

STRUCTURE AND PRODUCTION IN A DETRITUS RICH ESTUARINE MANGROVE SWAMP

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ABSTRACT

Productivity studies in a detritus rich mangrove swamp showed that the aquatic component of this ecosystem is heterotrophic ($P/R = 0.77$). ^{14}C assimilation ranged from 1.92 to $7.49 \text{ mgC m}^{-3} \text{ hr}^{-1}$. Chlorophyll *a* values ranged from 0.08 to 1.76 mg m^{-3} . In contrast to this, the mangrove flora are abundant in this region, contributing to a large amount of detritus. These observations add evidence to the concept of a 'detritus food chain' than a 'grazing food chain' between autotrophs and heterotrophs in these waters.

Mangroves are one among the several specialized marine ecosystems in which productivity at different trophic levels and energy flow assume unusual importance. Energy input at primary levels in these environments is high. However, in mangroves the primary production is contributed both by terrestrial (mangrove vegetation) and aquatic (phytoplankton and other aquatic algae) components. Hence, it is essential to determine the contribution of the different sources in understanding the trophic dynamics of the mangrove ecosystem.

Mangrove foliage plays an important role in the formation of detritus which is consumed by a variety of estuarine organisms (Heald and Odum, 1970). Hence to understand the complexities of the mangrove ecosystem, the following investigations were undertaken.

The mangrove swamp under investigation lies in Kollur estuary near Coondapoor (Karnataka) along the central west coast of India (Fig. 1).

Three rivers, namely, Chakranadi, Varahi and Haladi originate in the high vallies of western ghats, join together just before Coondapoor and open into the Arabian Sea. They take a circuitous route through the mangrove swamps. The total area occupied by mangroves in this estuarine system is approximately $30,700 \text{ m}^2$.

Major floral elements in this swamp are *Rhizophora mucronata*, *R. conjugata*, *Avicennia officinalis*, *A. alba*, *Bruguiera parviflora*, *Sonneratia acida*, *Acanthus ilicifolius*, *Acrostichum auroum*, *Cyperus* sp. and *Fimbristylis* sp. There are about six major zones in the area covered by mangrove trees (Fig. 1).

Climatological features such as rainfall, wind speed and atmospheric temperature play an important role in the development of mangrove swamps. Most of the rainfall occurs during June, July and August and it reduces the salinity and temperature. During the same period the wind speed is maximum (Fig. 2). Although

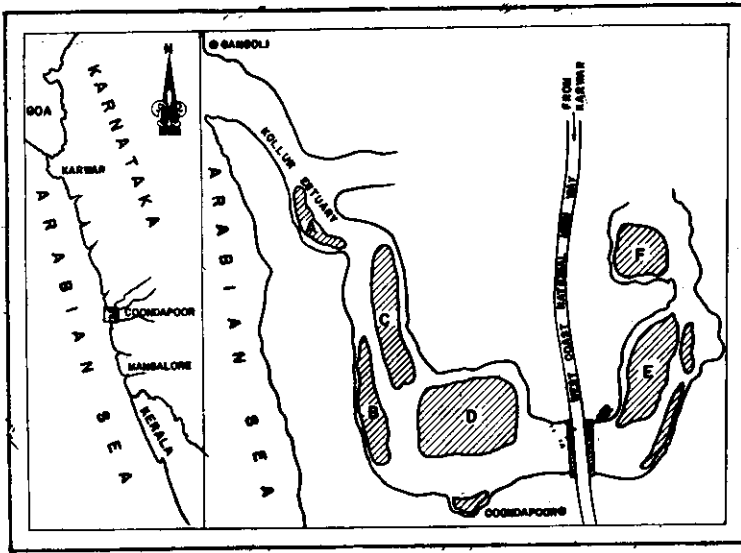


Fig. 1. Karnataka coast showing the observation point and diagrammatic representation of Coondapoor mangroves showing different zones.

