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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/m^3/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 *Nautica* spp. in the mid-littoral zone, *Cerethidium* 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 filamentous 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 ecosystems 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 shellfishes. 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 vegetations colonise on muddysea 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 morphologically and physiologically adapted to withstand vide 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 substrata and prevent erosion. The area consequently 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.

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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

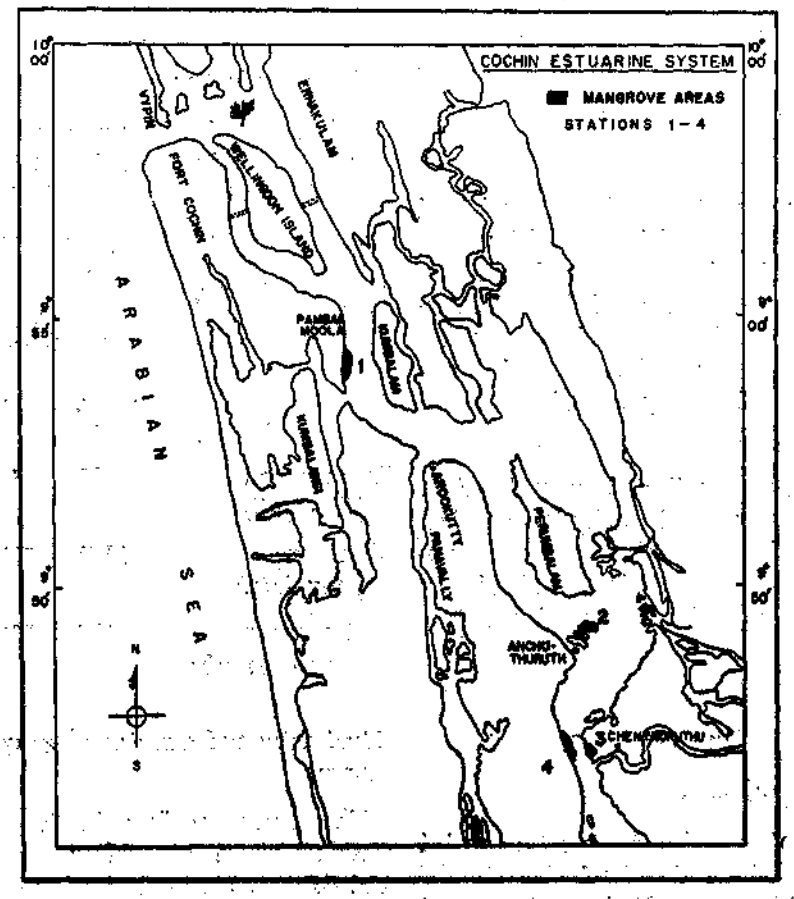

Fig. 1. Cochin Estuarine System with stations surveyed.

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*, *Aegiceras*, *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) ; 2.02 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.

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

Primary production

Primary productivity was estimated by both oxygen technique and ^{14}C technique. In general, the values ranged from 240-2150 mgC/m^3/day in different months of the year. The seasonal variation in production is presented below.

	Production mgC/m^3/day			
	Stn. 1	*Stn.* 2	*Stn.* 3	*Stn.* 4
Pre-monsoon (Jan-April)	900	450	620	665
Monsoon (May-Aug.)	1370	510	610	370
Postmonsoon (Sept.-December)	805	560	630	455

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 officianalis*. The upper zone is colonised by typically terrestrial trees such as *Thespesia pupulnea*.

The muddy outpocket which is often exposed during low tide, was inhabitated 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 *Penaeus* and *Metapenaeus* occur commonly in the swampy pools.

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

Hydromedusae such as *Eirene* 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*, *Aegiceros corniculatum*, *Clerodendrum inerme* 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 *Ilobium* sp. and its egg masses could be observed in the exposed muddy areas. Juveniles of *Penaeus 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 cylindrica*, *Aegiceros corniculatum*, *Clerodendrum inerme*, *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 *Metapograpsus* could be found in different months. In the creeks and ponds, juveniles of *Haplocheilus*, *Ambassis*, *Etroplus*, *gobiids*, *Tetradon* and *Batrachus* could be found in different seasons.

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

Habitat	Flora	Fauna
Mid-tidal zone	*Acanthus ilicifolius*, *Excoecaria agallocha*, *Aegiceros corniculatum* and *Clerodendrum inerme*	*Scylla serrata*, *Uca annulipes*, *Uca vocans*, *Sesarma lanatum*, *Sesarma plicatum*, *Metapagrapsus messor*, hermit crabs, burrowing amphipods, barnacles, wood boring bivalves, *Littorina* sp. and *Nerita* sp.
Upper tidal zone	*Avicennia officinalis*,	*Terebralia* sp., *Cerethedium* sp., small gastropods,

Habitat	Flora	Fauna
	Rhizophora mucronata and *Brugulera cylindrica*	polychaetes and diogenes.
Tidal pools & creeks	*Acrostichum aureum*, *Eriocolon* sp., *Cyperus* sp. and *Ipomea*	Amphipods, alphaeids, small *Neptunus*, juveniles of *P. indicus, M. dobsoni M. monoceros. Etroplus maculatus, E. suratensis, Ambassis dayi* and *A. commersoni*
Terrestrial*	*Thespesia pupulnea*, *Vitex* sp., *Phyllanthus* sp. *Calophyllum inophyllum* and *Panicum* sp.	

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/m^2/year and the annual consumption of the zooplankton herbivores as only about 30 gC/m^2. 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, Cerethidia* and *Terebralia*), bivalves (*Gelonia, Enigmonia, Pharella, Modiolus*), crustaceans (*Sesarma, Uca, Ilyoplax, Scylla, Thalassina*), fishes (*Periopthalmus, Ambassis, Scatophagus, Platycephalus*) 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 lichens, littorine snails, barnacles and mangrove bivalve *Enigmonia*. 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

* The terrestrial zone was completely dominated by terrestrial angiosperms.

detritus and mangrove dwelling invertebrates. In the case of mullet, 40% of the diet consisted of detritus and in *Haplocheilus melastigma* it was over 80%, for *Plotosus caninus*, the chief food consisted of mangrove snail *Cerethidia*. 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.

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