CHAPTER 1. INTRODUCTION AND OBJECTIVES

The mangrove ecosystem represents a unique biodiversity feature of the earth. They occupy littoral regions throughout the tropics and sub-tropics. Hence they are common near estuaries of rivers, creeks, lagoons and low islands. These formations form a link between terrestrial and marine ecosystems (Kjerfve, 1990). The mangrove species are adapted to grow in saline habitats (range: 3-37 ppt), that are regularly or occasionally inundated and also are capable of withstanding the stresses of continuous flooding and high salinity. Mangrove ecosystem is inherently complex supporting several niches generated by its highly dynamic state. Each niche varies from one another in its water depth, salinity, period of inundation, tidal velocity and bottom constituents. These varied environments support a rich floral and faunal diversity.

It has been suggested that river-borne nutrients enhance the productivity in a mangrove ecosystem. When compared to sandy regions, the mangrove vegetation becomes more prolific in the deltaic regions, with clayey or silty substrates i.e., depositional environments. Rich fauna is due to the surplus sink of food i.e., organic material from the vegetation facilitating the operation of the detritus-based food chain which forms the very basis of the complex environment. This fragmented plant material or litter offers an increased surface area, providing substrate for the microbial community. The detritus-based food chain starting from the fallen litter passes along planktons, fishes, crabs and other marine fauna. Loads of nutrients are also trapped by the buffering of the direct effect of run-off waters which are not easily lost, but recycled within the system. Consequently, such an environment provides shelter and refuge, spawning grounds/natural nurseries for economically important species (Uma, 1992). Moreover mangroves are endowed with the capacity of high productivity of 2400 g/m²/year, which is even greater than that of a tropical forest (WWF, 1992). The natural functioning of a mangrove ecosystem supports high secondary productivity as well, in the form of estuarine and coastal fisheries. Thus mangrove productivity supports higher sustainable economies when compared to pond aquaculture activities (Turner, 1985; UNESCO 1985/1986b; Kjerfve, 1990).

The mangrove plants are characterized by stilt roots, knee roots, pneumatophores, salt-excreting glands (hydathodes), coriaceous leaves (with some xerophytic structures).
vivipary, enabling the fruit to remain buoyant and viable for long periods and to grow on soft mud, under varying conditions of salinity. Moreover, mangrove forests prevent bank erosion, offer protection from storm surge, acting as natural wind breaks, and protect the land from disastrous cyclonic weather.

Floristic diversity in mangroves is low when compared to other forest types. Globally two well-defined areas of mangrove forests can be recognized namely, the Eastern zone (East Africa, Asia and Australia) and Western zone (America and West Africa), the former being richer. The largest mangrove forest in the world is in Brazil (25,000 km²), followed by Indonesia (21,762.7 km²) and Australia (11,617 km²).

In India, there have been estimates of mangrove forests from time to time. In 1989 the Forest Survey of India (FSI) based on satellite imageries prepared by the National Remote Sensing Agency (NRSA) for the period 1981-83 and 1985-87 respectively, estimated about 4225 km² of mangrove forest. This forms about 3.03% of the total geographic area of the country, with over 70% of the total mangrove forest along the east coast. This showed a decline of 36.9% in mangrove forest cover, when compared to the initial figure of 6819.7 km² (Sidhu, 1963). However, the earlier figures had included degraded mangroves also in their estimates. Mangroves along the west coast of India are spread over Gujarat, Maharashtra, Goa, Karnataka, Kerala and the Lakshadweep islands, while those along the east coast are in Tamil Nadu, Andhra Pradesh, Orissa, West Bengal and the Andaman and Nicobar islands. The luxuriant mangrove formations of Bhitar Kanika in Orissa, occupying the Mahanadi region is a classical example of deltaic mangrove.

One of the better preserved patches in Southern India, is in Pichavaram. Mangroves and mangrove associates together form a total of 26 species. Presence of the natural hybrid namely Rhizophora X. lamarckii is a unique feature. This species has adapted best to the prevailing climatic and edaphic conditions of Pichavaram. Though the vegetation here has been subjected to intense exploitation and large parts of the forest have already disappeared, there are areas such as the Periaguda islands that do provide a suitable zone for studying the limits and conditions necessary for eco-redevelopment as well as variation in structure and floristic composition in relation to gradual changes in the environment. Hence study was focused on Pichavaram mangroves.
Zonation

Mangrove vegetation varies in size and appearance, most of it occupying the fringes of the intertidal shallows between land and sea; it also has the ability to withstand regular fresh water and salt water flooding. Zonation is an important feature of mangrove vegetation. Species differ from the waterward to the landward zone, the former being occupied by certain species and the successive zones by yet other species. The species occupying the waterward zone (shore) generally vary from place to place for e.g., zones may start from *Rhizophora, Heritiera* or *Sonneratia*. However, of all the zones, the fringe zone is notably very important as the presence of this zone keeps the species of the rest of the zones intact and stable. Once the fringe species collapse, they get replaced by species of the rest of the zones disturbing the entire ecosystem. Hence *phytosociology* (vegetation patterns, zonation and related factors, and *phenology* (growth and reproductive fitness) of the major fringing species of Pichavaram, are the main focus of thesis.

