 \times W} \times V$$
mg g^{-1} fresh wt. of leaf tissue.

$$\text{Chlorophyll } \underline{a} = \frac{12.3 \times D\,663 - 0.86 \times D\,645}{d \times 1000 \times W} \times V$$
mg g^{-1} fresh wt. of leaf tissue.

$$\text{Chlorophyll } \underline{b} = \frac{19.3 \times D\,645 - 3.6 \times D\,663}{d \times 1000 \times W} \times V$$
mg g^{-1} fresh wt. of leaf tissue.

Where, D = Optical Density of Chlorophyll extract at the respective wave length.
V = The final volume of the 80% acetone-Chlorophyll extract.
d = The path of light in cm, and
W = Weight in g. of the fresh leaf tissue.

D) Pneumatophores or Breathing roots :

The following Morphological parameters of *Avicennia marina* and *Avicennia officinalis* were studied from plants of approximately 1 metre height :

1. The number of pneumatophores produced.
2. The average height of pneumatophores.
3. The average distance between two consecutive pneumatophores.
4. The average circumference (girth) of pneumatophores.
5. The average number of lenticels (breathing pores) present in cm^2 area on pneumatophore.

E) Bio - mass estimation : It was carried out by studying the dry wt. of plant parts, following standard methods.

F) Analysis of Water Samples :

Water samples from all sites were collected for testing the following parameters such as pH, BOD, COD, DO, SO_4, organic matter, conductivity and chloride content, so as to ascertain pollution levels.

The methodology for testing water samples was followed from "Course Manual for waste water Management in Refinery" (NEERI, 1998).

G) Analysis of Soil Samples :

Soil samples were collected from all sites for analyses of pH, SO_4, Organic matter and chloride content, for the estimation of pollution levels by following the methods of Trivedi & Goel (1984).

Following computerised Instruments were used (Courtesy Reliance Petroleum Ltd.) :

Parameters	Name of Instrument	Name of Company	Instrument Make
pH	pH Meter	Melter Toledo, Switzerland.	MP 225
Conductivity	Conductivity meter	Melter Toledo , Switzerland.	MP 225
Chloride	Chlorometer	Euroglass Analytical Instruments, Holland.	TN-3000
Total Organic Carbon	Total Organic Carbon Analyser	Simadzu & Co., Japan.	TOC-5000A

Standardization of Sampling

Samples studied from each spot		Total spots selected at each site		Total samples studied from each site	Sampling values recorded from each site
5	x	5	=	25	Average of 25 samplings

EXPERIMENTAL RESULTS
&
DISCUSSION

Sustainable conservation of mangrove resource is vital for ensuring our accountability to future generations. Consumption of competing productions of mangroves has encouraged mono-cultures and thus reduced ecological and economic space for its biodiverse production. But even more vital is the concern for stemming the erosion of knowledge on the importance of conservation of mangrove vegetation which is even more rapid than the erosion of biodiversity of mangroves.

Rising population pressure has resulted in serious environmental and socio-economic crises in Indian coastal cities. Environmental and socio-economic problems of coastal ecosystems in developing country like India encompass a large number of anthropogenic activities. The impact of major anthropogenic activities on coastal resources can be illustrated as discharge of domestic and industrial effluents, agricultural wastes, tourism and shipping oil spoils and over-exploitation of living coastal resources. Human activities create stress on ecosystem beyond its tolerance limit that can pose hazards to the coastal and marine environment, and to the health and safety of the population living in the coastal areas. Local environmental problems coupled with mismanagement of the coastal resources are threatening these life support systems. (Vinod K.Sharma, Piyush Tiwari and Ranjana Jaiswal, 2000).

The coastal marine environment of Mumbai and regions around comprising of the Arabian Sea to the west and a number of tidal inlets such as Thane creek, Mahim creek are the recipients of a variety of pollutants emanating through domestic and industrial waste water discharge (Zingde and Govindan, 2000). In addition, a large number of industries – both large scale and small scale, established in the drainage zones of Thane creek, Mahim creek **(Fig. 3)** etc. also contribute to pollution loads to these water bodies. These inputs have affected the water quality, sediment quality and biological characteristics of receiving waters to varying degrees. Thane creek receives waste waters from heavily industrialised Thane – Belapur belt stretching along its eastern shores, a group of industries largely concentrated around Chembur and domestic waste water through several point sources stretching between Colaba and Thane. Industries located around Rasayan release the effluents into Patalganga estuary while those at Nagothane use Amba estuary for effluent disposal. Both these estuaries open into Dharamtar creek which is an inlet of Thane creek. Loading, unloading operations at Mumbai and Jawaharlal Nehru ports and ship-generated wastes including bilge also are expected to contribute to the environmental degradation of Thane creek. Mahim creek and the other creeks are the recipients of large volumes of domestic waste waters apart from industries located in their drainage zones.

These inputs have affected the water quality, sediment quality, and biological characteristics of receiving waters to varying degrees.

The impact of anthropogenic pollutants decreases considerably from creek to offshore areas and in insignificant beyond 5 km from the shore line (Zingde and Govindan, 2000).

Major beaches and seafronts on the west coast of Mumbai display high degree of pollution in terms of low Dissolved Oxygen (DO) and high Biochemical Oxygen Demand (BOD). Some of the creeks also show unacceptable water quality during low tide. To assess the present status of the west coast as it is receiving waste water from five service zones a survey was conducted by Rakesh Kumar and Subramanium (2000). This assessment was carried out at a distance of 1 km from the shore with regard to Dissolved Oxygen and other biological parameters. Of the 24 km long stretch of the coast line, about 5 km was highly polluted in terms of low DO. A DO range of less than 2 mg/l was found at Malad, Mahim and Worli.

Dissolved Oxygen in a water body is an important parameter, since the existence of aquatic life including fisheries is intimately linked with its availability. The sources of DO in water are photosynthesis and dissolution from the atmosphere across the air-water interface. However, the DO is consumed during microbial oxidation of organic detritus which is measured in terms of BOD. Some fraction of DO is also utilized by higher organisms through respiration. Although considerable controversy exists over the levels of DO required for a healthy ecosystem, it is considered that DO should not fall below 2.5 mg/l for prolonged periods. Release of large volumes of organic wastes influence DO levels in the creeks substantially, as evident from Table given below. Generally DO increases with the incursion of tidal waters and attains maximum around high tide followed by decrease with very low values around low tide. Extreme low values in Mahim and Versova creek throughout a tide cycle indicate the severity of pollutants in these creeks.

Location	DO
Thane creek (Bhandup)	0.5 – 3
Thane creek (Colaba)	2 – 3
5 km off (Harbour mouth)	2 – 5
10 km off (Harbour mouth)	3 – 5
Mahim creek	0 – 0.5
Mahim bay	0 – 3

Table : Typical DO at selected locations in coastal water of Mumbai during Premonsoon (Zingde and Govindan, 2000)

Unpolluted sea water has low BOD of generally less than 3 mg/l. The BOD in the creeks around Mumbai is variable and tide-dependent and the values can exceed 20 mg/l in Mahim and Versova creeks. The open-shore water has considerable lower BOD though values as high as 4 mg/l are sometimes encountered (Zingde and Govindan, 2000).

The levels of DO in water resources are much lower than the permissible standards. Most of city's refuge is disposed off in its coastal water which includes the coast line and six major creeks: Vasai, Manori, Malad, Mahim, Thane and Dharamtar. This is increasingly deteriorating the quality of coastal water (Please see table given below).

Stations	Year	Salinity (ppt)	BOD (mg/l)	DO (mg/l)
Colaba (City)	1986	36.3	0.49	5.61
	1991	37.8	0.91	4.80
Thane creek (Suburbs)	1986	35.8	0.66	4.45
	1991	36.4	3.2	3.9
Mahim Bay (City)	1986	36.1	1.7	4.1
	1991	36.9	3.1	3.7
Versova (Suburbs)	1986	30.9	1.1	2.89
	1991	32.9	2.8	1.9
Vasai (Suburbs)	1986	35.7	1.0	3.7
	1991	36.0	1.98	2.16

Table Physico – chemical parameters in different coastal regions in MMR (Vinod K.Sharma, Piyush Tiwari and Ranjana Jaiswal, 2000)

The findings from the present study (Table Nos. 21 to 26) are in agreement with the above observations made by the previous workers which confirm the high degree of water pollution level in the coastal sea water of Mumbai.

The values obtained to detect the pollution levels of water and soil were variable during different seasons of the year and also at very shorter intervals of a few days. This was also stated by Zingde and Govindan (2000). Hence the above values could not be ascertained as *static*, but it undoubtedly reveals that both the soil and water components were polluted at the sites selected for the present study, during all the seasons.

Water and air pollution are the old problems to man, and its effects felt since many years; because these problems occur by physical, chemical, physiological and biological means.

Due to large scale of industrialisation, air and water get mixed up with diverse pollutants emanating from a large number and variety of industries and also automobile exhausts. Plants, being stationary, are considered to be reliable indicators of air and water pollution than man and animals (Helmat and Berge, 1973).

The plants, being constantly exposed to the environment, absorb, accumulate and integrate pollutants impinging on their areas exposed to pollutants. The effects of pollutants on plants are varied. The damage caused due to acute or chronic levels of pollution on plants are visible as well as hidden. Various types of pollutants create different viable injurious symptoms on leaves. The external injury is visible after a sufficient number of chlorophyllous mesophyll cells have been damaged.

The effect of pollutants on sublethal level is the stunted growth performance of plants without any external injury symptoms. Such an effect is variously termed as 'visible', 'physiological' of 'subtle' injury. This type of 'injury' is reflected in the form of reduced shoot length, smaller photosynthetic area, enhanced lignified mechanical tissues, reduced photosynthetic area, lower phytomass, earlier and reduced flowering, smaller flowers, accelerated senescence of leaves, etc.

The present investigation on the mangroves was undertaken to find out the morphological, anatomical and physiological adaptations, if any, as these species of plants are living under salinity stress and pollution stress at various sites in the coastal areas of MMR.

It has been reported (Ravindran *et. al.*, 1999) that exogenous addition of varying concentrations of NaCl (from 100mM to 50 mM) to seedlings of *Acanthus ilicifolius* showed marked effects in its growth and mineral constituents. While concentration upto 200 nM NaCl enhanced the shoot and root lengths & increased production of dry weight, its concentration above 200 nM reduced the uptake and accumulation of the micronutrients Cu, Mn, Zn and Fe, thus affecting the growth of the plant with reduction in the shoot and root lengths & total dry weight.

Taking into account of the magnitude and level of growth reductions for the different plant parts and the percentage reductions in the total dry weight per plant, it is possible to find out the order of sensitivity of the different mangrove species to the polluted atmospheric conditions.

Several factors such as concentration of pollutant, salinity, length of exposure, species of plant, stage of plant development, plant environment (temperature, light, humidity, soil, mineral nutrition etc.) and resistance of species influence the degree of injury suffered by mangrove vegetation from pollutants. Depending upon the species of mangrove plant and its environment, there are various factors which may be of much greater importance than others during any given exposure...

COMPARATIVE RESULTS

Root System: Species of mangroves like *Acanthus ilicifolius*, *Avicennia marina* and *Avicennia officinalis* have a highly branched, ramifying network of root system which not only fixes the plant to the marshy substratum but also successfully prevent soil erosion (**Fig. 4**). The branches of the root system even pervade and grow into the cracks and crevices of the rocky / coral surfaces of the coastal areas so that the plant could withstand the onslaught of tidal waves and cyclonic storms.

The root system of *Rhizophora muconata* is supported by prominent and thick **prop roots** which fix the plant well above the marshy substratum (**Fig. 5**). However, as compared to *Acanthus ilicifolius* and *Avicennia* species, the root system of Rhizophora is not well branched out.

In addition to the ramifying network of root system, *Avicennia* species also possess a unique feature – **pneumatophores** or **breathing roots** (**Fig. 6**). These are apogeotropic roots arising from the lateral roots and growing well above the marshy surface. They have numerous **lenticels** or **breathing pores** on the surface. Thus, the root system of *Avicennia marina* and *Avicennia officinalis* are well adapted morphologically as compared to the other genera investigated.

The **length of Stem axis** (Table Nos. 1,2,3 & 4) was highest in *Avicennia marina*, followed by *Acanthus ilicifolius*, *Rhizophora mucronata*, *Salvadora persica*, *Sonneratia apetala*; and the least in *Avicennia officinalis*. There was a maximum increase of length of axis in winter when compared with monsoon and summer seasons.

The control site *viz*. Mankhurd – Vashi creed (towards Vashi) recorded the maximum increase in length of stem axis compared to the more polluted sites. The polluted sites recorded marked stunted growth of stem axis of 1st, 2nd, 3rd and 4th internodes, at all seasons.

Area of Lamina (Table Nos. 5,6 & 7) was the largest in *Rhizophora mucronata* followed by *Acanthus ilicifolius*, *Salvadora persica* and *Sonneratia apetala*. The *Avicennia* species showed the least area of lamina. *Avicennia marina* had a larger laminar area as compared to that of *Avicennia officinalis*. The laminar area increased to the maximum during the period from monsoon to winter.

However, there was a marked reduction in the laminar area of the leaves from 1st, 2nd and 5th nodes of all the species of mangroves studied from the polluted sites at all seasons.

Area (Size) of Stoma (Table No. 8) was the largest in *Rhizophora mucronata* (Fig.21) followed by that of *Sonneratia apetala*, *Acanthus ilicifolius* and *Salvadora persica*. The *Avicennia* species had the least area of stoma, it being larger in *A. marina* followed by *A. officinalis*. The area of stoma increased prominently from monsoon to winter season, than from winter to summer.

There was an overall decrease in the size of stoma in the plants growing in the pollution stress – affected sites, at all seasons of the year.

Stomatal Index (Table No. 9) was highest in *Acanthus ilicifolius*, followed by *Avicennia marina*, *Avicennia officinalis*, *Salvadora persica*, *Rhizophora mucromata*, and the least in *Sonneratia apetala*.

There was an increase in the stomatal index from monsoon to winter and a little increase from winter to summer. The plants from the control site had comparatively lesser stomatal index than those from the polluted sites. There was maximum increase in stomatal index of *Avicennia marina* followed by *Avicennia officinalis*. There was a marginal increase of stomatal index in *Rhizophora mucronata*, with increase in pollution.

An interesting characteristic feature in mangrove plants is their ability to exude out excess salt through specialised epidermal depressions called **salt glands**/hydathodes, present in their epidermal surface. These are well developed, and could be seen with the naked eye as minute brownish spots on the abaxial epidermal surface of *Rhizophora mucronata* (Fig.20), whereas they are present on the adaxial epidermal layer in *Avicennia* species. (Fig.15).

Thickness of Leaf (Table No. 10) was maximum in *Sonneratia apetala*, followed by *Salvadora persica* and *Rhizophora mucronata*. *Avicennia marina* leaf was thicker than *A. officinalis*. The least thickness of leaf was observed in *Acanthus ilicifolius*. The thickness of leaf increased drastically from monsoon to winter season. The increase was less from winter to summer.

The thickness of leaf decreased with increase in pollution level. The increased thickness of leaf observed during monsoon – winter is due to increase in the water – storage tissue within the leaf (Mullan, 1931).

Normally the transactions of petiole and midrib of leaf show 'U' – shaped arrangement of vascular bundles without having produced much secondary vascular tissues. But, the transactions of petiole and midrib of the leaves of *Avicennia marina* and *Salvadora persica* show well – developed vascular bundles arranged as a broad ring and showing prominent secondary growth as in stem(Fig.11).

In *Avicennia marina*, the petiole (Fig.12) also shows two lateral smaller vascular bundles showing secondary growth. In *Sonneratia apetala* the secondary vascular cylinders in the petiole and midrib of the leaf also enclose a few included phloem, strands consisting of thin – walled cells, providing flexibility to the otherwise rigid petioles so that the leaves can sway with the velocity of wind.

The development of secondary xylem elements in the petiole and midrib provide more area of passage for conduction of water from the stem to the lamina. Being highly lignified, they also provide mechanical support to the leaf, as these vascular strands are continuous with the vascular cylinder of the stem axis, thus preventing premature leaf – fall or senescence of leaves and thereby increasing productivity.

Total radius of stem (Table No. 11) was highest in *Acanthus ilicifolius*, followed by *Rhizophora mucronata*. *Avicennia marina* showed a higher value of stem radius as compared to *A. officinalis*. *Sonneratia apetala* also showed a higher value, and the least was that of *Salvadora persica*. There was a well pronounced increase in the girth of stem from monsoon to winter. The total radius of stem decreased with increased pollution.

Though the girth of stem was comparatively thinner in *Salvadora* and *Avicennia marina*, its vascular cylinder was proportionately thicker, showing well – developed secondary xylem elements which can withstand the pollution and salinity stress. (Fig. 16).

Conversely, the ratio of vascular cylinder, consisting of the conducting tissues, to the total girth of stem increased with a higher value in *Salvadora*, followed by *Avicennia marina* and *A. officinalis*. Whereas, *Acanthus ilicifolius*, which had maximum total radius of stem, showed the least value. This clearly shows that the species having more total stem girth need not have proportionate increase in thickness of vascular cylinder. On the other hand, the pollution and salinity stress brought of effective changes in the non – vascular tissues including water storage parenchyma, thus reducing their thickness in *Salvadora* and *Avicennia marina.*

The **number of xylem vessels per cm^2 and Diameter of xylem vessels** (Table No. 12) The average number of xylem vessels per cm^2 in transactions of stem was maximum in *Avicennia marina*, followed by *A. officinalis* and *Salvadora*. Though *Rhizophora* had the least number of xylem vessels per cm^2, it showed the maximum diameter of its xylem vessels, followed by *Salvadora* and *Sonneratia*.

Though the xylem vessels of *Avicennia* have narrow lumen, they have greatly lignified cell wall having affinity for water. Hence, it is presumed that the highly lignified vessels perform more rapid conduction of water and hence *Avicennia marina* is well adapted in this respect. (Fig. 17).

Palisade ratio (Table No. 13) *Avicennia marina* exhibited a high value of palisade ratio, followed by *Acanthus ilicifolius*, *Avicinnia officinalis*, *Rhizophora mucronata*, *Salvadora persica* and *Sonneratia apetala*. The value of palisade ratio increased from monsoon to winter season. There was a marked decrease in the value of palisade ratio in plants from polluted sites (Fig. 19).

Total Chlorophyll (Table No. 14). The value was highest in *Avicennia marina* followed by *A. officinalis*, *Rhizophora*, *Sonneratia*, *Salvadora*, and the least in *Acanthus*. While the value increased moderately from monsoon to winter, there was only a marginal increase in the value from winter to summer. Compared to the control site, there was clear cut decrease in the chlorophyll content of plants from the polluted sites investigated.

Since chlorophyll represents an important component of photosynthetic machinery, a decline in the value of chlorophyll contents can affect the overall photosynthesis process in the respective plant. This is because of the high acidic industrial effluents rich in total solids calcium, chlorine and other elements. Its Biochemical Oxygen Demand (BOD) is more with high amount of organic matter in the effluent, and also because of accumulation of high amount of organic matter in the chloroplast lamellae (Alschen, 1984).

Pneumatophores (Table No. 15) (Fig. No. 6) were seen in the species of *Avicennia*. In the present study, *A. marina* possessed more number of pneumatophores as compared to *A. officinalis*. One meter height plants were selected for the study on various parameters of pneumatophores, as they were more potential for the production and growth of pneumatophores. The number of pneumatophores increased from monsoon to winter and then summer. Maximum increase was noticed in winter season.

The phenomenon that the frequency of development of pneumatophores was more in the polluted sites, indicates the ability of the plants' defence mechanism to cope up with the pollution stress from its immediate environment.

The **average height of pneumatophore** (Table No. 16) was found to be maximum in *Avicennia marina* in comparison with *A. officinalis*. The height increased drastically from monsoon to winter and gradually from winter to summer. The average height of pneumatophores was comparatively less in the polluted sites.

The **circumference of pneumatophore** (Table No. 17) of *Avicennia marina* was found to be more than that of *A. officinalis*. The increase in circumference was more prominent from monsoon to winter and less prominent from winter to summer. The circumference of pneumatophores decreased in both the species of *Avicennia* from control site to the polluted sites.

The **distance between consecutive pneumatophores** (Table No. 18) was less in *Avicennia marina* followed by *A. officinalis*. The distance further decreased from monsoon to winter. From winter to summer, there was just a little marked difference. This distance decreased in the polluted sites as compared to the control site.

The decrease in the circumference of pneumatophore and the distance between consecutive production of pneumatophores could be considered as favourable adaptations of this genus to combat pollution stress.

The **number of lenticels per cm^2** (Table No. 19) was highest in *Avicennia marina*, followed by *A. officinalis.* Lenticels or breathing pores are the ventilators of the plant for exchange of gases and aeration of its inner tissues. Remarkable increase in the number of lenticels was observed in both the species of *Avicennia* from monsoon to winter. This number slowly increased from winter to summer. The number of lenticels increased in the polluted sites than from the control site. This clearly indicates that the *Avicennia* species are able to adapt themselves to the polluted environments.

Biomass (Table No. 20) expressed in **percentage dry weight**, was observed to be highest in *Salvadora persica*, followed by *Sonneratia apetala, Acanthus ilicifolius, Rhizophora mucronata, Avicennia marina* and the least in *Avicennia officinalis.* An increase in dry weight was observed from monsoon to winter. The increase in dry weight was very meagre from winter to summer. There was a pronounced decrease in biomass of mangrove species in the polluted sites as compared to the control site. This could be due to the pollution stress interacting with the metabolic activities of the plant, by reducing the chlorophyll contents and thereby affecting the photosynthetic output, eventually leading to loss of biomass and dry weight.

COMPARATIVE TABLES

Table No : 1

COMPARATIVE TA BLE NO. I A
Length of Internodes (1st Internode) in cm

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M 1.7	M 1.3	M 1.4	M 1.2	M 1.1	M 1.3	M 1.4
		W 2.1	W 1.6	W 1.6	W 1.3	W 1.3	W 1.5	W 1.5
		S 2.3	S 1.7	S 1.8	S 1.4	S 1.4	S 1.6	S 1.7
2.	*Avicennia marina*	M 1.2	M 1.2	M 0.9	M 0.8	M 0.8	M 0.9	M 0.9
		W 1.6	W 1.5	W 1.2	W 1.4	W 1.1	W 1.5	W 1.5
		S 1.7	S 1.6	S 1.4	S 1.4	S 1.1	S 1.5	S 1.6
3.	*Avicennia officinalis*	M 1.7	M 1.1	M 1.3	M 1.1	M 1.0	M 1.3	M 1.2
		W 2.0	W 1.4	W 1.5	W 1.2	W 1.1	W 1.2	W 1.4
		S 2.0	S 1.4	S 1.6	S 1.5	S 1.3	S 1.5	S 1.6
4.	*Rhizophora mucronata*	M 0.4	M -	M 0.3	M 0.5	M 0.3	M 0.2	M 0.3
		W 0.6	W -	W 0.6	W 0.8	W 0.6	W 0.5	W 0.5
		S 0.9	S -	S 0.8	S 0.9	S 0.8	S 0.6	S 0.6
5.	*Salvadora persica*	M 1.5	M 1.4	M 1.2	M 1.0	M 1.0	M 1.2	M 1.0
		W 1.8	W 1.7	W 1.4	W 1.3	W 1.2	W 1.3	W 1.3
		S 1.8	S 1.8	S 1.5	S 1.5	S 1.3	S 1.5	S 1.4
6.	*Sonneratia apetala*	M 1.4	M 0.9	M 0.9	M 0.9	M 0.9	M 0.9	M 1.1
		W 1.6	W 1.3	W 1.2	W 1.1	W 1.2	W 1.0	W 1.3
		S 1.7	S 1.3	S 1.4	S 1.4	S 1.2	S 1.2	S 1.4

Where M = Monsoon
W = Winter
S = Summer

Table No : 2

COMPARATIVE TABLE NO. I B
Length of Internodes (2^{nd} Internode) in cm

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M 2.9	M 2.6	M 2.4	M 2.3	M 2.2	M 2.4	M 2.4
		W 3.3	W 2.9	W 2.8	W 2.5	W 2.5	W 2.7	W 2.7
		S 3.3	S 3.0	S 2.9	S 2.6	S 2.7	S 2.9	S 2.8
2.	*Avicennia marina*	M 4.6	M 3.7	M 3.9	M 3.7	M 3.6	M 3.8	M 3.8
		W 4.9	W 4.0	W 4.1	W 4.0	W 3.9	W 4.2	W 4.1
		S 5.0	S 4.1	S 4.3	S 4.1	S 4.2	S 4.4	S 4.3
3.	*Avicennia officinalis*	M 2.0	M 1.6	M 1.6	M 1.3	M 1.2	M 1.5	M 1.5
		W 2.3	W 1.9	W 1.8	W 1.7	W 1.4	W 1.8	W 1.9
		S 2.6	S 2.0	S 1.9	S 1.7	S 1.6	S 2.0	S 2.1
4.	*Rhizophora mucronata*	M 0.9	M -	M 0.8	M 0.7	M 0.6	M 0.8	M 0.7
		W 1.1	W -	W 0.9	W 1.2	W 1.3	W 1.0	W 0.9
		S 1.4	S -	S 1.2	S 1.3	S 1.5	S 1.2	S 1.1
5.	*Salvadora persica*	M 3.5	M 3.1	M 2.9	M 3.0	M 2.8	M 3.0	M 3.1
		W 3.9	W 3.5	W 3.2	W 3.4	W 3.1	W 3.3	W 3.4
		S 4.0	S 3.6	S 3.4	S 3.6	S 3.3	S 3.5	S 3.5
6.	*Sonneratia apetala*	M 2.9	M 6.7	M 6.5	M 6.5	M 6.3	M 6.5	M 6.6
		W 3.3	W 7.0	W 6.9	W 6.9	W 6.6	W 6.1	W 6.9
		S 3.4	S 7.2	S 6.9	S 7.1	S 6.7	S 6.9	S 7.1

Where M = Monsoon
W = Winter
S = Summer

Table No : 3

COMPARATIVE TABLE NO. I C

Length of Internodes (3rd Internode) in cm

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)		Alibaug Dharamtar Creek		Godbunder Cheena Creek		Mahim-Khar Danda Creek		Mahim-Kurla Creek		Mankhurd-Vashi (towards Mankhurd) Creek		Thane-Kalyan Creek	
1.	*Acanthus ilicifolius*	M	4.0	M	3.4	M	3.5	M	3.4	M	3.3	M	3.3	M	3.5
		W	4.4	W	3.4	W	3.8	W	3.7	W	3.5	W	3.7	W	3.8
		S	4.5	S	3.4	S	3.9	S	4.0	S	3.6	S	3.7	S	3.8
2.	*Avicennia marina*	M	6.0	M	6.1	M	5.7	M	5.4	M	5.2	M	5.6	M	5.7
		W	6.3	W	6.3	W	6.1	W	5.9	W	5.5	W	5.9	W	6.0
		S	6.5	S	6.3	S	6.4	S	6.2	S	5.7	S	6.1	S	6.2
3.	*Avicennia officinalis*	M	2.3	M	2.1	M	1.8	M	1.7	M	1.5	M	1.8	M	1.9
		W	2.7	W	2.4	W	2.1	W	2.1	W	1.8	W	2.1	W	2.2
		S	2.8	S	2.5	S	2.2	S	2.4	S	1.8	S	2.2	S	2.4
4.	*Rhizophora mucronata*	M	2.8	M	-	M	2.4	M	2.3	M	2.2	M	2.3	M	2.0
		W	3.3	W	-	W	2.9	W	3.0	W	3.2	W	2.9	W	2.7
		S	3.7	S	-	S	3.1	S	3.5	S	3.4	S	3.4	S	2.8
5.	*Salvadora persica*	M	3.7	M	3.3	M	3.1	M	3.1	M	3.0	M	3.1	M	3.3
		W	4.0	W	3.7	W	3.4	W	3.4	W	3.3	W	3.4	W	3.7
		S	4.2	S	3.9	S	3.5	S	3.5	S	3.3	S	3.4	S	3.9
6.	*Sonneratia apetala*	M	3.1	M	5.9	M	5.5	M	5.4	M	5.2	M	5.8	M	5.9
		W	3.4	W	6.3	W	5.8	W	5.7	W	5.4	W	6.0	W	6.2
		S	3.5	S	6.3	S	5.9	S	5.9	S	5.5	S	6.2	S	6.3

