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SYMPOSIUM SERIES 6

Abbreviation

AN APPRAISAL OF THE BIOTIC AND ABIOTIC FACTORS OF
THE MANGROVE ECOSYSTEM IN THE COCHIN BACKWATER, KERALA

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ABSTRACT
In view of the significance of the mangrove areas for coastal aquaculture, a reconnaissance survey
of the mangrove areas in the Cochin estuarine system was undertaken during 1976-78. The mangroves
of Cochin are formative, mostly developing on small reclaimed or natural islands. Environmental
characters showed considerable seasonal fluctuations, especially the salinity which in some of
the natural ponds in the mangrove area varied from freshwater condition to high saline, mainly due
to the monsoonal and tidal influence. The rate of primary production ranged from 0.02 to 2.0 gC/m²/
day which fluctuated from the ambient waters of the estuary.

The dominant mangrove vegetation is constituted by species of Acanthus, Excoecaria, Clerodendrum,
Aegiceras, Avicennia and Rhizophora. Most of the resident fauna include typical mangrove forms
such as Uca spp. in the upper littoral zone, hermit crabs and Nauticus spp. in the mid-littoral zone,
Cerithidium sp. and Terebralia sp. on the mud-flats and on the trunks and leaves of mangroves the
gastropods Littorina sp. are also common. Wood boring organisms such as Sphaeroma sp. among
crustaceans and teredinids and bivalves were observed to cause damage to the dead roots and trunks
of mangrove trees. In tidal pools and creeks of mangroves, concentration of larvae and juveniles
of prawns and fishes was observed during certain seasons in conjunction with thick growth of fila-
mentous algae. These seeds are usually collected by local people for the stocking of perennial and
seasonal culture fields in and around the area.

INTRODUCTION
In recent years there has been a growing interest and awareness of the mangrove eco-
systems as evidenced in the proceedings and deliberations of International and regional
symposia and seminars. The mangrove ecosystem usually harbours a characteristic faunal
assemblage consisting of resident and migratory animals. It also serves as a breeding and
nursery ground for many finfishes and shell-fishes. In many parts of the Indo-Pacific, the
mangrove areas are proved to be potential sites for culture of fishes, crustaceans and
molluscs.

Further, mangrove vegetation colonise on muddy shores along the borders of the
estuaries and typically comprise of highly specialised trees and shrubs mostly belonging
to the families, Acanthaceae, Avicenniaceae, Euphorbiaceae, Myrsinaceae, Rhizophoraceae
and Verbenaceae. This vegetation is morpho-
logically and physiologically adapted to with-
stand viole fluctuations in salinity and hence
referred to as ' Halophytes '. The root system
of these plants serve to bind the deposited
estuarine mud together and stabilize the sub-
strata and prevent erosion. The area con-
sequently becomes a region of accretion and
high production. The bacterial and fungal
 decomposition of the litter fall in the system in considerable quantity results in the high primary production which in turn leads to dense population of secondary and tertiary producers.

A preliminary survey of the mangrove ecosystems was taken up during the years 1976 to 1978 and as the first step, the backwater areas around Cochin was studied and the findings are enumerated in this account.

The authors wish to express their grateful thanks to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute for the encouragement and guidance given in carrying out this survey and also to Dr. P. V. Ramachandran Nair for helpful suggestions given.

**Area of Study**

The area of present survey extended from the vicinity of Cochin Harbour in the north, to Perumbalam in the south and the stations, mostly islets were located in the Cochin Backwater system connected to the Vembanad Lake (Fig. 1).

**Station 1**

Pambaimoola (Local name) is located about 5 km south of Cochin in the backwater system and is mainly a shallow muddy bay which extends to about 800 sq. metres. In swampy pools, dense patches of *Acanthus ilicifolius* dominate and on the shoreward side patches of *Avicennia officinalis* occur.
Station 2
This is a small island near Perumbalam Island in the Vembanad Lake. The mangrove here consists of low wooded shrubs mostly belonging to genera Clerodendrum, Aegkeras, Excoecaria and Rhizophora. During low tide, half of the island is exposed with muddy and sandy flats.

