Chapter 7

SUMMARY AND CONCLUSION

Mangroves are tropical tidal wetlands which form highly specialized ecosystems characterized by salt resistant plants growing in the intertidal areas along sheltered sea coasts and estuaries. Since it lies in the confluence of land, sea water and fresh water, it is an excellent reservoir of plant, animal and microbial species. The mangrove ecosystems in Kerala have depleted heavily in the recent past due to anthropogenic reasons and have become shrunk to a few small pockets. While studying mangroves as a part of research, it is important to focus on the analysis of the system as a whole and the present investigation was an attempt in that direction.

This study entitled “Microalgal vegetation in the selected mangrove ecosystems of Kerala” was an attempt to understand the microalgal diversity in the selected stations in relation to the ecosystem dynamics. The stations selected were Kumbalam, Panangad, Nettoor, Puthuvypu, Murikkinpadam and Mangalavanam.

The floral components of mangrove ecosystem include eumangroves, associated plants, planktonic microalgae and microphytobenthos. The research todate has mainly focused on the macrofloral and faunal communities, and inspite of their immense contribution to the bioproductivity of the system, the planktonic and benthic microalgae still remain to be investigated.

A survey and classification of the mangrove tracheophytes was carried out as the first part of this study. 11 true mangroves, 7 mangrove associates,
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4 back mangals and one consortive mangrove were identified from the study area. *Aegiceras corniculatum* (L) Blanco, which has not been reported to be present along Cochin estuary, was encountered during this study. *Heliotropium curassavicum* L. and *Ipomoea pes caprae* L., two mangrove associates, which are listed as not present in Cochin estuary by Mandal and Naskar (2008), who proposed the latest classification for Indian mangroves, have also been encountered during this study. Based on their associate features, *Cerbera odolum*, *Ardissia littoralis* and *Cayratia triloba* are listed in this study as back mangals and *Acrostichum aureum* as a consortive mangrove.

The seasonal and spatial distribution of planktonic microalgae and microphytobenthos in the selected mangrove stations, the impact of physicochemical variables like temperature, salinity, pH, nutrients and dissolved oxygen on the distribution and abundance of these algal forms, the assessment of biomass and productivity potential of these micro algae and their identification were the key aspects of this study.

72 species of planktonic microalgae were identified from the six mangrove stations studied during 2003-2004. They belong to 42 genera and four classes viz, Bacillariophyceae, Chlorophyceae, Cyanophyceae and Dinophyceae. Class Bacillariophyceae was the dominant group among the mangrove planktonic algae, constituting 79.16% (57 species). Blue greens were represented by 7 species (9.72 %), green algae by 5 species (6.94%) and Dinophyceae by 3 species (4.16 %). Pennate diatom, *Navicula* was the most abundant genera represented by 8 species. There were 5 species of *Nitzschia* and four each of *Amphora* and *Coscinodiscus*.

The distribution and abundance of planktonic microalgae varied remarkably. *Nitzschia closterium*, *Pleurosoma aestuarii*, *Navicula mutica* and
Gyrosigma tenuissimum were present in all three seasons. The threshold limit of salinity for microalgal abundance was found to be around 21 ppt. Green algae showed their presence during monsoon in all the stations. A bimodal hike in standing crop was observed at station 1 and a unimodal pattern at station 2 as against a trimodal peak reported for Cochin estuary. Nitrogen fixing cyanobacteria encountered during this study offers the possibilities of using them as natural candidates for future reforestation and rehabilitation of destroyed mangroves. Thermophilic and eurhialine planktonic algae were observed during pre monsoon from one of the stations. Three way ANOVA revealed significant spatial variation in chlorophyll \(a\) concentration. The annual average biomass represented by planktonic microalgal chlorophyll \(a\) ranged from 37.74 \(\mu\)gL\(^{-1}\) to 227.69 \(\mu\)gL\(^{-1}\) between stations. It was found that post monsoon is usually characterized by high chlorophyll \(a\) values. Other pigments except chlorophyll \(b\) showed significant positive correlation with chlorophyll \(a\). (Chlorophyll \(a\) values ranging between 0.20 \(\mu\)gL\(^{-1}\) to 105.60 \(\mu\)gL\(^{-1}\) were reported for Pichavaram mangroves.).