Where M = Monsoon
W = Winter
S = Summer

Table No : 4

COMPARATIVE TABLE NO. I D
Length of Internodes (4^{th} Internode) in cm

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M 4.9	M 4.7	M 4.2	M 4.4	M 4.3	M 4.2	M 4.3
		W 5.2	W 4.8	W 4.6	W 4.5	W 4.5	W 4.6	W 4.5
		S 5.4	S 5.0	S 4.7	S 4.9	S 4.7	S 4.9	S 4.8
2.	*Avicennia marina*	M 7.0	M 6.3	M 6.5	M 6.1	M 6.0	M 6.5	M 6.3
		W 7.5	W 6.6	W 6.9	W 6.4	W 6.4	W 6.7	W 6.6
		S 7.6	S 7.0	S 7.0	S 6.6	S 6.5	S 6.8	S 6.9
3.	*Avicennia officinalis*	M 2.5	M 2.3	M 1.8	M 1.9	M 1.8	M 1.9	M 2.1
		W 2.9	W 2.6	W 2.4	W 2.3	W 2.3	W 2.2	W 2.3
		S 3.1	S 2.9	S 2.6	S 2.5	S 2.4	S 2.5	S 2.7
4.	*Rhizophora mucronata*	M 4.3	M -	M 4.0	M 4.2	M 4.2	M 3.8	M 3.7
		W 4.9	W -	W 4.7	W 4.7	W 4.6	W 4.2	W 4.1
		S 5.3	S -	S 5.0	S 4.9	S 4.8	S 5.0	S 4.4
5.	*Salvadora persica*	M 4.0	M 3.7	M 3.2	M 3.2	M 3.2	M 3.3	M 3.4
		W 4.4	W 3.9	W 3.5	W 3.5	W 3.5	W 3.5	W 3.7
		S 4.5	S 4.2	S 3.9	S 3.6	S 3.6	S 3.6	S 4.0
6.	*Sonneratia apetala*	M 3.8	M 3.7	M 2.8	M 3.0	M 3.0	M 2.8	M 2.9
		W 4.3	W 4.0	W 3.1	W 3.3	W 3.4	W 3.3	W 3.2
		S 4.5	S 4.2	S 3.3	S 3.5	S 3.7	S 3.5	S 3.4

Where M = Monsoon
W = Winter
S = Summer

Table No : 5

COMPARATIVE TABLE NO. II A
Area of Lamina (1st Node) in cm^2

S. No.	Species	Season	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M	0.7	0.4	0.4	0.3	0.2	0.30	0.3
		W	0.9	0.6	0.6	0.33	0.29	0.34	0.31
		S	1.2	0.75	0.8	0.35	0.31	0.40	0.33
2.	*Avicennia marina*	M	0.4	0.39	0.33	0.39	0.40	0.41	0.44
		W	0.8	0.79	0.48	0.44	0.42	0.43	0.47
		S	0.9	0.82	0.57	0.60	0.43	0.45	0.5
3.	*Avicennia officinalis*	M	0.5	0.5	0.30	0.25	0.28	0.29	0.31
		W	0.6	0.41	0.35	0.30	0.30	0.38	0.33
		S	0.6	0.44	0.50	0.32	0.31	0.42	0.41
4.	*Rhizophora mucronata*	M	12.9	-	12.7	12.6	12.4	12.6	12.7
		W	13.2	-	13.0	13.0	12.9	12.8	12.8
		S	13.5	-	13.1	13.3	13.2	13.4	13.4
5.	*Salvadora persica*	M	1.2	1.1	0.8	0.86	0.83	0.8	0.91
		W	1.4	1.4	1.1	1.3	0.85	0.87	1.1
		S	1.5	1.6	1.2	1.7	0.87	0.90	1.4
6.	*Sonneratia apetala*	M	1.0	0.2	0.13	0.12	0.1	0.13	0.14
		W	1.3	0.5	0.15	0.7	0.15	0.9	0.8
		S	1.4	0.52	0.17	0.8	1.0	1.1	1.0

Where M = Monsoon
W = Winter
S = Summer

Table No : 6

COMPARATIVE TABLE NO. II B
Area of Lamina (2nd Node) in cm^2

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M 23.9	M 23.2	M 23.0	M 22.9	M 22.8	M 22.0	M 23.3
		W 24.4	W 23.5	W 23.3	W 23.3	W 23.1	W 22.79	W 23.8
		S 24.7	S 23.7	S 23.5	S 23.4	S 23.4	S 23.83	S 24.0
2.	*Avicennia marina*	M 8.3	M 7.8	M 7.7	M 7.4	M 7.2	M 7.0	M 7.4
		W 8.9	W 8.1	W 7.9	W 7.6	W 7.4	W 7.45	W 7.7
		S 9.0	S 8.3	S 8.0	S 7.8	S 7.6	S 7.7	S 7.82
3.	*Avicennia officinalis*	M 6.9	M 6.9	M 6.1	M 6.10	M 6.0	M 6.0	M 5.9
		W 7.4	W 7.3	W 6.3	W 6.32	W 6.20	W 6.2	W 6.1
		S 7.6	S 7.5	S 6.5	S 6.45	S 6.31	S 6.4	S 6.4
4.	*Rhizophora mucronata*	M 26.0	M -	M 25.9	M 25.7	M 25.5	M 25.4	M 25.1
		W 26.4	W -	W 26.3	W 26.2	W 26.0	W 26.1	W 26.2
		S 26.8	S -	S 26.7	S 26.6	S 26.2	S 26.5	S 26.4
5.	*Salvadora persica*	M 10.3	M 9.8	M 9.2	M 9.21	M 9.10	M 9.2	M 9.0
		W 10.4	W 10.1	W 9.5	W 10.12	W 9.82	W 9.3	W 9.3
		S 10.4	S 10.3	S 9.7	S 10.21	S 10.1	S 9.41	S 9.7
6.	*Sonneratia apetala*	M 4.0	M 3.52	M 3.51	M 3.25	M 3.10	M 3.30	M 3.50
		W 4.7	W 3.88	W 3.54	W 3.48	W 3.27	W 3.36	W 3.80
		S 5.0	S 4.1	S 3.58	S 3.53	S 3.62	S 3.52	S 4.0

Where M = Monsoon
W = Winter
S = Summer

Table No : 7

COMPARATIVE TABLE NO. II C
Area of Lamina (5^{th} Node) in cm^2

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)		Alibaug Dharamtar Creek		Godbunder Cheena Creek		Mahim-Khar Danda Creek		Mahim-Kurla Creek		Mankhurd-Vashi (towards Mankhurd) Creek		Thane-Kalyan Creek	
1.	*Acanthus ilicifolius*	M	50.0	M	48.0	M	45.5	M	44.8	M	44.6	M	45.1	M	45.2
		W	51.7	W	48.4	W	45.8	W	45.1	W	45.0	W	45.7	W	45.8
		S	52.1	S	48.6	S	45.9	S	45.8	S	45.8	S	46.0	S	46.6
2.	*Avicennia marina*	M	9.4	M	9.0	M	9.1	M	8.6	M	8.5	M	8.7	M	8.6
		W	9.8	W	9.3	W	9.2	W	8.9	W	8.63	W	8.9	W	9.0
		S	10.1	S	9.7	S	9.5	S	9.2	S	8.9	S	9.1	S	9.3
3.	*Avicennia officinalis*	M	8.4	M	8.0	M	7.7	M	7.77	M	7.43	M	7.6	M	7.5
		W	8.8	W	8.3	W	7.9	W	7.91	W	7.67	W	7.7	W	7.8
		S	9.0	S	8.5	S	8.1	S	8.2	S	7.8	S	7.9	S	8.0
4.	*Rhizophora mucronata*	M	75.9	M	-	M	75.4	M	67.9	M	67.4	M	68.2	M	68.0
		W	77.4	W	-	W	77.0	W	69.0	W	69.5	W	69.5	W	68.7
		S	78.1	S	-	S	77.9	S	70.5	S	70.2	S	70.1	S	70.0
5.	*Salvadora persica*	M	18.0	M	15.0	M	15.0	M	14.91	M	14.72	M	14.9	M	15.2
		W	18.5	W	15.4	W	15.25	W	15.23	W	15.18	W	15.18	W	15.4
		S	18.9	S	15.6	S	15.9	S	16.1	S	16.3	S	15.8	S	15.8
6.	*Sonneratia apetala*	M	17.5	M	17.12	M	17.0	M	16.7	M	16.8	M	16.9	M	17.0
		W	17.9	W	17.40	W	17.3	W	17.1	W	17.0	W	17.4	W	17.7
		S	18.1	S	17.56	S	18.0	S	17.5	S	17.2	S	17.6	S	17.9

Where M = Monsoon
W = Winter
S = Summer

Table No : 8

COMPARATIVE TABLE NO. III
Area of Stoma in mm^2

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M 0.011 W 0.014 S 0.018	M 0.011 W 0.012 S 0.014	M 0.010 W 0.013 S 0.014	M 0.010 W 0.015 S 0.016	M 0.010 W 0.017 S 0.018	M 0.012 W 0.013 S 0.015	M 0.010 W 0.014 S 0.016
2.	*Avicennia marina*	M 0.008 W 0.011 S 0.013	M 0.004 W 0.009 S 0.011	M 0.007 W 0.009 S 0.010	M 0.007 W 0.010 S 0.011	M 0.007 W 0.013 S 0.015	M 0.007 W 0.010 S 0.019	M 0.007 W 0.010 S 0.014
3.	*Avicennia officinalis*	M 0.005 W 0.009 S 0.010	M 0.007 W 0.006 S 0.007	M 0.004 W 0.008 S 0.009	M 0.004 W 0.010 S 0.011	M 0.004 W 0.012 S 0.014	M 0.004 W 0.008 S 0.014	M 0.004 W 0.009 S 0.010
4.	*Rhizophora mucronata*	M 0.029 W 0.039 S 0.036	M - W - S -	M 0.027 W 0.032 S 0.034	M 0.026 W 0.030 S 0.032	M 0.024 W 0.028 S 0.030	M 0.030 W 0.033 S 0.039	M 0.028 W 0.030 S 0.037

Where M = Monsoon
W = Winter
S = Summer

Contd...

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
5.	*Acanthus ilicifolius* (adaxial) (abaxial)	M 0.007 0.011	M 0.011 0.006	M 0.006 0.007	M 0.006 0.007	M 0.007 0.011	M 0.006 0.007	M 0.006 0.007
		W 0.011 0.015	W 0.009 0.014	W 0.008 0.009	W 0.009 0.011	W 0.012 0.014	W 0.008 0.014	W 0.008 0.012
		S 0.015 0.017	S 0.012 0.015	S 0.009 0.010	S 0.010 0.013	S 0.013 0.015	S 0.010 0.015	S 0.010 0.014
6.	*Acanthus ilicifolius* (adaxial) (abaxial)	M 0.017 0.018	M 0.013 0.014	M 0.014 0.012	M 0.013 0.014	M 0.017 0.018	M 0.013 0.014	M 0.013 0.014
		W 0.019 0.020	W 0.017 0.014	W 0.017 0.012	W 0.018 0.017	W 0.020 0.019	W 0.018 0.015	W 0.017 0.017
		S 0.022 0.024	S 0.018 0.015	S 0.019 0.019	S 0.019 0.020	S 0.021 0.021	S 0.019 0.020	S 0.019 0.019

Where M = Monsoon
W = Winter
S = Summer

Table No : 9

COMPARATIVE TABLE NO. IV
Stomatal Index Leave of (5th node) in %

S. No	Species	Mankhurd-Vashi Creek (towards Vashi)		Alibaug Dharamtar Creek		Godbunder Cheena Creek		Mahim-Khar Danda Creek		Mahim-Kurla Creek		Mankhurd-Vashi (towards Mankhurd) Creek		Thane-Kalyan Creek	
1.	*Acanthus ilicifolius*	M	20.8	M	31.22	M	32.1	M	33.1	M	33.4	M	25.4	M	31.5
		W	21.0	W	32.7	W	32.3	W	32.6	W	32.8	W	32.7	W	33.1
		S	21.1	S	33.0	S	32.4	S	32.9	S	33.0	S	33.0	S	33.3
2.	*Avicennia marina*	M	20.1	M	36.7	M	48.2	M	38.0	M	38.2	M	35.06	M	37.5
		W	20.3	W	40.1	W	50.0	W	35.3	W	35.9	W	50.7	W	51.2
		S	20.5	S	40.2	S	50.1	S	35.5	S	36.1	S	50.9	S	51.4
3.	*Avicennia officinalis*	M	16.2	M	26.5	M	31.2	M	27.1	M	27.3	M	30.5	M	26.3
		W	16.4	W	26.9	W	31.3	W	32.1	W	32.9	W	40.1	W	40.4
		S	16.6	S	30.1	S	31.5	S	32.4	S	33.6	S	40.3	S	40.6
4.	*Rhizophora mucronata*	M	4.0	M	-	M	4.1	M	4.2	M	4.2	M	4.5	M	4.6
		W	4.2	W	-	W	4.2	W	4.5	W	4.6	W	5.0	W	5.2
		S	4.3	S	-	S	4.4	S	4.8	S	4.9	S	5.2	S	5.3

Contd...

S. No	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
5.	*Salvadora persica (adaxial) (abaxial)*	M 10.2	M 19.8	M 21.5	M 20.0	M 20.1	M 20.9	M 19.6
		12.01	22.9	23.4	23.2	23.4	21.2	23.0
		W 10.3	W 20.0	W 21.9	W 22.0	W 22.4	W 22.6	W 22.9
		12.4	23.1	23.7	23.9	24.1	24.3	24.8
		S 10.5	S 20.1	S 22.0	S 22.4	S 22.8	S 22.8	S 22.9
		12.5	23.3	23.8	24.2	24.3	24.5	24.9
6.	*Sonneratia apetala (adaxial) (abaxial)*	M 3.2	M 13.20	M 14.00	M 13.90	M 13.99	M 10.1	M 13.10
		3.8	15.1	15.20	15.87	15.90	9.9	15.5
		W 3.3	W 13.60	W 14.16	W 14.4	W 14.7	W 14.7	W 15.0
		3.9	15.3	15.50	15.6	15.8	16.0	16.3
		S 3.4	S 13.6	S 14.18	S 14.6	S 14.8	S 14.9	S 15.4
		4.1	15.6	15.80	15.7	16.0	16.1	16.5

Where M = Monsoon
W = Winter
S = Summer

COMPARATIVE TABLE NO. V **Table No : 10**

Thickness of Leaf (5th node) in mm

S. No.	Species	Season	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M	0.588	0.566	0.563	0.558	0.552	0.557	0.560
		W	0.605	0.583	0.590	0.583	0.568	0.563	0.561
		S	0.622	0.586	0.598	0.592	0.576	0.572	0.571
2.	*Avicennia marina*	M	0.690	0.588	0.590	0.580	0.486	0.587	0.584
		W	0.717	0.605	0.605	0.600	0.594	0.594	0.592
		S	0.733	0.621	0.618	0.621	0.608	0.612	0.609
3.	*Avicennia officinalis*	M	0.602	0.474	0.473	0.473	0.460	0.454	0.451
		W	0.616	0.498	0.481	0.474	0.466	0.462	0.457
		S	0.628	0.513	0.494	0.512	0.488	0.479	0.469
4.	*Rhizophora mucronata*	M	0.942	-	0.931	0.927	0.924	0.920	0.918
		W	0.956	-	0.942	0.940	0.936	0.931	0.926
		S	0.975	-	0.953	0.949	0.946	0.942	0.932
5.	*Salvadora persica*	M	0.992	1.273	1.270	1.266	1.161	1.274	1.258
		W	1.745	1.295	1.291	1.286	1.276	1.260	1.268
		S	1.770	1.299	1.296	1.290	1.279	1.268	1.271
6.	*Sonneratia apetala*	M	0.829	1.389	1.387	1.383	1.379	1.365	1.373
		W	2.001	1.416	1.405	1.399	1.389	1.373	1.380
		S	2.017	1.420	1.410	1.410	1.396	1.380	1.388

Where M = Monsoon
W = Winter
S = Summer

Table No : 11

COMPARATIVE TABLE NO. VI
Total Radius of Stem (4th Internode) in mm

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)		Alibaug Dharamtar Creek		Godbunder Cheena Creek		Mahim-Khar Danda Creek		Mahim-Kurla Creek		Mankhurd-Vashi (towards Mankhurd) Creek		Thane-Kalyan Creek	
1.	*Acanthus ilicifolius*	M	4.172	M	4.031	M	4.032	M	3.972	M	3.962	M	3.950	M	3.968
		W	4.184	W	4.048	W	4.040	W	4.020	W	4.005	W	4.000	W	3.993
		S	4.201	S	4.123	S	4.098	S	4.087	S	4.094	S	4.082	S	4.076
2.	*Avicennia marina*	M	1.708	M	1.615	M	1.557	M	1.560	M	1.549	M	1.543	M	1.539
		W	1.734	W	1.644	W	1.583	W	1.591	W	1.597	W	1.592	W	1.600
		S	1.752	S	1.692	S	1.607	S	1.618	S	1.612	S	1.608	S	1.611
3.	*Avicennia officinalis*	M	1.302	M	1.220	M	1.227	M	1.214	M	1.207	M	1.206	M	1.203
		W	1.325	W	1.275	W	1.265	W	1.286	W	1.255	W	1.250	W	1.266
		S	1.342	S	1.295	S	1.297	S	1.309	S	1.278	S	1.267	S	1.281
4.	*Rhizophora mucronata*	M	3.310	M	-	M	3.296	M	3.305	M	3.300	M	3.302	M	3.307
		W	3.357	W	-	W	3.334	W	3.344	W	3.332	W	3.331	W	3.339
		S	3.381	S	-	S	3.365	S	3.370	S	3.351	S	3.368	S	3.360
5.	*Salvadora persica*	M	0.760	M	0.720	M	0.710	M	0.736	M	0.722	M	0.701	M	0.720
		W	0.780	W	0.757	W	0.740	W	0.751	W	0.740	W	0.737	W	0.742
		S	0.793	S	0.787	S	0.763	S	0.772	S	0.788	S	0.751	S	0.763
6.	*Sonneratia apetala*	M	1.470	M	1.430	M	1.432	M	1.423	M	1.410	M	1.460	M	1.450
		W	1.481	W	1.472	W	1.460	W	1.470	W	1.454	W	1.485	W	1.470
		S	1.502	S	1.490	S	1.480	S	1.491	S	1.472	S	1.500	S	1.492

Where M = Monsoon
W = Winter
S = Summer

COMPARATIVE TABLE OF AVERAGE DIAMETER OF STEM, VASCULAR CYLINDER, NO. OF VESSELS AND DIAMETER OF VESSELS **Table No : 12**

S. No.	Species		Average of total radius of Stem in mm		Average of total Vascular cylinder in mm		Average of total no. of Vessels per cm^2		Average of diameter of Vessels (lumen) in mm
1.	*Acanthus ilicifolius*	M	4.012	M	0.392	M	187	M	0.109
		W	4.046	W	0.417	W	198	W	0.100
		S	4.109	S	0.437	S	200	S	0.098
2.	*Avicennia marina*	M	1.581	M	0.854	M	262	M	0.119
		W	1.620	W	0.880	W	277	W	0.110
		S	1.642	S	0.935	S	281	S	0.107
3.	*Avicennia officinalis*	M	1.226	M	0.532	M	251	M	0.107
		W	1.273	W	0.560	W	263	W	0.099
		S	1.300	S	0.595	S	269	S	0.097
4.	*Rhizophora mucronata*	M	2.824	M	1.148	M	170	M	0.192
		W	2.860	W	1.152	W	177	W	0.180
		S	2.883	S	1.186	S	180	S	0.177
5.	*Salvadora persica*	M	0.720	M	0.392	M	245	M	0.133
		W	0.746	W	0.415	W	257	W	0.121
		S	0.773	S	0.433	S	260	S	0.118
6.	*Sonneratia apetala*	M	1.440	M	0.490	M	212	M	0.124
		W	1.470	W	0.531	W	227	W	0.114
		S	1.492	S	0.559	S	231	S	0.112

Where M = Monsoon
W = Winter
S = Summer

Table No : 13

COMPARATIVE TABLE NO. VII
Palisade Ratio Leaves of (5th node)

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M 9.0	M 8.2	M 8.0	M 8.1	M 8.5	M 8.0	M 8.4
		W 9.4	W 8.3	W 8.4	W 8.3	W 8.6	W 8.8	W 9.0
		S 9.9	S 8.5	S 8.7	S 8.5	S 8.9	S 8.8	S 9.2
2.	*Avicennia marina*	M 9.3	M 7.9	M 8.0	M 8.0	M 7.0	M 6.1	M 8.1
		W 9.6	W 8.2	W 8.3	W 8.8	W 9.0	W 8.8	W 8.3
		S 10.1	S 8.6	S 8.7	S 9.0	S 9.2	S 9.0	S 8.8
3.	*Avicennia officinalis*	M 8.5	M 7.7	M 7.9	M 7.9	M 8.0	M 8.2	M 8.0
		W 9.3	W 8.0	W 8.2	W 8.6	W 8.4	W 8.3	W 8.2
		S 9.7	S 8.4	S 8.5	S 8.8	S 8.6	S 8.5	S 8.3
4.	*Rhizophora mucronata*	M 7.8	M -	M 7.0	M 6.9	M 7.0	M 7.2	M 7.6
		W 8.2	W -	W 7.6	W 7.4	W 7.3	W 7.5	W 7.8
		S 8.4	S -	S 7.8	S 7.8	S 7.9	S 7.6	S 7.9
5.	*Salvadora persica*	M 3.3	M 2.2	M 2.3	M 1.9	M 1.9	M 2.2	M 2.2
		W 3.8	W 2.4	W 2.4	W 3.1	W 3.4	W 3.7	W 3.0
		S 4.0	S 2.7	S 2.6	S 3.2	S 3.4	S 3.9	S 3.1
6.	*Sonneratia apetala*	M 2.9	M 1.6	M 1.7	M 1.7	M 1.8	M 2.1	M 1.8
		W 3.3	W 1.9	W 1.8	W 2.3	W 2.6	W 2.8	W 3.1
		S 3.7	S 2.2	S 2.0	S 2.5	S 2.7	S 2.9	S 3.1

Where M = Monsoon
W = Winter
S = Summer

Table No : 14

COMPARATIVE TABLE NO. VIII

Total Chlorophyll Leaves of (5^{th} node) in mg / g fresh weight of leaf tissue.

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)		Alibaug Dharamtar Creek		Godbunder Cheena Creek		Mahim-Khar Danda Creek		Mahim-Kurla Creek		Mankhurd-Vashi (towards Mankhurd) Creek		Thane-Kalyan Creek	
1.	*Acanthus ilicifolius*	M	0.1317	M	0.1124	M	0.1127	M	0.1134	M	0.1137	M	0.1134	M	0.1143
		W	0.1420	W	0.1290	W	0.1366	W	0.1442	W	0.1518	W	0.1594	W	0.1672
		S	0.1548	S	0.1362	S	0.1378	S	0.1458	S	0.1539	S	0.1618	S	0.1693
2.	*Avicennia marina*	M	0.8564	M	0.8294	M	0.8294	M	0.8381	M	0.8382	M	0.8292	M	0.8380
		W	0.8699	W	0.8467	W	0.8543	W	0.8580	W	0.8656	W	0.8732	W	0.8810
		S	0.8840	S	0.8686	S	0.8640	S	0.8692	S	0.8778	S	0.8864	S	0.8924
3.	*Avicennia officinalis*	M	0.8484	M	0.8374	M	0.8365	M	0.8060	M	0.8398	M	0.8365	M	0.7766
		W	0.8592	W	0.8428	W	0.8504	W	0.8619	W	0.8695	W	0.8732	W	0.7769
		S	0.8794	S	0.8492	S	0.8612	S	0.8680	S	0.8742	S	0.8738	S	0.7786
4.	*Rhizophora mucronata*	M	0.8221	M	-	M	0.8091	M	0.8121	M	0.8180	M	0.8249	M	0.8332
		W	0.8268	W	-	W	0.8141	W	0.8200	W	0.8206	W	0.8278	W	0.8356
		S	0.8288	S	-	S	0.8210	S	0.8388	S	0.8310	S	0.8306	S	0.8412
5.	*Salvadora persica*	M	0.1568	M	0.1384	M	0.1380	M	0.1398	M	0.1399	M	0.1373	M	0.1397
		W	0.1696	W	0.1514	W	0.1569	W	0.1717	W	0.1717	W	0.1793	W	0.1871
		S	0.1702	S	0.1531	S	0.1578	S	0.1726	S	0.1726	S	0.1808	S	0.1889
6.	*Sonneratia apetala*	M	0.3860	M	0.3832	M	0.3669	M	0.3900	M	0.3906	M	0.3672	M	0.4001
		W	0.3967	W	0.3843	W	0.3840	W	0.3916	W	0.3992	W	0.4068	W	0.4146
		S	0.3992	S	0.3851	S	0.3848	S	0.3920	S	0.3408	S	0.4076	S	0.4158

Where M = Monsoon
W = Winter
S = Summer

COMPARATIVE TABLE NO. IX A

Table No : 15

No. of Pneumatophores from 1m height plant

S. No.	Species	Season	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Avicennia marina*	M	38	37	43	46	56	61	49
		W	46	50	56	60	69	68	60
		S	49	56	60	68	76	71	63
2.	*Avicennia officinalis*	M	37	32	31	39	38	40	41
		W	41	42	46	51	57	54	52
		S	43	45	48	56	64	57	56

COMPARATIVE TABLE NO. IX B

Table No : 16

Average height of Pneumatophores in cm.

S. No.	Species	Season	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Avicennia marina*	M	19	22	17.5	20	19	17	21
		W	25	28	31	25	29	30	27
		S	26	30	33	30	31	32	30
2.	*Avicennia officinalis*	M	18	19	12.3	18	17	14.2	19
		W	22	25	26	24	26	27	28
		S	24	28	27	28	30	29	31

Where M = Monsoon
W = Winter
S = Summer

Table No : 17

COMPARATIVE TABLE NO. IX C
Average circumference of Pneumatophores in cm.

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Avicennia marina*	M 3.9	M 3.5	M 3.3	M 3.3	M 3.2	M 3.6	M 3.4
		W 4.1	W 4.3	W 4.5	W 4.5	W 4.7	W 5.0	W 5.2
		S 4.3	S 4.4	S 4.7	S 4.6	S 4.8	S 5.1	S 5.2
2.	*Avicennia officinalis*	M 3.6	M 3.2	M 2.8	M 3.0	M 3.0	M 2.8	M 3.1
		W 3.8	W 4.1	W 4.3	W 4.3	W 4.5	W 4.9	W 5.1
		S 3.9	S 4.2	S 4.6	S 4.5	S 4.7	S 5.0	S 5.3

Table No : 18

COMPARATIVE TABLE NO. IX D
Distance between consecutive Pneumatophores in cm.

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Avicennia marina*	M 10.2	M 9.2	M 9.8	M 6.2	M 5.6	M 6.9	M 8.0
		W 13.4	W 10.3	W 10.9	W 7.3	W 6.8	W 7.3	W 8.3
		S 14.1	S 10.8	S 11.3	S 7.5	S 7.1	S 7.6	S 8.9
2.	*Avicennia officinalis*	M 11.3	M 10.2	M 10.6	M 9.9	M 8.1	M 8.6	M 10.4
		W 16.2	W 13.3	W 12.2	W 10.2	W 10.3	W 9.2	W 11.2
		S 16.8	S 14.1	S 12.8	S 11.3	S 10.4	S 9.9	S 11.8

Where M = Monsoon
W = Winter
S = Summer

Table No : 19

COMPARATIVE TABLE NO. IX E
No. of Lenticels in cm^2.

