

ALGAE ASSOCIATED WITH MANGROVES

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INTRODUCTION

Mangroves are salt-tolerant plants of tropical and sub-tropical Intertidal regions of the World. They play an important role in replenishing the fertility of the coastal regions and support coastal inhabitants socio-economically. Other uses of mangroves for extraction of tannin, timber products, aquaculture, etc., have been recently well organised.

The mangrove ecosystem is a complex and dynamic one. The uniqueness of this ecosystem is that the biota is constantly under physiological stress caused by extreme environmental conditions. Despite such extreme conditions, mangroves have been successfully colonised by developing morphological, reproductive and physiological adaptations (Saenger, 1982; Clough *et al.*, 1982). The mangrove community is not uniform structurally or floristically because of the number of environmental factors that influence on individual mangrove species differently. The various brought about by tide and coastal currents have made organisms of this ecosystem adapt to continuous changing conditions.

The mangrove ecosystems of the World contain about 60 tree species and provide a living support system for dependant biota – about 2000 species of fish, invertebrates and epiphytic plants. (Barth, 1982).

BENTHIC ALGAE

Algae are a primitive group of plants capable of synthesising the complex organic matter. In spite of the considerable diversity in the thallus structure, the important characteristic that distinguishes most algae from other photosynthetic plants is the formation of the reproductive cell and unicellular reproductive organs or multicellular organs.

Algae are classified into a number of systematic groups. They are found in shallow Intertidal and sub-tidal area where 0.1% photosynthetic light is available. Their distribution in the Intertidal areas and geographical regions of the World depends on various environmental factors, the major ones being temperature, light, salinity, nutrient, substrate, etc. In the Intertidal area, algae show distinct zonation on the rocky shores while no zonation occurs in the mangrove area. The rise and fall of the tide is the most important factor in colonisation of the mangrove-associated algae because during low tide algae are subjected to the prevailing salinity conditions, high temperature of the soil and loss of water from thallus due to exposure.

In a mangrove community, number of associated mangrove species are also observed. These plants not only confine to mangrove areas alongwith exclusive mangrove species, but are also found in other coastal ecosystems. This type of association may be considered as casual or intimate which increases the diversity of mangrove community (Saenger *et al.*, 1977), Jagtap (1986) has reported 44 species of algae belonging to 30 genera from Goa coast. (Table 1). This type of variation in the number of algal species perhaps could be attributed to the tolerance capacity of the respective algae in colonising unstable mangrove areas.

Table 1 Algae associated with mangroves

Chlorophyta	Rhodophyta
1. <i>Ulva fasciata</i>	1. <i>Gracilaria verrucosa</i>
2. <i>U. lactuca</i>	2. <i>Hypena musciformis</i>
3. <i>U. reticulata</i>	3. <i>Catenalla impudica</i>
4. <i>Enteromorpha clathrata</i>	4. <i>Caloglossa leprieuri</i>
5. <i>E. intestinalis</i>	5. <i>Polysiphonia macrocarpa</i>
6. <i>E. flexuosa</i>	6. <i>P. ianosa</i>
7. <i>Monostroma</i> sp.	7. <i>Bostrychia tenella</i>
8. <i>Cladophora</i> sp.	
9. <i>Chaetomorpha linum</i>	Cyanophyta
10. <i>Rhizoclonium knereri</i>	1. <i>Chlorococcus turgidus</i>
11. <i>R. riparium</i>	2. <i>Aphaniotheca saxicola</i>
12. <i>Codium fragile</i>	3. <i>Oscillatoria earlei</i>
13. <i>Codium elongatum</i>	4. <i>O. limosa</i>
15. <i>Dichotomosiphon salina</i>	5. <i>O. nigrovirdis</i>
Phaeophyta	6. <i>O. annae</i>
1. <i>Giffordia mitchellae</i>	7. <i>O. pinceps</i>
2. <i>Dictyota indica</i>	8. <i>O. marttinii</i>
3. <i>Padina tetrastratica</i>	9. <i>Oscillatoria</i> sp.
4. <i>Spatoglossum asperum</i>	10. <i>Phormidium fragile</i>
5. <i>Colpomenia sinuosa</i>	11. <i>Phormidium</i> sp.
6. <i>Sargassum</i> sp.	12. <i>Spirulina</i> sp.
	13. <i>Schizothrix</i> sp.
	14. <i>Macrocoleus echthnoplastes</i>
	15. <i>Anabaena</i> sp.
	16. <i>Calothrix crustacea</i>

SUBSTRATE

Substrate plays very important role in algal establishment in Intertidal and subtidal areas. Even though substrate is meant only for attachment, it is vital for the algae to get attached to one place without which it can be drifted away by water movements caused by the rise and fall of tides and currents. In the rocky coastal area, algae attach themselves to the substratum with discoidal type of hold-fast, while on the mud and sand or dead shell particles the attachment is with the help of rhizoidal hold-fast. Three microhabitats such as (a) mud surface, (b) surface of tree trunk stilt roots, and upper branches and canopies of the trees, can be identified based on algal association in mangrove areas.

