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STUDIES ON BOD_5 AND DISSOLVED OXYGEN IN THE KADINAMKULAM KAYAL, SOUTHERN KERALA

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ABSTRACT

This paper discusses the salient features associated with the variation in the BOD_5 and dissolved oxygen concentration in the Kadinamkulam Kayal based on fortnightly data from two selected stations from October 1987 to September 1988. The BOD_5 ranged from 5.76 to 24.39 mg/1 in the surface water and from 4.96 to 22.60 mg/1 in the bottom water at station-1 whereas at station-2, it ranged from 0 to 3.74 mg/1 in the surface water and from 0 to 3.40 mg/1 in the bottom water. The dissolved oxygen concentration ranged from 0 to 0.72 mg/1 in the surface water and from 0 to 0.42 mg/1 in the bottom water at station-1. At station-2 it ranged from 2.69 to 6.21 mg/1 in the surface water and from 1.97 to 5.74 mg/1 in the bottom water. The pre-monsoom period showed the highest BOD_5 of 16.68 mg/1 while the monsoon period showed the lowest of 0.61 mg/1. The dissolved oxygen concentration reached its peak during the monsoon period (5.52 mg/1). Long spells of anoxic condition during the post and pre-monsoon periods was a characteristic feature of the retting zone.

Key words : Retting, water quality, BOD_5, dissolved oxygen, pollution.

INTRODUCTION

The Kadinamkulam Kayal, a temporary estuary lying in the southern part of Kerala (Lat 8°35′ - 8°40′N; Long 76°44′ - 76°51′E) is the largest of its kind in Trivandrum district, Kerala. Connected with the Anchuthengu Kayal on the north and the Veli Kayal on the south, the Kadinamkulam Kayal remains connected with the Lakshadweep sea for varying periods depending on rainfall and river discharge. Intensive retting of coconut husks along the shallow regions of the Kayal has been a major source of pollution leading to marked deterioration in water quality.

Estuaries are unique environments that play an important role in the transfer of products of continental weathering to the ocean. Because of the major changes in physico-chemical conditions between fresh and saline water, the distribution of chemical constituents between dissolved and particulate forms may be modified by interactions in estuaries. Hence, assessment of the quality of water in an estuary is of great significance. The Kayals of Kerala, representing the estuarine tracts along the coasts have become extensively polluted in many places because of the retting of coconut husk. Water quality status of several estuaries in Kerala have been reported (Abdul Azis 1978; Abdul Azis and Nair, 1986; Bijoy Nandan, Abdul Azis and Natarajan, 1989 and James, 1987). Only very few studies have so far been reported

on the Biochemical oxygen Demand (BOD) of estuarine and inshore waters of India. Basu (1966) had reported on the biochemical oxygen demand, its chemical reaction, mathematical interpretation and methodology. The present study examines the status of Kadinamkulam Kayal with reference to the variation of BOD_5 and disolved oxygen.