S. No.	Species	Mankhurd-Vashi Creek (towards Vashi)		Alibaug Dharamtar Creek		Godbunder Cheena Creek		Mahim-Khar Danda Creek		Mahim-Kurla Creek		Mankhurd-Vashi (towards Mankhurd) Creek		Thane-Kalyan Creek	
1.	*Avicennia marina*	M	8.0	M	8.1	M	8.0	M	8.5	M	8.4	M	9.0	M	8.2
		W	8.3	W	8.7	W	8.9	W	9.1	W	9.7	W	10.0	W	8.8
		S	8.6	S	9.1	S	9.3	S	10.4	S	10.2	S	10.5	S	9.9
2.	*Avicennia officinalis*	M	6.0	M	7.0	M	6.8	M	7.6	M	8.0	M	8.0	M	8.1
		W	6.8	W	7.2	W	7.3	W	8.0	W	8.4	W	8.5	W	8.4
		S	7.2	S	7.5	S	7.8	S	9.2	S	9.5	S	9.4	S	9.0

Where M = Monsoon
W = Winter
S = Summer

Table No : 20

COMPARATIVE TABLE NO. X
Biomas (Dry wt.) in %

S. No.	Species	Season	Mankhurd-Vashi Creek (towards Vashi)	Alibaug Dharamtar Creek	Godbunder Cheena Creek	Mahim-Khar Danda Creek	Mahim-Kurla Creek	Mankhurd-Vashi (towards Mankhurd) Creek	Thane-Kalyan Creek
1.	*Acanthus ilicifolius*	M	84.2	82.6	80.0	83.2	83.5	81.1	83.0
		W	87.9	83.1	83.5	84.1	84.9	85.1	85.3
		S	88.2	84.1	84.2	85.0	85.4	85.6	85.9
2.	*Avicennia marina*	M	79.4	78.2	75.1	80.1	80.2	76.2	78.9
		W	83.6	79.3	79.0	82.3	82.2	81.2	80.2
		S	84.3	79.5	79.2	83.0	83.4	82.3	81.1
3.	*Avicennia officinalis*	M	78.2	68.1	69.9	70.1	70.0	65.9	66.6
		W	80.3	76.0	76.2	77.7	78.0	79.0	77.6
		S	8.2	76.1	76.4	78.3	78.4	79.2	78.0
4.	*Rhizophora mucronata*	M	85.0	-	82.1	82.7	82.5	80.8	80.3
		W	87.3	-	83.0	83.5	83.2	83.7	83.9
		S	88.0	-	83.4	84.0	83.4	84.6	84.3
5.	*Salvadora persica*	M	90.6	83.1	83.1	83.7	83.8	84.6	84.1
		W	92.2	87.7	88.0	88.7	89.1	88.3	87.5
		S	93.3	88.0	89.3	89.2	89.7	88.9	88.2
6.	*Sonneratia apetala*	M	88.1	82.3	85.2	83.1	82.2	84.5	83.0
		W	90.2	85.7	86.1	86.7	87.0	87.1	87.4
		S	91.0	86.3	87.2	87.0	87.8	87.3	87.3

Where M = Monsoon
W = Winter
S = Summer

Table No : 21

ANALYSES OF WATER SAMPLES FOR ASCERTAINING POLLUTION VALUES FOR THE FOLLOWING PARAMETERS DURING MONSOON

PARAMETERS	STANDARD	SITES						
		STANDARD CONTROL S	A	B	C(i)	C(ii)	D	E
pH	6.0 - 8.0	7.1	7.3	7.1	7.2	7.1	7.2	7.4
BOD	100 mg / l	6.5	10.0	10.2	17.2	17.8	8.6	8.1
COD	250 mg / l	310	308	295	341	360	293	337
DO	mg / l	6	6	5.8	1.5	1.1	4	5
SO_4	1000 mg / l	820	800	705	730	730	850	735
Organic Matter	mg / l	180	190	189	183	180	185	185
Conductivity	S / cm	49700	16100	2220	1723	1735	47900	5320
Chloride	ppm	17720	3029	712	549	463	15339	918

S = Mankhurd - Vashi Creek (towards Vashi)
A = Alibaug - Dharamtar Creek
B = Godbunder - Cheena Creek
C(i) = Mahim Creek - Mahim - Khar Danda
C(ii) = Mahim Creek - Mahim - Kurla
D = Mankhurd - Vashi Creek (towards Mankhurd)
E = Thane - Kalyan - bypass

Table No : 22

ANALYSES OF WATER SAMPLES FOR ASCERTAINING POLLUTION VALUES FOR THE FOLLOWING PARAMETERS DURING WINTER

PARAMETERS	STANDARD	SITES						
		STANDARD CONTROL S	A	B	C(i)	C(ii)	D	E
pH	6.0 - 8.0	7.3	7.5	7.2	7.4	7.5	7.2	7.4
BOD	100 mg / l	6.8	10.5	10.3	17.7	18.1	8.9	8.4
COD	250 mg / l	325	320	303	350	372	300	345
DO	mg / l	5.8	5.4	5.5.	1.2	1.0	3.7	4.8
SO_4	1000 mg / l	812	795	700	724	726	843	731
Organic Matter	mg / l	197	202	199	197	199	200	202
Conductivity	S / cm	49877	16350	2350	1871	1897	48007	48107
Chloride	ppm	17825	3100	777	597	508	15391	971

S = Mankhurd - Vashi Creek (towards Vashi)
A = Alibaug - Dharamtar Creek
B = Godbunder - Cheena Creek
C(i) = Mahim Creek - Mahim - Khar Danda
C(ii) = Mahim Creek - Mahim - Kurla
D = Mankhurd - Vashi Creek (towards Mankhurd)
E = Thane - Kalyan - bypass

Table No : 23

ANALYSES OF WATER SAMPLES FOR ASCERTAINING POLLUTION VALUES FOR THE FOLLOWING PARAMETERS DURING SUMMER

PARAMETERS	STANDARD	SITES						
		STANDARD CONTROL S	A	B	C(i)	C(ii)	D	E
pH	6.0 - 8.0	7.4	7.6	7.4	7.6	7.7	7.3	7.5
BOD	100 mg / l	6.9	10.6	10.6	18.0	18.4	9.1	8.6
COD	250 mg / l	331	337	315	161	387	313	355
DO	mg / l	5.6	5.4	5.3	1.0	0.9	3.4	4.7
SO_4	1000 mg / l	808	790	693	717	720	835	722
Organic Matter	mg / l	205	214	207	211	207	214	217
Conductivity	S / cm	49907	16397	2411	1917	1953	48074	48169
Chloride	ppm	17901	3168	827	652	567	15453	1033

S = Mankhurd - Vashi Creek (towards Vashi)
A = Alibaug - Dharamtar Creek
B = Godbunder - Cheena Creek
C(i) = Mahim Creek - Mahim - Khar Danda
C(ii) = Mahim Creek - Mahim - Kurla
D = Mankhurd - Vashi Creek (towards Mankhurd)
E = Thane - Kalyan - bypass4

Table No : 24

ANALYSES OF SOIL SAMPLES FOR ASCERTAINING POLLUTION VALUES FOR THE FOLLOWING PARAMETERS DURING MONSOON

PARAMETERS	STANDARD	SITES						
		STANDARD CONTROL S	A	B	C(i)	C(ii)	D	E
pH	7.0 - 8.5	7.7	7.9	7.8	8.0	8.1	7.8	7.6
SO_4	1000 mg / l	937	912	826	928	920	916	879
Organic Matter	mg / l	607	693	669	638	640	690	643
Chloride	ppm	32470	3197	2227	3892	2746	2761	2450

S = Mankhurd - Vashi Creek (towards Vashi)

A = Alibaug - Dharamtar Creek

B = Godbunder - Cheena Creek

C(i) = Mahim Creek - Mahim - Khar Danda

C(ii) = Mahim Creek - Mahim - Kurla

D = Mankhurd - Vashi Creek (towards Mankhurd)

E = Thane - Kalyan - bypass

Table No : 25

ANALYSES OF SOIL SAMPLES FOR ASCERTAINING POLLUTION VALUES FOR THE FOLLOWING PARAMETERS DURING WINTER

PARAMETERS	STANDARD	SITES						
		STANDARD CONTROL S	A	B	C(i)	C(ii)	D	E
pH	7.0 - 8.5	7.9	8.1	7.9	8.2	8.2	7.9	7.8
SO_4	1000 mg / l	930	902	812	913	906	900	862
Organic Matter	mg / l	637	708	692	658	661	703	655
Chloride	ppm	34215	3227	2252	3927	2777	2781	2485

S = Mankhurd - Vashi Creek (towards Vashi)

A = Alibaug - Dharamtar Creek

B = Godbunder - Cheena Creek

C(i) = Mahim Creek - Mahim - Khar Danda

C(ii) = Mahim Creek - Mahim - Kurla

D = Mankhurd - Vashi Creek (towards Mankhurd)

E = Thane - Kalyan - bypass

Table No : 26

ANALYSES OF SOIL SAMPLES FOR ASCERTAINING POLLUTION VALUES FOR THE FOLLOWING PARAMETERS DURING SUMMER

PARAMETERS	STANDARD	SITES						
		STANDARD CONTROL S	A	B	C(i)	C(ii)	D	E
pH	7.0 - 8.5	8.1	8.2	8.1	8.3	8.4	8.0	7.9
SO_4	1000 mg / l	921	889	801	899	889	881	847
Organic Matter	mg / l	672	751	740	710	717	748	707
Chloride	ppm	35417	3437	2425	4135	3005	2985	2692

S = Mankhurd - Vashi Creek (towards Vashi)

A = Alibaug - Dharamtar Creek

B = Godbunder - Cheena Creek

C(i) = Mahim Creek - Mahim - Khar Danda

C(ii) = Mahim Creek - Mahim - Kurla

D = Mankhurd - Vashi Creek (towards Mankhurd)

E = Thane - Kalyan - bypass

DETAILED TABLES

(Monsoon Season)

STANDARD / CONTROL

Mankhurd - Vashi Creek
(towards Vashi)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.7	2.9	4.0	4.9	0.7	23.9	50.0
2.	*Avicennia marina*	1.2	4.6	6.0	7.0	0.4	8.3	9.4
3.	*Avicennia officinalis*	1.7	2.0	2.3	2.5	0.5	6.9	8.4
4.	*Rhizophora mucronata*	0.4	0.9	2.8	4.3	12.9	26.0	75.9
5.	*Salvadora persica*	1.5	3.5	3.7	4.0	1.2	10.3	18.0
6.	*Sonneratia apetala*	1.4	2.9	3.1	3.8	1.0	4.9	17.5

Table II (a)

Mankhurd - Vashi Creek
(towards Vashi)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.011
2.	*Avicennia marina*	0.008
3.	*Avicennia officinalis*	0.005
4.	*Rhizophora mucronata*	0.029
5.	*Salvadora persica*	
	(adaxial)	0.007
	(abaxial)	0.011
6.	*Sonneratia apetala*	
	(adaxial)	0.017
	(abaxial)	0.018

Table II (b)

Mankhurd - Vashi Creek
(towards Vashi)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	20.8
2.	*Avicennia marina*	20.1
3.	*Avicennia officinalis*	16.2
4.	*Rhizophora mucronata*	4.0
5.	*Salvadora persica*	
	(adaxial)	10.2
	(abaxial)	12.0
6.	*Sonneratia apetala*	
	(adaxial)	3.2
	(abaxial)	3.8

Table II (c)

Mankhurd-Vashi Creek
(towards Vashi)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.350	0.056	0.056	0.042	0.140	0.056
		2nd node	0.476	0.070	0.112	0.042	0.126	0.126
		5th node	0.588	0.098	0.210	0.154	0.098	0.028
2.	*Avicennia marina*	1st node	0.336	0.070	0.112	0.070		0.084
		2nd node	0.476	0.224	0.098	0.056		0.098
		5th node	0.690	0.196	0.226	0.184		0.084
3.	*Avicennia officinalis*	1st node	0.266	0.042	0.070	0.042	0.042	0.070
		2nd node	0.420	0.168	0.126	-	0.042	0.084
		5th node	0.602	0.224	0.126	-	0.070	0.182
4.	*Rhizophora mucronata*	1st node	0.245	0.039	0.065	0.101	0.030	0.010
		2nd node	0.610	0.050	0.136	0.134	0.271	0.019
		5th node	0.942	0.058	0.446	0.169	0.225	0.044
5.	*Salvadora persica*	1st node	0.770	0.021	0.182	0.420	0.126	0.021
		2nd node	0.801	0.043	0.364	0.510	0.221	0.091
		5th node	0.992	0.099	0.679	0.723	0.129	0.103
6.	*Sonneratia apetala*	1st node	0.670	0.034	0.199	0.526	0.271	0.029
		2nd node	0.729	0.052	0.420	0.618	0.311	0.085
		5th node	0.829	0.094	0.745	0.819	0.213	0.115

Table II (d)

Mankhurd-Vashi Creek
(towards Vashi)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.172	0.028	0.126	0.686	0.392	2.940	187 / 0.109
2.	*Avicennia marina*	1.708	0.098	0.112	0.154	0.854	0.490	262 / 0.119
3.	*Avicennia officinalis*	1.302	0.056	0.084	0.140	0.557	0.465	246 / 0.107
4.	*Rhizophora mucronata*	3.310	0.042	0.302	0.650	1.148	1.168	170 / 0.192
5.	*Salvadora persica*	0.760	0.014	0.084	0.210	0.382	0.070	245 / 0.133
6.	*Sonneratia apetala*	1.470	0.112	0.238		0.490	0.630	212 / 0.124

Table (II) (e)

Mankhurd-Vashi Creek
(towards) Vashi

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.9	6.1	9.0
2.	*Avicennia marina*	3.9	6.5	9.3
3.	*Avicennia officinalis*	3.7	6.3	8.5
4.	*Rhizophora mucronata*	3.5	5.8	7.8
5	*Salvadora persica*	2.2	2.7	3.3
6.	*Sonneratia apetala*	2.0	2.6	2.9

Table III

Mankhurd-Vashi Creek
(towards) Vashi

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0306	Chl 'a' = 0.0585	Chl 'a' = 0.0759
		Chl 'b' = 0.0099	Chl 'b' = 0.0385	Chl 'b' = 0.0558
		T.C. = 0.0405	T. C. = 0.0998	T. C. = 0.1317
2.	*Avicennia marina*	Chl 'a' = 0.4715	Chl 'a' = 0.5330	Chl 'a' = 0.6156
		Chl 'b' = 0.1890	Chl 'b' = 0.2169	Chl 'b' = 0.2408
		T.C. = 0.6605	T. C. = 0.7499	T. C. = 0.8564
3.	*Avicennia officinalis*	Chl 'a' = 0.2728	Chl 'a' = 0.4514	Chl 'a' = 0.5635
		Chl 'b' = 0.1883	Chl 'b' = 0.2965	Chl 'b' = 0.2849
		T.C. = 0.4611	T. C. = 0.7473	T. C. = 0.8484
4.	*Rhizophora mucronata*	Chl 'a' = 0.1942	Chl 'a' = 0.4969	Chl 'a' = 0.5701
		Chl 'b' = 0.0533	Chl 'b' = 0.2122	Chl 'b' = 0.2520
		T.C. = 0.2475	T. C = 0.7091	T. C. = 0.8221
5.	*Salvadora persica*	Chl 'a' = 0.0585	Chl 'a' = 0.0783	Chl 'a' = 0.1008
		Chl 'b' = 0.0225	Chl 'b' = 0.0320	Chl 'b' = 0.0560
		T.C. = 0.0810	T. C. = 0.1103	T. C. = 0.1568
6.	*Sonneratia apetala*	Chl 'a' = 0.0807	Chl 'a' = 0.1209	Chl 'a' = 0.2188
		Chl 'b' = 0.0516	Chl 'b' = 0.0799	Chl 'b' = 0.1672
		T.C. = 0.1323	T. C. = 0.2008	T. C. = 0.3860

Table IV

Mankhurd-Vashi Creek
(towards) Vashi

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	38	19	3.9	10.2	8.0
2.	*Avicennia officinalis*	37	18	3.6	11.3	6.0

Table V

Mankhurd-Vashi Creek
(towards) Vashi

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	84.2
2.	*Avicennia marina*	79.4
3.	*Avicennia officinalis*	78.2
4.	*Rhizophora mucronata*	85.0
5.	*Salvadora persica*	90.6
6.	*Sonneratia apetala*	88.1

(Monsoon Season)

A) Alibaug - Dharamtar Creek

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.3	2.6	3.4	4.2	0.40	23.2	48.0
2.	*Avicennia marina*	1.2	3.7	6.1	6.3	0.39	7.8	9.0
3.	*Avicennia officinalis*	1.1	1.6	2.1	2.3	0.50	6.9	8.0
4.	*Salvadora persica*	1.4	3.1	3.3	3.2	1.1	9.8	15.0
5.	*Sonneratia apetala*	0.9	6.7	5.9	3.7	0.2	3.5	17.1

Table II (a) **Alibaug - Dharamtar Creek**

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.011
2.	*Avicennia marina*	0.007
3.	*Avicennia officinalis*	0.004
4.	*Salvadora persica*	
	(adaxial)	0.006
	(abaxial)	0.006
5.	*Sonneratia apetala*	
	(adaxial)	0.013
	(abaxial)	0.014

Table II (b) **Alibaug - Dharamtar Creek**

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	31.22
2.	*Avicennia marina*	36.7
3.	*Avicennia officinalis*	26.5
4.	*Salvadora persica*	
	(adaxial)	19.8
	(abaxial)	22.9
5.	*Sonneratia apetala*	
	(adaxial)	13.20
	(abaxial)	15.1

Table II (c)

Alibaug - Dharamtar Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.333	0.051	0.052	0.040	0.137	0.053
		2nd node	0.456	0.066	0.108	0.039	0.121	0.122
		5th node	0.566	0.091	0.206	0.152	0.095	0.022
2.	*Avicennia marina*	1st node	0.253	0.039	0.068	0.037	0.039	0.070
		2nd node	0.350	0.128	0.100	0.041		0.081
		5th node	0.588	0.219	0.121	0.069		0.179
3.	*Avicennia officinalis*	1st node	0.321	0.066	0.108	0.067		0.080
		2nd node	0.353	0.121	0.092	0.049		0.091
		5th node	0.474	0.192	0.121	0.080		0.081
4.	*Salvadora persica*	1st node	0.754	0.019	0.177	0.417	0.121	0.020
		2nd node	0.922	0.048	0.198	0.500	0.135	0.041
		5th node	1.273	0.121	0.347	0.609	0.148	0.048
5.	*Sonneratia apetala*	1st node	0.878	0.022	0.189	0.510	0.130	0.027
		2nd node	1.027	0.039	0.200	0.598	0.162	0.028
		5th node	1.389	0.046	0.298	0.711	0.305	0.029

Table II (d)

A) Alibag - Dharamtar Creek

T. S. of Stem (4^{th} Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.031	0.020	0.116	0.670	0.424	2.801	191 / 0.108
2.	*Avicennia marina*	1.615	0.086	0.088	0.130	0.912	0.399	264 / 0.114
3.	*Avicennia officinalis*	1.220	0.052	0.068	0.120	0.572	0.410	255 / 0.104
4.	*Salvadora persica*	0.720	0.012	0.072	0.181	0.425	0.030	250 / 0.123
5.	*Sonneratia apetala*	1.430	0.097	0.210		0.590	0.533	230 / 0.120

Table (II) (e) — Alibaug - Dharamtar Creek

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.6	5.5	8.2
2.	*Avicennia marina*	2.5	5.9	7.9
3.	*Avicennia officinalis*	2.4	5.5	7.7
4.	*Salvadora persica*	1.0	1.8	2.2
5.	*Sonneratia apetala*	0.9	1.4	1.6

Table III — Alibaug - Dharamtar Creek

Chlorophyll Content

(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0109	Chl 'a' = 0.0431	Chl 'a' = 0.0565
		Chl 'b' = 0.0100	Chl 'b' = 0.0379	Chl 'b' = 0.0559
		T.C. = 0.0209	T. C. = 0.0810	T. C. = 0.1124
2.	*Avicennia marina*	Chl 'a' = 0.4514	Chl 'a' = 0.4339	Chl 'a' = 0.5876
		Chl 'b' = 0.1901	Chl 'b' = 0.2172	Chl 'b' = 0.2418
		T.C. = 0.6415	T. C. = 0.7309	T. C. = 0.8294
3.	*Avicennia officinalis*	Chl 'a' = 0.2438	Chl 'a' = 0.5137	Chl 'a' = 0.5515
		Chl 'b' = 0.1893	Chl 'b' = 0.2971	Chl 'b' = 0.2859
		T.C. = 0.4423	T. C. = 0.7310	T. C. = 0.8374
4.	*Salvadora persica*	Chl 'a' = 0.0390	Chl 'a' = 0.0597	Chl 'a' = 0.0810
		Chl 'b' = 0.0235	Chl 'b' = 0.0347	Chl 'b' = 0.0574
		T.C. = 0.0625	T. C. = 0.0944	T. C. = 0.1384
5.	*Sonneratia apetala*	Chl 'a' = 0.0644	Chl 'a' = 0.1016	Chl 'a' = 0.1982
		Chl 'b' = 0.0529	Chl 'b' = 0.0892	Chl 'b' = 0.2000
		T.C. = 0.1173	T. C. = 0.1908	T. C. = 0.3982

Table IV Alibaug - Dharamtar Creek

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	37	22	3.5	9.2	8.1
2.	*Avicennia officinalis*	32	19	3.2	10.2	7.0

Table V Alibaug - Dharamtar Creek

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	82.6
2.	*Avicennia marina*	78.2
3.	*Avicennia officinalis*	68.1
4.	*Salvadora persica*	83.1
5.	*Sonneratia apetala*	82.3

(Monsoon Season)

B) Godbunder - Cheena Creek

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.4	2.4	3.5	4.2	0.4	23.0	45.5
2.	*Avicennia marina*	0.9	3.9	5.7	6.5	0.33	7.7	9.1
3	*Avicennia officinalis*	1.3	1.6	1.8	1.8	0.30	6.1	7.7
4.	*Rhizophora mucronata*	0.3	0.8	2.4	4.0	12.7	25.9	75.4
5.	*Salvadora persica*	1.2	2.9	3.1	3.2	0.8	9.2	15.0
6.	*Sonneratia apetala*	0.9	6.5	5.5	2.8	0.13	3.51	17.0

Table II (a) Godbunder - Cheena Creek

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.010
2.	*Avicennia marina*	0.007
3.	*Avicennia officinalis*	0.004
4.	*Rhizophora mucronata*	0.027
5.	*Salvadora persica*	
	(adaxial)	0.006
	(abaxial)	0.007
6.	*Sonneratia apetala*	
	(adaxial)	0.014
	(abaxial)	0.012

Table II (b) Godbunder - Cheena Creek

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.1
2.	*Avicennia marina*	48.2
3.	*Avicennia officinalis*	31.2
4.	*Rhizophora mucronata*	4.0
5	*Salvadora persica*	
	(adaxial)	21.9
	(abaxial)	23.7
6	*Sonneratia apetala*	
	(adaxial)	14.16
	(abaxial)	15.50

Table II (c) Godbunder - Cheena Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1^{st} node	0.329	0.050	0.052	0.038	0.138	0.051
		2^{nd} node	0.426	0.066	0.108	0.039	0.124	0.125
		5^{th} node	0.563	0.094	0.206	0.140	0.097	0.026
2.	*Avicennia marina*	1^{st} node	0.324	0.067	0.108	0.067		0.082
		2^{nd} node	0.473	0.192	0.121	0.077		0.083
		5^{th} node	0.590	0.222	0.122	0.164		0.082
3.	*Avicennia officinalis*	1^{st} node	0.251	0.039	0.066	0.040	0.038	0.068
		2^{nd} node	0.408	0.166	0.120	0.041		0.081
		5^{th} node	0.473	0.192	0.121	0.080		0.080
4.	*Rhizophora mucronata*	1^{st} node	0.240	0.039	0.064	0.098	0.029	0.010
		2^{nd} node	0.602	0.050	0.135	0.132	0.268	0.017
		5^{th} node	0.931	0.058	0.445	0.165	0.221	0.042
5.	*Salvadora persica*	1^{st} node	0.754	0.018	0.179	0.417	0.121	0.019
		2^{nd} node	0.919	0.048	0.200	0.499	0.132	0.040
		5^{th} node	1.270	0.120	0.344	0.610	0.147	0.049
6.	*Sonneratia apetala*	1^{st} node	0.882	0.026	0.191	0.509	0.130	0.026
		2^{nd} node	1.026	0.037	0.198	0.600	0.162	0.029
		5^{th} node	1.387	0.046	0.300	0.710	0.301	0.030

Table II (d)

B) Godbunder - China Creek

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.032	0.020	0.116	0.669	0.427	2.800	192 / 0.105
2.	*Avicennia marina*	1.557	0.091	0.078	0.118	0.960	0.310	268 / 0.108
3.	*Avicennia officinalis*	1.227	0.050	0.070	0.118	0.579	0.410	220 / 0.102
4.	*Rhizophora mucronata*	3.296	0.042	0.301	0.648	1.158	1.158	192 / 0.181
5.	*Salvadora persica*	0.710	0.012	0.077	0.180	0.411	0.030	256 / 0.124
6.	*Sonneratia apetala*	1.432	0.107	0.215		0.590	0.520	220 / 0.118

Table II (e) **B)Godbunder - Cheena Creek**

Palisade Ratio

S. No.	Species	Palisade Ratio – Leaf from 1st node	Palisade Ratio – Leaf from 2nd node	Palisade Ratio – Leaf from 5th node
1.	*Acanthus ilicifolius*	2.7	5.7	8.0
2.	*Avicennia marina*	2.7	6.1	8.0
3.	*Avicennia officinalis*	2.7	5.9	7.9
4.	*Rhizophora mucronata*	2.9	5.9	7.0
5.	*Salvadora persica*	1.2	2.0	2.3
6.	*Sonneratia apetala*	1.1	1.5	1.7

Table III **B)Godbunder - Cheena Creek**

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0094	Chl 'a' = 0.0360	Chl 'a' = 0.0529
		Chl 'b' = 0.1070	Chl 'b' = 0.0414	Chl 'b' = 0.0560
		T.C. = 0.0205	T. C. = 0.0801	T. C. = 0.1127
2.	*Avicennia marina*	Chl 'a' = 0.4482	Chl 'a' = 0.5082	Chl 'a' = 0.5829
		Chl 'b' = 0.1891	Chl 'b' = 0.2170	Chl 'b' = 0.2409
		T.C. = 0.6406	T. C. = 0.7303	T. C. = 0.8290
3.	*Avicennia officinalis*	Chl 'a' = 0.2430	Chl 'a' = 0.4181	Chl 'a' = 0.5416
		Chl 'b' = 0.1888	Chl 'b' = 0.2970	Chl 'b' = 0.2855
		T.C. = 0.4418	T. C. = 0.7281	T. C. = 0.8365
4.	*Rhizophora mucronata*	Chl 'a' = 0.1750	Chl 'a' = 0.3914	Chl 'a' = 0.5521
		Chl 'b' = 0.0550	Chl 'b' = 0.2110	Chl 'b' = 0.2570
		T.C. = 0.2300	T. C = 0.6024	T. C. = 0.8091
5.	*Salvadora persica*	Chl 'a' = 0.0382	Chl 'a' = 0.0576	Chl 'a' = 0.0789
		Chl 'b' = 0.0230	Chl 'b' = 0.0329	Chl 'b' = 0.0566
		T.C. = 0.0618	T. C. = 0.0913	T. C. = 0.1380
6.	*Sonneratia apetala*	Chl 'a' = 0.0582	Chl 'a' = 0.0972	Chl 'a' = 0.1542
		Chl 'b' = 0.0518	Chl 'b' = 0.0781	Chl 'b' = 0.1993
		T.C. = 0.1132	T. C. = 0.1818	T. C. = 0.3669

Table IV Godbunder - Cheena Creek

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm²
1.	*Avicennia marina*	43	17.5	3.3	9.8	8.0
2.	*Avicennia officinalis*	31	12.3	2.8	10 6	6.8

Table V Godbunder - Cheena Creek

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	80
2.	*Avicennia marina*	75.1
3.	*Avicennia officinalis*	69.9
4.	*Rhizophora mucronata*	82.1
5.	*Salvadora persica*	83.1
6.	*Sonneratia apetala*	85.2

(Monsoon Season)

C) Mahim Creek i) Mahim -Khardanda (Carter Road Coast)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm²		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.2	2.3	3.4	4.4	0.3	22.9	44.8
2.	*Avicennia marina*	0.8	3.7	5.4	6.1	0.39	7.4	8.6
3.	*Avicennia officinalis*	1.1	1.3	1.7	1.9	0.25	6.10	7.77
4.	*Rhizophora mucronata*	0.5	0.7	2.3	4.2	12.6	25.7	67.9
5.	*Salvadora persica*	1.0	3.0	3.1	3.2	0.86	9.21	14.91
6.	*Sonneratia apetala*	0.9	6.5	5.4	3.0	0.12	3.25	16.7

Table II (a)

Mahim Creek i) Mahim -Khardanda (Carter Road Coast)

Measurement of stomata

S. No.	Species	Area of stoma in mm²
1.	*Acanthus ilicifolius*	0.010
2.	*Avicennia marina*	0.007
3.	*Avicennia officinalis*	0.004
4.	*Rhizophora mucronata*	0.026
5.	*Salvadora persica* (adaxial) (abaxial)	0.006 0.007
6.	*Sonneratia apetala* (adaxial) (abaxial)	0.013 0.014

Table II (b)

Mahim Creek i) Mahim -Khardanda (Carter Road Coast)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.1
2.	*Avicennia marina*	38.0
3.	*Avicennia officinalis*	27.1
4.	*Rhizophora mucronata*	4.2
5.	*Salvadora persica* (adaxial) (abaxial)	20.0 23.2
6.	*Sonneratia apetala* (adaxial) (abaxial)	13.90 15.87

Table II (c)

