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PRIMARY PRODUCTIVITY OF THE RETTING ZONES IN THE KADINAMKULAM ESTUARY, SOUTH-WEST COAST OF INDIA

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ABSTRACT

Retting of coconut husk is one of the major problems of pollution in the estuaries (Kayals) of Kerala. This paper discusses the salient features associated with the variation in gross and net primary productivity values in the Kadinamkulam Kayal based on fortnightly data from two selected stations from October 1987 to September 1988. The gross primary productivity value in the surface water ranged from 0.06 to 0.29 $gC/m^3/day$ at Station I and from 0.06 to 1.49 $gC/m^3/day$ at station II. In the bottom water it ranged from 0 to 0.21 $gC/m^2/day$ at station I whereas that at station II from 0.03 to 1.41 $gC/m^3/day$. The net productivity in the surface water at station I varied from 0 to 0.24 $gC/m^3/day$ whereas that at station II varied from 0.02 to 1.44 $gC/m^3/day$. At the bottom water it varied from 0 to 0.19 $gC/m^3/day$ at station I and from 0.01 to 1.21 $gC/m^3/day$ at station II. The monsoon period showed the highest mean seasonal value at stations I and II. The total depletion of dissolved oxygen giving rise to anoxic condition coupled with the production of large quantities of hydrogen sulphide was found to be detrimental to the gross and net productivity values in the retting zone.

Key-words: Retting, productivity, pollution.

INTRODUCTION

The retting of coconut husk in Kerala leads to an extensive pollution of the clean and highly productive estuaries of Kerala. The process of retting involves the immersion of raw coconut husks in shallow waters for a period of 6-10 months for microbial decomposition. Retting brought about by the pectinolytic activity of microorganisms like bacteria, fungi and yeast releases a large amount of organic matter like pectin, pentosan, polyphenols, tannins etc. into the medium. Important flora associated with retting include bacteria such as *Aerobacter, Pseudomonas, Bacillus, Paracolobactrum, Escherichia* and *Micrococcus*; fungi such as *Aspergillus niger, Penicillium* sp., *Fusarium* sp. and yeast such as *Candida* sp., *Cryptococcus* sp. and *Rhodotorula* sp. (Bhat and Nambudiri, 1971).

All organic matter available in the estuary is primarily synthesised by the primary producers and the products are transferred to consumers through different trophic levels. The changes in the water quality of a system drastically affects the primary production, thereby bringing about major ecological changes.

The present study represents the first set of data from the retting zones that gives some insight into the pattern of primary production in such anoxic biomes.

STUDY AREA

The investigation was conducted in the Kadinamkulam Kayal (lat. 8°56′ – 8°40′N and long. 76°45′ – 76°52′E) Kerala (Fig. 1). Two stations representing different ecological conditions were selected. Station I (Kotrakiri) represented a polluted zone, which is an interior bay of the Kayal used entirely for the retting of coconut husk. Station II (Perumathura) is an area free from retting activity and is exposed to fresh water influx and sea - estuary mixing. The Vamanapuram river empties into the estuary at its northern extremity at Perumathura.

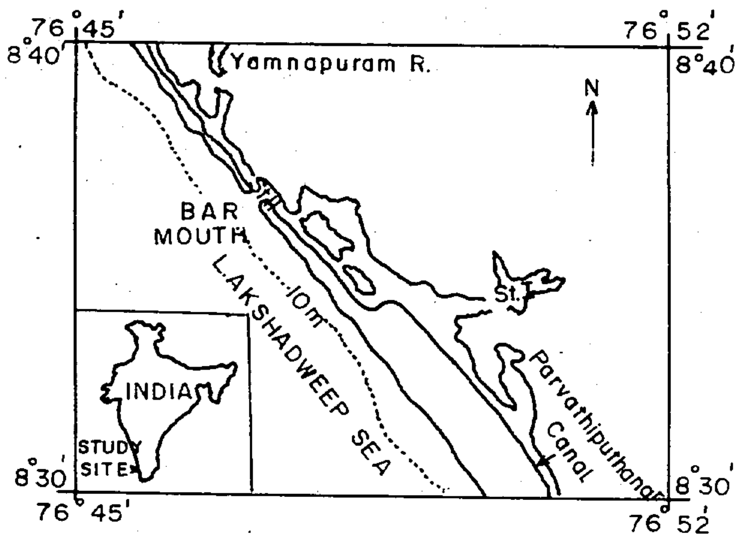

Fig. 1. Map indicating the study sites in Kadinamkulam estuary (St. I. Kotrakiri; St. II. Perumathura).

