Phytosociology and edaphic attributes of mangroves in Chettuwai backwater system, Thrissur, Kerala
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ABSTRACT
A phytosociological and edaphic study was carried out in the mangroves of Chettuwai backwater system in Kerala. Floristic analysis revealed that the vegetation comprised of 12 mangrove species belonging to 10 families. Rhizophora mucronata reported maximum density and basal area, whereas, maximum frequency was observed in the case of Bruguiera cylindrica. The entire vegetation looked like a Rhizophora dominated community. The other floristic elements were represented by Avicennia officinalis, Bruguiera cylindrica, Aegiceras corniculatum, Acanthus illicifolius, Premna latifolia and Derris trifoliatum. Importance value index was maximum for Rhizophora mucronata. Simpson’s index of diversity was relatively low (0.54). Zonal distribution of plants was observed with respect to change in edaphic attributes. Soil was generally acidic in nature. Electrical conductivity and concentration of available P and K decreased down to the profile. Soil organic carbon and nitrogen did not vary significantly down to the profile. However, organic C and electrical conductivity showed significant variation between the zones. Potassium did not show significant variation between various zones studied.

Keywords: Mangroves- Phytosociology- Edaphic parameters- Floristic – Diversity index.

1. Introduction
Mangroves are coastal formations found along the lands in close proximity to the sea and at the mouths of rivers and backwaters that get inundated daily by the tide and exposed only at low water. The world wide distribution of mangroves extended over 30 countries including those of Island Nations are estimated as 99300 km², out of which about 6-8 million hectares are in the Asia Pacific region. It is estimated that in India there are about 55 mangrove species distributed under 35 genera and 25 families (Thothathri, 1981). Blasco (1977) estimated the total area of mangroves in India as 3565 km². According to an estimate, Kerala once supported about 700 km² mangroves and what we see now are only relics of a great past (Ramachandran et al., 1985). It can be noted that out of the total 1670 ha of mangroves in Kerala, 1470 ha are with private holders. Growing awareness on the protective, productive and social functions of mangrove ecosystems has highlighted the need to conserve and manage them sustainably.

Phytosociology is the study of vegetation and its internal relationships of plant communities and their structure, composition, successional relations and relationship with environmental factors. Phytosociological studies have been reported in mangrove vegetation as well as other forest ecosystems of India (Dagar and Sharma, 1989; Pascal, 1988; Devi and Behera 2003). However, only few have attempted to document the floristic diversity and structural
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characteristics of mangrove formations in Kerala (Basha, 1991; Kurian, 1994; Sunilkumar, 2002). Edaphic attributes of plant communities reveals the symbiotic influence of physico-chemical properties on plant growth and distribution. Study of soil parameters is also important in the assessment of species distribution pattern with respect to soil characteristics. Hence, the present study aimed to explore the species composition and estimation of floristic diversity and also to analyze the edaphic attributes of mangroves at Chettuwai backwater system.

2. Materials and methods

2.1 Study area

Figure 1: Study area

The study was conducted in mangroves formations at Chettuwai back water interface, which comes under Orumanayur Grama Panchayat of Chavakkad Taluk in Thrissur district of Kerala state, India. This estuary is situated in the latitude 10º 32’ N and longitude 76º 02’ E. The rivers of Kecheri puzha and Karanjira puzha joins with Arabian Sea through the Chettuwai estuary which harbours a significant stretch of mangrove vegetation. Chettuwai mangroves was mainly formed as part of island ecosystem which is completely demarcated by backwater system. Ecotourism as well as other biotic interference has created large scale disruption of this fragile community. This in turn has resulted in a huge decline of mangrove cover and ultimately affected the natural regeneration.

2.2 Phytosociological Analysis

Phytosociological studies were carried out following the quadrate method. Sample plots were taken perpendicular to the shoreline from the leeward side of the river. Each sample plot was divided into smaller quadrates of 5m x 5m size. The outlines of the quadrants were marked with pegs. This exercise were repeated at pre-determined intervals along the transect. All the
trees equal to and above 10 cm girth at breast height (GBH) were enumerated by measuring the girth using a tape. Other individual species having a GBH below 10cm were also enumerated. Plant specimens were collected for identification and herbaria prepared. Numerical data for individual species were analyzed for abundance, relative density, percentage frequency, basal area and relative basal area, importance value index and relative importance value index.