C) Mahim Creek i) Mahim-Khardanda (Carter Road Coast)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.326	0.050	0.051	0.038	0.137	0.050
		2nd node	0.447	0.064	0.107	0.039	0.119	0.118
		5th node	0.558	0.094	0.202	0.150	0.091	0.021
2.	*Avicennia marina*	1st node	0.243	0.036	0.066	0.035	0.038	0.068
		2nd node	0.396	0.119	0.160	0.028	0.010	0.079
		5th node	0.058	0.118	0.218	0.034	0.037	0.178
3.	*Avicennia officinalis*	1st node	0.310	0.065	0.104	0.033	0.030	0.078
		2nd node	0.442	0.090	0.219	0.028	0.017	0.088
		5th node	0.473	0.118	0.189	0.049	0.038	0.079
4.	*Rhizophora mucronata*	1st node	0.852	0.041	0.072	0.580	0.038	0.012
		2nd node	0.893	0.052	0.239	0.370	0.280	0.027
		5th node	0.927	0.058	0.444	0.160	0.218	0.038
5.	*Salvadora persica*	1st node	0.749	0.018	0.176	0.416	0.120	0.019
		2nd node	0.913	0.046	0.197	0.498	0.134	0.038
		5th node	1.266	0.119	0.346	0.610	0.145	0.046
6.	*Sonneratia apetala*	1st node	0.870	0.021	0.187	0.508	0.128	0.026
		2nd node	1.019	0.037	0.199	0.595	0.161	0.027
		5th node	1.383	0.044	0.297	0.710	0.304	0.028

Table II (d)

C) Mahim Creek i) Mahim-Khardanda
(Carter Road Coast)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	3.972	0.023	0.121	0.658	0.460	2.710	190 / 0.105
2.	*Avicennia marina*	1.560	0.083	0.088	0.122	0.887	0.380	272 / 0.110
3.	*Avicennia officinalis*	1.214	0.051	0.068	0.114	0.609	0.372	245 / 0.106
4.	*Rhizophora mucronata*	3.305	0.043	0.303	0.647	1.172	1.152	200 / 0.175
5.	*Salvadora persica*	0.736	0.013	0.078	0.140	0.475	0.030	263 / 0.122
6.	*Sonneratia apetala*	1.423	0.087	0.201		0.653	0.482	207 / 0.118

Table (II) (e)

C) Mahim Creek i) Mahim-Khardanda (Carter Road Coast)

Palisade Ratio

S. No.	Species	Palisade Ratio Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.9	5.0	8.1
2.	*Avicennia marina*	5.0	7.1	8.0
3.	*Avicennia officinalis*	2.6	6.8	7.9
4.	*Rhizophora mucronata*	3.1	6.2	6.9
5.	*Salvadora persica*	1.2	1.7	1.9
6.	*Sonneratia apetala*	0.9	1.5	1.7

Table III

C) Mahim Creek i) Mahim-Khardanda (Carter Road Coast)

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0189	Chl 'a' = 0.0372	Chl 'a' = 0.0547
		Chl 'b' = 0.0110	Chl 'b' = 0.0436	Chl 'b' = 0.0579
		T.C. = 0.0212	T. C. = 0.0812	T. C. = 0.1134
2.	*Avicennia marina*	Chl 'a' = 0.4482	Chl 'a' = 0.5099	Chl 'a' = 0.5847
		Chl 'b' = 0.1906	Chl 'b' = 0.2174	Chl 'b' = 0.2425
		T.C. = 0.6427	T. C. = 0.7339	T. C. = 0.8382
3.	*Avicennia officinalis*	Chl 'a' = 0.2440	Chl 'a' = 0.4198	Chl 'a' = 0.5472
		Chl 'b' = 0.1910	Chl 'b' = 0.3017	Chl 'b' = 0.3060
		T.C. = 0.4427	T. C. = 0.7383	T. C. = 0.8398
4.	*Rhizophora mucronata*	Chl 'a' = 0.1250	Chl 'a' = 0.4030	Chl 'a' = 0.5561
		Chl 'b' = 0.0550	Chl 'b' = 0.2000	Chl 'b' = 0.2560
		T.C. = 0.1800	T. C. = 0.6030	T. C. = 0.8121
5.	*Salvadora persica*	Chl 'a' = 0.0398	Chl 'a' = 0.0597	Chl 'a' = 0.0801
		Chl 'b' = 0.0259	Chl 'b' = 0.0367	Chl 'b' = 0.0584
		T.C. = 0.0644	T. C. = 0.0962	T. C. = 0.1398
6.	*Sonneratia apetala*	Chl 'a' = 0.0610	Chl 'a' = 0.1101	Chl 'a' = 1597
		Chl 'b' = 0.0537	Chl 'b' = 0.0909	Chl 'b' = 0.2012
		T.C. = 0.1183	T. C. = 0.1930	T. C. = 0.4003

Table IV

C) Mahim Creek i) Mahim - Khardanda
(Carter Road Coast)

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	46	20	3.3	6.2	8.5
2.	*Avicennia officinalis*	39	18	3.0	9.9	7.6

Table V

C) Mahim Creek i) Mahim - Khardanda
(Carter Road Coast)

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	83.2
2.	*Avicennia marina*	80.1
3.	*Avicennia officinalis*	70.1
4.	*Rhizophora mucronata*	82.7
5.	*Salvadora persica*	83.7
6.	*Sonneratia apetala*	83.1

(Monsoon Season)

C) Mahim Creek ii) Mahim Kurla

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.1	2.2	3.3	4.3	0.1	22.8	44.6
2.	*Avicennia marina*	0.8	3.6	5.2	6.0	0.40	7.2	8.5
3.	*Avicennia officinalis*	1.0	1.2	1.5	1.8	0.28	6.00	7.43
4.	*Rhizophora mucronata*	0.3	0.6	2.2	4.2	13.2	25.5	67.4
5.	*Salvadora persica*	1.0	2.8	3.0	3.2	0.83	9.10	14.72
6.	*Sonneratia apetala*	0.9	6.3	5.2	3.0	0.11	3.10	16.8

Table II (a) **Mahim Creek ii) Mahim Kurla**

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.010
2.	*Avicennia marina*	0.007
3.	*Avicennia officinalis*	0.004
4.	*Rhizophora mucronata*	0.031
5.	*Salvadora persica* (adaxial) (abaxial)	 0.006 0.007
6.	*Sonneratia apetala* (adaxial) (abaxial)	 0.013 0.014

Table II (b) **Mahim Creek ii) Mahim Kurla**

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.4
2.	*Avicennia marina*	38.2
3.	*Avicennia officinalis*	27.3
4.	*Rhizophora mucronata*	4.2
5.	*Salvadora persica* (adaxial) (abaxial)	 20.1 23.4
6.	*Sonneratia apetala* (adaxial) (abaxial)	 13.99 15.90

Table II (c)

C) Mahim Creek ii) Mahim-Kurla

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.321	0.049	0.050	0.037	0.136	0.049
		2nd node	0.442	0.063	0.106	0.038	0.118	0.117
		5th node	0.552	0.093	0.200	0.149	0.090	0.020
2.	*Avicennia marina*	1st node	0.230	0.035	0.065	0.040	0.031	0.067
		2nd node	0.382	0.118	0.159	0.017	0.015	0.068
		5th node	0.486	0.127	0.117	0.033	0.032	0.177
3.	*Avicennia officinalis*	1st node	0.309	0.064	0.106	0.031	0.031	0.077
		2nd node	0.438	0.218	0.089	0.024	0.020	0.087
		5th node	0.460	0.118	0.188	0.046	0.030	0.078
4.	*Rhizophora mucronata*	1st node	0.832	0.041	0.072	0.570	0.028	0.012
		2nd node	0.863	0.052	0.229	0.360	0.270	0.027
		5th node	0.924	0.058	0.443	0.159	0.217	0.038
5.	*Salvadora persica*	1st node	0.744	0.017	0.175	0.415	0.119	0.018
		2nd node	0.908	0.045	0.196	0.497	0.133	0.037
		5th node	1.161	0.118	0.345	0.509	0.144	0.045
6.	*Sonneratia apetala*	1st node	0.865	0.020	0.186	0.507	0.127	0.025
		2nd node	1.014	0.036	0.198	0.594	0.160	0.026
		5th node	1.379	0.043	0.296	0.710	0.303	0.027

Table II (d)

C) Mahim Creek ii) Mahim-Kurla

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	3.962	0.022	0.120	0.657	0.465	2.698	200 / 0.104
2.	*Avicennia marina*	1.549	0.082	0.087	0.120	0.880	0.380	265 / 0.109
3.	*Avicennia officinalis*	1.207	0.050	0.067	0.110	0.610	0.370	250 / 0.105
4.	*Rhizophora mucronata*	3.300	0.043	0.304	0.650	1.141	1.162	210 / 0.172
5.	*Salvadora persica*	0.722	0.012	0.077	0.184	0.410	0.039	258 / 0.120
6.	*Sonneratia apetala*	1.410	0.085	0.198		0.647	0.480	221 / 0.116

Table (II) (e) C) Mahim Creek ii) Mahim-Kurla

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.9	5.1	8.5
2.	*Avicennia marina*	5.3	5.9	8.1
3.	*Avicennia officinalis*	2.8	6.1	8.0
4.	*Rhizophora mucronata*	3.4	6.4	7.0
5.	*Salvadora persica*	1.2	1.8	1.9
6.	*Sonneratia apetala*	1.0	1.6	7.0

Table III C) Mahim Creek ii) Mahim-Kurla

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0190	Chl 'a' = 0.0375	Chl 'a' = 0.0549
		Chl 'b' = 0.0111	Chl 'b' = 0.0438	Chl 'b' = 0.0581
		T.C. = 0.0214	T. C. = 0.0813	T. C. = 0.1137
2.	*Avicennia marina*	Chl 'a' = 0.4484	Chl 'a' = 0.5110	Chl 'a' = 0.5851
		Chl 'b' = 0.1907	Chl 'b' = 0.2177	Chl 'b' = 0.2426
		T.C. = 0.6429	T. C. = 0.7342	T. C. = 0.8382
3.	*Avicennia officinalis*	Chl 'a' = 0.2442	Chl 'a' = 0.4200	Chl 'a' = 0.5472
		Chl 'b' = 0.1910	Chl 'b' = 0.3019	Chl 'b' = 0.3062
		T.C. = 0.4427	T. C. = 0.7385	T. C. = 0.8398
4.	*Rhizophora mucronata*	Chl 'a' = 0.1239	Chl 'a' = 0.4000	Chl 'a' = 0.5542
		Chl 'b' = 0.0548	Chl 'b' = 0.2000	Chl 'b' = 0.2564
		T.C. = 0.1787	T. C. = 0.6000	T. C. = 0.8106
5.	*Salvadora persica*	Chl 'a' = 0.0399	Chl 'a' = 0.0600	Chl 'a' = 0.8010
		Chl 'b' = 0.0260	Chl 'b' = 0.0369	Chl 'b' = 0.0585
		T.C. = 0.0645	T. C. = 0.0964	T. C. = 0.1399
6.	*Sonneratia apetala*	Chl 'a' = 0.0612	Chl 'a' = 0.1103	Chl 'a' = 0.1599
		Chl 'b' = 0.0537	Chl 'b' = 0.0910	Chl 'b' = 0.2013
		T.C. = 0.1184	T. C. = 0.1931	T. C. = 0.3408

Table IV C) Mahim Creek ii) Mahim - Kurla

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	56	19	3.2	5.6	8.4
2.	*Avicennia officinalis*	38	17	3.0	8.1	8

Table V C) Mahim Creek ii) Mahim - Kurla

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	83.5
2.	*Avicennia marina*	80.2
3.	*Avicennia officinalis*	70.0
4.	*Rhizophora mucronata*	82.5
5.	*Salvadora persica*	83.8
6.	*Sonneratia apetala*	82.2

(Monsoon Season)

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
7.	*Acanthus ilicifolius*	1.3	2.4	3.3	4.2	0.30	22.0	45.1
8.	*Avicennia marina*	0.9	3.8	5.6	6.5	0.41	7.01	8.7
9.	*Avicennia officinalis*	1.3	1.5	1.8	1.9	0.29	6.0	7.6
10.	*Rhizophora mucronata*	0.2	0.8	2.9	3.8	12.6	25.4	66.2
11.	*Salvadora persica*	1.2	3.0	3.1	3.3	0.8	9.2	14.9
12.	*Sonneratia apetala*	0.9	6.5	5.8	2.8	0.13	3.30	16.9

Table II (a)

Mankhurd-Vashi Creek
(towards Mankhurd)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.012
2.	*Avicennia marina*	0.007
3.	*Avicennia officinalis*	0.004
4.	*Rhizophora mucronata*	0.030
5.	*Salvadora persica*	
	(adaxial)	0.006
	(abaxial)	0.007
6.	*Sonneratia apetala*	
	(adaxial)	0.013
	(abaxial)	0.014

Table II (b)

Mankhurd-Vashi Creek
(towards Mankhurd)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	25.4
2.	*Avicennia marina*	35.0
3.	*Avicennia officinalis*	30.5
4.	*Rhizophora mucronata*	4.5
5.	*Salvadora persica*	
	(adaxial)	20.9
	(abaxial)	21.2
6.	*Sonneratia apetala*	
	(adaxial)	10.1
	(abaxial)	9.9

Table II (c)

D) Mankhurd – Vashi Creek (towards Mankhurd)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.334	0.051	0.052	0.040	0.139	0.052
		2nd node	0.461	0.067	0.109	0.040	0.122	0.128
		5th node	0.557	0.092	0.207	0.141	0.095	0.022
2.	*Avicennia marina*	1st node	0.349	0.039	0.117	0.059	0.058	0.066
		2nd node	0.500	0.162	0.202	0.037	0.020	0.080
		5th node	0.587	0.122	0.220	0.035	0.032	0.178
3.	*Avicennia officinalis*	1st node	0.323	0.065	0.109	0.036	0.032	0.081
		2nd node	0.455	0.220	0.092	0.026	0.025	0.092
		5th node	0.454	0.112	0.191	0.035	0.035	0.081
4.	*Rhizophora mucronata*	1st node	0.550	0.039	0.167	0.302	0.031	0.011
		2nd node	0.680	0.051	0.140	0.248	0.223	0.018
		5th node	0.920	0.059	0.387	0.152	0.280	0.042
5.	*Salvadora persica*	1st node	0.755	0.029	0.180	0.417	0.120	0.019
		2nd node	0.922	0.049	0.198	0.500	0.132	0.041
		5th node	1.274	0.121	0.346	0.611	0.146	0.048
6	*Sonneratia apetala*	1st node	0.877	0.024	0.188	0.510	0.130	0.025
		2nd node	1.028	0.038	0.194	0.598	0.164	0.030
		5th node	1.365	0.045	0.287	0.701	0.302	0.029

Table II (d)

D) Mankhurd - Vashi Creek (towards Mankhurd)

T. S. of Stem (4^{th} Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	3.950	0.022	0.121	0.682	0.189	2.936	202 / 0.104
2.	*Avicennia marina*	1.543	0.092	0.060	0.101	0.900	0.390	278 / 0.107
3.	*Avicennia officinalis*	1.206	0.051	0.081	0.137	0.536	0.401	250 / 0.103
4.	*Rhizophora mucronata*	3.302	0.040	0.300	0.642	1.158	1.162	177 / 0.170
5.	*Salvadora persica*	0.701	0.012	0.081	0.207	0.336	0.065	250 / 0.120
6.	*Sonneratia apetala*	1.460	0.105	0.235		0.618	0.502	224 / 0.114

Table (II) (e)

D) Mankhurd-Vashi Creek (towards Mankhurd)

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.5	4.8	8.0
2.	*Avicennia marina*	5.2	6.2	7.9
3.	*Avicennia officinalis*	2.4	5.8	8.2
4.	*Rhizophora mucronata*	3.5	6.2	7.2
5.	*Salvadora persica*	1.1	1.5	2.2
6.	*Sonneratia apetala*	0.8	1.6	2.1

Table III

D) Mankhurd-Vashi Creek (towards Mankhurd)

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0098	Chl 'a' = 0.0365	Chl 'a' = 0.0530
		Chl 'b' = 0.0109	Chl 'b' = 0.0415	Chl 'b' = 0.0560
		T.C. = 0.0215	T. C. = 0.0810	T. C. = 0.1134
2.	*Avicennia marina*	Chl 'a' = 0.4480	Chl 'a' = 0.5083	Chl 'a' = 0.5829
		Chl 'b' = 0.1891	Chl 'b' = 0.2169	Chl 'b' = 0.2408
		T.C. = 0.6406	T. C. = 0.7308	T. C. = 0.8292
3.	*Avicennia officinalis*	Chl 'a' = 0.2432	Chl 'a' = 0.4179	Chl 'a' = 0.5416
		Chl 'b' = 0.1890	Chl 'b' = 0.2970	Chl 'b' = 0.2850
		T.C. = 0.4415	T. C. = 0.7284	T. C. = 0.8365
4.	*Rhizophora mucronata*	Chl 'a' = 0.1265	Chl 'a' = 0.4062	Chl 'a' = 0.5582
		Chl 'b' = 0.0582	Chl 'b' = 0.2010	Chl 'b' = 0.2569
		T.C. = 0.1817	T. C. = 0.6072	T. C. = 0.8149
5.	*Salvadora persica*	Chl 'a' = 0.0380	Chl 'a' = 0.0580	Chl 'a' = 0.0787
		Chl 'b' = 0.0228	Chl 'b' = 0.0325	Chl 'b' = 0.0569
		T.C. = 0.0920	T. C. = 0.0910	T. C. = 0.1373
6.	*Sonneratia apetala*	Chl 'a' = 0.0581	Chl 'a' = 0.0970	Chl 'a' = 0.1544
		Chl 'b' = 0.0519	Chl 'b' = 0.0802	Chl 'b' = 0.1995
		T.C. = 0.1131	T. C. = 0.1812	T. C. = 0.3692

Table IV

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	61	17	3.6	6.9	9.0
2.	*Avicennia officinalis*	40	14.2	2.8	8.6	8.0

Table V

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	81.1
2.	*Avicennia marina*	76.2
3.	*Avicennia officinalis*	65.9
4.	*Rhizophora mucronata*	80.8
5.	*Salvadora persica*	84.6
6.	*Sonneratia apetala*	84.5

(Monsoon Season)

E) Thane-Kalyan bypass

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.4	2.4	3.5	4.3	0.30	22.0	45.02
2.	*Avicennia marina*	0.9	3.8	5.7	6.3	0.44	7.4	8.6
3.	*Avicennia officinalis*	1.2	1.5	1.9	2.1	0.31	5.9	7.5
4.	*Rhizophora mucronata*	0.3	0.7	2.0	3.7	12.7	25.1	68.0
5.	*Salvadora persica*	1.0	3.1	3.3	3.4	0.91	9.0	15.2
6.	*Sonneratia apetala*	1.1	6.6	5.9	2.9	0.14	3.50	17.0

Table II (a) Thane-Kalyan bypass

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.010
2.	*Avicennia marina*	0.007
3.	*Avicennia officinalis*	0.004
4.	*Rhizophora mucronata*	0.028
5.	*Salvadora persica* (adaxial) (abaxial)	 0.006 0.007
6.	*Sonneratia apetala* (adaxial) (abaxial)	 0.013 0.014

Table II (b) Thane-Kalyan bypass

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	31.5
2.	*Avicennia marina*	37.5
3.	*Avicennia officinalis*	26.3
4.	*Rhizophora mucronata*	4.6
5.	*Salvadora persica* (adaxial) (abaxial)	 19.6 23.0
6.	*Sonneratia apetala* (adaxial) (abaxial)	 13.10 15.5

Table II (c)

E) Thane – Kalyan bypass

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.334	0.052	0.053	0.039	0.138	0.052
		2nd node	0.454	0.065	0.109	0.040	0.120	0.120
		5th node	0.562	0.092	0.204	0.151	0.092	0.023
2.	*Avicennia marina*	1st node	0.246	0.038	0.067	0.037	0.039	0.065
		2nd node	0.403	0.121	0.163	0.028	0.011	0.080
		5th node	0.584	0.220	0.120	0.047	0.030	0.177
3.	*Avicennia officinalis*	1st node	0.319	0.065	0.107	0.035	0.032	0.080
		2nd node	0.448	0.091	0.220	0.026	0.021	0.090
		5th node	0.571	0.191	0.120	0.046	0.033	0.081
4.	*Rhizophora mucronata*	1st node	0.752	0.041	0.072	0.480	0.038	0.012
		2nd node	0.853	0.052	0.229	0.360	0.270	0.027
		5th node	0.918	0.058	0.443	0.156	0.218	0.038
5.	*Salvadora persica*	1st node	0.750	0.018	0.178	0.418	0.120	0.016
		2nd node	0.920	0.049	0.196	0.498	0.137	0.040
		5th node	1.268	0.120	0.346	0.610	0.146	0.046
6.	*Sonneratia apetala*	1st node	0.876	0.021	0.191	0.509	0.130	0.025
		2nd node	1.025	0.038	0.199	0.599	0.162	0.027
		5th node	1.383	0.043	0.300	0.710	0.302	0.028

Table II (d)

E) Thane - Kalyan bypass

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	3.968	0.023	0.120	0.660	0.450	2.715	205 / 0.104
2.	*Avicennia marina*	1.539	0.097	0.096	0.120	0.838	0.388	280 / 0.105
3.	*Avicennia officinalis*	1.203	0.053	0.071	0.115	0.594	0.370	252 / 1.102
4.	*Rhizophora mucronata*	3.307	0.040	0.302	0.641	1.160	1.164	178 / 0.169
5.	*Salvadora persica*	0.720	0.013	0.080	0.192	0.390	0.045	255 / 0.118
6.	*Sonneratia apetala*	1.450	0.089	0.209		0.562	0.590	226 / 0.114

Table (II) (e)

E) Thane-Kalyan bypass

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.8	5.1	8.4
2.	*Avicennia marina*	2.5	5.3	8.1
3.	*Avicennia officinalis*	5.7	7.2	8.0
4.	*Rhizophora mucronata*	3.3	6.6	7.6
5.	*Salvadora persica*	1.2	1.8	2.2
6.	*Sonneratia apetala*	1.1	1.6	1.8

Table III

E) Thane-Kalyan bypass

Chlorophyll Content

(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0188	Chl 'a' = 0.0367	Chl 'a' = 0.0545
		Chl 'b' = 0.0110	Chl 'b' = 0.0442	Chl 'b' = 0.0576
		T.C. = 0.0210	T. C. = 0.0830	T. C. = 0.1143
2.	*Avicennia marina*	Chl 'a' = 0.4495	Chl 'a' = 0.5110	Chl 'a' = 0.5850
		Chl 'b' = 0.1911	Chl 'b' = 0.2180	Chl 'b' = 0.2424
		T.C. = 0.6425	T. C. = 0.7340	T. C. = 0.8380
3.	*Avicennia officinalis*	Chl 'a' = 0.2456	Chl 'a' = 0.4199	Chl 'a' = 0.5468
		Chl 'b' = 0.1912	Chl 'b' = 0.3015	Chl 'b' = 0.3057
		T.C. = 0.4432	T. C. = 0.7382	T. C. = 0.8396
4.	*Rhizophora mucronata*	Chl 'a' = 0.1324	Chl 'a' = 0.4042	Chl 'a' = 0.5565
		Chl 'b' = 0.0562	Chl 'b' = 0.2008	Chl 'b' = 0.2567
		T.C. = 0.1886	T. C. = 0.6050	T. C. = 0.8132
5.	*Salvadora persica*	Chl 'a' = 0.0391	Chl 'a' = 0.0594	Chl 'a' = 0.0796
		Chl 'b' = 0.0252	Chl 'b' = 0.0360	Chl 'b' = 0.0582
		T.C. = 0.0639	T. C. = 0.0956	T. C. = 0.1397
6.	*Sonneratia apetala*	Chl 'a' = 0.0609	Chl 'a' = 0.1100	Chl 'a' = 0.1595
		Chl 'b' = 0.0535	Chl 'b' = 0.0906	Chl 'b' = 0.2010
		T.C. = 0.1182	T. C. = 0.1928	T. C. = 0.4001

Table IV

E) Thane-Kalyan bypass

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumfe rence in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	49	21	3.4	8.0	8.2
2.	*Avicennia officinalis*	41	19	3.1	10.4	8.1

Table V

E) Thane-Kalyan bypass

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	83.0
2.	*Avicennia marina*	78.9
3.	*Avicennia officinalis*	66.6
4.	*Rhizophora mucronata*	80.3
5.	*Salvadora persica*	84.1
6.	*Sonneratia apetala*	83.0

(Winter Season)

STANDARD / CONTROL

Mankhurd - Vashi Creek
(towards Vashi)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.1	3.3	4.4	5.2	0.9	24.4	51.7
2.	*Avicennia marina*	1.6	4.9	6.3	7.5	0.8	8.9	9.8
3.	*Avicennia officinalis*	2.0	2.3	2.7	2.9	0.6	7.4	8.8
4.	*Rhizophora mucronata*	0.6	1.1	3.3	4.9	13.2	26.4	77.4
5.	*Salvadora persica*	1.8	3.9	4.0	4.4	1.4	10.4	18.5
6.	*Sonneratia apetala*	1.6	3.3	3.4	4.3	1.3	4.7	17.9

Table II (a)

Mankhurd - Vashi Creek
(towards Vashi)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.014
2.	*Avicennia marina*	0.011
3.	*Avicennia officinalis*	0.009
4.	*Rhizophora mucronata*	0.033
5.	*Salvadora persica*	
	(adaxial)	0.011
	(abaxial)	0.015
6.	*Sonneratia apetala*	
	(adaxial)	0.019
	(abaxial)	0.020

Table II (b)

Mankhurd - Vashi Creek
(towards Vashi)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	21.0
2.	*Avicennia marina*	20.3
3.	*Avicennia officinalis*	16.4
4.	*Rhizophora mucronata*	4.2
5.	*Salvadora persica*	
	(adaxial)	10.3
	(abaxial)	12.4
6.	*Sonneratia apetala*	
	(adaxial)	3.3
	(abaxial)	3.9

Table II (c)

Mankhurd-Vashi Creek
(towards Vashi)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.364	0.059	0.059	0.045	0.142	0.059
		2nd node	0.492	0.073	0.115	0.046	0.129	0.129
		5th node	0.605	0.101	0.212	0.159	0.102	0.031
2.	*Avicennia marina*	1st node	0.346	0.072	0.115	0.073		0.086
		2nd node	0.377	0.126	0.101	0.058		0.092
		5th node	0.717	0.198	0.229	0.187		0.103
3.	*Avicennia officinalis*	1st node	0.276	0.044	0.070	0.045	0.044	0.073
		2nd node	0.356	0.114	0.109	0.045		0.088
		5th node	0.616	0.226	0.130	0.074		0.186
4.	*Rhizophora mucronata*	1st node	0.294	0.042	0.088	0.102	0.045	0.017
		2nd node	0.704	0.059	0.143	0.285	0.186	0.031
		5th node	0.956	0.060	0.451	0.172	0.227	0.046
5.	*Salvadora persica*	1st node	0.786	0.024	0.185	0.423	0.130	0.024
		2nd node	1.242	0.044	0.367	0.514	0.223	0.094
		5th node	1.745	0.101	0.681	0.726	0.131	0.106
6.	*Sonneratia apetala*	1st node	1.072	0.037	0.202	0.528	0.274	0.031
		2nd node	1.503	0.056	0.423	0.622	0.314	0.088
		5th node	2.001	0.098	0.748	0.822	0.215	0.118

Table II (d)

Mankhurd-Vashi Creek
(towards Vashi)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.184	0.030	0.130	0.677	0.417	2.930	198 / 0.106
2.	*Avicennia marina*	1.734	0.101	0.115	0.152	0.991	0.375	277 / 0.114
3.	*Avicennia officinalis*	1.325	0.059	0.087	0.130	0.670	0.379	263 / 0.100
4.	*Rhizophora mucronata*	3.357	0.045	0.311	0.661	1.174	1.166	177 / 0.189
5.	*Salvadora persica*	0.780	0.016	0.088	0.200	0.415	0.061	257 / 0.129
6.	*Sonneratia apetala*	1.481	0.115	0.220		0.531	0.615	227 / 0.120

Table (II) (e)

Mankhurd-Vashi Creek (towards) Vashi

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	4.2	6.3	9.4
2.	*Avicennia marina*	4.1	6.7	9.6
3.	*Avicennia officinalis*	4.0	6.5	9.3
4.	*Rhizophora mucronata*	3.7	7.0	8.2
5.	*Salvadora persica*	2.4	3.1	3.8
6.	*Sonneratia apetala*	2.4	3.0	3.3