ALGAL ASSOCIATION

Algae colonising the mud surface are seasonal because of the unstable conditions caused by the erosion and accretion during the season. Mud surface harbours unicellular algae (diatoms) and multicellular algae dominated by blue-green (*Oscillatoria*, *Macrocoleus* and *Schizothrix* spp.) form a characteristic reddish, bluish or greenish mat on the mud surface.

The benthic algae of the mud surface are represented by the green filamentous *Enteromorpha clathrata*, *Rhizoclonium* spp. and thalloid *Monostroma* sp., *Ulva fasciata*, etc. These algae are found growing in extreme conditions in the salinity range from 30 to 40‰ high temperature and nutrients and high light intensity. *Enteromorpha* spp. shows luxuriant growth and is usually found covering entire mud surface. During the afforestation programme at Jaitapur (Ratnagiri) undertaken by Social Forestry, Government of Maharashtra the canopy of the mangrove seedling of *Rhizophora mucronata* was found covered with *Enteromorpha* sp. In many cases, seedlings were bent due to the weight of this alga. Sometimes due to the strong cyclonic winds, algae growing in the nearby rocky area are uprooted and enter the mangrove area. *Sargassum* spp., *Spatoglossum asperum*, *Padina teltrastromatica*, *Ulva lactuca*, *Ulva fasciata*, *Gracilaria verrucosa*, *Hypena musciformis*, *Acanthophora specifera*, *Polysiphonia macrocarpa*, *Codium* spp. are some such examples.

The epiphytic algal flora on mangrove trunks, pneumatophores, stilt roots, upper branches and canopies are comparatively poor. Red algae dominate in these groups and are represented by genus *Bostrychia* spp., *Caloglossa* and *Catenella*. These algae grow in the open, more exposed illuminated area, and form greenish-brown mat-like covering on the tree trunk, pneumatophores and stilt roots. On pneumatophores, *Bostrychia-Catenella-Caloglossa-Catenella* association is seen. The level of settlement on these substrates depends on the tolerance capacity of the algae to the environmental fluctuations. It has been reported that *Bostrychia tenella* can grow above high tide level if it is kept moist and shaded (Almodovar and Biebl, 1962) while Gayral (1966) found that *Bostrychia* spp. can withstand a longer period of desiccation. There is not much information on the tolerance capacity of the algal species under extreme conditions, however, based on broad geographical distribution, most species appear to tolerate a wide range of water and air temperature fluctuation.

BIOTIC FACTORS

With regard to the biotic factors there are a number of animals grazing on mangrove associated algal species. Cribb (1979) recorded traces of *Cladophora* sp. in faecal pellets of gastropod *Littorina* and *Cerithidea* spp. Algae in mangrove habitats generally constitute a significant food resource for various species of mangrove creek fishes and mud-skippers (Beumer 1971, 1978 and Milward, 1974). Odum and Heald (1972) reported that molluscs and crustaceans are the major consumers of diatoms and filamentous algae of the mangrove communities. Competition in respect to space, light and nutrients is another important biotic factor for the survival of the algal species. Green filamentous algae *Enteromorpha* spp. cover other smaller algae of the Intertidal areas, thus depriving the smaller algae from sufficient light, space and nutrients, creating unfavourable conditions for their survival. However, some algae do survive in such conditions by minimising their requirement, perhaps by modifying their metabolic processes. Some pneumatophores and tree trunks were also found covered with *Enteromorpha* spp.

CONCLUSION

In general, mangrove habitat as a whole is unfavourable for the growth of the algal species because of the lack of stable substrate, high turbidity and physiological stress due to the environmental extremes. Algae observed in the Intertidal regions of mangrove areas are very rich and diverse in both quality and quantity. Over the years algae have probably developed resistance

to the extreme conditions and adapted to survive in this environment. The literature with regard to algae associated with mangroves is meagre, and whatever information is available does not give sufficient understanding of the mechanism of survival of algae in extreme conditions, their interaction with other biota and genetic changes brought about in such environment over the years. Therefore more in-depth studies in this field area needed to understand their survival strategy for better utilisation and management.

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