Temporal and Spatial Variations in the Structure of Macroalgal Communities Associated with Mangroves of Pichavaram (South India)

T. Nedumaran and P. Perumal

Center of Advanced Study in Marine Biology, Annamalai University, Parangipettai-608 502, Tamil Nadu, India
Department of Biotechnology, Periyar University, Salem-636 011, T.N., India

Abstract: Present study was carried out on the distribution pattern of macro algae in Pichavaram mangroves (South India). From April 2000 to March 2001. Monthly samplings were made and the algae were identified after collecting them from the stilt roots of Rhizophora mucronata, pneumatophores of Avicennia marina and from the attachment of jetty pillars. Totally 16 macroalgae were recorded which belongs to the following divisions viz; Chlorophyta (7): Phaeophyta (2) and Rhodophyta (7). The algal species were found to be abundant during post monsoon season. Caulerpa sertularioides (Division: Chlorophyta) is recorded for the first time from this mangroves. Further, the recorded physicochemical parameters were related with the distributional pattern of algae.

Key words: Distribution - Mangroves - Physico-chemical - Pichavaram - South India

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 thus supporting the coastal inhabitants socio-economically. The mangrove ecosystem is a complex and dynamic one. The mangrove community is not uniform structurally or floristically because of the number of environmental factors that influence on individual mangrove species differently. Algae are a primitive group of plants capable of synthesizing the complex organic matter. Their distribution in the inter-tidal area of different and geographical regions of the world depends on various environmental factors, the major ones being temperature, light, salinity nutrient and substrate, [1]. The seaweeds are rich in mangrove habitats with most species directly attaching with the aerial roots of mangroves.

The marine algae constitute an important component of the complex food web in the mangrove ecosystem [2-3]. The ecology of algae salt marsh and mangrove swamps have been studied in foreign countries [4-9]. However, very little information is available on the ecology of marine algae from mangrove ecosystems in India [10-12].

Hence, the present investigation is to provide information about the temporal and spatial variation of the species composition and the vertical distribution of mangrove macroalgal communities assessing the changes in some environmental factors.

MATERIALS AND METHODS

For the present investigation two stations were (station-I and station II) located in the Pichavaram mangroves (Lat 11°21N: Long 79°50E) is situated along, the south east coast of India about 230 km south of Chennai in Tamil Nadu (Fig.1). It is spread over an area of about 1,100 hectare consisting of 51 islets, ranging in size from 10m² to 2km². About 50% of total area is covered by the forest, 40% by water ways and the remaining filled by sand and mud flats [13]. It lies in between the Vellar and Coleroon estuarine system maximum depth in the mangrove area is approximately 3m and minimum being 30-50 cm. The tidal amplitude range between 0.15m and 10m and samplings were made from April-2000 to march 2001. To estimate the physico and chemical characteristics- the surface water sample was collected monthly in a plastic container. Temperature, Salinity, pH, dissolved oxygen and nutrients such as nitrate, nitrite, phosphate and silicate were estimated by adopting standard procedures [14].
The collection of algae was made by using a small forceps and knife. At first, a place rich in algal community was selected in the biotope where *Rizophora mucronata*, *Avichmea officinalis* and *Avicennia marina* were thin in population. The collected samples were washed in clean estuarine water in the laboratory and preserved in 5% formalin for the identification later by referring to standard keys given by F.E. Fritch [15-18]. The Checklist of Indian marine algae published by Krishnamurthy and Joshi [19]. CMFRI Bulletin, Vol. 41, 1992) was followed in listing them systematically.

**RESULTS**

Monthly rainfall values (mm) varied from 10.00 (pre-monsoon) the 297.5 (mm) summer No rainfall was recorded during Feb and March. Atmospheric temperature (°C) ranged between 28 to 38 at station 1 and 28 to 36.5 at station-2 (Fig.2) surface water temperature (°C) varied from 27.5 to 36 at station -1 and from 26.5 to 36.5 at station 2 (Fig.3). Salinity showed wide variations and fluctuated from 8 to 33% at station 1 and 4 to 25% at station-2 (Fig. 4). The pH ranged between 7.2 and 8.0 at station -1 and 7.1 and 8.2 at Station 2 (Fig. 5). Dissolved oxygen concentration (ml/l) varied from 2.5 to 5.0 at station 1 and 2.6 to 4.8 at station-2 (Fig 6) with the maximum during the monsoon season and the minimum concentration during the post monsoon season at the both stations.

In the case of nutrients, the ranges (µM) of nitrate and nitrite were: 28.5 - 9.5 at station -1 and 30.6 - 9.5 at station.-2, 1.0 - 5.7 at station 1, 2 - 5.9 at station 2 respectively. The concentration ranges of phosphate and silicate were; 0.7 - 2.1 in station-1 and 0.7 - 2.3 in station -2; 22.1 - 83 in station-1; 22.7-88.5 in station-2 respectively (Fig. 7-10); At both the stations, all nutrients were high in monsoon season and low in nitrate summer season at both stations.