Table III

Mankhurd-Vashi Creek (towards) Vashi

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0416	Chl 'a' = 0.0662	Chl 'a' = 0.0862
		Chl 'b' = 0.0100	Chl 'b' = 0.0370	Chl 'b' = 0.0558
		T.C. = 0.0516	T. C. = 0.1032	T. C. = 0.1420
2.	*Avicennia marina*	Chl 'a' = 0.4855	Chl 'a' = 0.5430	Chl 'a' = 0.5834
		Chl 'b' = 0.1909	Chl 'b' = 0.2181	Chl 'b' = 0.2865
		T.C. = 0.6764	T. C. = 0.7611	T. C. = 0.8699
3.	*Avicennia officinalis*	Chl 'a' = 0.2812	Chl 'a' = 0.5418	Chl 'a' = 0.6167
		Chl 'b' = 0.1899	Chl 'b' = 0.2172	Chl 'b' = 0.2425
		T.C. = 0.4711	T. C. = 0.7590	T. C. = 0.8592
4.	*Rhizophora mucronata*	Chl 'a' = 0.2812	Chl 'a' = 0.5020	Chl 'a' = 0.5730
		Chl 'b' = 0.1899	Chl 'b' = 0.2109	Chl 'b' = 0.2538
		T.C. = 0.4711	T. C. = 0.7129	T. C. = 0.8268
5.	*Salvadora persica*	Chl 'a' = 0.1991	Chl 'a' = 0.0950	Chl 'a' = 0.1114
		Chl 'b' = 0.0561	Chl 'b' = 0.0350	Chl 'b' = 0.0582
		T.C. = 0.2552	T. C. = 0.1300	T. C. = 0.1696
6.	*Sonneratia apetala*	Chl 'a' = 0.0873	Chl 'a' = 0.1294	Chl 'a' = 0.2379
		Chl 'b' = 0.0558	Chl 'b' = 0.0828	Chl 'b' = 0.1588
		T.C. = 0.1431	T. C. = 0.2122	T. C. = 0.3967

Table IV

Mankhurd-Vashi Creek
(towards) Vashi

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	46	25	4.1	13.4	8.3
2.	*Avicennia officinalis*	41	22	3.8	16.2	6.8

Table V

Mankhurd-Vashi Creek
(towards) Vashi

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	87.9
2.	*Avicennia marina*	83.6
3.	*Avicennia officinalis*	80.3
4.	*Rhizophora mucronata*	87.3
5.	*Salvadora persica*	92.2
6.	*Sonneratia apetala*	90.2

(Winter Season)

A) Alibaug - Dharamtar Creek

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.6	2.9	3.4	4.8	0.60	23.5	48.4
2.	*Avicennia marina*	1.5	4.0	6.3	6.6	0.41	8.1	9.3
3.	*Avicennia officinalis*	1.4	1.9	2.4	2.6	0.79	7.3	8.3
4.	*Salvadora persica*	1.7	3.5	3.7	3.9	1.4	10.1	15.4
5.	*Sonneratia apetala*	1.3	7.0	6.3	4.0	0.50	3.88	17.40

Table II (a) Alibaug - Dharamtar Creek

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.012
2.	*Avicennia marina*	0.009
3.	*Avicennia officinalis*	0.006
4.	*Salvadora persica* (adaxial) (abaxial)	0.009 0.014
5.	*Sonneratia apetala* (adaxial) (abaxial)	0.017 0.014

Table II (b) Alibaug - Dharamtar Creek

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.7
2.	*Avicennia marina*	40.1
3.	*Avicennia officinalis*	26.9
4.	*Salvadora persica* (adaxial) (abaxial)	20.0 23.1
5.	*Sonneratia apetala* (adaxial) (abaxial)	13.6 15.3

Table II (c)

Alibaug - Dharamtar Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.341	0.052	0.053	0.043	0.139	0.054
		2nd node	0.473	0.069	0.111	0.044	0.125	0.124
		5th node	0.583	0.093	0.209	0.158	0.099	0.024
2.	*Avicennia marina*	1st node	0.361	0.140	0.070	0.079		0.072
		2nd node	0.421	0.165	0.126	0.047		0.083
		5th node	0.605	0.221	0.124	0.078		0.182
3.	*Avicennia officinalis*	1st node	0.327	0.067	0.110	0.037	0.032	0.081
		2nd node	0.355	0.123	0.095	0.054		0.083
		5th node	0.498	0.194	0.122	0.088		0.094
4.	*Salvadora persica*	1st node	0.765	0.020	0.179	0.420	0.124	0.022
		2nd node	0.940	0.051	0.210	0.507	0.139	0.042
		5th node	1.295	0.123	0.350	0.617	0.154	0.05[illegible]
5.	*Sonneratia apetala*	1st node	0.892	0.024	0.192	0.514	0.133	0.029
		2nd node	1.049	0.042	0.203	0.606	0.167	0.031
		5th node	1.416	0.049	0.304	0.720	0.311	0.032

Table II (d)

A) Alibag - Dharamtar Creek

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.048	0.022	0.120	0.665	0.444	2.797	203 / 0.106
2.	*Avicennia marina*	1.644	0.088	0.090	0.128	0.958	0.380	270 / 0.110
3.	*Avicennia officinalis*	1.235	0.055	0.070	0.118	0.622	0.370	266 / 0.102
4.	*Salvadora persica*	0.757	0.014	0.075	0.179	0.445	0.041	261 / 0.119
5.	*Sonneratia apetala*	1.472	0.107	0.215		0.630	0.520	270 / 0.118

Table (II) (e) Alibaug - Dharamtar Creek

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.6	5.7	8.3
2.	*Avicennia marina*	2.7	6.5	8.2
3.	*Avicennia officinalis*	2.5	5.8	8.0
4.	*Salvadora persica*	1.0	2.0	2.4
5.	*Sonneratia apetala*	1.1	1.6	1.9

Table III Alibaug - Dharamtar Creek

Chlorophyll Content

(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0246	Chl 'a' = 0.0511	Chl 'a' = 0.0721
		Chl 'b' = 0.0100	Chl 'b' = 0.0372	Chl 'b' = 0.0569
		T.C. = 0.0346	T. C. = 0.0883	T. C. = 0.1290
2.	*Avicennia marina*	Chl 'a' = 0.4683	Chl 'a' = 0.5281	Chl 'a' = 0.6039
		Chl 'b' = 0.1911	Chl 'b' = 0.2182	Chl 'b' = 0.2428
		T.C. = 0.6594	T. C. = 0.7463	T. C. = 0.8467
3.	*Avicennia officinalis*	Chl 'a' = 0.2640	Chl 'a' = 0.4464	Chl 'a' = 0.5561
		Chl 'b' = 0.1900	Chl 'b' = 0.2978	Chl 'b' = 0.2867
		T.C. = 0.4540	T. C. = 0.7442	T. C. = 0.8428
4.	*Salvadora persica*	Chl 'a' = 0.0505	Chl 'a' = 0.0800	Chl 'a' = 0.0930
		Chl 'b' = 0.0237	Chl 'b' = 0.0352	Chl 'b' = 0.0584
		T.C. = 0.0742	T. C. = 0.1152	T. C. = 0.1514
5.	*Sonneratia apetala*	Chl 'a' = 0.0701	Chl 'a' = 0.1146	Chl 'a' = 0.2253
		Chl 'b' = 0.0560	Chl 'b' = 0.0829	Chl 'b' = 0.1590
		T.C. = 0.1261	T. C. = 0.1975	T. C. = 0.3843

Table IV

Alibaug - Dharamtar Creek

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	50	28	4.3	10.3	8.7
2.	*Avicennia officinalis*	42	25	4.1	13.3	7.2

Table V

Alibaug - Dharamtar Creek

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	83.1
2.	*Avicennia marina*	79.3
3.	*Avicennia officinalis*	76.0
4.	*Salvadora persica*	87.7
5.	*Sonneratia apetala*	85.7

(Winter Season)

B) Godbunder - Cheena Creek

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.6	2.8	3.8	4.6	0.6	23.3	45.8
2.	*Avicennia marina*	1.2	4.1	6.1	6.9	0.35	7.9	9.2
3.	*Avicennia officinalis*	1.5	1.8	2.1	2.4	0.48	6.3	7.9
4.	*Rhizophora mucronata*	0.6	0.9	2.9	4.7	13.0	26.0	77.0
5.	*Salvadora persica*	1.4	3.2	3.4	3.5	1.1	9.5	15.4
6.	*Sonneratia apetala*	1.2	6.9	5.8	3.1	0.15	3.48	17.3

Table II (a) Godbunder - Cheena Creek

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.013
2.	*Avicennia marina*	0.009
3.	*Avicennia officinalis*	0.008
4.	*Rhizophora mucronata*	0.032
5.	*Salvadora persica* (adaxial) (abaxial)	0.008 0.009
6.	*Sonneratia apetala* (adaxial) (abaxial)	0.017 0.012

Table II (b) Godbunder - Cheena Creek

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.3
2.	*Avicennia marina*	50.0
3.	*Avicennia officinalis*	31.3
4.	*Rhizophora mucronata*	4.2
5.	*Salvadora persica* (adaxial) (abaxial)	21.9 23.7
6.	*Sonneratia apetala* (adaxial) (abaxial)	14.16 15.50

Table II (c)

B) Godbunder – Cheena Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with Epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.342	0.052	0.055	0.041	0.140	0.054
		2nd node	0.477	0.069	0.111	0.042	0.128	0.128
		5th node	0.590	0.097	0.208	0.156	0.100	0.029
2.	*Avicennia marina*	1st node	0.257	0.044	0.069	0.035	0.036	0.073
		2nd node	0.414	0.171	0.124	0.020	0.015	0.084
		5th node	0.605	0.127	0.225	0.037	0.023	0.183
3.	*Avicennia officinalis*	1st node	0.331	0.070	0.115	0.031	0.030	0.085
		2nd node	0.361	0.125	0.095	0.027	0.020	0.094
		5th node	0.481	0.126	0.195	0.036	0.030	0.084
4.	*Rhizophora mucronata*	1st node	0.682	0.041	0.085	0.499	0.042	0.015
		2nd node	0.687	0.056	0.141	0.278	0.183	0.029
		5th node	0.942	0.058	0.449	0.1[illegible]3	0.223	0.044
5.	*Salvadora persica*	1st node	0.771	0.023	0.183	0.421	0.122	0.022
		2nd node	0.937	0.052	0.204	0.503	0.135	0.043
		5th node	1.291	0.123	0.348	0.616	0.152	0.052
6.	*Sonneratia apetala*	1st node	0.901	0.029	0.196	0.514	0.133	0.029
		2nd node	1.042	0.040	0.201	0.605	0.165	0.031
		5th node	1.405	0.049	0.303	0.715	0.305	0.033

Table II (d)

B) Godbunder -Cheena Creek

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.040	0.024	0.123	0.657	0.456	2.780	222 / 0.102
2.	*Avicennia marina*	1.583	0.093	0.080	0.120	0.900	0.390	294 / 0.105
3.	*Avicennia officinalis*	1.263	0.052	0.073	0.115	0.641	0.380	380 / 0.100
4.	*Rhizophora mucronata*	3.334	0.042	0.308	0.651	1.168	1.165	210 / 0.175
5.	*Salvadora persica*	0.740	0.012	0.077	0.140	0.475	0.036	264 / 0.122
6.	*Sonneratia apetala*	1.460	0.100	0.210		0.640	0.510	240 / 0.116

Table (II) (e) Godbunder - Cheena Creek

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.9	6.0	8.4
2.	*Avicennia marina*	3.0	6.4	8.3
3.	*Avicennia officinalis*	2.8	6.1	8.2
4.	*Rhizophora mucronata*	3.0	6.2	7.6
5.	*Salvadora persica*	1.2	2.2	2.4
6.	*Sonneratia apetala*	1.3	1.7	1.8

Table III **Godbunder - Cheena Creek**

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0275	Chl 'a' = 0.0560	Chl 'a' = 0.0804
		Chl 'b' = 0.0101	Chl 'b' = 0.0373	Chl 'b' = 0.0562
		T.C. = 0.0376	T. C. = 0.0933	T. C. = 0.1366
2.	*Avicennia marina*	Chl 'a' = 0.4711	Chl 'a' = 0.5331	Chl 'a' = 0.6113
		Chl 'b' = 0.1913	Chl 'b' = 0.2182	Chl 'b' = 0.2430
		T.C. = 0.6624	T. C. = 0.7513	T. C. = 0.8543
3.	*Avicennia officinalis*	Chl 'a' = 0.2667	Chl 'a' = 0.4512	Chl 'a' = 0.5635
		Chl 'b' = 0.1903	Chl 'b' = 0.2980	Chl 'b' = 0.2869
		T.C. = 0.4570	T. C. = 0.7492	T. C. = 0.8504
4.	*Rhizophora mucronata*	Chl 'a' = 0.1823	Chl 'a' = 0.4870	Chl 'a' = 0.5567
		Chl 'b' = 0.0561	Chl 'b' = 0.2111	Chl 'b' = 0.2574
		T.C. = 0.2384	T. C. = 0.6981	T. C. = 0.8141
5.	*Salvadora persica*	Chl 'a' = 0.0508	Chl 'a' = 0.0799	Chl 'a' = 0.0983
		Chl 'b' = 0.0237	Chl 'b' = 0.0353	Chl 'b' = 0.0586
		T.C. = 0.0745	T. C. = 0.1152	T. C. = 0.1569
6.	*Sonneratia apetala*	Chl 'a' = 0.0695	Chl 'a' = 0.1144	Chl 'a' = 0.2248
		Chl 'b' = 0.0558	Chl 'b' = 0.0831	Chl 'b' = 0.1592
		T.C. = 0.1253	T. C. = 0.1975	T. C. = 0.3840

Table IV

Godbunder - Cheena Creek

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	56	31	4.5	10.9	8.9
2.	*Avicennia officinalis*	46	26	4.3	12.2	7.3

Table V

Godbunder - Cheena Creek

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	83.5
2.	*Avicennia marina*	79.0
3.	*Avicennia officinalis*	76.2
4.	*Rhizophora mucronata*	83.0
5.	*Salvadora persica*	88.0
6.	*Sonneratia apetala*	86.1

(Winter Season)

C) Mahim Creek i) Mahim -Khardanda
(Carter Road Coast)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.3	2.5	3.7	4.5	0.33	23.3	45.1
2.	*Avicennia marina*	1.2	4.0	5.9	6.4	0.44	7.6	8.9
3.	*Avicennia officinalis*	1.4	1.7	2.1	2.3	0.30	6.32	7.91
4.	*Rhizophora mucronata*	0.8	1.2	3.0	4.7	13.0	26.2	69.0
5.	*Salvadora persica*	1.3	3.4	3.4	3.5	1.3	10.12	15.23
6.	*Sonneratia apetala*	1.1	6.9	5.7	3.3	0.7	10.3	17.1

Table II (a)

Mahim Creek i) Mahim -Khardanda
(Carter Road Coast)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.015
2.	*Avicennia marina*	0.001
3.	*Avicennia officinalis*	0.010
4.	*Rhizophora mucronata*	0.030
5.	*Salvadora persica* (adaxial) (abaxial)	0.009 0.011
6.	*Sonneratia apetala* (adaxial) (abaxial)	0.018 0.017

Table II (b)

Mahim Creek i) Mahim -Khardanda
(Carter Road Coast)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.6
2.	*Avicennia marina*	35.3
3.	*Avicennia officinalis*	32.1
4.	*Rhizophora mucronata*	4.5
5.	*Salvadora persica* (adaxial) (abaxial)	22.0 23.9
6.	*Sonneratia apetala* (adaxial) (abaxial)	14.4 15.6

Table II (c)

C) Mahim Creek i) Mahim – Khardanda (Carter Road Coast)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with Epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.339	0.052	0.055	0.039	0.139	0.054
		2nd node	0.472	0.069	0.109	0.039	0.128	0.127
		5th node	0.583	0.096	0.208	0.153	0.098	0.028
2.	*Avicennia marina*	1st node	0.343	0.072	0.120	0.031	0.035	0.085
		2nd node	0.479	0.150	0.123	0.052	0.060	0.094
		5th node	0.600	0.126	0.225	0.061	0.073	0.103
3.	*Avicennia officinalis*	1st node	0.328	0.070	0.114	0.026	0.045	0.073
		2nd node	0.356	0.094	0.124	0.040	0.057	0.084
		5th node	0.474	0.125	0.195	0.045	0.062	0.083
4.	*Rhizophora mucronata*	1st node	0.870	0.042	0.089	0.599	0.042	0.015
		2nd node	0.918	0.057	0.241	0.378	0.383	0.029
		5th node	0.940	0.058	0.448	0.167	0.223	0.044
5.	*Salvadora persica*	1st node	0.766	0.023	0.182	0.418	0.121	0.022
		2nd node	0.931	0.051	0.203	0.500	0.135	0.043
		5th node	1.286	0.023	0.347	0.613	0.151	0.052
6.	*Sonneratia apetala*	1st node	0.894	0.029	0.195	0.510	0.131	0.029
		2nd node	0.034	0.040	0.200	0.0601	0.163	0.031
		5th node	1.399	0.049	0.302	0.711	0.304	0.033

Table II (d)

C) Mahim Creek i) Mahim - Khardanda
(Carter Road Coast)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.020	0.025	0.125	0.652	0.508	2.700	230 / 0.100
2.	*Avicennia marina*	1.591	0.090	0.088	0.120	0.950	0.343	297 / 0.102
3.	*Avicennia officinalis*	1.286	0.052	0.079	0.113	0.627	0.365	277 / 0.098
4.	*Rhizophora mucronata*	3.344	0.044	0.306	0.645	1.199	1.150	222 / 0.172
5.	*Salvadora persica*	0.751	0.014	0.079	0.137	0.494	0.027	280 / 0.120
6.	*Sonneratia apetala*	1.470	0.102	0.200		0.698	0.470	244 / 0.112

Table (II) (e)

C) Mahim Creek i) Mahim – Khardanda (Carter Road Coast)

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.1	5.5	8.3
2.	*Avicennia marina*	5.2	7.5	8.8
3.	*Avicennia officinalis*	2.8	7.2	8.6
4.	*Rhizophora mucronata*	3.3	6.5	7.4
5.	*Salvadora persica*	1.3	2.3	3.1
6.	*Sonneratia apetala*	1.4	1.8	2.3

Table III

C) Mahim Creek ii) Mahim – Khardanda (Carter Road Coast)

Chlorophyll Content

(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0304	Chl 'a' = 0.0608	Chl 'a' = 0.0878
		Chl 'b' = 0.0102	Chl 'b' = 0.0375	Chl 'b' = 0.0564
		T.C. = 0.0406	T. C. = 0.0983	T. C. = 0.1442
2.	*Avicennia marina*	Chl 'a' = 0.4739	Chl 'a' = 0.6280	Chl 'a' = 0.6186
		Chl 'b' = 0.1915	Chl 'b' = 0.2183	Chl 'b' = 0.2433
		T.C. = 0.6654	T. C. = 0.7563	T. C. = 0.8619
3.	*Avicennia officinalis*	Chl 'a' = 0.2696	Chl 'a' = 0.4560	Chl 'a' = 0.5710
		Chl 'b' = 0.1904	Chl 'b' = 0.2982	Chl 'b' = 0.2870
		T.C. = 0.4600	T. C. = 0.7542	T. C. = 0.8580
4.	*Rhizophora mucronata*	Chl 'a' = 0.1440	Chl 'a' = 0.4918	Chl 'a' = 0.5627
		Chl 'b' = 0.0560	Chl 'b' = 0.2110	Chl 'b' = 0.2573
		T.C. = 0.2000	T. C. = 0.7026	T. C. = 0.8200
5.	*Salvadora persica*	Chl 'a' = 0.0535	Chl 'a' = 0.0849	Chl 'a' = 0.1138
		Chl 'b' = 0.0240	Chl 'b' = 0.0355	Chl 'b' = 0.0589
		T.C. = 0.0775	T. C. = 0.1202	T. C. = 0.1717
6.	*Sonneratia apetala*	Chl 'a' = 0.0723	Chl 'a' = 0.1192	Chl 'a' = 0.2325
		Chl 'b' = 0.0560	Chl 'b' = 0.0833	Chl 'b' = 0.1595
		T.C. = 0.1283	T. C. = 0.2025	T. C. = 0.3920

Table IV

C) Mahim Creek i) Mahim - Khardanda
(Carter Road Coast)

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	60	25	4.5	7.3	9.1
2.	*Avicennia officinalis*	51	24	4.3	10.2	8.0

Table V

C) Mahim Creek i) Mahim - Khardanda
(Carter Road Coast)

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	84.1
2.	*Avicennia marina*	82.3
3.	*Avicennia officinalis*	77.7
4.	*Rhizophora mucronata*	83.5
5.	*Salvadora persica*	88.7
6.	*Sonneratia apetala*	86.7

(Winter Season)

C) Mahim Creek ii) Mahim Kurla

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.3	2.5	3.5	4.5	0.29	23.1	45.0
2.	*Avicennia marina*	1.1	3.9	5.5	6.4	0.42	7.4	8.63
3.	*Avicennia officinalis*	1.1	1.4	1.8	2.3	0.30	6.20	7.67
4.	*Rhizophora mucronata*	0.6	1.3	3.2	4.6	12.9	26.0	69.5
5.	*Salvadora persica*	1.2	3.1	3.3	3.5	0.85	9.82	15.18
6.	*Sonneratia apetala*	1.2	6.6	5.4	3.4	0.15	3.27	17.0

Table II (a) **Mahim Creek ii) Mahim Kurla**

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.017
2.	*Avicennia marina*	0.013
3.	*Avicennia officinalis*	0.012
4.	*Rhizophora mucronata*	0.036
5.	*Salvadora persica* (adaxial) (abaxial)	0.012 0.014
6.	*Sonneratia apetala* (adaxial) (abaxial)	0.020 0.019

Table II (b) **Mahim Creek ii) Mahim Kurla**

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.8
2.	*Avicennia marina*	35.9
3.	*Avicennia officinalis*	32.9
4.	*Rhizophora mucronata*	4.6
5.	*Salvadora persica* (adaxial) (abaxial)	22.4 24.1
6.	*Sonneratia apetala* (adaxial) (abaxial)	14.7 15.8

Table II (c)

C) Mahim Creek ii) Mahim - Kurla

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with Epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.336	0.052	0.056	0.036	0.138	0.020
		2nd node	0.463	0.069	0.108	0.032	0.127	0.025
		5th node	0.568	0.096	0.206	0.145	0.094	0.027
2.	*Avicennia marina*	1st node	0.242	0.043	0.068	0.026	0.032	0.073
		2nd node	0.403	0.170	0.121	0.018	0.010	0.084
		5th node	0.594	0.125	0.224	0.033	0.030	0.182
3.	*Avicennia officinalis*	1st node	0.319	0.069	0.111	0.035	0.020	0.084
		2nd node	0.350	0.124	0.092	0.020	0.025	0.094
		5th node	0.466	0.194	0.124	0.036	0.030	0.082
4.	*Rhizophora mucronata*	1st node	0.278	0.041	0.084	0.097	0.041	0.015
		2nd node	0.682	0.056	0.141	0.274	0.182	0.029
		5th node	0.936	0.057	0.448	0.165	0.223	0.044
5.	*Salvadora persica*	1st node	0.760	0.023	0.181	0.414	0.120	0.022
		2nd node	0.927	0.051	0.201	0.496	0.132	0.042
		5th node	1.276	0.122	0.364	0.608	0.148	0.052
6.	*Sonneratia apetala*	1st node	0.886	0.029	0.194	0.506	0.129	0.028
		2nd node	1.028	0.040	0.198	0.597	0.162	0.031
		5th node	1.389	0.048	0.301	0.706	0.302	0.032

Table II (d)

C) Mahim Creek ii) Mahim - Kurla

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.005	0.025	0.125	0.651	0.514	2.690	223 / 0.099
2.	*Avicennia marina*	1.597	0.087	0.088	0.116	0.938	0.368	300 / 0.100
3.	*Avicennia officinalis*	1.255	0.051	0.068	0.106	0.670	0.360	280 / 0.96
4.	*Rhizophora mucronata*	3.332	0.041	0.309	0.645	1.179	1.158	225 / 0.170
5.	*Salvadora persica*	0.740	0.012	0.078	0.168	0.450	0.032	284 / 0.118
6.	*Sonneratia apetala*	1.454	0.102	0.196		0.685	0.471	250 / 0.110

Table (II) (e) C) Mahim Creek i) Mahim – Kurla

Palisade Ratio

S. No.	Species	Palisade Ratio Leaf from 1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.3	5.7	8.6
2.	*Avicennia marina*	5.9	6.8	9.0
3.	*Avicennia officinalis*	3.2	6.3	9.0
4.	*Rhizophora mucronata*	3.7	6.7	7.3
5.	*Salvadora persica*	1.5	2.6	3.4
6.	*Sonneratia apetala*	1.7	2.1	2.6

Table III C) Mahim Creek ii) Mahim – Kurla

Chlorophyll Content

(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0334	Chl 'a' = 0.0659	Chl 'a' = 0.0951
		Chl 'b' = 0.0102	Chl 'b' = 0.0376	Chl 'b' = 0.0567
		T.C. = 0.0436	T. C. = 0.1035	T. C. = 0.1518
2.	*Avicennia marina*	Chl 'a' = 0.4769	Chl 'a' = 0.4581	Chl 'a' = 0.6260
		Chl 'b' = 0.1915	Chl 'b' = 0.2582	Chl 'b' = 0.2435
		T.C. = 0.6684	T. C. = 0.7563	T. C. = 0.8695
3.	*Avicennia officinalis*	Chl 'a' = 0.2726	Chl 'a' = 0.4609	Chl 'a' = 0.5782
		Chl 'b' = 0.1904	Chl 'b' = 0.2983	Chl 'b' = 0.2874
		T.C. = 0.4630	T. C. = 0.7592	T. C. = 0.8656
4.	*Rhizophora mucronata*	Chl 'a' = 0.1846	Chl 'a' = 0.4911	Chl 'a' = 0.5630
		Chl 'b' = 0.0561	Chl 'b' = 0.2113	Chl 'b' = 0.2576
		T.C. = 0.2407	T. C. = 0.7024	T. C. = 0.8206
5.	*Salvadora persica*	Chl 'a' = 0.0584	Chl 'a' = 0.0897	Chl 'a' = 0.1127
		Chl 'b' = 0.0241	Chl 'b' = 0.0355	Chl 'b' = 0.0590
		T.C. = 0.0825	T. C. = 0.1252	T. C. = 0.1717
6.	*Sonneratia apetala*	Chl 'a' = 0.0749	Chl 'a' = 0.1241	Chl 'a' = 0.1810
		Chl 'b' = 0.0564	Chl 'b' = 0.0834	Chl 'b' = 0.1598
		T.C. = 0.1313	T. C. = 0.2075	T. C. = 0.3408

Table IV

C) Mahim Creek ii) Mahim - Kurla

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	69	29	4.7	6.8	9.7
2.	*Avicennia officinalis*	57	26	4.5	10.3	8.4

Table V

C) Mahim Creek ii) Mahim - Kurla

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	84.9
2.	*Avicennia marina*	82.2
3.	*Avicennia officinalis*	78.0
4.	*Rhizophora mucronata*	83.2
5.	*Salvadora persica*	89.1
6.	*Sonneratia apetala*	87.0

(Winter Season)

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1^{st} Inter-node	2^{nd} Inter-node	3^{rd} Inter-node	4^{th} Inter-node	1^{st} node	2^{nd} node	5^{th} node
1.	*Acanthus ilicifolius*	1.5	2.7	3.7	4.6	0.34	22.79	45.7
2.	*Avicennia marina*	1.2	4.2	5.9	6.7	0.38	7.45	8.9
3.	*Avicennia officinalis*	1.5	1.8	2.1	2.2	0.43	6.25	7.7
4.	*Rhizophora mucronata*	0.5	1.0	2.9	4.2	12.8	25.1	69.2
5.	*Salvadora persica*	1.3	3.3	3.4	3.5	0.87	9.30	15.18
6.	*Sonneratia apetala*	1.0	6.1	6.0	3.3	0.9	3.36	17.4

Table II (a)

Mankhurd-Vashi Creek
(towards Mankhurd)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.013
2.	*Avicennia marina*	0.010
3.	*Avicennia officinalis*	0.008
4.	*Rhizophora mucronata*	0.033
5.	*Salvadora persica*	
	(adaxial)	0.008
	(abaxial)	0.014
6.	*Sonneratia apetala*	
	(adaxial)	0.018
	(abaxial)	0.015

Table II (b)

Mankhurd-Vashi Creek
(towards Mankhurd)

Stomatal Index (5^{th} node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.8
2.	*Avicennia marina*	50.7
3.	*Avicennia officinalis*	40.1
4.	*Rhizophora mucronata*	5.0
5.	*Salvadora persica*	
	(adaxial)	22.6
	(abaxial)	24.3
6.	*Sonneratia apetala*	
	(adaxial)	14.7
	(abaxial)	16.0

Table II (c)