Station 3
This is also a small island (opposite to Chenthuruthu) covered with Acanthus ilicifolius in patches, along the fringes. Most part of the island which has a clayey soil has been utilised for paddy-cum-prawn culture by the local people.

Station 4
It has fairly a vast area in the mainland opposite to station 3 and is covered by more terrestrial vegetation due to man-made changes. The mangrove vegetation could be seen intermingled with terrestrial trees and also coconut plantation. A number of shallow ponds occur which serve as good nursery grounds for prawn and estuarine fish larvae.

Routine data were collected every fortnight on the mangrove vegetation, physico-chemical factors of the water such as temperature, salinity, oxygen content, nutrients and primary productivity. Qualitative data on fauna were also collected.

RESULTS

Physico-chemical features
Average monthly surface temperature varied from 25 to 30°C in station 1; 28.2 to 38.3°C in station 2; 24.2 to 36.5°C in station 3 and 31.2 to 41.0°C in station 4. Monthly average values of surface salinity varied from 0.77‰ to 29.0‰ (station 1), 0.21 to 29.21‰ (in station 2), 0.68 to 30.26‰ (Station 3) and 0.90‰ to 29.0‰ in station 4.

Dissolved oxygen content in the mangrove creeks showed seasonal changes and ranged from 1.03 to 5.03 ml/l (station 1); 2.92 to 5.6 ml/l (station 2); 3.15 to 6.33 ml/l (station 3) and 2.91 to 5.6 ml/l in station 4.

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Stn. 1</th>
<th>Stn. 2</th>
<th>Stn. 3</th>
<th>Stn. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrite N</td>
<td>0.74-0.85</td>
<td>0.35-0.85</td>
<td>0.40-0.59</td>
<td>0.43-0.82</td>
</tr>
<tr>
<td>(µg at/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphate</td>
<td>1.0-1.52</td>
<td>0.00-1.68</td>
<td>0.00-2.27</td>
<td>0.00-1.59</td>
</tr>
<tr>
<td>(µg at/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon (mgC/g)</td>
<td>21.2-27.69</td>
<td>16.0-26.30</td>
<td>21.8-31.84</td>
<td>15.2-1.82</td>
</tr>
</tbody>
</table>

Primary production
Primary productivity was estimated by both oxygen technique and ¹⁴C technique. In general, the values ranged from 240-2150 mgC/m²/day in different months of the year. The seasonal variation in production is presented below.

<table>
<thead>
<tr>
<th>Production mgC/m²/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Pre-monsoon (Jan-April)</td>
</tr>
<tr>
<td>900 450 620 665</td>
</tr>
<tr>
<td>Monsoon (May-Aug.)</td>
</tr>
<tr>
<td>1370 510 610 370</td>
</tr>
<tr>
<td>Postmonsoon (Sept.-December)</td>
</tr>
<tr>
<td>805 560 630 455</td>
</tr>
</tbody>
</table>

Distribution and zonation of mangrove flora and fauna
The mangrove flora in the tidal zone of station 1 was dominated by Acanthus ilicifolius and the rest consisted of Clerodendrum inerme, Rhizophora mucronata and Avicennia officinalis. The upper zone is colonised by typically terrestrial trees such as Thespesia populnea.

The muddy outpocket which is often exposed during low tide, was inhabited by Terebralia
with a density of 15-25 no./sq.m. This area is used for soaking timber and is highly polluted.

At the upper fringe of the swampy area Nerita and Littorina could be found on hard substrata and Crassostrea and barnacles in the lower zone. Burrowing polychaetes and egg case of Marphysia were also common. Occasionally Modiolus sp. were observed as attached to Terebralia. A few nudibranch were collected from the leaves of Acanthus.

Above the intertidal zone crabs belonging to the families Portunidae, Ocypodidae and Grapsidae are commonly found. Juveniles of Haplocheilus, Therapon, Ambassis and of the prawns Peneaus and Metapenaeus occur commonly in the swampy pools.