1. Density = Number of individuals of a species per ha.
2. Abundance = Total number of individual/ No. of quadrats of occurrence
3. Basal area = GBH²/ 4Pi
4. Relative density = No. of individuals of a species ×100/no. individuals of all Species
5. Percentage frequency = no. of quadrats of occurrence × 100/Total no. of i. quadrats studied
6. Relative basal area = Basal area of the species × 100/Basal area of all i. Species
7. Importance value index = Relative density + Relative frequency + a. Relative basal Area
8. Simpson index (Simpson, 1949)

\[ D = 1 - \sum \left( \frac{n_i}{N} \right)^2 \]

Where: \( n_i \) = number of individual of the, \( i^{th} \) species.
\( N \) = total number of individuals in the plot.
\( S \) = total number of species
\( D \) = Simpson’s diversity index

9. Shannon Diversity Index

\[ H = \sum_{i=1}^{S} \left( P_i \times \ln P_i \right) \]

where:

\( H \) = Shannon diversity index
\( P_i \) = fraction of the entire population made up of species \( i \)
\( S \) = numbers of species encountered
\( \Sigma \) = sum from species 1 to species \( S \)

2.3 Physico-chemical properties of soil

Soil samples were collected from the different mangrove zones of the study site. Soil profiles up to a depth of 60 cm were taken and soil samples from depths 0-20 cm, 20-40 cm, 40-60 cm were collected in polybags. These samples were further dried in shade, powdered, sieved and brought to the laboratory. Before distillation, soil samples were kept for pre-digestion and digestion. Samples were analyzed for following parameters (Jackson, 1973).

1. pH - in a 1:2 mixture of soil (<2mm) and distilled water with pH meter.
2. Electrical conductivity of the soil suspension used for pH determination with Conductivity Bridge.
4. Total Nitrogen by semi micro kjeldal method.
5. Available Potassium using flame photometer.
6. Available Phosphorous (Bray and Kurtz method)

3. Result and discussion

3.1 Species composition

The floristic composition revealed a total of 12 pure mangroves species. Out of this four each were trees and shrubs, one each a grass, creeper, liana and a pteridophyte (Table 1). These species were belonging to 12 genera and 10 families. A monocot belonging to the genus *Cyperus* was recorded from the degraded islands of Chettuwai apart from the presence of several *Poaceae* members. Similarly, the pteridophyte, *Achrostichum aureum* was present invariably in all the islands. The entire system looked like a *Rhizophora* dominated mangrove formation. Other species such as *Bruguiera, Excoecaria, Avicennia* were also distributed towards the landward side. The species diversity here was relatively very low when compared to mangroves of Kannur from where about 17 species were recorded (Jose, 2003). Studies reported from Puduvyppu area showed that the mangrove forest there had an ‘Avicennia’ look. Here the frequency of *Bruguiera, Excoecaria, and Rhizophora* were found to be increased towards the landward side (Sureskumar, 1993). In the present study, the back mangroves comprised of 12 species. Thus, confirming to the usual trends that the number of species which are able to survive in the harsh conditions of tidal zones in the study area was lower as compared to other tropical formations like moist deciduous or evergreen forests.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Species</th>
<th>Family</th>
<th>Habit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Avicennia officinalis</em></td>
<td>Avicenniaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhizophora mucronata</em></td>
<td>Rhizophoraceae</td>
<td>Tree</td>
</tr>
<tr>
<td>3</td>
<td><em>Excoecaria agallocha</em></td>
<td>Euphorbiaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>4</td>
<td><em>Bruguiera cylindrica</em></td>
<td>Rhizophoraceae</td>
<td>Tree</td>
</tr>
<tr>
<td>5</td>
<td><em>Aegiceras corniculatum</em></td>
<td>Myrsinaceae</td>
<td>shrub</td>
</tr>
<tr>
<td>6</td>
<td><em>Acanthus ilicifolius</em></td>
<td>Acanthaceae</td>
<td>Shrub</td>
</tr>
<tr>
<td>7</td>
<td><em>Acrostichum aureum</em></td>
<td>Pteridaceae</td>
<td>Pteridophyte</td>
</tr>
<tr>
<td>8</td>
<td><em>Derris trifoliatum</em></td>
<td>Fabaceae</td>
<td>Liana</td>
</tr>
<tr>
<td>9</td>
<td><em>Premna latifolia</em></td>
<td>Verbenaceae</td>
<td>Shrub</td>
</tr>
<tr>
<td>10</td>
<td><em>Cyperus spp.</em></td>
<td>Cyperaceae</td>
<td>Grass</td>
</tr>
<tr>
<td>11</td>
<td><em>Ipomea biloba</em></td>
<td>Convolvulaceae</td>
<td>Creeper</td>
</tr>
<tr>
<td>12</td>
<td><em>Clerodendron inermi</em></td>
<td>Verbenaceae</td>
<td>Shrub</td>
</tr>
</tbody>
</table>