D) Mankhurd-Vashi Creek
(towards Mankhurd)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with Epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.332	0.052	0.060	0.033	0.137	0.053
		2nd node	0.460	0.046	0.069	0.108	0.032	0.127
		5th node	0.563	0.096	0.205	0.142	0.093	0.027
2.	*Avicennia marina*	1st node	0.248	0.044	0.068	0.029	0.034	0.073
		2nd node	0.406	0.170	0.123	0.015	0.014	0.084
		5th node	0.594	0.126	0.225	0.030	0.031	0.183
3.	*Avicennia officinalis*	1st node	0.318	0.069	0.111	0.034	0.020	0.084
		2nd node	0.347	0.124	0.110	0.018	0.015	0.094
		5th node	0.462	0.194	0.123	0.033	0.030	0.082
4.	*Rhizophora mucronata*	1st node	0.275	0.041	0.084	0.094	0.041	0.015
		2nd node	0.678	0.056	0.141	0.271	0.181	0.029
		5th node	0.931	0.057	0.446	0.161	0.223	0.044
5.	*Salvadora persica*	1st node	0.758	0.023	0.181	0.412	0.120	0.022
		2nd node	0.911	0.051	0.200	0.488	0.130	0.042
		5th node	1.260	0.122	0.345	0.602	0.147	0.052
6.	*Sonneratia apetala*	1st node	0.880	0.029	0.194	0.500	0.129	0.028
		2nd node	1.010	0.040	0.191	0.589	0.160	0.030
		5th node	1.373	0.048	0.300	0.893	0.300	0.031

Table II (d)

D) Mankhurd - Vashi Creek
(towards Mankhurd)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.000	0.025	0.125	0.650	0.280	2.920	225 / 0.101
2.	*Avicennia marina*	1.592	0.094	0.085	0.110	0.943	0.360	292 / 0.104
3.	*Avicennia officinalis*	1.250	0.051	0.068	0.105	0.669	0.357	280 / 0.100
4.	*Rhizophora mucronata*	3.331	0.040	0.308	0.644	1.189	1.158	218 / 0.170
5.	*Salvadora persica*	0.737	0.012	0.080	0.188	0.407	0.050	270 / 0.112
6.	*Sonneratia apetala*	1.475	0.102	0.225		0.583	0.565	252 / 0.114

Table (II) (e)

D) Mankhurd –Vashi Creek
(towards Mankhurd)

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.5	5.9	8.8
2.	*Avicennia marina*	5.5	7.0	8.8
3.	*Avicennia officinalis*	3.5	6.4	8.3
4.	*Rhizophora mucronata*	3.6	6.8	7.5
5.	*Salvadora persica*	1.8	2.8	3.7
6.	*Sonneratia apetala*	2.0	2.2	2.8

Table III

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0366	Chl 'a' = 0.0710	Chl 'a' = 0.1027
		Chl 'b' = 0.0103	Chl 'b' = 0.0337	Chl 'b' = 0.0567
		T.C. = 0.0469	T. C. = 0.1087	T. C. = 0.1594
2.	*Avicennia marina*	Chl 'a' = 0.4799	Chl 'a' = 0.4631	Chl 'a' = 0.6262
		Chl 'b' = 0.1916	Chl 'b' = 0.2982	Chl 'b' = 0.1429
		T.C. = 0.6714	T. C. = 0.7613	T. C. = 0.7301
3.	*Avicennia officinalis*	Chl 'a' = 0.2755	Chl 'a' = 0.4660	Chl 'a' = 0.5858
		Chl 'b' = 0.1905	Chl 'b' = 0.2984	Chl 'b' = 0.2875
		T.C. = 0.4660	T. C. = 0.7644	T. C. = 0.8732
4.	*Rhizophora mucronata*	Chl 'a' = 0.1876	Chl 'a' = 0.4962	Chl 'a' = 0.5701
		Chl 'b' = 0.0561	Chl 'b' = 0.2114	Chl 'b' = 0.2577
		T.C. = 0.2440	T. C. = 0.7076	T. C. = 0.8278
5.	*Salvadora persica*	Chl 'a' = 0.0615	Chl 'a' = 0.0947	Chl 'a' = 0.1201
		Chl 'b' = 0.0242	Chl 'b' = 0.0356	Chl 'b' = 0.0592
		T.C. = 0.0860	T. C. = 0.1302	T. C. = 0.1793
6.	*Sonneratia apetala*	Chl 'a' = 0.0779	Chl 'a' = 0.1292	Chl 'a' = 0.2470
		Chl 'b' = 0.0564	Chl 'b' = 0.0835	Chl 'b' = 0.1599
		T.C. = 0.1343	T. C. = 0.2127	T. C. = 0.4068

Table IV

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	68	30	5.0	7.3	10.0
2.	*Avicennia officinalis*	54	27	4.9	9.2	8.5

Table V

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	85.1
2.	*Avicennia marina*	81.2
3.	*Avicennia officinalis*	79.0
4.	*Rhizophora mucronata*	83.2
5.	*Salvadora persica*	88.3
6.	*Sonneratia apetala*	87.1

(Winter Season)

E) Thane-Kalyan bypass

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.5	2.7	3.8	4.5	0 31	23.8	45.8
2.	*Avicennia marina*	1.4	4.1	6.0	6.6	0 32	7.7	9.0
3.	*Avicennia officinalis*	1.5	1.9	2.2	2.3	0.47	6.1	7.8
4.	*Rhizophora mucronata*	0.5	0.9	2.7	4.1	12.6	26.2	68.7
5.	*Salvadora persica*	1.3	3.4	3.7	3.7	1.1	9.30	15.4
6.	*Sonneratia apetala*	1.3	6.8	6.2	3.2	0.8	3.80	17.7

Table II (a) Thane-Kalyan bypass

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.014
2.	*Avicennia marina*	0.010
3.	*Avicennia officinalis*	0.009
4.	*Rhizophora mucronata*	0.030
5.	*Salvadora persica*	
	(adaxial)	0.008
	(abaxial)	0.012
6.	*Sonneratia apetala*	
	(adaxial)	0.017
	(abaxial)	0.017

Table II (b) Thane-Kalyan bypass

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.1
2.	*Avicennia marina*	51.2
3.	*Avicennia officinalis*	40.4
4.	*Rhizophora mucronata*	5.2
5.	*Salvadora persica*	
	(adaxial)	22.9
	(abaxial)	24.8
6.	*Sonneratia apetala*	
	(adaxial)	15.0
	(abaxial)	16.3

Table II (d)

E) Thane – Kalyan bypass

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	3.993	0.024	0.125	0.648	0.496	2.700	230 / 0.100
2.	*Avicennia marina*	1.600	0.094	0.086	0.110	0.930	0.380	294 / 0.104
3.	*Avicennia officinalis*	1.266	0.051	0.067	0.105	0.671	0.372	281 0.088
4.	*Rhizophora mucronata*	3.339	0.041	0.308	0.643	1.205	1.142	206 / 0.168
5.	*Salvadora persica*	0.742	0.012	0.077	0.137	0.469	0.047	272 / 0.110
6.	*Sonneratia apetala*	1.470	0.105	0.210		0.600	0.555	260 / 0.112

Table (II) (e) E) Thane – Kalyan bypass

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.7	6.1	9.0
2.	*Avicennia marina*	5.8	7.4	8.3
3.	*Avicennia officinalis*	3.6	6.8	8.2
4.	*Rhizophora mucronata*	3.9	6.9	7.8
5.	*Salvadora persica*	1.9	3.0	3.0
6.	*Sonneratia apetala*	2.2	2.7	3.1

Table III E) Thane – Kalyan bypass

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0397	Chl 'a' = 0.0758	Chl 'a' = 0.1103
		Chl 'b' = 0.0104	Chl 'b' = 0.0379	Chl 'b' = 0.0569
		T.C. = 0.0501	T. C. = 0.1137	T. C. = 0.1672
2.	*Avicennia marina*	Chl 'a' = 0.4826	Chl 'a' = 0.4679	Chl 'a' = 0.1506
		Chl 'b' = 0.1918	Chl 'b' = 0.2984	Chl 'b' = 0.6263
		T.C. = 0.6744	T. C. = 0.7663	T. C. = 0.7769
3.	*Avicennia officinalis*	Chl 'a' = 0.2806	Chl 'a' = 0.4710	Chl 'a' = 0.5933
		Chl 'b' = 0.1906	Chl 'b' = 0.2984	Chl 'b' = 0.2877
		T.C. = 0.4712	T. C. = 0.7694	T. C. = 0.8810
4.	*Rhizophora mucronata*	Chl 'a' = 0.1910	Chl 'a' = 0.5014	Chl 'a' = 0.5779
		Chl 'b' = 0.0562	Chl 'b' = 0.2114	Chl 'b' = 0.2577
		T.C. = 0.2472	T. C. = 0.7128	T. C. = 0.8356
5.	*Salvadora persica*	Chl 'a' = 0.0652	Chl 'a' = 0.0717	Chl 'a' = 0.1279
		Chl 'b' = 0.0242	Chl 'b' = 0.0357	Chl 'b' = 0.0592
		T.C. = 0.0894	T. C. = 0.1360	T. C. = 0.1871
6.	*Sonneratia apetala*	Chl 'a' = 0.0812	Chl 'a' = 0.1350	Chl 'a' = 0.2546
		Chl 'b' = 0.0566	Chl 'b' = 0.0835	Chl 'b' = 0.1600
		T.C. = 0.1378	T. C. = 0.2185	T. C. = 0.4146

(Summer Season)

STANDARD / CONTROL

Mankhurd - Vashi Creek (towards Vashi)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.3	3.3	4.5	5.4	1.2	24.7	52.1
2.	*Avicennia marina*	1.5	5.0	6.3	7.6	0.9	9.0	10.1
3.	*Avicennia officinalis*	2.0	2.6	2.8	3.1	0.6	7.6	9.0
4.	*Rhizophora mucronata*	0.9	1.4	3.7	5.3	13.5	26.8	78.1
5.	*Salvadora persica*	1.8	4.0	4.0	4.5	1.5	10.4	18.9
6.	*Sonneratia apetala*	1.7	3.4	3.5	4.5	1.4	5.0	18.1

Table II (a)

Mankhurd - Vashi Creek (towards Vashi)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.018
2.	*Avicennia marina*	0.010
3.	*Avicennia officinalis*	0.013
4.	*Rhizophora mucronata*	0.036
5.	*Salvadora persica* (adaxial) (abaxial)	0.015 0.017
6.	*Sonneratia apetala* (adaxial) (abaxial)	0.022 0.024

Table II (b)

Mankhurd - Vashi Creek (towards Vashi)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	21.1
2.	*Avicennia marina*	20.5
3.	*Avicennia officinalis*	16.6
4.	*Rhizophora mucronata*	4.3
5.	*Salvadora persica* (adaxial) (abaxial)	10.5 12.5
6.	*Sonneratia apetala* (adaxial) (abaxial)	3.4 4.1

Table II (c)

C) Mankhurd-Vashi Creek (towards Vashi)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.379	0.059	0.065	0.52	0.147	0.046
		2nd node	0.511	0.073	0.125	0.053	0.135	0.125
		5th node	0.622	0.102	0.225	0.161	0.102	0.032
2.	*Avicennia marina*	1st node	0.362	0.072	0.125	0.045	0.034	0.086
		2nd node	0.394	0.127	0.107	0.036	0.032	0.092
		5th node	0.733	0.196	0.240	0.110	0.087	0.100
3.	*Avicennia officinalis*	1st node	0.297	0.044	0.078	0.057	0.044	0.074
		2nd node	0.377	0.124	0.119	0.026	0.020	0.088
		5th node	0.628	0.0151	0.224	0.035	0.035	0.183
4.	*Rhizophora mucronata*	1st node	0.312	0.044	0.091	0.112	0.047	0.0018
		2nd node	0.747	0.061	0.160	0.305	0.189	0.032
		5th node	0.975	0.061	0.455	0.182	0.230	0.047
5.	*Salvadora persica*	1st node	0.802	0.025	0.189	0.443	0.131	0.024
		2nd node	1.266	0.046	0.371	0.528	0.225	0.096
		5th node	1.770	0.102	0.691	0.732	0.133	0.107
6.	*Sonneratia apetala*	1st node	1.088	0.038	0.207	0.532	0.280	0.031
		2nd node	1.533	0.057	0.429	0.633	0.325	0.089
		5th node	2.017	0.099	0.750	0.831	0.217	0.120

Table II (d)

Mankhurd-Vashi Creek
(towards Vashi)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.201	0.031	0.133	0.675	0.537	2.825	210 / 0.104
2.	*Avicennia marina*	1.752	0.102	0.117	0.128	1.035	0.370	281 / 0.110
3.	*Avicennia officinalis*	1.342	0.061	0.088	0.128	0.710	0.355	275 / 0.098
4.	*Rhizophora mucronata*	3.381	0.048	0.319	0.658	1.186	1.170	180 / 0.186
5.	*Salvadora persica*	0.793	0.016	0.089	0.197	0.433	0.058	260 / 0.125
6.	*Sonneratia apetala*	1.502	0.118	0.212		0.559	0.613	237 / 0.117

Table (II) (e)

Mankhurd-Vashi Creek
(towards) Vashi

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	4.3	6.8	9.9
2.	*Avicennia marina*	7.1	8.4	10.1
3.	*Avicennia officinalis*	4.2	7.0	9.7
4.	*Rhizophora mucronata*	4.0	6.3	8.4
5.	*Salvadora persica*	2.5	3.3	4.0
6.	*Sonneratia apetala*	2.5	3.1	3.7

Table III

Mankhurd-Vashi Creek
(towards) Vashi

Chlorophyll Content

(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0469	Chl 'a' = 0.0708	Chl 'a' = 0.0991
		Chl 'b' = 0.0150	Chl 'b' = 0.0392	Chl 'b' = 0.0557
		T.C. = 0.0619	T. C. = 0.1100	T. C. = 0.1548
2.	*Avicennia marina*	Chl 'a' = 0.4902	Chl 'a' = 0.5502	Chl 'a' = 0.6418
		Chl 'b' = 0.1938	Chl 'b' = 0.2201	Chl 'b' = 0.2422
		T.C. = 0.6840	T. C. = 0.7703	T. C. = 0.8840
3.	*Avicennia officinalis*	Chl 'a' = 0.2896	Chl 'a' = 0.5487	Chl 'a' = 0.6394
		Chl 'b' = 0.1921	Chl 'b' = 0.2169	Chl 'b' = 0.2400
		T.C. = 0.4808	T. C. = 0.7684	T. C. = 0.8794
4.	*Rhizophora mucronata*	Chl 'a' = 0.2021	Chl 'a' = 0.5297	Chl 'a' = 0.5728
		Chl 'b' = 0.0582	Chl 'b' = 0.2140	Chl 'b' = 0.2560
		T.C. = 0.2603	T. C. = 0.7437	T. C. = 0.8288
5.	*Salvadora persica*	Chl 'a' = 0.0708	Chl 'a' = 0.0999	Chl 'a' = 0.1120
		Chl 'b' = 0.0271	Chl 'b' = 0.0382	Chl 'b' = 0.0582
		T.C. = 0.0979	T. C. = 0.1381	T. C. = 0.1702
6.	*Sonneratia apetala*	Chl 'a' = 0.0905	Chl 'a' = 0.1328	Chl 'a' = 0.2389
		Chl 'b' = 0.0577	Chl 'b' = 0.0866	Chl 'b' = 0.1586
		T.C. = 0.1482	T. C. = 0.2194	T. C. = 0.3975

Table IV

Mankhurd-Vashi Creek
(towards) Vashi

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	49	26	4.3	14.1	8.6
2.	*Avicennia officinalis*	43	24	3.9	16.8	7.2

Table V

Mankhurd-Vashi Creek
(towards) Vashi

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	88.2
2.	*Avicennia marina*	84.3
3.	*Avicennia officinalis*	81.2
4.	*Rhizophora mucronata*	88.0
5.	*Salvadora persica*	93.3
6.	*Sonneratia apetala*	91.0

(Summer Season)

A) Alibaug - Dharamtar Creek

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm²		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.7	3.0	3.4	5.0	0.75	23.7	48.6
2.	*Avicennia marina*	1.6	4.1	6.3	7.0	0.82	8.3	9.7
3.	*Avicennia officinalis*	1.4	2.0	2.5	2.2	0.44	7.5	8.5
4.	*Salvadora persica*	1.8	3.6	3.9	4.2	1.6	10.3	15.6
5.	*Sonneratia apetala*	1.3	7.2	6.3	4.2	0.52	4.1	17.56

Table II (a) Alibaug - Dharamtar Creek

Measurement of stomata

S. No.	Species	Area of stoma in mm²
1.	*Acanthus ilicifolius*	0.014
2.	*Avicennia marina*	0.011
3.	*Avicennia officinalis*	0.007
4.	*Salvadora persica* (adaxial) (abaxial)	0.012 0.015
5.	*Sonneratia apetala* (adaxial) (abaxial)	0.018 0.015

Table II (b) Alibaug - Dharamtar Creek

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.0
2.	*Avicennia marina*	40.2
3.	*Avicennia officinalis*	30.1
4.	*Salvadora persica* (adaxial) (abaxial)	20.1 23.3
5.	*Sonneratia apetala* (adaxial) (abaxial)	13.6 15.6

Table II (c)

Alibaug - Dharamtar Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.371	0.059	0.063	0.050	0.144	0.055
		2nd node	0.500	0.073	0.124	0.047	0.131	0.125
		5th node	0.586	0.092	0.210	0.161	0.100	0.023
2.	*Avicennia marina*	1st node	0.358	0.072	0.124	0.076		0.086
		2nd node	0.382	0.127	0.102	0.061		0.091
		5th node	0.621	0.188	0.193	0.142		0.098
3.	*Avicennia officinalis*	1st node	0.272	0.044	0.070	0.046	0.044	0.073
		2nd node	0.362	0.124	0.112	-	0.039	0.087
		5th node	0.513	0.161	0.140	-	0.110	0.102
4.	*Salvadora persica*	1st node	0.790	0.025	0.184	0.428	0.130	0.023
		2nd node	1.250	0.046	0.368	0.519	0.222	0.095
		5th node	1.299	0.050	0.382	0.539	0.230	0.098
5.	*Sonneratia apetala*	1st node	1.067	0.037	0.200	0.525	0.275	0.030
		2nd node	1.400	0.057	0.373	0.590	0.300	0.080
		5th node	1.420	0.058	0.377	0.600	0.305	0.080

Table II (d)

A) Alibaug-Dharmtar Creek

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.123	0.024	0.124	0.660	0.525	2.790	208 / 0.104
2.	*Avicennia marina*	1.692	0.090	0.093	0.122	1.015	0.372	286 / 0.104
3.	*Avicennia officinalis*	1.295	0.056	0.071	0.113	0.658	0.397	270 / 0.100
4.	*Salvadora persica*	0.787	0.015	0.077	0.170	0.490	0.035	273 / 0.114
5.	*Sonneratia apetala*	1.490	0.109	0.210		0.661	0.510	290 / 0.115

Table (II) (e) Alibaug - Dharamtar Creek

Palisade Ratio

S. No.	Species	Palisade Ratio Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	2.8	5.9	8.5
2.	*Avicennia marina*	2.9	6.9	8.6
3.	*Avicennia officinalis*	2.7	6.1	8.4
4.	*Salvadora persica*	1.2	2.3	2.7
5.	*Sonneratia apetala*	1.2	1.7	2.2

Table III **Alibaug - Dharamtar Creek**

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0269	Chl 'a' = 0.0532	Chl 'a' = 0.0787
		Chl 'b' = 0.0108	Chl 'b' = 0.0380	Chl 'b' = 0.0575
		T.C. = 0.0377	T. C. = 0.0912	T. C. = 0.1362
2.	*Avicennia marina*	Chl 'a' = 0.4696	Chl 'a' = 0.5314	Chl 'a' = 0.6256
		Chl 'b' = 0.1921	Chl 'b' = 0.2188	Chl 'b' = 0.2430
		T.C. = 0.6617	T. C. = 0.7502	T. C. = 0.8686
3.	*Avicennia officinalis*	Chl 'a' = 0.2679	Chl 'a' = 0.4510	Chl 'a' = 0.5623
		Chl 'b' = 0.1917	Chl 'b' = 0.2987	Chl 'b' = 0.2869
		T.C. = 0.4596	T. C. = 0.7497	T. C. = 0.8492
4.	*Salvadora persica*	Chl 'a' = 0.0532	Chl 'a' = 0.0817	Chl 'a' = 0.0946
		Chl 'b' = 0.0245	Chl 'b' = 0.0366	Chl 'b' = 0.0585
		T.C. = 0.0777	T. C. = 0.1183	T. C. = 0.1531
5.	*Sonneratia apetala*	Chl 'a' = 0.0729	Chl 'a' = 0.1170	Chl 'a' = 0.2259
		Chl 'b' = 0.0568	Chl 'b' = 0.0840	Chl 'b' = 0.1592
		T.C. = 0.1297	T. C. = 0.2010	T. C. = 0.3851

Table IV   Alibaug - Dharamtar Creek

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	56	30	4.4	10.8	9.1
2.	*Avicennia officinalis*	45	28	4.2	14.1	7.5

Table V   Alibaug - Dharamtar Creek

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	84.1
2.	*Avicennia marina*	79.5
3.	*Avicennia officinalis*	76.1
4.	*Salvadora persica*	88.0
5.	*Sonneratia apetala*	86.3

(Summer Season)

B) Godbunder - Cheena Creek

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.8	2.9	3.9	4.7	0.8	23.5	45.9
2.	*Avicennia marina*	1.4	4.3	6.1	7.0	0.6	8.0	9.5
3.	*Avicennia officinalis*	1.6	1.9	2.2	2.6	0.5	6.5	8.1
4.	*Rhizophora mucronata*	0.8	1.2	3.1	5.0	13.1	26.7	77.9
5.	*Salvadora persica*	1.5	3.4	3.5	3.5	1.2	9.7	15.6
6.	*Sonneratia apetala*	1.4	6.9	5.9	3.9	0.17	3.58	18.0

Table II (a) **Godbunder - Cheena Creek**

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.014
2.	*Avicennia marina*	0.010
3.	*Avicennia officinalis*	0.009
4.	*Rhizophora mucronata*	0.034
5.	*Salvadora persica*	
	(adaxial)	0.009
	(abaxial)	0.010
6.	*Sonneratia apetala*	
	(adaxial)	0.019
	(abaxial)	0.017

Table II (b) **Godbunder - Cheena Creek**

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.4
2.	*Avicennia marina*	50.1
3.	*Avicennia officinalis*	31.5
4.	*Rhizophora mucronata*	4.4
5.	*Salvadora persica*	
	(adaxial)	22.0
	(abaxial)	23.8
6.	*Sonneratia apetala*	
	(adaxial)	14.2
	(abaxial)	15.8

Table II (c)

B) Godbunder-Cheena Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
7.	*Acanthus Ilicifolius*	1st node	0.365	0.052	0.06	0.046	0.143	0.054
		2nd node	0.487	0.069	0.112	0.049	0.130	0.128
		5th node	0.598	0.097	0.215	0.161	0.101	0.024
8.	*Avicennia marina*	1st node	0.356	0.072	0.124	0.034	0.032	0.086
		2nd node	0.420	0.118	0.154	0.030	0.032	0.086
		5th node	0.618	0.188	0.193	0.114	0.050	0.073
9.	*Avicennia officinalis*	1st node	0.271	0.039	0.084	0.039	0.042	0.067
		2nd node	0.352	0.114	0.122	0.020	0.019	0.082
		5th node	0.494	0.131	0.140	0.011	0.020	0.102
10.	*Rhizophora mucronata*	1st node	0.298	0.044	0.092	0.114	0.048	0.018
		2nd node	0.740	0.061	0.159	0.301	0.187	0.032
		5th node	0.953	0.061	0.450	0.178	0.217	0.047
11.	*Salvadora persica*	1st node	0.910	0.048	0.217	0.392	0.127	0.016
		2nd node	1.105	0.049	0.400	0.495	0.136	0.044
		5th node	1.296	0.122	0.390	0.587	0.150	0.047
12.	*Sonneratia apetala*	1st node	0.925	0.020	0.280	0.480	0.120	0.025
		2nd node	1.225	0.035	0.320	0.610	0.175	0.026
		5th node	1.410	0.046	0.427	0.600	0.308	0.029

Table (II) d

B) Godbunder - Cheena Creek

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.098	0.026	0.124	0.664	0.514	2.770	220 / 0.098
2.	*Avicennia marina*	1.607	0.094	0.083	0.117	0.997	0.308	296 / 0.102
3.	*Avicennia officinalis*	1.297	0.052	0.077	0.113	0.697	0.358	272 / 0.099
4.	*Rhizophora mucronata*	3.365	0.043	0.311	0.648	1.213	1.150	225 / 0.172
5.	*Salvadora persica*	0.763	0.014	0.080	0.138	0.511	0.020	277 / 0.120
6.	*Sonneratia apetala*	1.480	0.110	0.205		0.665	0.500	260 / 0.113

Table II (c)

B) Godbunder - Cheena Creek

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.329	0.050	0.052	0.038	0.138	0.051
		2nd node	0.426	0.066	0.108	0.039	0.124	0.125
		5th node	0.563	0.094	0.206	0.140	0.097	0.026
2.	*Avicennia marina*	1st node	0.324	0.067	0.108	0.067	0.077	0.082
		2nd node	0.473	0.192	0.121	0.084	0.008	0.083
		5th node	0.590	0.222	0.122	0.164	0.083	0.081
3.	*Avicennia officinalis*	1st node	0.251	0.039	0.066	0.040	0.038	0.068
		2nd node	0.408	0.166	0.120	0.041	0.021	0.081
		5th node	0.473	0.192	0.121	0.080	0.020	0.080
4.	*Rhizophora mucronata*	1st node	0.240	0.039	0.064	0.098	0.029	0.010
		2nd node	0.602	0.050	0.135	0.132	0.268	0.017
		5th node	0.931	0.058	0.445	0.165	0.221	0.042
5.	*Salvadora persica*	1st node	0.754	0.018	0.179	0.417	0.121	0.019
		2nd node	0.919	0.048	0.200	0.499	0.132	0.040
		5th node	1.270	0.120	0.344	0.610	0.147	0.049
6.	*Sonneratia apetala*	1st node	0.882	0.026	0.191	0.509	0.130	0.026
		2nd node	1.026	0.037	0.198	0.600	0.162	0.029
		5th node	1.387	0.046	0.300	0.710	0.301	0.030

Table IV

Godbunder - Cheena Creek

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	60	33	4.7	11.3	9.3
2.	*Avicennia officinalis*	48	27	4.6	12.8	7.8

Table V

Godbunder - Cheena Creek

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	84.2
2.	*Avicennia marina*	79.2
3.	*Avicennia officinalis*	76.4
4.	*Rhizophora mucronata*	83.4
5.	*Salvadora persica*	89.3
6.	*Sonneratia apetala*	87.2

(Summer Season)

C) Mahim Creek i) Mahim -Khardanda (Carter Road Coast)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.4	2.6	4.0	4.9	0.35	23.4	45.8
2.	*Avicennia marina*	1.4	4.1	6.2	6.6	0.60	7.8	9.2
3.	*Avicennia officinalis*	1.5	1.7	2.4	2.5	0.5	6.45	8.2
4.	*Rhizophora mucronata*	0.9	1.3	3.5	4.9	13.3	26.6	70.5
5.	*Salvadora persica*	1.5	3.6	3.5	3.6	1.7	10.21	16.1
6.	*Sonneratia apetala*	1.4	7.1	5.9	3.5	0.85	3.53	17.5

Table II (a)

Mahim Creek i) Mahim -Khardanda (Carter Road Coast)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.016
2.	*Avicennia marina*	0.011
3.	*Avicennia officinalis*	0.011
4.	*Rhizophora mucronata*	0.032
5.	*Salvadora persica* (adaxial) (abaxial)	 0.010 0.013
6.	*Sonneratia apetala* (adaxial) (abaxial)	 0.019 0.020

Table II (b)

Mahim Creek i) Mahim -Khardanda (Carter Road Coast)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	32.9
2.	*Avicennia marina*	35.5
3.	*Avicennia officinalis*	32.4
4.	*Rhizophora mucronata*	4.8
5.	*Salvadora persica* (adaxial) (abaxial)	 22.4 24.2
6.	*Sonneratia apetala* (adaxial) (abaxial)	 14.5 15.7

Table II (c)

