CHAPTER VII

SUMMARY AND CONCLUSION

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SUMMARY

The present investigation was carried out on mangrove distribution and physiological changes of mangroves of Cochin under varying hydrological conditions. The main objectives of this investigation were the following.

1. To study the present status of mangrove vegetation and to prepare a map of the mangroves in the Cochin area.
2. To study the relationship of water, soil texture and soil chemistry on the distribution of mangroves.
3. To study the physiology of mangrove species in relation to their distribution patterns.
4. To suggest the methods for the management of mangroves of Cochin.

Chapter I: General Introduction

This chapter describes the status of mangroves of the world, India, Kerala and Cochin. Review of literature regarding the distribution of mangroves is incorporated in this chapter. Studies on mangroves of Cochin are also highlighted in the General Introduction.

Chapter II: Survey of Mangroves of Cochin

This chapter deals with the survey of mangroves in Cochin area. After a preliminary survey eleven mangrove growing stations were selected for the study. They were Kannamally, Kumbalangi, Kumbalam, Nettoor, Mangalavanam, Panambukad, Puthuvypu, Pallipuram, Karumallor, Pattanam and Moothakunnam. The occurrence, density and diversity of mangrove species at each station were determined. Different
mangrove associations and relationship of mangroves with semi and associated mangrove flora were assessed. Ten species of true mangroves, 4 species of semi mangroves and 6 species of mangrove associated species were identified.

Chapter III: Influence of Soil Factors on Mangrove Distribution

Soil factors such as pH, organic carbon, and soil texture were analysed and their influence on the distribution of the mangroves of Cochin area were assessed. Soil samples were collected from the 11 stations identified. The samples were taken from the surface up to 15 cm depth during premonsoon, monsoon and postmonsoon seasons of 1997 and 1998. The pH of soil samples were noticed by using portable pen-pH meter. Percentage of organic carbon in the soil was estimated by using 'Walkley and Blacks' rapid titration method. Determinations of grain size of the soil was carried out by using 230 mesh wet sieve. The percentage of sand, silt and clay fractions were computed. In the present study the highest soil pH was noticed at Mangalavanam and lowest at Pattanam. pH of all the study sites were acidic except at Mangalavanam. Present study revealed that the organic carbon content was highest in Puthuvypu, Panambukad and Nettoor and lowest in Pattanam, Pallipuram and Kumbalangi. The lowest organic carbon content may be due to the highly disturbed nature of these places. Soil grain size analysis showed that the soils were of predominantly sandy nature with variable amounts of silt and clay.

Chapter IV: Influence of Water Quality on Mangrove Distribution

This chapter deals with the hydrological analysis of mangrove flood water. Water samples were collected monthly during 1997 and 1998 from eleven stations. The parameters such as salinity, pH, total hardness, total alkalinity and primary productivity were estimated. The salinity of the water samples were determined by
argentometric titrations. Calcium and Magnesium hardness were estimated using EDTA complexometric method. Total alkalinity of water was also estimated by titration method. Primary productivity of mangrove water was analysed by oxigen method. The correlation between these factors and mangrove diversity were assessed. Influence of physico-chemical quality of water and mangrove distribution pattern in Cochin area are discussed in this chapter. Mangroves of Cochin area prefers acidic pH. Species like Avicennia officinalis L and Acanthus ilicifolius L tolerate alkaline pH as well. The salinity of the mangrove water ranged between $8 \times 10^{-3}$ in the monsoon and $35.2 \times 10^{-3}$ in premonsoon. Avicennia officinalis L. tolerate salinity of sea water. In most of the stations studied seasonal variations of total alkalinity and hardness were significant. Maximum productivity was noticed at Panambukad.

Chapter V: Physiological Adaptations of Mangrove Flora of Cochin

This chapter comprises the physiological adaptations of mangroves and their biochemical relationship. The mangrove species could be grouped into three as salt exclusion type, salt extrusion type and salt accumulation type based on adaptations. Results of quantitative estimation of β alanine is given in this chapter. Relationship of β alanine content in mangroves and their distribution pattern are discussed. There occurs a strong relation between β-alanine salinity and distribution of species.

Chapter VI: Factors Affecting the Distribution and Recommendations for Conservation of Mangrove Flora of Cochin

In this chapter the anthropogenic factors affecting the distribution and diversity of mangrove flora of Cochin are discussed. Conservation methods to be adopted at Cochin area are described. Recommendations for the management of mangrove flora of Cochin are also suggested.
CONCLUSION

Mangroves now found in Cochin have not so far attained their full growth as degrading factors always disturbed their proliferations. Whatever patches present now are either in the process of primary succession towards climax or under secondary succession after the destruction of the primary vegetation. More or less arrested succession was seen in certain locations of Cochin i.e., in Pattanam, Moothakunnam and Kumbalam. Observations in Panambukad region confirmed the existence of Rhizophora, Brugniera and Sonneratia species in the soil where the tidal inundation by sea water occurs twice a day. Acanthus ilicifolius L. was found to be less efficient in competing with Avicennia in regions of lesser inundation. Kandelia candel L. was seen associated with Rhizophora mucronata Lamk. Acanthus ilicifolius L. together with Acrostichum aureum L. in a station can be regarded as an indication of reclaimed area. Semi mangrove species Derris ulignosa Benth. was found associated with Avicennia officinalis L. No specific relationship between the occurrence of mangrove associated species and mangrove species were observed. Avicennia and Sonneratia appeared as pioneers. Reclaimed lands were first colonized by Avicennia officinalis L. followed by Acanthus ilicifolius L. Rhizophora mucronata Lamk. was found especially at the banks of ditches and ponds of estuarine habitat. Mangrove like Kandelia candel L., which was quite common to Cochin coast, however, is found to disappear due to the various anthropogenic activities.