MATERIAL AND METHODS

The present study covered the period from October 1987 to September 1988 in the surface and bottom waters at both the stations. The depth of the water column at station I ranged from 44 to 173 cm and that at Station II from 44 to 180 cm. Bottom water was taken with a locally designed bottom water sampler of 1 litre capacity. The primary productivity was estimated using the conventional "light and dark bottle" method (Strickland and Parsons, 1972). In this method the increase of oxygen arising from photosynthesis was measured in a BOD bottle containing a sample of water for a period of six hours. At the same time, the decrease of oxygen in a darkened bottle was used to measure the respiration occurring simultaneously with photosynthesis during the same period. The dissolved oxygen content was then determined (Winkler method). The gross and net productivity thus measured are expressed in $gC/m^3/day$. Standard procedures were followed for the study of dissolved oxygen, hydrogen sulphide, BOD_5, nitrate, nitrite, ammonia, zooplankton and benthos (APHA, 1980; Davis, 1955; Holme and Mc Intyre, 1971).

RESULTS AND DISCUSSION

Water quality

Depletion of dissolved oxygen leading to anoxic condition coupled with the production of large amounts of hydrogen sulphide was the outstanding feature of the water quality changes observed at the retting zones. The dissolved oxygen concentration at the retting zone ranged from 0 to 0.72 mg/l whereas that at the nonretting zone ranged from 2.28 to 6.21 mg/l in the surface and bottom waters. The hydrogen sulphide value at the retting zone varied from 7.60 to 40.20 mg/l and that at the nonretting zones ranged from 0 to 3 mg/l, in the surface and bottom waters. Very high BOD_5 value was another notable aspect of the water quality in the retting zone. It ranged from 4.96 to 24.39 mg/l in the surface and bottom waters at the retting zone and from 0 to 3.74 mg/l in the non-retting zone. Generally the nitrate contents were lower while the nitrite and ammonia contents were higher in the retting zone. The NO_3-N values at station I varied from 0 to 2.48 µg at/l and that at station II from 0 to 4 µg at/l. The nitrite and ammonia concentrations ranged from 0 to 1.78 µg at/l and 6.40 to 37.70 µg respectively at the retting zone and from 0 to 1.66 µg at/l and 0 to 11.70 µg at the nonretting zone.

Primary productivity

The most alarming situation noticed during the present study was the poor productivity levels for certain period and total failure of the productivity mechanism during a major part of the year (Fig. 2).

Gross productivity was zero in the surface and bottom waters from October 1987 to May 1988 at station I. At station II it ranged from 0.06 (May) to 1.49 (July) at surface and from 0.03 (May) to 1.41 $gC/m^3/day$ (September) at bottom. Net productivity was 0.24 $gC/m^3/day$ in July in the surface water. At station II it varied from 0.02 in April to 1.44 $gC/m^3/day$ in July. At station II it varied from 0.01 in October to 1.21 $gC/m^3/day$ in September. ANOVA of gross and net productivity values showed that the variations were significant at 1% level between stations (DF=1, Mean SS=6.72, F=119.43), fortnights (DF=7, Mean SS=0.28, F=5) and between the surface and bottom water (DF=3, Mean SS=0.31, F=5.57). Fortnightly variation of primary productivity within stations were also significant at 1% level (ANOVA: DF=2, Mean SS=0.57, F=10.20). When the seasonal mean values were computed the monsoon period recorded the highest