3.2 Zonation

Mangrove forests generally exhibit specific pattern of zonation. A particular zone is dominated by a species which is mainly due to the pH and other edaphic attributes. In Chettuwai, the proximal zone was characterized by the preponderance of *Aegiceras corniculatum* and *Acanthus ilicifolius*. However in some patches, *Avicennia officinalis* has replaced *Acanthus ilicifolius*. The intermediate zone comprised of species like *Bruguiera cylindrica* and *Rhizophora mucronata*. The major back mangroves included *Calophyllum inophyllum, Lannea coromandelica, Hibiscus tiliaceous*, etc.
3.3 Phytosociological analysis

Structural features of the mangroves at Chettuwai revealed that 401 individuals/ha having a GBH of >10cm were recorded from the sample area. Out of this, species constituting maximum relative density and relative basal area was represented by *Rhizophora mucronata* (54.98 and 54.64) followed by *Bruguiera cylindrica* (39.05 and 34.02) and *Avicennia officinalis* (5.22 and 6.19). *Rhizophora mucronata* registered the maximum (0.53 m²) relative basal area. Minimum relative basal area was recorded for *Excoecaria agallocha* (0.05 m²). Frequency and relative frequency was maximum for *Bruguiera cylindrica* (41.86) and minimum for *Excoecaria agallocha* (2.33). Maximum importance value index and relative value index were registered was for *Rhizophora mucronata* (149.15 and 49.72) followed by *Bruguiera cylindrica* (114.94 and 38.31) and *Avicennia officinalis* (27.68 and 9.23). Vidyasagar et al. (2011) had reported maximum importance value index for *Avicennia officinalis* in the mangroves of Kannur.

### Table 2: Phytosociological parameters of mangroves at Chettuwai (>10cm GBH)

<table>
<thead>
<tr>
<th>SI. No.</th>
<th>Species</th>
<th>Relative BA</th>
<th>Relative density</th>
<th>Relative frequency</th>
<th>Importance value index</th>
<th>Relative importance value index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Rhizophora mucronata</em></td>
<td>54.64</td>
<td>54.98</td>
<td>39.53</td>
<td>149.15</td>
<td>49.72</td>
</tr>
<tr>
<td>2</td>
<td><em>Bruguiera cylindrica</em></td>
<td>34.02</td>
<td>39.05</td>
<td>41.86</td>
<td>114.94</td>
<td>38.31</td>
</tr>
<tr>
<td>3</td>
<td><em>Avicennia officinalis</em></td>
<td>6.19</td>
<td>5.22</td>
<td>16.28</td>
<td>27.68</td>
<td>9.23</td>
</tr>
<tr>
<td>4</td>
<td><em>Excoecaria agallocha</em></td>
<td>5.15</td>
<td>0.75</td>
<td>2.33</td>
<td>8.22</td>
<td>2.74</td>
</tr>
</tbody>
</table>

![Importance Value Index](image)

**Figure 2:** Importance Value Index of mangrove species at Chettuwai

3.4 Diversity Indices
Simpson's diversity index (also known as Species diversity index) is one of the diversity indices, used to measure species diversity. It takes into account the number of species present, as well as the relative abundance of each species. For Chettuwai mangrove, the Simpson’s index was found to be 0.54 which means that more than 54 percent of the individuals belong to different species. In Chettuwai, the Shannon Weiner diversity index was 0.882 (H max). Suressh Kumar (1993) reported that Shannon Weiner diversity index was ranged from 3.8 to 4.3 (H max) for mangroves of Puthuvyppu. Present study indicated comparatively low value due to the occurrence less number of true mangroves in Chettuwai.