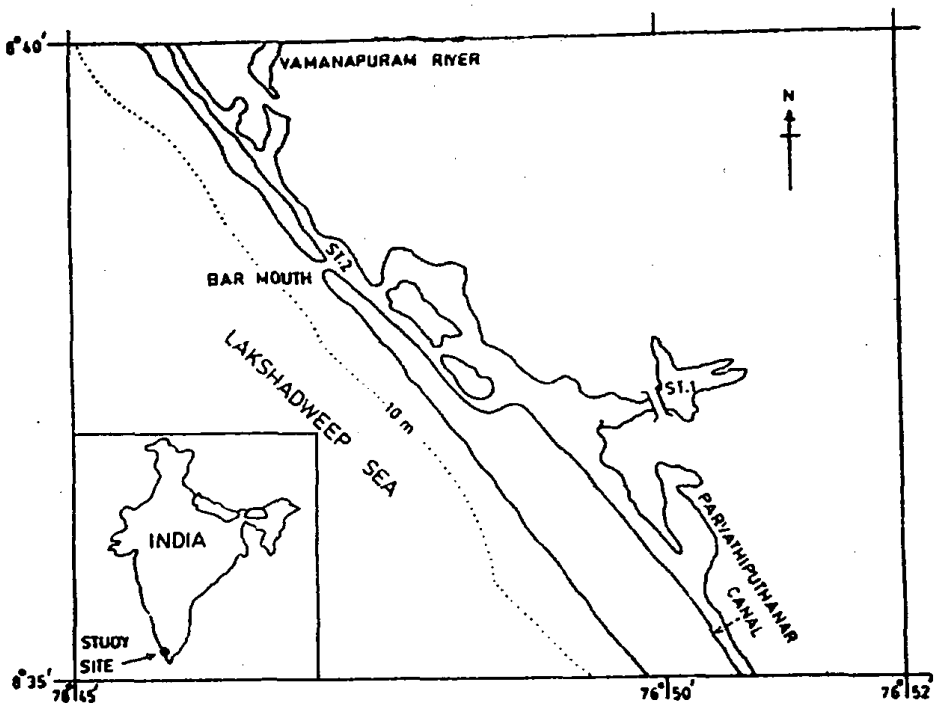


Fig. 1. Map of the KadinamkulamKayal indicating the study sites. (St. 1. Kotrakiri, St. 2. Perumathura)

Two stations representing different ecological conditions in the Kadinamkulam Kayal were selected for the study (Fig. 1). Station-1 (Kotrakiri) representing the polluted zone is an interior bay of the Kayal used entirely for the retting of coconut husk and station-2 (Perumathura) represents an area free from retting and exposed to fresh water influx and sea-estuary mixing. The Vamanpuram river empties into the Kayal at its northern extremity at Perumathura.

MATERIAL AND METHODS

Fortnightly data pertaining to BOD_5 and dissolved oxygen collected from the above two stations from October 1987 to September 1988 form the basis of this paper. The biochemical oxygen demand was estimated by standard procedures (APHA, 1965; Basu, 1966; Loganathan, Ramadhas and Venugopalan, 1985). BOD_5 was

measured by incubating the sample in a BOD incubator at 20°C for 5 days followed by the estimation of oxygen concentration. Since station-1 was found to be heavily polluted, the synthetic ditution water technique (Basu, 1966) was adopted. Seeding of the dilution water with bacterial flora was not made due to its presence in the samples. The BOD_5 was then estimated following equation (Basu, 1966 and APHA, 1965)

$$BOD_5 \text{ in mg/1} = \frac{(S_1 - S_2) \times 100}{\% \text{ dilution used}}$$

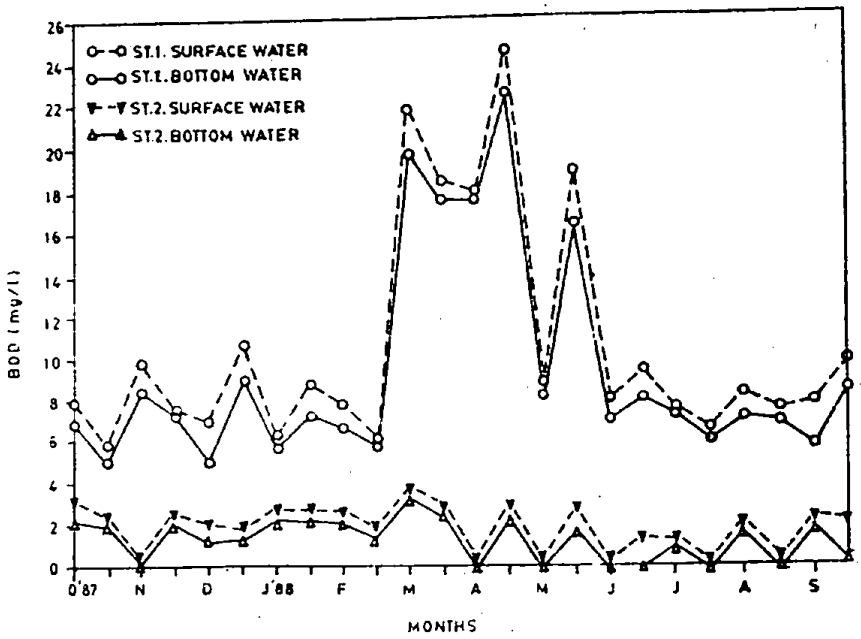
Where S_1 = Dissolved oxygen of dilution water on '0' day and S_2 = Dissolved oxygen of dilution sample after 5 days of incubation. Dissolved oxygen was estimated by Alsterberg's (azide) modified Winkler method (APHA, 1965).