C) Mahim Creek i) Mahim – Khardanda
(Carter Road Coast)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with Epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.349	0.052	0.054	0.048	0.139	0.054
		2nd node	0.490	0.070	0.119	0.049	0.129	0.127
		5th node	0.592	0.096	0.210	0.163	0.099	0.028
2.	*Avicennia marina*	1st node	0.360	0.072	0.130	0.036	0.040	0.085
		2nd node	0.489	0.150	0.127	0.054	0.065	0.094
		5th node	0.621	0.225	0.130	0.066	0.083	0.104
3.	*Avicennia officinalis*	1st node	0.348	0.070	0.124	0.036	0.046	0.073
		2nd node	0.376	0.125	0.104	0.045	0.067	0.084
		5th node	0.512	0.197	0.135	0.055	0.082	0.083
4.	*Rhizophora mucronata*	1st node	0.880	0.042	0.094	0.605	0.042	0.015
		2nd node	0.928	0.057	0.245	0.382	0.383	0.029
		5th node	0.949	0.058	0.449	0.177	0.223	0.044
5.	*Salvadora persica*	1st node	0.776	0.023	0.185	0.428	0.121	0.022
		2nd node	0.951	0.051	0.213	0.510	0.139	0.043
		5th node	1.290	0.123	0.347	0.615	0.156	0.052
6.	*Sonneratia apetala*	1st node	0.914	0.040	0.205	0.520	0.133	0.029
		2nd node	1.054	0.040	0.205	0.611	0.168	0.031
		5th node	1.410	0.049	0.322	0.741	0.324	0.033

Table II (d)

C) Mahim Creek i) Mahim- Khardanda (Carter Road Coast)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.087	0.026	0.128	0.675	0.598	2.685	240 / 0.097
2.	*Avicennia marina*	1.618	0.090	0.090	0.118	0.989	0.331	315 / 0.100
3.	*Avicennia officinalis*	1.309	0.053	0.080	0.110	0.708	0.358	290 / 0.098
4.	*Rhizophora mucronata*	3.370	0.045	0.307	0.642	1.238	1.138	245 / 0.170
5.	*Salvadora persica*	0.772	0.014	0.080	0.130	0.523	0.025	299 / 0.119
6.	*Sonneratia apetala*	1.491	0.102	0.198		0.730	0.461	265 / 0.111

Table II (e)

C)Mahim Creek i) Mahim – Khardanda
(Carter Road Coast)

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.2	5.7	8.5
2.	*Avicennia marina*	5.5	7.9	9.0
3.	*Avicennia officinalis*	3.0	7.5	8.8
4.	*Rhizophora mucronata*	3.6	6.9	7.8
5.	*Salvadora persica*	1.4	2.5	3.2
6.	*Sonneratia apetala*	1.6	2.0	2.5

Table III

C) Mahim Creek (a) Mahim – Khardanda
(Carter Road Coast)

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0364	Chl 'a' = 0.0626	Chl 'a' = 0.0894
		Chl 'b' = 0.0106	Chl 'b' = 0.0373	Chl 'b' = 0.0564
		T.C. = 0.0470	T. C. = 0.0999	T. C. = 0.1458
2.	*Avicennia marina*	Chl 'a' = 0.4757	Chl 'a' = 0.4814	Chl 'a' = 0.5820
		Chl 'b' = 0.1917	Chl 'b' = 0.4814	Chl 'b' = 0.5820
		T.C. = 0.6674	T. C. = 0.7597	T. C. = 0.8692
3.	*Avicennia officinalis*	Chl 'a' = 0.2665	Chl 'a' = 0.4609	Chl 'a' = 0.5803
		Chl 'b' = 0.2000	Chl 'b' = 0.2983	Chl 'b' = 0.2817
		T.C. = 0.4665	T. C. = 0.7592	T. C. = 0.8680
4.	*Rhizophora mucronata*	Chl 'a' = 0.1843	Chl 'a' = 0.4956	Chl 'a' = 0.5635
		Chl 'b' = 0.0561	Chl 'b' = 0.2111	Chl 'b' = 0.2575
		T.C. = 0.2404	T. C = 0.7066	T. C. = 0.8210
5.	*Salvadora persica*	Chl 'a' = 0.0549	Chl 'a' = 0.0885	Chl 'a' = 0.1048
		Chl 'b' = 0.0240	Chl 'b' = 0.0395	Chl 'b' = 0.0588
		T.C. = 0.0789	T. C. = 0.1244	T. C. = 0.1636
6.	*Sonneratia apetala*	Chl 'a' = 0.0734	Chl 'a' = 0.1225	Chl 'a' = 0.2224
		Chl 'b' = 0.0560	Chl 'b' = 0.0840	Chl 'b' = 0.1596
		T.C. = 0.1294	T. C. = 0.2065	T. C. = 0.3820

Table IV

C) Mahim Creek i) Mahim - Khardanda (Carter Road Coast)

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	68	30	4.6	7.5	10.4
2.	*Avicennia officinalis*	56	28	4.5	11.3	9.2

Table V

C) Mahim Creek i) Mahim - Khardanda (Carter Road Coast)

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	85.0
2.	*Avicennia marina*	83.0
3.	*Avicennia officinalis*	78.3
4.	*Rhizophora mucronata*	84.0
5.	*Salvadora persica*	89.2
6.	*Sonneratia apetala*	87.0

(Summer Season)

C) Mahim Creek ii) Mahim Kurla

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.4	2.7	3.6	4.7	0.31	23.4	45.8
2.	*Avicennia marina*	1.1	4.2	5.7	6.5	0.43	7.6	8.9
3.	*Avicennia officinalis*	1.3	1.6	1.8	2.4	0.31	6.31	7.8
4.	*Rhizophora mucronata*	0.8	1.5	3.4	4.8	13.2	26.2	70.2
5.	*Salvadora persica*	1.3	3.3	3.3	3.6	0.87	10.1	16.3
6.	*Sonneratia apetala*	1.2	6.7	5.5	3.7	1.0	3.62	17.2

Table II (a) Mahim Creek ii) Mahim Kurla

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.018
2.	*Avicennia marina*	0.015
3.	*Avicennia officinalis*	0.014
4.	*Rhizophora mucronata*	0.030
5.	*Salvadora persica*	
	(adaxial)	0.013
	(abaxial)	0.015
6.	*Sonneratia apetala*	
	(adaxial)	0.021
	(abaxial)	0.021

Table II (b) Mahim Creek ii) Mahim Kurla

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.0
2.	*Avicennia marina*	36.1
3.	*Avicennia officinalis*	33.6
4.	*Rhizophora mucronata*	5.0
5.	*Salvadora persica*	
	(adaxial)	22.8
	(abaxial)	24.3
6.	*Sonneratia apetala*	
	(adaxial)	14.8
	(abaxial)	16.0

Table II (c)

C) Mahim Creek ii) Mahim – Kurla

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1^{st} node	0.346	0.052	0.060	0.042	0.138	0.020
		2^{nd} node	0.473	0.069	0.109	0.041	0.127	0.025
		5^{th} node	0.576	0.096	0.206	0.155	0.094	0.027
2.	*Avicennia marina*	1^{st} node	0.258	0.044	0.070	0.036	0.034	0.073
		2^{nd} node	0.413	0.170	0.123	0.022	0.015	0.084
		5^{th} node	0.606	0.225	0.135	0.041	0.035	0.182
3.	*Avicennia officinalis*	1^{st} node	0.235	0.069	0.113	0.038	0.022	0.084
		2^{nd} node	0.360	0.124	0.093	0.025	0.030	0.064
		5^{th} node	0.488	0.194	0.128	0.046	0.035	0.082
4.	*Rhizophora mucronata*	1^{st} node	0.298	0.041	0.0.94	0.107	0.049	0.015
		2^{nd} node	0.692	0.057	0.152	0.274	0.182	0.029
		5^{th} node	0.946	0.506	0.449	0.172	0.224	0.044
5.	*Salvadora persica*	1^{st} node	0.780	0.023	0.190	0.419	0.125	0.022
		2^{nd} node	0.947	0.051	0.211	0.506	0.132	0.042
		5^{th} node	1.279	0.122	0.364	0.612	0.148	0.052
6.	*Sonneratia apetala*	1^{st} node	0.896	0.029	0.195	0.516	0.129	0.028
		2^{nd} node	1.048	0.040	0.200	0.601	0.172	0.031
		5^{th} node	1.396	0.049	0.302	0.709	0.305	0.032

Table II (d)

C) Mahim Creek ii) Mahim - Kurla

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.094	0.025	0.126	0.647	0.614	2.682	233 / 0.097
2.	*Avicennia marina*	1.612	0.089	0.090	0.103	1.020	0.310	320 / 0.098
3.	*Avicennia officinalis*	1.278	0.053	0.070	0.104	0.699	0.352	295 / 0096
4.	*Rhizophora mucronata*	3.351	0.044	0.310	0.640	1.207	1.150	240 / 0.167
5.	*Salvadora persica*	0.788	0.013	0.080	0.165	0.500	0.030	300 / 0.116
6.	*Sonneratia apetala*	1.472	0.102	0.193		0.710	0.467	265 / 0.113

Table II (e) C) Mahim Creek (ii) Mahim – Kurla

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.3	6.8	8.9
2.	*Avicennia marina*	6.2	7.8	9.2
3.	*Avicennia officinalis*	4.0	6.7	8.6
4.	*Rhizophora mucronata*	3.9	6.9	7.9
5.	*Salvadora persica*	1.7	2.8	3.6
6.	*Sonneratia apetala*	1.7	2.3	2.9

Table III C) Mahim Creek (ii) Mahim – Kurla

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0360	Chl 'a' = 0.0606	Chl 'a' = 0.0879
		Chl 'b' = 0.0106	Chl 'b' = 0.0373	Chl 'b' = 0.0560
		T.C. = 0.0466	T. C. = 0.0979	T. C. = 0.1439
2.	*Avicennia marina*	Chl 'a' = 0.4744	Chl 'a' = 0.4519	Chl 'a' = 0.5808
		Chl 'b' = 0.1916	Chl 'b' = 0.2981	Chl 'b' = 0.2870
		T.C. = 0.6666	T. C. = 0.7500	T. C. = 0.8678
3.	*Avicennia officinalis*	Chl 'a' = 0.2660	Chl 'a' = 0.4593	Chl 'a' = 0.5767
		Chl 'b' = 0.2000	Chl 'b' = 0.2982	Chl 'b' = 0.2875
		T.C. = 0.4660	T. C. = 0.7575	T. C. = 0.8642
4.	*Rhizophora mucronata*	Chl 'a' = 0.1848	Chl 'a' = 0.4952	Chl 'a' = 0.5631
		Chl 'b' = 0.0561	Chl 'b' = 0.2110	Chl 'b' = 0.2575
		T.C. = 0.2409	T. C = 0.7062	T. C. = 0.8206
5.	*Salvadora persica*	Chl 'a' = 0.0529	Chl 'a' = 0.0883	Chl 'a' = 0.1056
		Chl 'b' = 0.0240	Chl 'b' = 0.0357	Chl 'b' = 0.0589
		T.C. = 0.0769	T. C. = 0.1222	T. C. = 0.6445
6.	*Sonneratia apetala*	Chl 'a' = 0.0730	Chl 'a' = 0.1222	Chl 'a' = 0.6445
		Chl 'b' = 0.0560	Chl 'b' = 0.0840	Chl 'b' = 0.1595
		T.C. = 0.1290	T. C. = 0.2062	T. C. = 0.38

Table IV

C) Mahim Creek ii) Mahim - Kurla

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	76	31	4.8	7.1	10.2
2.	*Avicennia officinalis*	64	30	4.7	10.4	9.5

Table V

C) Mahim Creek ii) Mahim - Kurla

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	85.4
2.	*Avicennia marina*	83.4
3.	*Avicennia officinalis*	78.4
4.	*Rhizophora mucronata*	83.4
5.	*Salvadora persica*	89.7
6.	*Sonneratia apetala*	87.8

(Summer Season)

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
7.	*Acanthus ilicifolius*	1.6	2.9	3.7	4.9	0.40	23.83	46.6
8.	*Avicennia marina*	1.5	4.4	6.1	6.8	0.45	7.7	9.1
9.	*Avicennia officinalis*	1.5	2.0	2.2	2.5	0.42	6.4	7.9
10.	*Rhizophora mucronata*	0.6	1.2	3.4	5.0	13.3	26.5	70.1
11.	*Salvadora persica*	1.5	3.5	3.4	3.6	0.90	9.41	15.8
12.	*Sonneratia apetala*	1.2	6.9	6.2	3.5	1.1	3.52	17.6

Table II (a)

Mankhurd-Vashi Creek
(towards Mankhurd)

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.015
2.	*Avicennia marina*	0.019
3.	*Avicennia officinalis*	0.014
4.	*Rhizophora mucronata*	0.039
5.	*Salvadora persica*	
	(adaxial)	0.010
	(abaxial)	0.015
6.	*Sonneratia apetala*	
	(adaxial)	0.019
	(abaxial)	0.020

Table II (b)

Mankhurd-Vashi Creek
(towards Mankhurd)

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.0
2.	*Avicennia marina*	50.9
3.	*Avicennia officinalis*	40.3
4.	*Rhizophora mucronata*	5.2
5.	*Salvadora persica*	
	(adaxial)	22.8
	(abaxial)	24.5
6.	*Sonneratia apetala*	
	(adaxial)	14.9
	(abaxial)	16.1

Table II (c)

D) Mankhurd – Vashi Creek
(towards Mankhurd)

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with Epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.362	0.054	0.060	0.053	0.143	0.053
		2nd node	0.480	0.046	0.070	0.118	0.042	0.127
		5th node	0.572	0.097	0.206	0.149	0.094	0.027
2.	*Avicennia marina*	1st node	0.258	0.044	0.078	0.034	0.039	0.073
		2nd node	0.416	0.171	0.124	0.020	0.019	0.084
		5th node	0.612	0.130	0.225	0.035	0.039	0.183
3.	*Avicennia officinalis*	1st node	0.328	0.073	0.115	0.039	0.021	0.084
		2nd node	0.357	0.125	0.115	0.020	0.020	0.094
		5th node	0.479	0.195	0.124	0.037	0.035	0.082
4.	*Rhizophora mucronata*	1st node	0.295	0.042	0.090	0.100	0.050	0.015
		2nd node	0.688	0.058	0.157	0.276	0.188	0.029
		5th node	0.942	0.057	0.450	0.162	0.229	0.044
5.	*Salvadora persica*	1st node	0.768	0.024	0.185	0.420	0.123	0.022
		2nd node	0.921	0.051	0.210	0.498	0.132	0.042
		5th node	1.258	0.122	0.347	0.609	0.148	0.052
6.	*Sonneratia apetala*	1st node	0.900	0.030	0.200	0.510	0.130	0.030
		2nd node	1.030	0.040	0.192	0.590	0.180	0.032
		5th node	1.380	0.049	0.303	0.895	0.302	0.031

Table II (d)

D) Mankhurd - Vashi Creek (towards Mankhurd)

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.082	0.027	0.125	0.645	0.385	2.900	236 / 0.099
2.	*Avicennia marina*	1.608	0.095	0.088	0.108	0.957	0.360	302 / 0.102
3.	*Avicennia officinalis*	1.267	0.052	0.070	0.103	0.688	0.354	291 / 0.098
4.	*Rhizophora mucronata*	3.368	0.044	0.310	0.640	1.226	1.149	225 / 0.168
5.	*Salvadora persica*	0.751	0.014	0.082	0.182	0.435	0.038	288 / 0.110
6.	*Sonneratia apetala*	1.490	0.108	0.220		0.612	0.550	270 / 0.112

Table II (e)

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Palisade Ratio

S. No.	Species	Palisade Ratio		
		Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.5	6.1	8.8
2.	*Avicennia marina*	5.9	7.7	9.0
3.	*Avicennia officinalis*	4.4	7.1	8.5
4.	*Rhizophora mucronata*	4.2	7.0	7.6
5.	*Salvadora persica*	1.9	2.9	3.9
6.	*Sonneratia apetala*	2.2	2.5	2.9

Table III

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0370	Chl 'a' = 0.0610	Chl 'a' = 0.0928
		Chl 'b' = 0.0107	Chl 'b' = 0.0371	Chl 'b' = 0.0572
		T.C. = 0.0477	T. C. = 0.0981	T. C. = 0.1500
2.	*Avicennia marina*	Chl 'a' = 0.4765	Chl 'a' = 0.4819	Chl 'a' = 0.5788
		Chl 'b' = 0.1917	Chl 'b' = 0.2783	Chl 'b' = 0.2876
		T.C. = 0.6682	T. C. = 0.7604	T. C. = 0.8664
3.	*Avicennia officinalis*	Chl 'a' = 0.2668	Chl 'a' = 0.4614	Chl 'a' = 0.5966
		Chl 'b' = 0.2002	Chl 'b' = 0.2983	Chl 'b' = 0.2672
		T.C. = 0.4670	T. C. = 0.7597	T. C. = 0.8638
4.	*Rhizophora mucronata*	Chl 'a' = 0.1851	Chl 'a' = 0.4977	Chl 'a' = 0.5637
		Chl 'b' = 0.0563	Chl 'b' = 0.2112	Chl 'b' = 0.2575
		T.C. = 0.2414	T. C = 0.7089	T. C. = 0.8206
5.	*Salvadora persica*	Chl 'a' = 0.0548	Chl 'a' = 0.0902	Chl 'a' = 0.1110
		Chl 'b' = 0.0242	Chl 'b' = 0.0372	Chl 'b' = 0.0588
		T.C. = 0.0799	T. C. = 0.1274	T. C. = 0.1698
6.	*Sonneratia apetala*	Chl 'a' = 0.0740	Chl 'a' = 0.1242	Chl 'a' = 0.2208
		Chl 'b' = 0.0560	Chl 'b' = 0.0852	Chl 'b' = 0.1599
		T.C. = 0.1300	T. C. = 0.2094	T. C. = 0.3807

Table IV

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	71	32	5.1	7.6	10.5
2.	*Avicennia officinalis*	57	29	5.0	9.9	9.4

Table V

D) Mankhurd-Vashi Creek
(towards Mankhurd)

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	85.6
2.	*Avicennia marina*	82.3
3.	*Avicennia officinalis*	79.2
4.	*Rhizophora mucronata*	84.0
5.	*Salvadora persica*	88.9
6.	*Sonneratia apetala*	87.3

(Summer Season)

E) Thane-Kalyan bypass

Table I

Morphological Parameters

S. No.	Species	(a) Length of Internodes in cm				(b) Area of Lamina in cm^2		
		1st Inter-node	2nd Inter-node	3rd Inter-node	4th Inter-node	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	1.7	2.8	3.8	4.8	0.33	24.0	46.6
2.	*Avicennia marina*	1.6	4.3	6.2	6.9	0.50	7.82	9.3
3.	*Avicennia officinalis*	1.6	2.1	2.4	2.7	0.41	6.4	8.0
4.	*Rhizophora mucronata*	0.6	1.1	2.8	4.4	13.4	26.4	70.0
5.	*Salvadora persica*	1.4	3.5	3.9	4.0	1.4	9.7	15.8
6.	*Sonneratia apetala*	1.4	7.1	6.3	3.4	0.14	4.0	17.9

Table II (a) Thane-Kalyan bypass

Measurement of stomata

S. No.	Species	Area of stoma in mm^2
1.	*Acanthus ilicifolius*	0.016
2.	*Avicennia marina*	0.014
3.	*Avicennia officinalis*	0.010
4.	*Rhizophora mucronata*	0.037
5.	*Salvadora persica*	
	(adaxial)	0.010
	(abaxial)	0.014
6.	*Sonneratia apetala*	
	(adaxial)	0.019
	(abaxial)	0.019

Table II (b) Thane-Kalyan bypass

Stomatal Index (5th node)

S. No.	Species	S.I. in %
1.	*Acanthus ilicifolius*	33.3
2.	*Avicennia marina*	51.4
3.	*Avicennia officinalis*	40.6
4.	*Rhizophora mucronata*	5.3
5.	*Salvadora persica*	
	(adaxial)	22.9
	(abaxial)	24.9
6.	*Sonneratia apetala*	
	(adaxial)	15.4
	(abaxial)	16.5

Table II (c)

E) Thane – Kalyan bypass

T. S. of Leaf

S. No.	Species	Leaves from nodes	Thickness of leaf in mm	Thickness of Adaxial Epidermis with epicuticular wax in mm	Thickness of Palisade Parenchyma in mm	Thickness of Storage Parenchyma in mm	Thickness of Spongy Parenchyma in mm	Thickness of Abaxial Epidermis with Epicuticular wax in mm
1.	*Acanthus ilicifolius*	1st node	0.329	0.052	0.057	0.033	0.136	0.054
		2nd node	0.479	0.070	0.117	0.035	0.130	0.027
		5th node	0.571	0.098	0.208	0.146	0.103	0.027
2.	*Avicennia marina*	1st node	0.262	0.050	0.072	0.030	0.042	0.073
		2nd node	0.425	0.175	0.127	0.020	0.018	0.084
		5th node	0.609	0.126	0.230	0.033	0.035	0.083
3.	*Avicennia officinalis*	1st node	0.333	0.069	0.111	0.030	0.035	0.085
		2nd node	0.357	0.090	0.124	0.020	0.022	0.094
		5th node	0.469	0.123	0.200	0.030	0.039	0.081
4.	*Rhizophora mucronata*	1st node	0.284	0.041	0.090	0.095	0.048	0.016
		2nd node	0.580	0.056	0.142	0.270	0.184	0.029
		5th node	0.932	0.058	0.447	0.161	0.225	0.044
5.	*Salvadora persica*	1st node	0.775	0.028	0.189	0.420	0.130	0.024
		2nd node	0.932	0.056	0.207	0.495	0.141	0.042
		5th node	1.271	0.122	0.345	0.610	0.148	0.052
6.	*Sonneratia apetala*	1st node	0.894	0.030	0.196	0.514	0.130	0.030
		2nd node	1.028	0.042	0.194	0.598	0.172	0.032
		5th node	1.388	0.049	0.301	0.704	0.304	0.032

Table II (d)

E) Thane - Kalyan bypass

T. S. of Stem (4th Internode)

S. No.	Species	Total radius in mm	Epi + Periderm in mm	Hypo-collenchyma in mm	Aerenchymatous cortex in mm	Vascular cylinder in mm	Pith in mm	No. of vessels per cm^2 / Diameter of vessels (lumen) in mm
1.	*Acanthus ilicifolius*	4.076	0.025	0.126	0.644	0.596	2.685	238 / 0.098
2.	*Avicennia marina*	1.611	0.096	0.102	0.105	0.933	0.375	307 / 0.102
3.	*Avicennia officinalis*	1.281	0.055	0.072	0.104	0.690	0.360	294 / 0.100
4.	*Rhizophora mucronata*	3.360	0.044	0.312	0.638	1.228	1.138	225 / 0.169
5.	*Salvadora persica*	0.763	0.013	0.080	0.135	0.495	0.040	280 / 0.110
6.	*Sonneratia apetala*	1.492	0.102	0.200		0.648	0.542	265 / 0.112

Table II (e) E)Thane-Kalyan Bypass

Palisade Ratio

S. No.	Species	Palisade Ratio Leaf from		
		1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	3.8	6.3	3.2
2.	*Avicennia marina*	3.7	7.0	8.8
3.	*Avicennia officinalis*	5.7	7.7	8.3
4.	*Rhizophora mucronata*	4.0	7.1	7.9
5.	*Salvadora persica*	1.9	3.3	3.1
6.	*Sonneratia apetala*	.4	3.0	3.1

Table III E)Thane-Kalyan Bypass

Chlorophyll Content
(in mg/g fresh weight of leaf tissue)

S.No.	Species	1st node	2nd node	5th node
1.	*Acanthus ilicifolius*	Chl 'a' = 0.0356	Chl 'a' = 0.0608	Chl 'a' = 0.0922
		Chl 'b' = 0.0106	Chl 'b' = 0.0370	Chl 'b' = 0.0571
		T.C. = 0.0462	T. C. = 0.0978	T. C. = 0.1493
2.	*Avicennia marina*	Chl 'a' = 0.4743	Chl 'a' = 0.4817	Chl 'a' = 0.5764
		Chl 'b' = 0.1916	Chl 'b' = 0.2783	Chl 'b' = 0.2860
		T.C. = 0.6659	T. C. = 0.7600	T. C. = 0.8624
3.	*Avicennia officinalis*	Chl 'a' = 0.2660	Chl 'a' = 0.4606	Chl 'a' = 0.5936
		Chl 'b' = 0.2000	Chl 'b' = 0.2980	Chl 'b' = 0.2670
		T.C. = 0.4660	T. C. = 0.7586	T. C. = 0.8606
4.	*Rhizophora mucronata*	Chl 'a' = 0.1862	Chl 'a' = 0.4985	Chl 'a' = 0.5637
		Chl 'b' = 0.0564	Chl 'b' = 0.2112	Chl 'b' = 0.2575
		T.C. = 0.2426	T. C = 0.7097	T. C. = 0.8212
5.	*Salvadora persica*	Chl 'a' = 0.0551	Chl 'a' = 0.0915	Chl 'a' = 0.1100
		Chl 'b' = 0.0241	Chl 'b' = 0.0377	Chl 'b' = 0.0588
		T.C. = 0.0792	T. C. = 0.1292	T. C. = 0.1688
6.	*Sonneratia apetala*	Chl 'a' = 0.0758	Chl 'a' = 0.1254	Chl 'a' = 0.2297
		Chl 'b' = 0.0562	Chl 'b' = 0.0853	Chl 'b' = 0.1561
		T.C. = 0.1320	T. C. = 0.2107	T. C. = 0.3858

Table IV

E) Thane - Kalyan bypass

Production of Pneumatophores from 1 metre height plant

S. No.	Species	No of Pneumatophores	Average height in cm	Average circumference in cm	Distance between two Pneumatophores in cm	No of lenticels in cm^2
1.	*Avicennia marina*	63	30	5.2	8.9	9.9
2.	*Avicennia officinalis*	56	31	5.3	11.8	9.0

Table V

E) Thane - Kalyan bypass

Biomass (Dry wt)

S. No.	Species	Dry wt in %
1.	*Acanthus ilicifolius*	85.9
2.	*Avicennia marina*	81.1
3.	*Avicennia officinalis*	78.0
4.	*Rhizophora mucronata*	84.3
5.	*Salvadora persica*	88.2
6.	*Sonneratia apetala*	87.3

CONCLUDING REMARKS

Fig. 1: Garbage dumpings in the Coastal Mangrove regions.

Fig. 2: Heavy vehicle movement destroying mangrove vegetation.

Fig. 3: Polluting ancillary industry close to the vicinity of mangrove vegetation.

Fig. 4: Ramifying network of roots of *Avicennia marina* still holding on to the ground.

Fig. 5: *Rhizophora mucronata* showing prop roots.

Fig. 6: Pneumatophores of *Avicennia marina*.

Fig. 7: *Acanthusilicifolus*

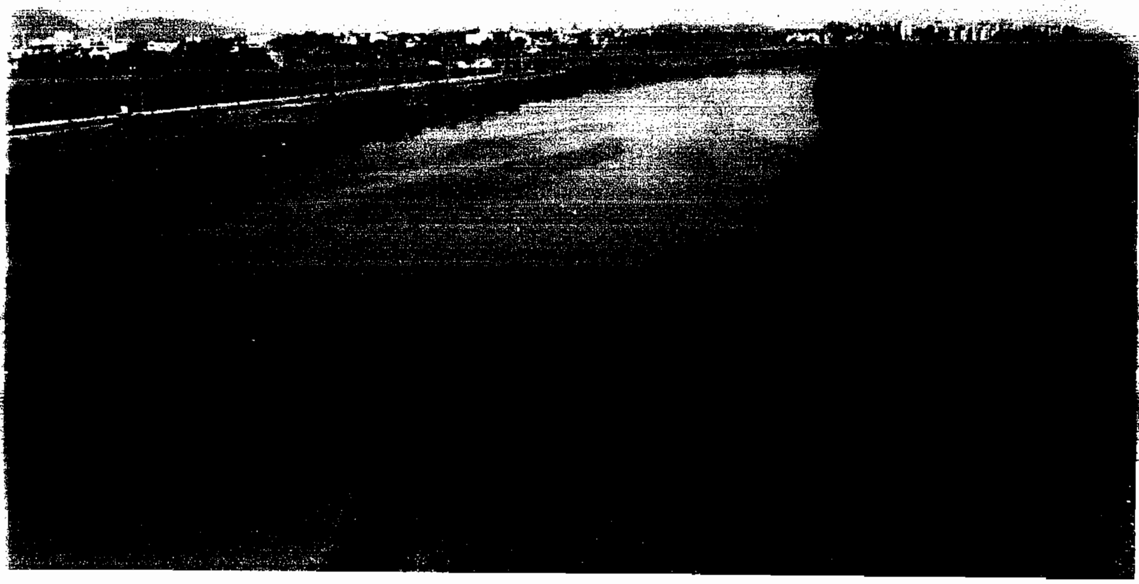

Fig. 8: Luxuriant growth of mangroves at Vashi end of Mankhurd-Vashi Creek.

Fig. 9: Scrubs of *Avicennia marina* still holding on at Mankhurd end of Mankhurd-Vashi Creek.