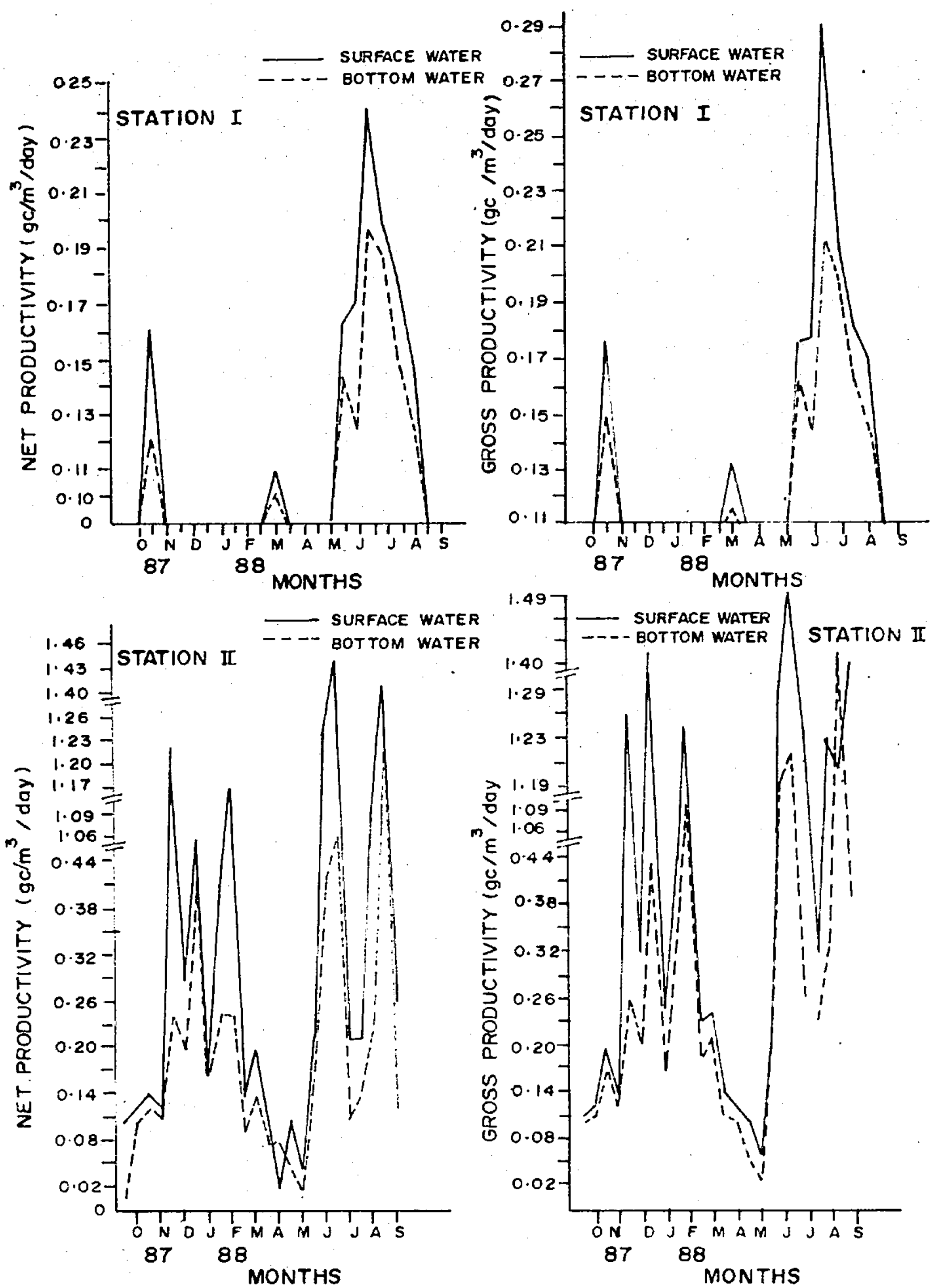

Fig. 2. Fortnightly variation in the gross and net primary productivity values at Stations I and II during 1987-88.

gross and net productivity in the surface and bottom waters at the retting and nonretting zones. Variations of primary productivity between seasons were significant at 1% level (ANOVA: DF=2, Mean SS=1.67, F=29.73). Seasonal variations of primary productivity within stations (ANOVA : DF=2, Mean SS=0.57, F=10.20) and fortnights (ANOVA: DF=14, Mean SS=0.24, F=4.22) were also significant at 1% level.