The southern side of station No. 2 is populated by low shrubs Clerodendrum inernae, Aegiceras corniculatum, Excoecaria agallocha and occasional stands of Rhizophora mucronata.

Hydromedusae such as Einvne sp. were collected in good numbers during summer months. In the sandy flats, tube dwelling polychaetes could be observed. Young ones of mussels and Modiolus occurred on dead mangrove trunks. Wood boring bivalves and crustaceans were noticed on certain occasions on mangrove stumps and breathing roots. Cerethedium usually occur in large numbers during March-May. Juveniles of Therapon Ambassis and prawns occur in good numbers in the tidal pools among mangrove vegetation.

The 3rd station was dominated by the following vegetation: Acanthus ilicifolius, Aegiceras corniculatum, Clerodendrum inermis and Rhizophora mucronata. This was backed by terrestrial forms like Vitex sp., Ipomea biloba, Phyllanthus sp. and Acrostichum aureum.

Boring bivalves were commonly observed in the dead roots of mangroves. During certain months anemones and gastropod Iobium sp. and its egg masses could be observed in the exposed muddy areas. Juveniles of Peneaus indicus, Metapenaeus dobsoni and M. monoceros were usually observed in the creeks of mangrove area. During summer months, when the salinity is high, prawn culture is practised in this island.

The station 4 has a good compliment of mixed mangroves such as Rhizophora mucronata, Bruguiera cylindraca, Aegiceras corniculatum, Clerodendrum inermis, Excoecaria agallocha and Acrostichum aureum. Terrestrial forms such as Calophyllum inophyllum, Ipomea biloba and Eriocolon sp. also occur. In general, the mangrove vegetation exhibit luxurient growth in the post-monsoon months with flowering in September to December period.

In station 4 species of Terebralia occur only in small numbers and in a scattered manner. Above the intertidal zone crabs such as Uca, Scylla serrata, Sesarma and Metapagoras could be found in different months. In the creeks and ponds, juveniles of Haplocheilus, Ambassis, Etraphus, gobid, Tetradon and Batrachus could be found in different seasons.

The distribution of flora and fauna commonly occurring in the different mangrove stations could be summarised as follows:

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Flora</th>
<th>Fauna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-tidal</td>
<td>Acanthus ilicifolius,</td>
<td>Scylla serrata, Uca amphilipes,</td>
</tr>
<tr>
<td>zone</td>
<td>Aegiceras corniculatum</td>
<td>Uca vocans, Sesarma lagunatum,</td>
</tr>
<tr>
<td></td>
<td>and Rhizophora mucronata</td>
<td>Sesarma pilacatum, Metapagoras messor,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>burrowing amphipods, barnacles,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wood boring bivalves, Littorina</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sp. and Nerita sp.</td>
</tr>
<tr>
<td>Upper</td>
<td>Arceensia officinalis</td>
<td>Terebralia sp., Cerethenum sp.,</td>
</tr>
<tr>
<td>tidal zone</td>
<td></td>
<td>small gastropods,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitat</td>
<td>Flora</td>
<td>Fauna</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Tidal pools &amp;</td>
<td>* Acrostichum aureum,</td>
<td>Amphipods, alphaeids, small <em>Neptunus</em>,</td>
</tr>
<tr>
<td>creeks</td>
<td>* Eriocolon sp.,</td>
<td><em>Eupomatias</em> mactacalus, <em>E. suratensis</em>,</td>
</tr>
<tr>
<td></td>
<td>* Cyperus sp. and</td>
<td><em>Ambassis dayi</em> and <em>A. commersoni</em></td>
</tr>
<tr>
<td></td>
<td>* Ipomea</td>
<td></td>
</tr>
<tr>
<td>Terrestrial*</td>
<td>* Theoppia pupulnea,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Vitex sp.,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Phyllanthus sp.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Calophyllum inophyllum and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Panicum sp.</td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION**

The mangroves in the Cochin Backwater system as it is observed now could be described as isolated patches which have undergone degradation due to man made changes. Blasco (1975) pointed out that out of the estimated 70,000 ha of mangrove areas in India, Kerala Backwaters have only a vestige of less than 100 ha. Although the backwater channels are shallow, narrow and well connected to the sea and the adjacent terrain with copious rainfall annually, mangrove development has been very much restricted. The areas bordering the canals are over populated and what was once a mangrove area has been converted into coconut groves and paddy fields or prawn culture fields.