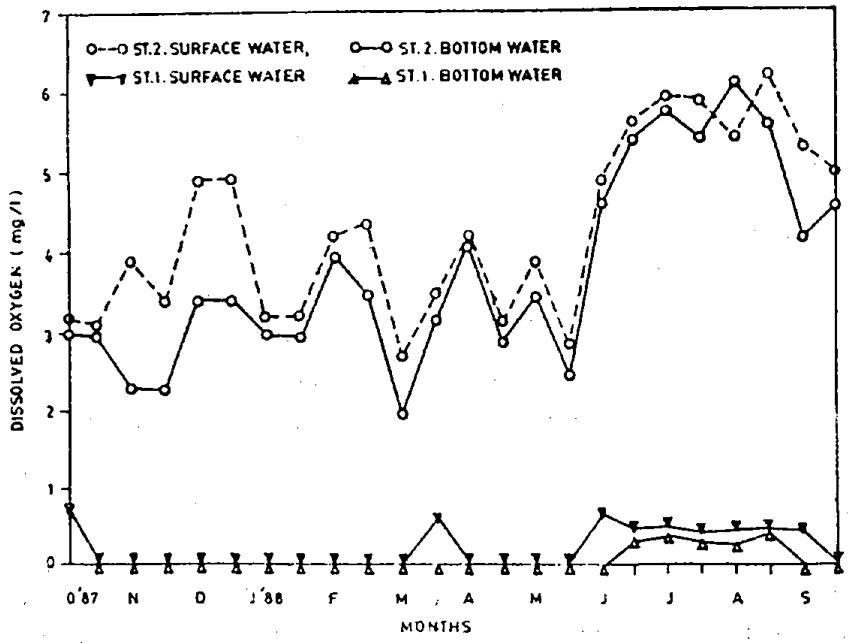
The variation of BOD_5 and dissolved oxygen in stations, seasons, fortnights and the surface and bottom waters was studied by the four-factor anlysis of variance (ANOVA) (Montgomery, 1976). Correlation of BOD_5 and dissolved oxygen in the surface and bottom waters has been carried out for both the stations and their correlation coefficients have been worked out (Kazmier and Pohl, 1987). Based on the previous studies, the year has been divided into three distinct periods, namely, monsoon, pre-monsoon and post-monsoon.

RESULTS AND DISCUSSION

Biochemical Oxygen Demand (BOD_5) : At station-1, the BOD_5 ranged from 5.76 to 24.39 mg/1 in surface water and 4.96 to 22.60 mg/1 in bottom water (Fig. 2) . The highest BOD_5 both at surface and bottom occurred during pre-monsoon while monsoon and post-monsoon showed much lower values. At station - 2, the BOD_5 was generally low ranging from 0 to 3.74 mg/1 and from 0 to 3.40 mg/1 at surface and bottom respectively, the pre and post-monsoon season showing high BOD_5 as compared to those during monsoon. Very high BOD_5 values was a characteristic feature of the polluted zone represented by station-1. Differences between surface and bottom water BOD_5 values were very narrow and a trend of stratification although not statistically significant, was discernible at both the stations.

ANOVA showed that the variation in BOD_5 between stations, seasons and fortnights was significant at 1% level. Within each station the seasonal variations and fortnightly variations were found to be significant at 1% level. Similarily within each season, the fortnightly variation was found to be significant at 1% level. The data showed that high BOD_5 value is an important feature associated with retting of coconut husk.





Figs.2 & 3. Fortnightly variations in BOD and Dissolved Oxygen during 1987-88 respectively.