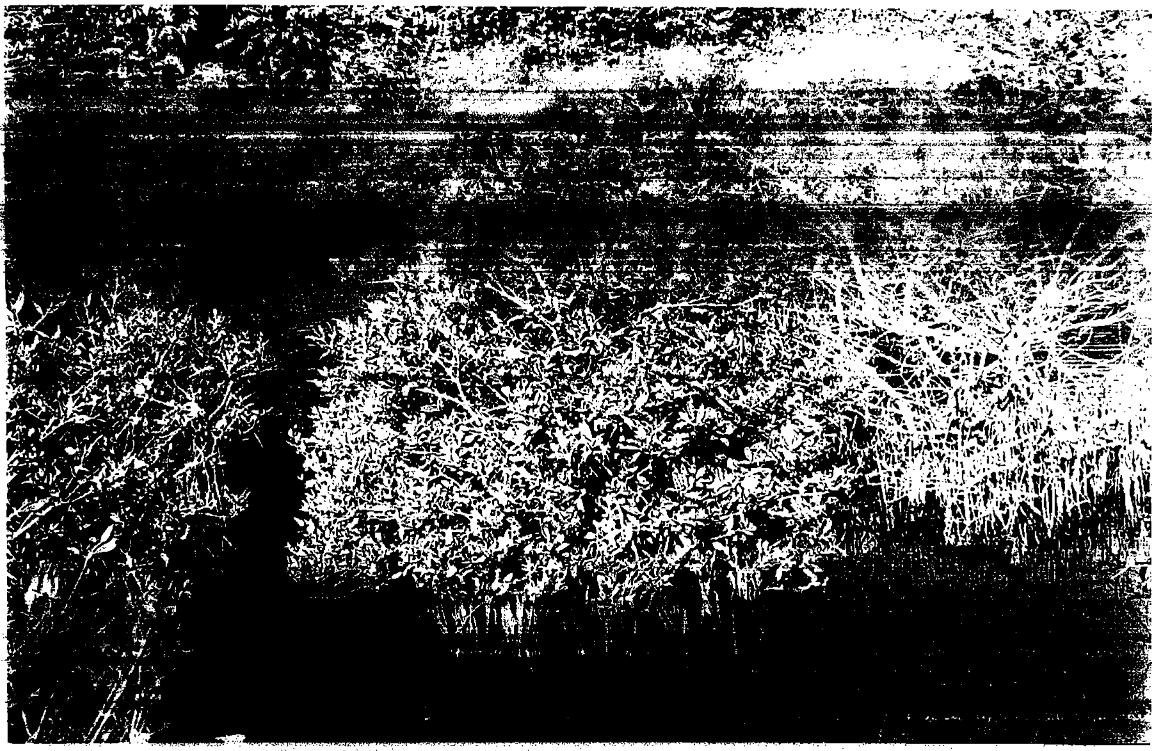

Fig. 10: *Avicennia marina* growing in polluted waters.

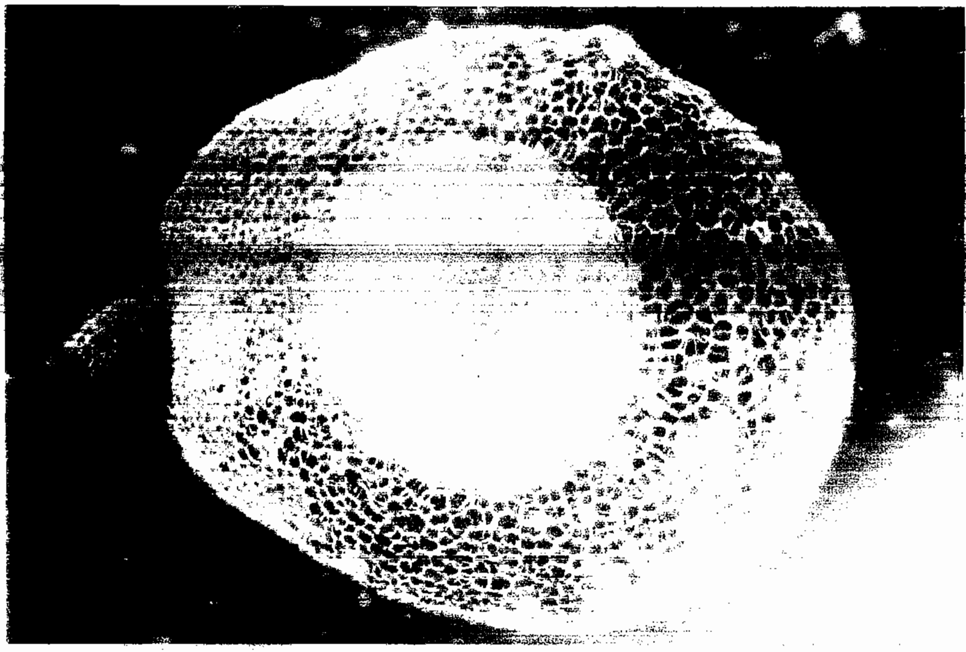

Fig. 11: *Salvadora persica*. **T.S. Petiole** showing central vascular cylinder **X 62.5**

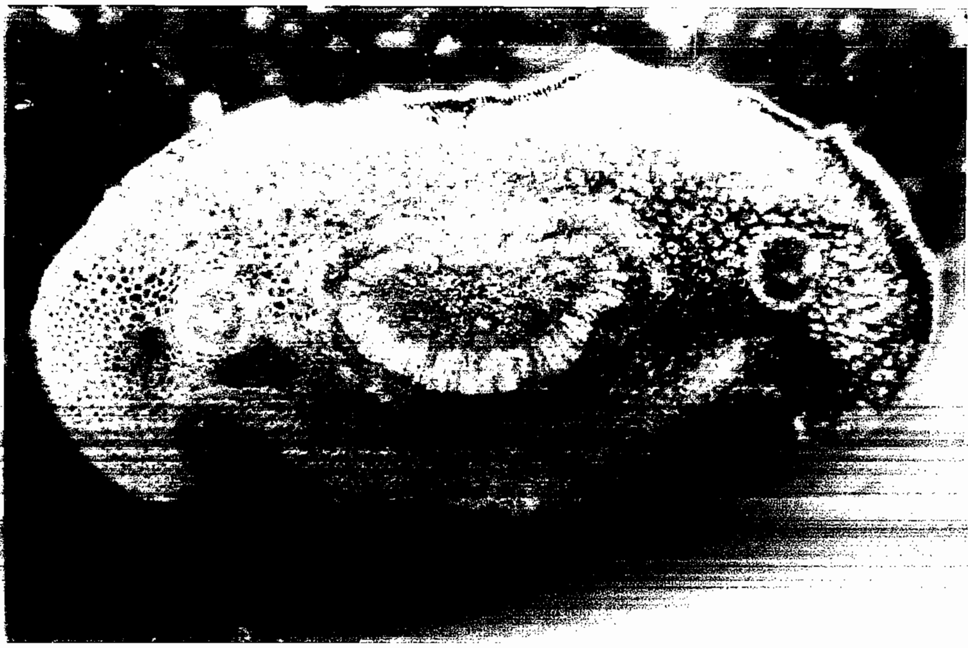

Fig. 12: *Avicennia marina.* **T.S. Petiole** showing central vascular cylinder and two lateral vascular bundles **X 62.5**

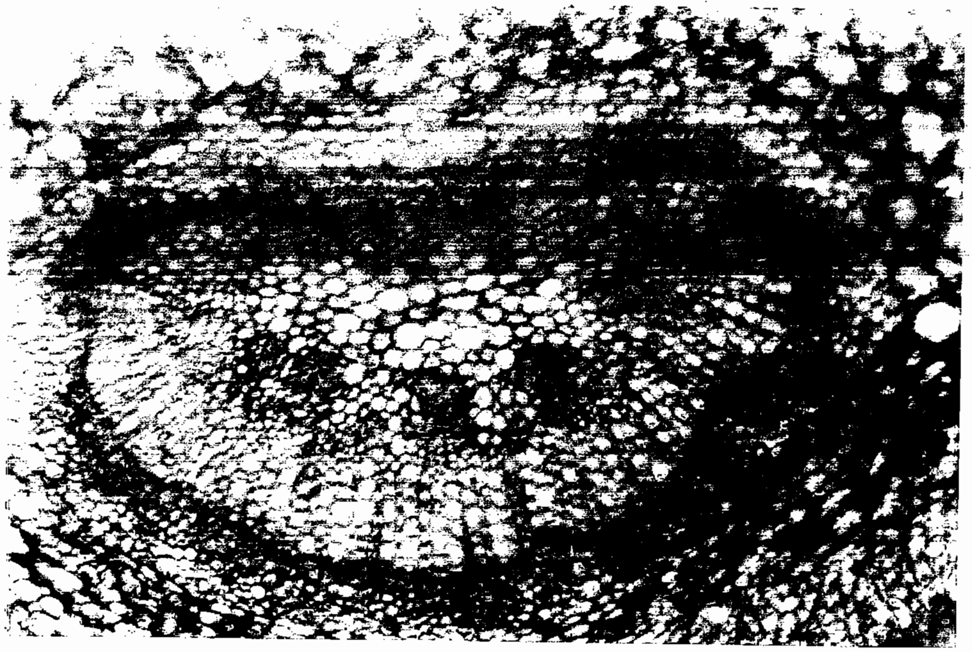

Fig. 13: *Avicennia marina.* **T.S. Petiole** Central vascular cylinder enlarged **X 125**

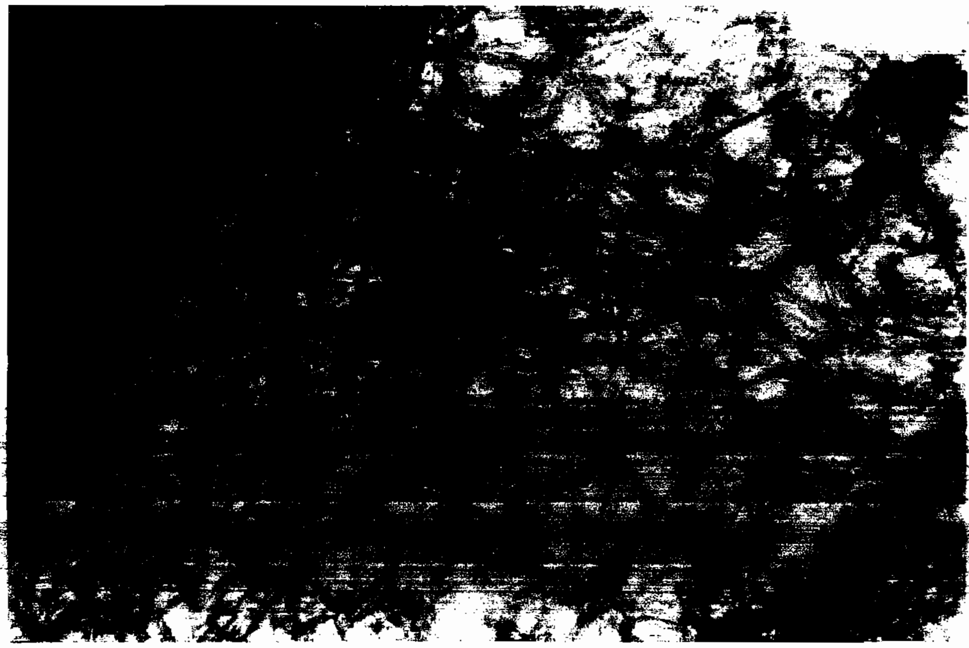

Fig. 14: *Avicennia marina.* **Adaxial epidermis of Leaf** showing salt gland (Surface view) **X 312.5**

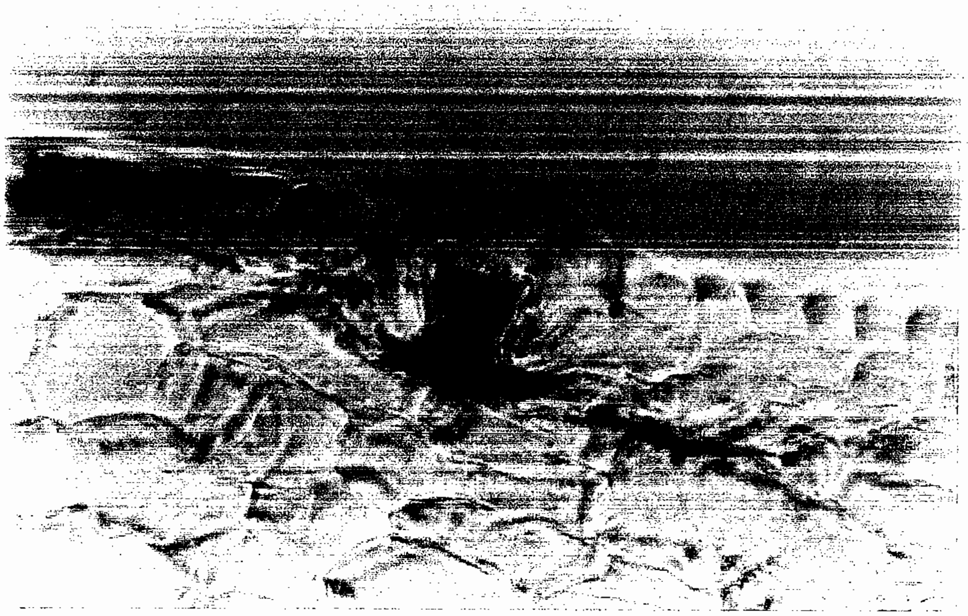

Fig. 15: *Avicennia marina.* **T.S. Leaf** showing salt gland (sectional view) on adaxial epidermis **X 500**

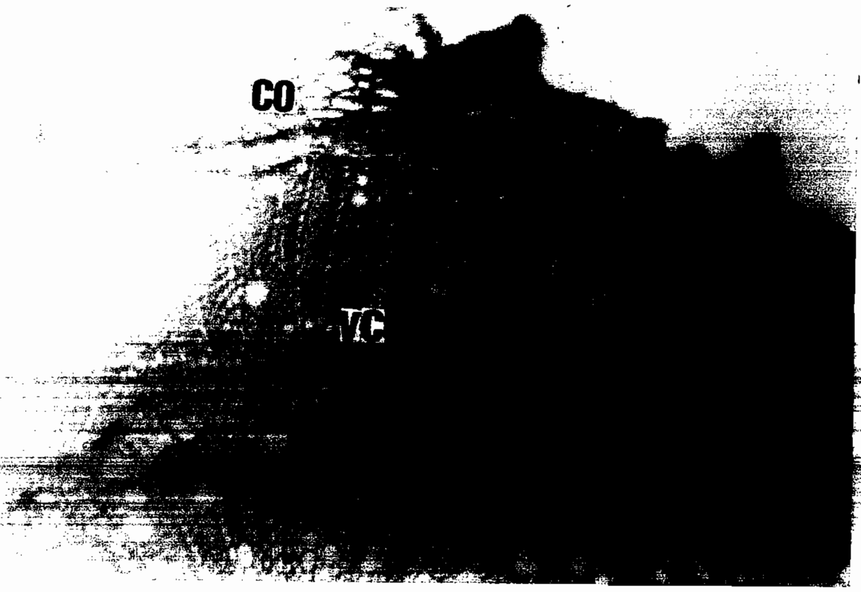

Fig. 16: *Avicennia marina.* **T.S. Stem** showing well-developed vascular cylinder **(VC)** and reduced cortex **X 125**

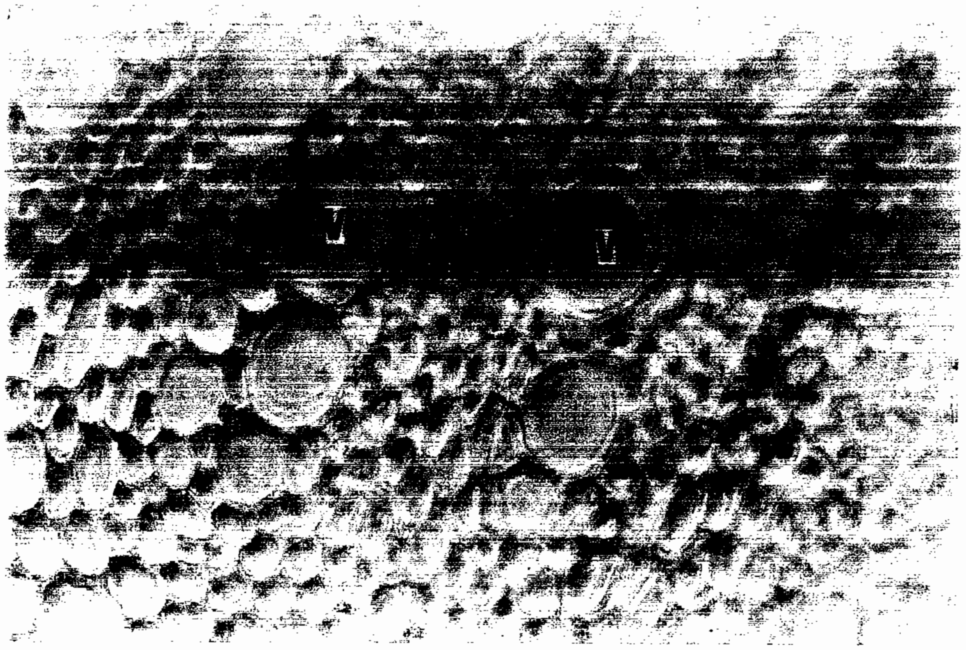

Fig. 17: *Avicennia marina* **T.S. Stem** showing vascular cylinder enlarged to show highly lignified xylem vessels **(V)** **X 500**

Fig. 18: *Rhizophora mucronata.* **T.S. Leaf** showing **VC** = Vascular Cylinder; **SP** = Storage parenchyma; **PP**= Palisade parenchyma. **X 62.5**

Fig. 19: *Rhizophora mucronata.* **T.S. Leaf.** A portion of **Fig. 18** enlarged. **X 125**

Fig. 20: *Rhizophora mucronata*. Abaxial epidermis of leaf showing enlarged **Hydathode(Hy)** and **Stomata (S)** in surface view. **X 500**

Fig. 21: *Rhizophora mucronata*. Abaxial epidermis showing well-developed **Stomata** in surface view **X 500**

From the findings of the Morphological, Micro-Morphological and Anatomical parameters on the six species of Mangrove species investigated, the following favourable adaptations for survival under stress, in the polluted environments, could be derived:

The overall impact of pollution and salinity stress generally appears to be greater on the overall growth of the mangroves.

The effects of pollutants directly and indirectly affect the plant growth pattern, its morphology and anatomy in most of these species of mangroves.

Growth analysis study provides a method for the determination of the effect of pollutants on gross physiological process. It benefits in determining which specific biochemical or physiological process are being affected (for example, photosynthesis). While absolute growth rate is simply an increase in plant biomass over the course of time, shift in the rate of growth is a very important aspect of the plant's response to pollutant atmosphere.

There is a seasonal increase in the growth of the plant axis, especially from monsoon to winter months followed by summer. This finding is more marked in *Acanthus ilicifolius*, *Avicennia marina* and *Avicennia officinalis.*

Correlation studies between growth analysis parameters have shown that the growth rate of the plant is correlated positively with leaf area and specific leaf.

Stress situation like mixture of pollutants and increased salinity adversely affects cell formation and cell elongation, thus resulting in stunted growth and decreased size and thickness of leaf.

Epidermis, being the outermost protective layer of the leaf and stem, exhibits modification in form, structure and function. The presence of thick epicuticular wax on the epidermis of these mangrove species is one such favourable adaptation.

The sensitivity of plant to pollutants is directly proportional to the stomatal index values in polluted conditions. The stomatal index was found to be more in the mangrove species growing under the pollution and salinity stress conditions.

An interesting and unique micromorphological observation made is the increased frequency and well-developed salt glands /hydathodes, which exude out excess salt under salinity stress, on the epidermal surface of the leaf. They are more pronounced in *Rhizophora* and *Avicennia*.

The reduced value of palisade ratio is invariably to the collapse of mesophyll tissue, presumably due to increased pollution level.

Reduced total chlorophyll content of the leaves is also indicative of pollution level which in turn is reflected in the less productivity and ultimate reduced value for biomass or dry weight.

Though the girth of stem was comparatively thinner in *Salvadora* and *Avicennia marina* from the polluted sites, their vascular cylinder was proportionately much thicker, showing well developed and lignified secondary xylem elements, which could withstand the pollution and salinity stress.

There was a marked increase in the number of water conducting vessels per unit area in *Avicennia marina*, along with more lignified cell walls which have affinity for absorbing water. Thus, the increased vessel lines bring about an increase in the water transport potential of this plant species.

More pronounced development of highly lignified secondary vascular cylinder surrounded by sclerenchymatous sheath, as evidenced from the anatomy of petiole and midrib of *Avicennia marina* and *Salvadora*, indicates that the conducting elements of their leaves are strongly articulated to the vascular cylinder of the stem and that the leaves are firmly fixed to the stem axis, thus preventing early senescence and premature leaf fall, and maintaining prolonged productivity.

The development of thin-walled cells of included phloem patches within the secondary vascular cylinder of the petiole and midrib of *Salvadora persica* provides easy flexibility to the otherwise rigid vasculature of petiole, facilitating easy swaying of the leaf even during high velocity of wind, without getting severed from the stem.

The perennating and highly branched network of root system of mangroves hold the plant firmly to the marshy or rocky substratum thus preventing soil erosion and withstand the onslaught of fierce tidal waves and storms.

While *Rhizophora mucronata* stands upright with the help of its thick prop roots, species of *Avicennia* from its lateral roots produce pneumatophores or breathing roots, which are apogeotropic, growing away from the polluted substratum, towards the atmosphere.

The increase in the number of **pneumatophores** or **breathing roots** and the number of **lenticels** or **breathing pores** conversely with the decrease in the height and circumference of pneumatophores of *Avicennia* species could be well correlated with the plant's ability to overcome the increased levels of pollution stress in these environments. The above values were better in *A. marina* than in *A. officinalis.*

The increased frequency of lenticels facilitates more aeration to the inner plant tissues in the polluted environment.

From the outcome of the above investigations based on morphological, micromorphological and anatomical adaptations for survival even in the polluted environments, these six species of mangroves could be graded in the following sequence. (Also, please see the chart on the following page(s)):

I *Avicennia marina*
II *Rhizophora mucronata*
III *Salvadora persica*
IV *Acanthus ilicifolius*
V *Avicennia officinalis* and
VI *Sonneratia apetala*

Mangroves have great ecological and economic significance in terms of their direct utilization for safety as well as for fish-production, and indirect significance in protecting the coastal erosion and maintaining ecological balance.

Since the mangrove vegetation cover in Mumbai Metropolitan Region has been disappearing due to various anthropogenic activities including pollution, it is very important to have effective conservation measures to protect the existing mangrove vegetation.

In addition, the findings of this investigation leading to the selection of mangrove species with favourable growth adaptations, even in polluted environments, could be used for reforestation of mangroves, so as to enhance the growth and increase in the intertidal vegetation cover.

Multispecific plantation of selected species of mangroves should be practised, as against monospecific plantation, as the latter would lead to dearth of biodiversity.

It is further suggested that more species of mangroves which are found growing at various coastal locations should also be subjected to similar studies, so as to ascertain their ability to outgrow the ever-increasing pollution / salinity stress.

PTO

Chart showing different grades for the Morphological / Micro-Morphological / Anatomical Parameters studied for the Adaptations of Mangrove species favouring luxuriant growth. (*** = Maximum, ** = Medium, * = Average)

S.no.	Parameters	*Acanthus ilicifolius*	*Avicennia marina*	*Avicennia officinalis*	*Rhizophora mucronata*	*Salvadora persica*	*Sonneratia apetala*
1.	Growth of stem axis (4th Internode)	**	***		*		
2.	Area of Lamina	**			***		*
3.	Thickness of Lamina				*	**	***
4.	Thickness of Epidermis + epicuticular wax	*	***		**		
5.	Frequency of salt glands /hydathodes		**	*	***		
6.	Size (Area) of stoma	*			***		**
7.	Stomatal Index	**	***	*			
8.	Palisade Ratio	**	***	*			
9.	Total Chlorophyll		***	**	*		
10.	Secondary vascular cylinder in petiole		***	*		**	
11.	Secondary vascular cylinder in midrib		***	*		**	
12.	Total radius of stem axis	***	*		**		
13.	Radius of Vascular cylinder		**	*	***		
14.	% of Vascular cylinder to Total radius of stem		**	*		***	
15.	No. of Vessels per cm^2 in T.S.Stem		***	**		*	
16.	Diameter of vessels				***	**	*
17.	Average diameter of Total vessel lines in cm^2		*		***	**	
18.	Area of Total Root network holding soil	*	***	**			
19.	Average No. of pneumatophore		***	**			
20.	Average height of pneumatophore		***	**			
21.	Average distance (least) between consecutive pneumatophores		***	**			
22.	Average circumference of pneumatophore		***	**			
23.	Average no. of lenticels per cm^2 on pneumatophore		***	**			

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ITEM NO: 2 (iii)

MMR-EIS
February 15, 2001

Sub : Project proposal regarding "Morphological and anatomical features favouring Luxuriant growth of Mangroves in Mumbai.

The project proponent submitted 6 copies of the final report by his letter dated January 15, 2000 and also requested the Society for extension of the project on similar terms and conditions.

As per the agreed scope of work the project proponent was supposed to carry out following activities/studies during the period of 18 months :

1. To record, study and photo-document the morphological and anatomical features of mangroves such as ontogeny, rate of development of leaf, size of lamina, palisade ratio, stomatal index, length of internodes, frequency/pattern of pneumatophores, chlorophyll content, etc.

2. To carry out study for total 8 sites of which 5 sites in stress affected/polluted areas and 3 sites in control areas for 3 seasons.

3. To carry out water and soil quality monitoring at the selected 8 locations for three seasons.

4. The outcome of the study is to identify and select mangrove species which could better adapted to and thrive under various stress conditions.

The comments on the final report are kept at page no. 177/c The final instalment of 20 % of the cost of the project may be released subject to fulfilment of the comments by the project proponent, if approved, please.

JPD(Env) & Planner (Env)

Chief, PD and Director, MMR-EIS

Item no: 2 (III)

Comment on the final Report

1 The morphological and anatomical features of mangroves such as ontogeny, rate of development of leaf, **area of lamina (1st, 2nd, &5th internodes), palisade ratio(5th internode), stomatal index (5th internode only), length of internodes(1st to 4th internodes), thickness of leaf(5th node only), total radius of stem(4th node only), frequency/pattern of pneumatophores, chlorophyl content(5th internode)**, etc. have been recorded, studied and photo-documented for total 7 sites of which 6 sites in stress affected/polluted areas and 1 site in control area for 3 seasons. The Table 12 gives Comparative analysis of diameter, vascular cylinder, no. of vessels, for 6 species. However, whether the study area for this is the control or test ?

Evolutionary history ?

2 The following five stress affected sites were selected for study for three seasons :

i) Alibag-Dharamtar Creek
ii) Ghodbunder-Cheena Creek
iii) Mahim Creek(Khar Danda and Kurla)
iv) Mankhurd-Vashi Creek(towards Mankhurd)
v) Thane-Kalyan Bypasses.

These should be shown on a map.

3 The following Control site was selected .

i) Vashi-Mankhurd Creek (towards Vashi)

(It was decided to select three control sites for better comparison)

4 The water and soil quality monitoring at the selected 8 locations for three seasons was carried out as proposed. The justification for the basis of selection of control sites and stress affected site was not given

in the report. Also based on this identification of the most polluted and least polluted sites was not done.

5 The Chapter on 'Introduction' has described review of literature on mangroves habitats, threats to mangroves, stress (pollution/salinity), tolerance of mangroves and afforestation of mangroves. In the report detailed methodology indicating number of replicates, procedure, etc is not given. The Chapter on 'Experimental Results' have described more about the findings of other researchers. In the report only Tables indicating results of water and soil quality for various physio-chemical parameters for 3 seasons are presented. The analysis and interpretation of data carried out for various parameters is not presented. The final report should have an Executive Summary highlighting the pollution status of study areas, features of mangrove species, and the findings and recommendations of the study.

6 As a final recommendation the study has identified and selected mangrove species which could better adapted to and thrive under various stress conditions. However, the reasons for selection of these species based on the findings of the study needs to be presented in the report. For example in the report following statements have been made:

- "The overall impact of pollution and salinity stress generally appears to be greater on the overall growth of mangroves."
- "The effects of pollutants directly and indirectly affect the plant growth pattern, its morphology, and anatomy in most of species of mangroves".
- "Stress situation like mixture of pollutants and increased salinity adversely affects cell formation and cell elongation, "

Such statements are too general and needs to be supplemented and established by the findings of the proposed study.

7 A review of literature should establish that morphological parameters in mangroves or in marine plants are known to be affected by water or soil pollution.

8 The project proponent should study the presence of NO2 –N in the mangrove ecosystem as its accumulation is indicative of high pollution stress. The studies related to finding out stomatal closure, leisions on the leaf, chlorosis, rate of photosynthesis, abscission, leaf fall, and stunted growth needs to be carried out. This will help to confirm the study findings.

Yes, but does it indicate stress level?