Wide seasonal fluctuations in the physico-chemical factors have been noticed in the mangrove areas investigated. The Cochin Backwater where these mangrove stations are located, is also subjected to considerable fluctuations in the above factors (Qasim et al., 1969).

Qasim (1970) estimated gross production in the estuary as ranging from 270-295 gC/m²/year and the annual consumption of the zooplankton herbivores as only about 30 gC/m². This indicated the availability of large surplus food in the estuary and the connected mangrove area which may perhaps be utilized by other members of the ecosystem such as herbivorous fishes (mullets) and omnivorous detritus feeders such as prawns.

Commenting on the faunal characteristics of Asian mangroves Morton (1978) has observed, that a wide range of animals including worms (*Phascolosoma*), snails (*Telescopium, Cerithidia and Terebralia*), bivalves (*Gelonia, Enigmion*, *Pharella, Modiolus*), crustaceans (*Sesarma, Uca, Ilyoplax, Scylla, Thalassina*), fishes (*Periopthalmus, Ambassis, Scatophagus, Platyccephalus*) and protochordates (*Balanoglossus*) are usually found in the mangrove habitat and they are capable of tolerating wide fluctuations in salinity. The mangrove soils and mud are acidic and deficient in calcium salts, so that the back of the mangroves are colonised by *Gelonia* or by pulmonate snails *Ellobium*, *Melampus* and *Cassidula*. On the trunks and roots of mangroves could be observed representatives of seashore life such as littorina snails, barnacles and mangrove bivalve *Enigmion*. These assemblages constitute a hard shore niche in an otherwise soft shore environment and the principle of inter-tidal zonations could be observed. The tides indeed are responsible for affecting, creating and maintaining the zonation of animal community.

Saseekumar (1978) has pointed out that the detritus foodweb based on mangrove plant material is more complex in the tropical areas due to the presence of more species of crustaceans, gastropods and fishes. The examination of gut contents of these fishes, some of them economically important, consisted of mangrove...
detritus and mangrove dwelling invertebrates. In the case of mullet, 40% of the diet consisted of detritus and in *Haplochelus melastigma* it was over 80%, for *Plotosus caninus*, the chief food consisted of mangrove snail *Cerithidia*. It is interesting to observe that these finfishes community occur in the Cochin mangroves also.

In the course of our observations on the mangrove areas of Cochin, on many occasions, juveniles of prawns were observed in the mangrove creeks and ponds, particularly associated with filamentous algae along the shore. It is well known that these areas serve as nursery grounds for the juvenile stages of prawns which feed on detritus rich benthos and flora of micro-algae. Saseekumar (1978) has drawn attention to the fact that the prawn catches in Malaysia were greater along the mangrove-rich west coast than the east coast. He has also drawn attention to similar linear relation between prawn production and acreage of mangroves already established in Indonesia. Though it may not be possible to establish such a relationship in the Cochin Backwater, the contributory factors from mangrove areas cannot be ruled out.

The objective of this account is to focus attention on the structure of the mangroves in the Cochin estuarine system and the characteristics of resident and migratory fauna. The seasonal fluctuations in the physico-chemical features and general productivity of the mangrove areas are influenced by the general dynamics of the estuarine system of the whole area.

Being overpopulated, the coastal areas have gradually been transformed to many productive uses such as coconut plantation, paddy-cum-prawn filtration and perennial prawn culture practices. In this process the fragile mangrove ecosystem has suffered depletion, a fact which must be viewed with concern from the point of view of conservation. That the mangrove creeks and swamps are utilised by the local population as the site for collection of seeds of cultivable finfishes and shellfishes, points to the ecological significance of mangroves for coastal aquaculture.

References