The mean planktonic primary productivity values for the entire stations studied was 2.258 gC/m\(^3\)/day or 824.024 ± 495.67 gmC/m\(^3\)/year. (The reported values for Dharmadam estuarine waters is between 0.24 to 1.14 gC/m\(^3\)/ day and that for Pichavaram is 1.67 gC/m\(^3\)/ day).

The phytozone, the depth upto which the phosynthetetic autotrophs can exist, for the stations studied has been found out after a series of trial standardization experiments. There found to be no significant biomass or viable cells below the depth of 6 centimeters and so a sediment depth of 6 centimeters was fixed as the phytozone. The sediment sample was subjected to strata wise analysis for studying the vertical distribution of microphytobenthos.
Eventhough the general trend of high biomass on the surface stratum of the sediment was followed, there were certain instances during which the subsurface stratum showed higher biomass than the surface stratum. The contribution of surface sediment to the total biomass is found to be 40 to 60 %. The remaining biomass was found to be buried inside the sediment. The ability of microphytobenthos to perform vertical migration and the potential to lead a facultative heterotrophic life were evidenced during this study through the paradoxical presence of these organisms well below the potential depth of light penetration. Some of the pinnate forms like *Pleurosigma angulatum*, *Pleurosigma falx*, *Amphora coffeaformis* and *Nitzschia closterium* were seen upto the last stratum of the sediment core.

80 species of microalgae were identified from the benthic habitat out of which 64 species (80%) were diatoms. 8 species coming under 5 genera (10%) represented the blue greens and seven species coming under 6 genera (8.75%) represented the green algae. There was only one species of dinoflagellates (1.25%) among the microphytobenthos. Among the microphytobenthic diatoms, majority were pennate forms. While there were 10 spp. of *Navicula*, 7 species were identified for *Nitzschia*.

Out of the 64 species of diatoms found as microphytobenthos, 26 were found to live exclusively in the benthic habitat. The presence of *Amphora coffeaformis* in all the strata of the sediment is worth mentioning. This ASP producing diatom is well accepted as a microphytobenthos, which lives as a facultative heterotroph. Diatom growth was found to be favoured by high Si:N ratio. Another important aspect of this study was the identification of pollution indicator diatoms like *Gomphonema parvulum* from the sediment sample. Some pennate diatoms which were present during all seasons and at all depths upto 6 cms could be having the basic benthic life style. *Cocconeis littoralis*,


Cocconeis placentula, Amphora proteus, Amphora turgida, Diploneis weisflogii, Amphora coffeaeformis, Gyrosigma laterostratum, were the spp that showed such a type of occurrence and they can be described as typical microphytobenthos.

Some epiphytic diatoms that inhabited the surface of stilt roots of Rhizophora mucronata and pneumatophores of Avicennia officinalis were also identified during this study. Important among them are, Achnanthes javanica, Amphora angusta, Amphora costata, Navicula marina, Navicula transitrans etc.

Even though the standing crop increased along with chlorophyll a, there was no definite pattern.

Chlorophyll a to pheopigment ratio went passed 0.5 mark at station 4 indicating its stressed physiological state which calls for special attention.

Another important observation of the study was that the biomass estimated as chlorophyll a value was higher for planktonic microalgae than for the microphytobenthos. While the annual mean microphytobenthic biomass ranged from 8.165 mg/m³ to 18.264 mg/m³ in the first year, it ranged between 7.928 mg/m³ to 25.876 mg/m³ during the second year. Planktonic chlorophyll a biomass ranged from 10.33 mg/m³ to 91.95 mg/m³ in the first year and 14.835 mg/m³ to 59.84 mg/m³ during the second year. It is due to the peculiarity of the ecosystem that such a result has been obtained. The sediment in mangroves is always subjected to stresses by tidal flushing and in all the stations studied there was stagnation of water resulting in a column of water above the sediment. This causes resuspension of sediment into the water column leading to a higher biomass content in the water column or in the planktonic sample. Thus the actual microphytobenthos temporarily become part of the phytoplankton and
contribute to the water column chlorophyll. Such resuspension is a feature of shallow waters and this does not mean that the contribution of microphytobenthos to the productivity of the system is less. However it is irrelevant in this context to think who contributes more. Together the planktonic microalgae and microphytobenthos contribute a considerable % of biomass which is evidenced from this study and this need to be counted whenever we estimate the productivity of mangrove ecosystem and then only the estimation would be realistic.

This study has attempted to bring to light a vital and too often neglected component of mangrove ecosystems, the microalgae, which lies beneath the spreading mangrove trees as silent dwellers of the system.