**Algal Distribution:** Presently a total of 16 species (of the 10 genera) of macro algae belonging to the following divisions have been recorded: Chlorophyta (7) Phaeophyta (2) and Rhodophyta (7) (Table 1). At station-1, 3-Chlorophyta, 2-Phaeophyta, 7-Rhodophyta and station, 2: 6-Chlorophyta. 2-Phaeophyta and 2-Rhodophyta were recorded. This list includes only those algae growing on the mangroves of pneumatophores and stilt roots of both the stations but Chladorophora has scattered distribution on the muddy substratum and Jetty pillars. The genera are listed here systematically with in each algal division and the following information is given, while the number of algae recorded in the Pichavaram mangroves will undoubtedly increase with more extensive collection. The alga *Caulerpa sterculoides* (Chlorophyta Division) was first recorded in these mangroves.
Fig. 2: Seasonal Variation in Atmospheric temperature during April 2000 to March 2001 at Stations 1 and 2

Fig. 3: Seasonal changes in Surface Water temperature during April 2000 to March 2001 at Stations 1 and 2

Fig. 4: Seasonal changes in Salinity during April 2000 to March 2001 at Stations 1 and 2

Fig. 5: Seasonal changes in pH during April 2000 to March 2001 at Stations 1 and 2
Fig. 6: Seasonal changes in dissolved oxygen during April 2000 to March 2001 at Stations 1 and 2

Fig. 7: Seasonal changes in Nitrate during April 2000 to March 2001 at Stations 1 and 2

Fig. 8: Seasonal changes in Nitrite during April 2000 to March 2001 at Stations 1 and 2

Fig. 9: Seasonal changes in phosphate during April 2000 to March 2001 at Stations 1 and 2
Fig. 10 Seasonal changes in Silicate during April 2000 to March 2001 at Stations 1 and 2

Table 1: Check list of algae of Pichavaram mangroves (April 2000 to March 2001)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Species</th>
<th>Station 1</th>
<th>Station 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Enteromorpha clathrata</em> (Roth) Grevi</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>2.</td>
<td><em>E. compressa</em> (Linn) Grevi</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td><em>Chaetomorpha aerea</em> kute</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td><em>C. linum</em> kutz</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td><em>C. crassa</em> Kutz</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>6.</td>
<td><em>Cladophora glomerata</em> (Linn.) Kutz</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>7.</td>
<td><em>Caulerpa sertularioides</em> (Gmelin) Howe</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

**Phaeophyta**

| 8.   | *Padina gymnospora* (kutez) | +         | +         |
| 9.   | *Rosenvingea intrica* (J. Ag) Boerges, | +         | +         |

**Rhodophyta**

| 10   | *Hypnea cornuta* (kutz) J. agardh | +         | -         |
| 11   | *H. musci formis* (walif) Lamour | +         | +         |
| 12   | *Spyridia fusiformis* Boerges | +         | -         |
| 13   | *Cauloglossa leprieurii* (mont) J. ag | +         | -         |
| 14   | *Polysiphonia platyarpa* Boerges | +         | +         |
| 15   | *Bostrychia raticans* (Vahi) J. ag | +         | -         |
| 16   | *Gracilaria frolifera* (forssk) Boerges | +         | -         |

**Division**

**Chlorophyta:** The chlorophyta is not generally thought of as being typical of mangrove communities though several green algae (Order-Ulvales) are distributed widely in Indian mangroves. Neither of those genera were collected at any of the localities in Pichavaram, Fine filamentous green algae in the genera *Chaetomorpha* and *Enteromorpha* are ubiquitous in salt marsh and mangroves and these genera were represented at most localities on the mud surface though never abundant.

**Phaeophyta**

| 8.   | *Padina gymnospora* (kutez) | +         | +         |
| 9.   | *Rosenvingea intrica* (J. Ag) Boerges, | +         | +         |

**Division:** Chlorophyta

**Class:** Chlorophyceae

**Order:** Ulvales

**Family:** Ulvaceae
Division

**Phaeophyta:** The brown algae are distinguished by their colour which varies from olive green through light golden to a deep shade of brown. Motile reproductive cells are commonly found in the brown algae. Most of the brown algae, which are recorded as growing with mangroves, are also found in adjacent communities.

- **Division:** Phaeophyta
- **Class:** Phaeophyceae
- **Order:** Dictyotales
- **Family:** Dictyotaceae
- **Genus:** Padina
- **Species:** *P. gymnospora* (Kutz.) Vickers.

- **Order:** Dictyosiphonales
- **Family:** Punctariaceae
- **Genus:** Rosenvingea
- **Species:** *R. intricata* (J. Ag.) Boerges.

**Division**

**Rhodophyta:** The algae commonly regarded typical of mangrove communities are all members of this division. The genera recorded here are mostly fine algae and larger folios species are not represented. The marine forms are recognized by their bright pink colour caused by the bile protein pigments, r-phycoerythrin and r-phytocyanin.