Threats and recent trends in conservation

Mangrove ecosystem is one of the most threatened wetland type today. They are receiving increasing global attention in the recent years, due to the role they play in mitigating the adverse impact of coastal storms as well as their potential value in facing the problems of natural calamities through possible changes in sea levels in future (Uma, 1992). Further, increased utilization pressure on these forests is well known as one of the major causal factors for the disappearance of this unique ecosystem. In general mangrove distribution is affected by continued changes due to clearing, land reclamation and associated biotic pressure and by natural changes due to erosion and siltation. Most developing countries are faced with the problem of population explosion and development, and consequent high demands for more land. Ong (1982) points out that since 1945, mangroves have been harvested in Malaysia for lumber and charcoal and that mangrove areas have been drained for aquaculture ponds and urban development, resulting in more than 20% degradation of the forest.

In India mangrove areas have been used up for urban, industrial and agricultural needs. For instance, there has been severe loss of mangroves along the coasts of Kerala and Bombay. In Andhra Pradesh, domestication of animals has already taken its toll of coastal vegetation and the *Rhizophora* species has practically disappeared. Lack of fresh water besides conversion of mangroves into salt pans, in the Sunderbans has
caused a rise in salinity leading to the decline of some typical species like *Herritiera* and *Nypa*. However, efforts are on to maintain these forests for a proper use of multiple products like honey, wax, fish and meat (Uma, 1992). The Government of India constituted a National Mangrove Committee in 1987 with a view to prepare a management action plan involving nodal academic and research institutions.

In Pichavaram, where the present study has been conducted, there has been a shift in the coastline due to geomorphic changes in the configuration of the terrain (Kerrest, 1980; Tissot, 1987). These natural changes coupled together with increased anthropogenic pressures on the ecosystem have caused species such as *Sonneratia apetala*, *Xylocarpus mekongensis* and *X. granatum* to become rare.

Other major threat to the mangrove ecosystem is, increased build up of CO$_2$ and other green house gases, sea level rise and climate change. Rise in sea level and the extent of its impact on mangroves are debatable topics. However, many experts have predicted that the global mean temperature will increase from 1.5 to 2.5°C leading to a rise in sea level of 0.2 to 1.4 m by mid 21st century and, that between 1990 and 2020, species extinction caused by deforestation will account for the loss of 5 to 15% of the world's species (Hopley & Kinsey, 1988; WRI, IUCN & UNEP, 1992). UNEP (1994) has put forward the following predictions and responses of mangroves to the changing climate.

- 6.0 cm rise in global mean sea level per decade, causing erosion of seaward margins of mangroves, progress of mangrove communities to landward regions, increase in secondary productivity due to increase in nutrient input caused by erosion;
- 0.5% increase in the level of atmospheric CO$_2$ per year, causing increase in water use efficiency of mangroves;
- 0.3°C increase in global mean temperature per decade, migration of mangroves to higher altitudes, change in phenological patterns and plant and animal composition, increase in overall net and gross productivity and acceleration of mangrove microbial process; and
- Changes in precipitation patterns, causing changes in soil water content and soil salinity; increase in primary productivity if there is an increase in precipitation to evapotranspiration ratio, and change in the distribution pattern of stenohaline species.

The International Society for Mangrove Ecosystems (ISME) has adopted a Charter for Mangroves in 1992, "that complements a World Charter for Nature that the General
Assembly of the UN proclaimed in October 1982 affirming that nature shall be respected, genetic viability on earth shall not be compromised, conservation shall be practiced, sustainable management shall be adopted by man, and nature shall be secured against degradation” (ISME, 1992).

Objectives

The major objectives of the present study was to

1. Carry out a detailed vegetation analysis, establish the major elements of the zones, examine phytosociological aspects, and, interpret the status of present vegetation, and, compare the present status with the satellite imageries of Pichavaram mangroves of the years 1986 and 1994;

2. Study the status and distribution, and, vegetative and reproductive phenology of the fringing species which belong to the genus Rhizophora; this is crucial for the survival of the Pichavaram mangroves; and an attempt to describe the resource allocation mechanism of these species;

3. Measure reproductive fitness by means of seedling recruitment, establishment and survival rates of the fringing species, and,

4. Identify major impacts, natural and man-made, and develop conservation strategies based on the results obtained from the above studies.