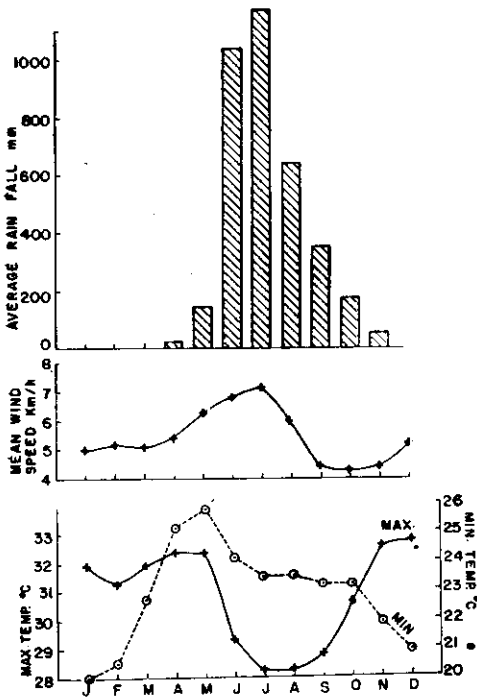


Fig. 2. Seasonal variations in rainfall, wind speed and atmospheric temperature.

these factors do not seem to have a major influence, high wind speed increases the falling of the leaves thus adding to the detrital matter.

Because of the circuitous course taken by the estuary and the presence of mangrove vegetation, the wave action becomes negligible. In this way favourable conditions are developed for the growth of the mangrove seedlings and trees. The average tidal range at Coondapoor is as follows:

High water—Mean higher—1.5 m
Mean lower—1.35 m

Low water—Mean lower—0.4 m
Mean higher—0.8 m

Environmental parameters such as the air and water temperature, salinity, dissolved oxygen, suspended load and pH were studied for a period of 24 hrs. The variations in these parameters during the diurnal cycle are shown in Table I.

Table II shows the area covered by the mangroves in the different zones, the

Table I. Diurnal changes in environmental parameters at Coondapoor.

Time hrs.	Dissolved oxygen mg/l	Water Temp. °C	Atmospheric temp. °C	Salinity ‰	Suspended load g/l	pH
1100	6.48	29.5	31.0	0.8	0.1254	7.3
1300	9.79	27.5	31.5	0.5	0.1246	
1600	7.01	28.5	31.5	0.6	0.1250	
1900	5.95	29.0	26.0	0.4	0.1197	
2200	5.02	29.0	26.0	0.4	0.1201	
0100	5.55	28.5	25.5	0.6	0.1250	
0400	5.29	28.0	24.5	0.55	0.1250	
0700	4.90	28.0	25.0	0.45	0.1260	
1000	6.35	29.5	26.5	0.3	0.1266	

Table II. Distribution of mangrove trees and seedlings in different zones near Coondapoor.

Zone	Total area	Dominant sp.	Mean Height	No. of trees/ quadrant 6 m × 6 m	No. of seedlings per quadrant
a	25000 m ²	<i>R. mucronata</i>	5.5 m	16	50
b	70000 m ²	<i>S. acida</i>	11.5 m	25	73
c	100000 m ²	<i>R. mucronata</i>	5.5 m	20	10
d	2000 m ²	"	3.5 m	5	46
e	10000 m ²	<i>R. conjugata</i>	2.5 m	11	29
f	100000 m ²	<i>R. mucronata</i>	4.5 m	9	17

dominant species of these zones, the height of these trees and their number in a quadrant measuring 6 m × 6 m. The rate of seedling development was found to be very high as a result of more organic matter and soft substratum. At certain places each *Rhizophora* tree was surrounded by 70 to 80 seedlings, which probably came up 2-3 years ago. On the hard substratum in zone 'C' the establishment of seedlings was very low (Table II).

The rate of fall of leaves and the dropping of seedlings was sufficiently high which resulted in the formation of a layer on the ground. The humus or the organic matter in different zones was found to range from 1.9 to 2.7%.

At the mouth of Kollur estuary at Gangoli village a thick deposit of detritus derived, mainly from the foliage of adjoining mangroves, was seen. At the high tide mark, the thickness of the detrital material was 52 cm, while at the mid tide and low tide levels, the thickness was 24.5 cm and 12.0 cm respectively.

The total approximate area covered by the detritus was 11,000 m². The average weight of this debris per unit area (30 cm × 30 cm) was 265 g. The undecomposed detrital material was mostly identified as leaves of *Rhizophora* sp. and *Avicennia* sp.

Studies on the community metabolism were undertaken by the diurnal curve

method of Odum and Hoskin (1958). Water samples for the measurement for dissolved oxygen and pigments were collected at 3 hr intervals for 27 hours. Phytoplankton production was estimated by ^{14}C method. Incubations with ^{14}C were made at 3 hr intervals from 7 AM to 7 PM (daylight hours). Extraction and estimation of photosynthetic pigments were made according to the procedures given by Strickland and Parsons (1972).