Dissolved oxygen : Depletion of oxygen resulting in long spells of extremely low concentrations was a characteristic feature of the water quality at station-1 (Fig. 3). The concentration ranged from 0 to 0.72 mg/1 in the surface water and 0 to 0.42 mg/1 in the bottom water at station-1 whereas it ranged from 2.96 to 6.21 mg/1 in the surface and 1.97 to 5.74 mg/1 in the bottom water at station-2. When the seasonal mean was examined, the dissolved oxygen content in the surface water at station-1 showed a marked increase during the monsoon period (0.45 mg/1) presumably due to the renewal of water consequent to monsoon rains and freshwater discharge. But, at station-2 the dissolved oxygen concentration in the surface water was maximum during the monsoon period (5.52 mg/1) and minimum during the pre-monsoon (3.59 mg/1) period. A clear stratification was discernible where the surface water concentration was higher than the bottom water throughout the period at station-2.

ANOVA showed that the variations in dissolved oxygen between stations, fortnights and surface and bottom water was significant at 1% level. At each station the seasonal variation, fortnightly variation and surface and bottom water variation showed 1% level of significance. Similarily within each season fortnightly variation was significant at 1% level. Thus it was observed that the depletion of oxygen is an important water quality change associated with retting of coconut husk. A similar situation has been observed by Abdul Azis (1978) from the retting zones of the Edava - Nadayara backwater where the dissolved oxygen concentration ranged from 0 to 3.45 mg/1.

Biochemical oxygen demand estimation is a vital tool in assessing organic pollution in aquatic biotopes. The BOD_5 values were generally found to be high at station-1 throughout the period of study particularly in the pre-monsoon period. But, at station-2 values were generally very low.

The concentration of dissolved oxygen in water can be taken as a significant index of its sanitary quality. Dissolved oxygen sag followed by its total depletion noticed at station-1 was an important feature of the Kadinamkulam Kayal during the present study. According to Adeney (1908), this anoxic condition observed can be attributed to the oxidation of the organic matter by bacteria resulting in the utilization of dissolved oxygen. The present study reflects a situation very much similar to the one depicted by Adeney (1908). The relation between the dissolved oxygen and organic load in the Kadinamkulam Kayal has been traced in the present study. Station-1 represents a permanent retting yard adjacent ot the Kadinamkulam Kayal. Huge quantities of coconut husks are kept in water for several months for organic decomposition. Thus the organic load at station-1 remains always very high resulting in greater microbial decomposition leading to depletion of oxygen and high BOD_5 values eventually leading to a state of anoxia.

The correlation coefficient between the surface water BOD_5 and dissolved oxygen gave a value of - 0.200 at station-1 while a value of - 0.609 (1% level of significance) was obtained at station-2. At station-1 the correlation between the bottom water BOD_5 and dissolved oxygen gave a correlation coefficient of - 0.236 whereas at station-2 it gave a coefficient of - 0.533 (1% level of significance). Thus the negative correlation observed at the two stations justified an inverse relationship between the BOD_5 and the dissolved oxygen of the retting zone in the Kadinamkulam Kayal.

According to Martin (1970), a water body with a BOD_5 of 8 mg/1 is considered to be moderately polluted. But according to ISI standard (IS : 4764 - 1973) the permissible limit of BOD_5 in the inland surface water is 20 mg/1. According to the Indian Council of Medical Research the standard (Union Public Health Service Standard) permitted is 5.0 mg/1. The eighth report of the Royal Commission (Vol-1 U.K.) has classified the stream water with a BOD_5 of 10 mg/1 as bad and 3 mg/1 as fairly clean. The BOD_5 values thus observed from the present study was verty high when compared to the above mentioned standards. The BOD_5 values reached up to 24.39 mg/1 at station-1 indicating deterioration of water quality in the Kadinamkulam Kayal.

The present study has revealed that the retting zones in the Kadinamkulam Kayal has been grossly polluted due to the very high organic load carried by the ecosystem in the form of raw coconut husk which in turn leads to consequent depletion of dissolved oxygen in the water. It is for the first time that the biochemical oxygen demand and its changes in relation to dissolved oxygen has been studied and reported from an area specific to pollution from retting of coconut husk. Such anoxic conditions coupled with very high BOD_5 values is a major threat to the survival of aquatic organisms in the water body.

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