Mangrove species that occurred in all sampling stations have shown the influence of pH in their distribution pattern. The soil pH was acidic in most of the sampling stations irrespective of their position from the sea. Kannamali and Palliparam
stations represent more or less same type of mangrove plants. This may be due to the presence of same pH prevailing in these stations. The lower soil pH was noticed at Pattanam, where *Acrostichum* and *Acanthus ilicifolius* L. dominated. The alkaline pH was only noticed in Mangalavanam, may be due to the close association of station with the mainland, which caused through mixing of run off water especially during the monsoon and postmonsoon seasons. Organic carbon content was highest in Puthuvypu, Panambukad and Nettoor where most species of mangroves were well flourished. Organic carbon content was lowest in Pattanam, Pallipuram and Kumbalangi where mangrove species were less. The reason may be the disturbed nature of these areas. Soil grain size analysis showed that the percentage of silt and clay was high in Kannamali, Kumbalangi and Panambukad stations. As the growth of *Acanthus ilicifolius* L. was maximum in Kumbalangi, it could be inferred that fine grain soil structure was preferred by the plant. Soil around *Avicennia officinalis* L. dominated zones i.e., in Kumbalam and Mangalavanam contains 80 to 85% sand. *Rhizophora mucronata* Lamk. dominated in muddy and sandy substrates with clay. During premonsoon, the sand, silt and clay percentage in the soil showed significant difference between the stations. Pattanam and Moothakunnam stations showed more or less identical soil silt variation during the study period. The genus *Bruguiera* was noticed in Mangalavanam, Puthuvypu, Kannamali and Panambukad may be due to high pH and more clay.

Species like *Avicennia officinalis* L. and *Acanthus ilicifolius* L. were tolerating alkaline pH. In the present investigation during premonsoon, monsoon and postmonsoon seasons salinity values varied throughout the observation period. Stations such as Kannamali, Kumbalangi, Mangalavanam, Panambukad, Puthuvypu and
Pallipuram showed high salinity values when compared with the other stations. This may be due to the shallowness of the area, evaporation due to the increased temperature, lack of fresh water influx and intrusion of sea water as well as the presence of salt impregnated marshy soil. In more saline conditions *Avicennia* was observed to grow in association with *Acanthus ilicifolius* L. in the present investigation. Increase in the environmental salinity considerably retarded the growth of the mangroves of Cochin area. The stunted growth of *Acanthus ilicifolius* L. in Puthuvypu and Pallipuram stations may be due to the high saline environment. The salinity was comparatively less in the mainland stations such as Karumallor and Pattanam. This may be due to the direct influx of rain water during North East and South West monsoon period. *Sonneratia caseolaris* L. was observed to grown in both seaward saline (Panambukad) and land ward non saline zones (Karumallor). In the present investigation significant seasonal water salinity variation was observed within the stations except at Panambukad and Moothakunnam. In most of the stations studied seasonal variations of total alkalinity and hardness were significant between stations and within the stations. But no influence of these parameters on the mangrove distribution in Cochin area could be traced out. Maximum productivity was noticed at Panambukad, may be due to the presence of suitable salinity *i.e.*, \(26 \times 10^3\) with other favouring conditions for increased primary productivity. Minimum productivity noticed in the present investigation at stations such as Karumallor, Pattanam and Moothakunnam may be due to the low pH. The present study revealed that the environmental factors such as pH and salinity have a dominant role in determining the presence or absence of a particular species in a particular region. Some species can tolerate high levels of external factors and others can tolerate only low levels. However
some species such as *Acanthus ilicifolius* L. and *Avicennia officinalis* L. can withstand and survive in both the extremes.

The observations showed that salt extrusion type mangroves are abundantly distributed in Cochin area. The salt exclusion type like *Kandelia candel* L. and *Rhizophora candelaria* DC. are found to be rare in the area. Salt accumulation types like *Excoecaria indica* Willd. and *Sonneratia caseolaris* L. are also fast depleting from the Cochin area. The quantitative analysis of β-alanine content of various samples of leaves showed that the value is not constant or same, when the samples of same species were collected from different saline localities. Correlation between β-alanine and salinity was also noticed. In stations of high salinity β-alanine content increased, while in less saline stations β-alanine decreased.

When the samples were collected from the same locality, during the same season no significant change was observed. This can be considered as an evidence of the same type of physiological adaptation to the same species which is subjected to same type of external factors.

Present study revealed that mangroves of Cochin area are under threat due to various reasons. So an urgent need of action plan for the conservation of mangroves of Cochin is required.