Average rate of primary production in the Kadinamkulam Kayal was low, when compared with the values reported from other estuaries in the tropical belt. The average gross production rate of the Ashtamudi estuary in Kerala was 143.88 mg C/m^3/hour (Nair, Dharmaraj, Abdul Azis, Arunachalam, Krishnakumar and Balasubramanian, 1983). The primary production values in the central west coast of India varied from 43.12 to 988.16 mg C/m^2/day (Neelakantan, Prasad, Nair, Gunaga and Kusuma, 1987).

One of the most obvious ecological factors influencing primary production is the amount of solar energy reaching the surface of the sea (Raymont, 1963). The retting of coconut husk at station-I led to the release of a number of organic compounds resulting in the transformation of the estuary into a dark, foul smelling stagnant, turbid zone. Formation of air bubbles and froth, slowly resulted in the formation of a scum in the Kayal. During this time husk particles and pith of the husks get accumulated in the water body. The husk particles along with the suspended load of sediments brought into the estuary by land drainage, lead to stagnant condition in the estuary. The correlation computed between the surface and bottom water gross and net productivity values with the corresponding depth of light penetration at stations I and II were positive. It was significant at 5% level with surface water gross primary productivity (r^2 = 0.454) and net primary productivity (r^2=0.433) at station II.

The total depletion of dissolved oxygen giving rise to anoxic condition coupled with the production of large quantities of hydrogen sulphide was found to be detrimental to the gross and net productivity. The correlation between dissolved oxygen and surface and bottom water gross and net productivity values were significant at 1% level at station I [surface water: r^2 = 0.700 (G.P.), 0.643 (N.P.); bottom water : r^2 = 0.696 (G.P.), r^2 = 0.682 (N.P.)] and at 5% level at station II [surface water: r^2 = 0.403 (G.P.), r^2 = 0.415 (N.P.); bottom water: r^2 = 0.434 (G.P.), r^2 = 0.311 (N.P.). A negative correlation emerged between hydrogen sulphide and surface and bottom water gross productivity values at both the stations. It was significant at 1% level with surface water gross (r^2 = –0.669) and net productivity (r^2 = –0.673) and bottom water gross (r^2 = –0.780) and net productivity values (r^2 = –0.793) at station I. Whereas at station II it was significant at 1% level with surface water gross (r^2 = –0.664) and net productivity values (r^2 = –0.565) and at 5% level with bottom water gross productivity values

(r^2 = –0.436). Ammonia showed a negative correlation with the surface and bottom water gross and net productivity values at both the stations. The relationship was significant at 5% level at station I only [surface water: r^2 = –0485 (G.P.), r^2 = –0.484 (N.P.); bottom water: r^2 = –0.420 (G.P.), r^2 = –0.421 (N.P.)]. The BOD_5 content at the retting and nonretting zones had a linear negative relation between the surface and bottom water gross and net productivity values.

Plankton and Benthos in relation to primary production

The zooplankton and benthos were quantitatively and qualitatively poor in the retting zone. The incidence, occurrence, abundance and diversity of fauna were low in the retting zones when compared to the nonretting zones. Annual density of zooplankton showed 80,233 no./m^3 at the retting zone (station I) and 2,16,450 no./m^3 at the nonretting zone (station II), whereas 579 no./m^2 of benthic animals at the retting zone and 740 no./m^2 at the nonretting zone. The opportunistic dominant species of zooplankton and benthos formed a major share of the density of fauna in the retting zones. The organisms were found to be tolerant to the anoxic sulphide biome in the retting zones. Correlation computed between different zooplankters and surface water gross and net productivity values were negative at station I and positive at station II. The correlation was significant at 5% level with Insecta [r^2 = – 0.396 (G.P.), r^2 = 0.421 (N.P.)] at station I and with fish larvae [r^2 = 0.451 (G.P.), r^2 = 0.384 (N.P.)] at station II. Benthic animals also showed a negative relationship with bottom water gross and net primary productivity values at the retting zone and a positive relation at the nonretting zone. It was significant at 1% level with Insecta [r^2 = – 0.604 (G.P.), r^2 = 0.616 (N.P.)] at station I.

The present study has revealed the deleterious effects of retting on the primary productivity and the ecosystem of the estuary.

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