- **Division:** Rhodophyta
- **Class:** Rhodophyceae
- **Sub-class:** Florideae
- **Order:** Gigartinales
- **Family:** Hypneaceae
- **Genus:** Hypnea
- **Species:** *H. musciformis* (wulf.) Lamour
  *H. cornuta* (Kutz.) J.Agardh.

- **Family:** Gracilariaceae
- **Genus:** Gracilaria
- **Species:** *G. folifera* (Forssk.) Boergs

- **Order:** Ceramiales
- **Family:** Ceramiaceae
- **Genus:** Spyridia
- **Species:** *S. fusiformis* Boergs.

- **Family:** Delesseriaceae
- **Genus:** Caloglossa
- **Species:** *C. leprieurii* (Mont.) J.Ag.

- **Genus:** Bostrychia
- **Species:** *B. radicans* Mont.

- **Genus:** Polysiphonia
- **Species:** *P. platycarpa* Boergs.

**DISCUSSION**

Physico-chemical parameters such as, temperature, salinity, dissolved oxygen, pH and nutrients were showed distinct seasonal variations in this study. The bulk of rain fall was obtained during the north east monsoon and the pattern of rainfall influenced the physico-chemical and biological characters of the study area. The recorded high temperature during summer at both the stations could be attributed to high solar radiation. The monsoonal low temperature could be due to strong land sea breeze, rainfall and cloudy sky. The high salinity values noticed during the summer season could be due to the high solar radiation and neritic water dominance [13]. The pH was low during monsoon season due to the influence of fresh water; reduction of salinity and decomposition of organic matter during pre-monsoon season pH was high because of the uptake of CO2 by phytoplankton. Similar observations were made earlier by [20]. The high dissolved oxygen concentration was due to the algal photosynthesis.

Inorganic nutrient concentration was always higher during monsoon season due to heavy rainfall, land drainage and input of fertilizer from the catchment areas and was low during other months due to their utilization by phytoplankton and macro algae [21]. Marine algae in Pichavaram mangroves have received little attention from physiologists and therefore it is more obligatory to make at least a maiden attempt to explore and explain the available marine algae of this area. Further, studies on algae associated with mangrove are very limited in India. Hence the present investigation would throw some light on the marine algal flora found in these mangroves in relation to their seasonal occurrence and distribution.

In general, the mangrove environment is unfavourable for the growth of many macro algae because of lack of suitable substratum. The substratum is unsteady and muddy. The mud in suspension will cause more turbidity, thereby reducing light penetration in to the water column and thus affecting the growth of seaweeds. Furthermore, there is always some physiological stress on these algae due to fluctuating salinity, as the mangrove environment is bathed between seawater and fresh water. However, some red algae belonging to the genera: *Bostrychia*, *Caloglossa*. *Hypnea* and *Gracilaria* constitute the unique algal vegetation of this environment; sometimes thick carpets of green algae like *Enteromorpha* and *Cladophora* grow on the mangrove mud under the shade provided by mangrove
canopy. But poor growth of such algae is a common feature in the interior mangrove areas because of very heavy shading of the mangrove thickets and relative stagnation of water.

Earlier reports suggest that the surface water temperature is found to be one of the important physical factors influencing seaweed growth and its abundance. The present study also supports this view as the surface water temperature showed negative correlation with species composition at station-1. This indicates that higher temperature decreases the species composition due to increased salinity, which might have affected the growth or bleaching of the algae to the disappearance of the algae in summer season. This observation is in close conformity with that of Pichavaram [12], Muttukadu [22-23] and Voolowar Bay [9].

In general, higher number of species composition and distribution of seaweeds were recorded at both the stations during pre-monsoon season. This could be due to the favourable physico-chemical parameters during that period reported in Waghotana estuary [24] and Mandapam regions [25]. Algae such as *Bostrychia radicans* and *Caloglossa leprieurii* occurring on the roots of *Rhizophora* species and *Avicennia* are found distributed throughout the year at station-I. *Enteromorpha* and *Chaetomorpha* common feature of the distributions throughout the study period by showing tolerance to fluctuating salinities. Scattered distribution of *Cladophora glomarata* is found near the freshwater regions of the mangroves (Station-2). *Enteromorpha* species are uprooted and enter the mangrove area.

Hence, it is necessary to document the biodiversity of seaweed resources in the mangrove ecosystems. A number of algae from mangrove habitats have potential commercial value. For example, the red alga, *Gracilaria changii* from malaysian mangrove habitats is an excellent source of agars and the agar content is between 12 and 25% of its dry weight [24]. *Monostroma axyspermum*, *Catenella impudica* and *Caloglossa leprieurii* are all edible food resources. The latter two species are also potential sources of dyes. *Caulerpa* sp. has yielded bioactive substances that may hold promise as pharmaceutical agents. This study is highlighted the variability of mangrove macroalgae in Pichavaram and suggested some factors that may affect distribution and abundance such variation however, typical of other marine and estuarine environments has shown with intertidal algae on rocky shores.

**ACKNOWLEDGEMENT**

We are grateful to the Director, CAS in Marine Biology, Parangipettai, for providing Laboratory facilities.

**REFERENCES**