Table 3: Physico-chemical properties of soil between different zones in mangroves at Chettuwai

<table>
<thead>
<tr>
<th></th>
<th>Electrical Conductivity</th>
<th>Carbon</th>
<th>Total Nitrogen</th>
<th>Available Potassium</th>
<th>Available Phosphorous</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>10.03&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.770&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.04&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1649&lt;sup&gt;a.00&lt;/sup&gt;</td>
<td>109.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>II</td>
<td>13.63&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.810&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1447&lt;sup&gt;a.00&lt;/sup&gt;</td>
<td>137.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>III</td>
<td>8.27&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>0.830&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1613&lt;sup&gt;a.00&lt;/sup&gt;</td>
<td>175.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>IV</td>
<td>5.30&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.810&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1144&lt;sup&gt;a.00&lt;/sup&gt;</td>
<td>141.1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*Significant at 0.05 levels; Means with same letter as superscript are homogeneous

4. Edaphic attributes of soil

Physico chemical analyses of the mangrove soils revealed that the soil colour was black due to the presence of high organic matter content. The clayey nature as well as the black colour decreased towards the landward side. In most of the areas soil was soft and muddy whereas in certain areas it became very hard and compact. Similar soil conditions were reported in the mangroves of Puduvyppu area by Suresh Kumar (1993). Le Van Khoa (1993) has reported that the organic matter content will be more in undisturbed sites. Only little variation was observed in organic matter content down to the profile within the zones. The soils of Chettuwai were acidic nature and it did not vary significantly within and between the zones. Electrical conductivity, however, decreased down to the profile which could be due to the presence of low salt content. In Sunderbans, Sah et al., (1989) has reported that there is an increase in pH and nutrient content with inundation. Water movements also increase the pH with depth (Kuraishi et al., 1985).

Electrical conductivity and organic C showed significant variation between the zones. Both parameters reached its maximum value in the middle zone. Since, conductivity is a measure of salinity, the zones showing maximum conductivity represents withshowed maximum salinity. This zone is characterized by Rhizophora mucronata and Bruguiera cylindrica. This indicates the influence of salinity on the species distribution. Rhizophora mucronata and Bruguiera cylindrica favoured high salinity. Study conducted by Dager and Sharma (1989)
has proved the importance of salinity on the distribution of these species. Electrical conductivity of soil at zone 2 varied significantly from the zones 3 and 4 respectively. In the Kannur mangroves, there was significant difference in the specific conductivity among various zones (Jose, 2003). Similarly in case of nitrogen content also, variation was significant between various zones studied, except zones 3 and 4. However, phosphorous content was significantly different between zones 3 and 4. Potassium did not show significant variation between various zones studied. Suresh Kumar (1993) reported that soil phosphorous and potassium content in the Puthuvyppu mangroves generally showed a decreasing trend down to the profile.

5. Conclusions

The mangrove forest of Chettuwai backwater system has low floristic diversity. A total of 12 pure mangroves species were recorded, out of which four each were trees and shrubs, one each from grass, creeper, liana and pteridophyte. *Rhizophora mucronata* showed maximum density and basal area, whereas, maximum frequency was observed in the case of *Bruguiera cylindrica*. The lowest density was for *Excoecaria agallocha*. The other floristic elements were represented by *Avicennia officinalis*, *Bruguiera cylindrica*, *Aegiceras corniculatum*, *Acanthus illicifolius*, *Premna latifolia* and *Derris trifoliatum*. Importance Value Index was maximum for *Rhizophora mucronata* followed by *Bruguiera cylindrica*, *Avicennia officinalis*, *Excoecaria agallocha*. Simpson's index of diversity was relatively low (0.54) when compared to other mangrove formations in the state.

Physico - chemical analysis of soil indicated a black colored soil with a high organic matter content. Only little variation was observed in organic matter content down to the profile with in the similar zones. The soil was acidic and it did not vary significantly within and between the zones. Electrical conductivity decreased down to the profile which may be due to the presence of low salt content. Electrical conductivity and organic C showed significant variation between the zones. Both parameters reached its maximum value in the middle zone. This zone is characterized by *Rhizophora mucronata* and *Bruguiera cylindrica*. Electrical conductivity of soil at zone 2 also varied significantly from the zones 3 and 4 respectively. Similarly, in the case of nitrogen content also, variation was significant between various zones studied except 3 and 4. However, phosphorous content was significantly different between zones 3 and 4. Potassium did not show significant variation between the various zones.

Acknowledgements

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6. References