The curve related to community metabolism in the mangrove is shown in Fig. 3. Gross production and consumption were 2.24 and $2.90 \text{ gC m}^{-2} \text{ day}^{-1}$, with $\text{P/R} = 0.77$. This shows that the aquatic component of mangrove ecosystem is heterotrophic. Fig. 4 gives the diurnal changes in chlorophyll *a*, *b* and *c*. Chlorophyll *a* ranged from 0.08 to 1.76 , chl. *b* from nil to 0.95 and chl. *c* from nil to 29.53 mg m^{-3} . Assimilation of carbon as measured by ^{14}C method ranged from 1.92 to $7.49 \text{ mgC m}^{-3} \text{ hr}^{-1}$. Dark fixation accounted for about 8–28%.

Measurements of primary production have been made only in few mangrove swamps. The data comparable to ours are those of Teixeira, Tundisi, and Yeaza (1969) in the Brazilian mangroves (0.21 to $1.14 \text{ gC m}^{-3} \text{ day}^{-1}$). Sundararaj and Krishnamurthy (1973)

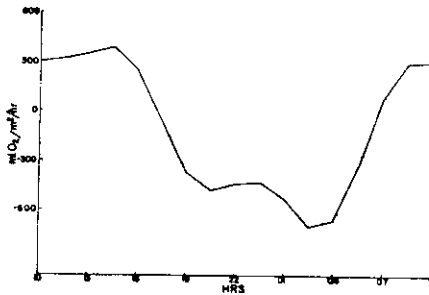


Fig. 3. Diurnal changes in dissolved oxygen.

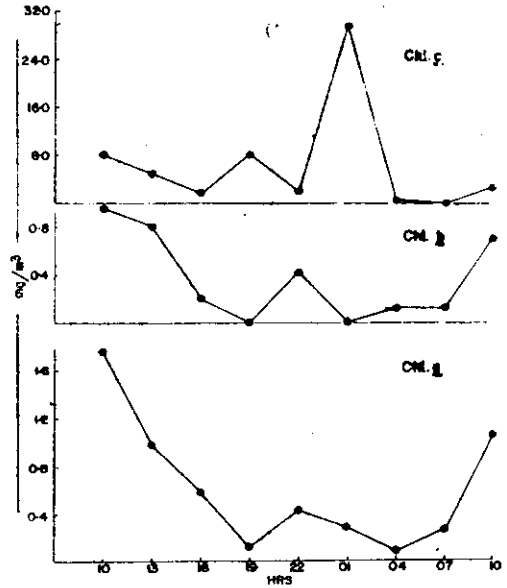


Fig. 4. Diurnal changes in chlorophylls.

gave a gross production of 4.2 to $10.05 \text{ gC m}^{-3} \text{ day}^{-1}$ in the Pichavaram mangroves (S. India). Carbon assimilation in the present study varied between 2 and $7 \text{ mgC m}^{-3} \text{ hr}^{-1}$. Our values are much lower than the net production values given by Tundisi (1969) which varied from 11.35 to $91.10 \text{ mgC m}^{-3} \text{ hr}^{-1}$ and also those of Sundararaj and Krishnamurthy (1973) which ranged from 300 to $662.12 \text{ mgC m}^{-3} \text{ hr}^{-1}$. The low production is also reflected very clearly from the chlorophyll *a* values which are several times lower than those reported by Sundararaj and Krishnamurthy (1973) (2.90 – 30.50 mg m^{-3}) and by Ramadhas, Rajendran and Venugopalan (1974) (7.20 mg m^{-3}) for Pichavaram mangroves.

Mangrove waters support a wide and rich fauna and act as breeding and nursery grounds for several species. Heald and Odum (1970) showed that many commercially important finfish and shellfish live in the mangrove

environment. In such conditions, organic detritus is the chief link between primary and secondary production (Odum and de La Cruz, 1967), and the major energy flow between autotrophic and heterotrophic levels is by way of 'detritus food chain' rather than the 'grazing food chain' (Teal, 1962). Heald (1971) estimated the production of organic detritus in a mangrove swamp as 9 tons/hectare/year. The major source of detritus has been found to be the mangrove vegetation (Walsh, 1974). The large amount of detritus present

in the swamp and at the mouth of the Kollur estuary confirm the above findings. Also the low primary production values and the heterotrophic mangrove waters found in the present study fully support the view expressed by Heald and Odum (1970), Odum and de La Cruz (1967), Teal (1962) and Walsh (1974).

ACKNOWLEDGEMENT

We are grateful to Dr. S. Z. Qasim, for the constant encouragement in mangrove studies. We are also thankful to Dr. S. N. Dwivedi, for his deep interest in this work.

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