

Sediments of a Retting Yard

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Sediments of a coconut husk retting yard and a reference station in Cochin backwaters were studied for 1 yr. Effects of monsoon were found significant. Organic carbon and organic matter showed enrichment in the retting ground sediments (av. 46.8 and 92.3 mg/g respectively) compared to the reference station (20.6 and 48.9 mg/g) and published data on estuarine sediments. C/N ratios were consistently higher in the retting yard. Organic nitrogen, however, did not show this trend. Annual average of bacterial biomass was higher in the reference station (25.7 mg/g as against 22.8 mg/g in the retting yard). Seasonal variations were more pronounced in this station. Bacterial contribution to total organics was consistently higher at the reference station (av. 72.55%) compared to the retting yard (av. 32.59%). Average energy content calculated for the retting ground was 1819 J/g dry weight, a value about twice that for the reference station and higher than the average for sedimented detritus in the Cochin backwaters (1497.9 J/g).

Retting of coconut husk is one of the sources of organic pollution in the backwaters of Kerala. Retting brought about by the pectinolytic activity of microorganisms liberates large quantities of organic matter into the medium. Higher salinities and temperatures accelerate the process with consequent increase in organic load of the medium¹. Sediments, are indicators of the quality of water overlying them and their study is a useful tool in work on environmental pollution. The present paper deals with some of the characteristics of sediments of a retting yard at Vaduthala located about 5 km upstream of barmouth in the northern arm of the Cochin backwaters (Fig. 1).

Materials and Methods

Sediment samples from 3 points (sts 1-3), in the retting ground and a reference station (st 4) were collected using a van Veen Grab. Homogenized samples were dried in a hot air oven (90°C). A portion was analysed for grain size (sand, silt and clay), by sieving and pipette methods². Organic carbon was estimated by wet oxidation³ and nitrogen by Kjeldal method⁴. Organic matter was calculated by multiplying carbon values by a factor⁵ of 1.724 and corrected for unoxidised nitrogen⁶. Energy content was obtained from organic matter using an equivalent of 21.6 J/mg of dry weight⁷. Bacterial biomass values were estimated from nitrogen content⁷.

Results and Discussion

Sediments of the retting ground were black in colour and malodorous akin to the green and black muds in

stagnant basins^{8,9}. Sandy clay was noticed at all stations, finer fraction being higher in the retting ground. Pith and fibre in appreciable quantities were also noticed. Silt and clay fraction was lower at all stations during the monsoon season.

Table 1 summarises some environmental parameters for bottom water in the area. The average figures for sedimentary characteristics reported in the text refer to pooled values for the retting ground

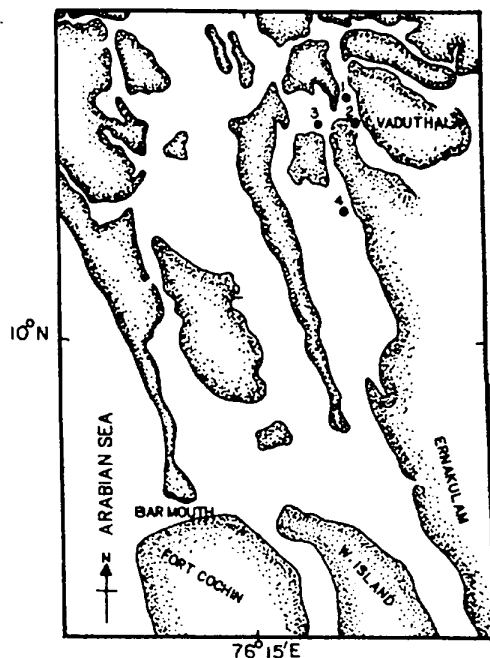


Fig. 1—Area of sampling and location of sts 1-4

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stations (sts 1-3). Monsoonal rains and associated changes in fresh water discharge influenced the environmental and sedimentary characteristics considerably (Fig. 2). Monthly values of organic carbon, nitrogen, C/N ratios, oxygen saturation deficit and rain fall are given in Fig. 2. Values for sts 1-3 are presented as averages in an effort to cover spacial heterogeneity.

Organic carbon—Peak values of organic carbon were in premonsoon (January-May) with lower values in the monsoon (June-October). Values increased with the prevalence of dry weather in the postmonsoon (November-December). The reference station (st 4) showed an increase in organic carbon early in the monsoon (June-July, Fig. 2). This increment from terrigenous sources, reported previously in the estuary¹⁰⁻¹³, however did not influence the values much at the retting ground (Fig. 2). Annual ranges for sts 1-3 were 6-175, 8-40 and 37-211 mg/g dry weight, with averages of 44.2, 27.2 and 68.8 mg/g respectively. These variations notwithstanding, the seasonal trends in all the 3 stations were similar with lower values in monsoon and higher values in the drier months. The pooled annual average of 46.8 mg/g in the retting yard represents a 2.25 fold enrichment compared to the reference station. This value is significantly higher than the published figures for Cochin backwaters and estuarine systems elsewhere in India^{10,11,13-19}. The present value is comparable to that of Sandilands²⁰ for a pulp mill effluent discharge site (54 mg/g) in western Nippigon Bay, but appreciably higher than the peak value (21.9 mg/g) reported by Ray²¹ for a distillery effluent discharge site as well as the average (19.6 mg/g) reported for sediments near an industrial belt in Cochin backwaters¹³. The near anoxic conditions and the higher proportion of fine grained material capable of holding larger amounts of organic matter²²⁻²⁴ seem to be responsible for the enrichment.

Oxygen saturation—The bottom oxygen levels in general showed a negative relationship with organic carbon and influenced the C/N ratios also to some extent, except during postmonsoon. Increase in organic load following faster rate of retting with increase in temperature and salinity¹ had probably not, by then, caught up with the available oxygen. It may also be mentioned that the reference station had a higher proportion of fine grained material during this season.

Organic nitrogen—The annual range of organic nitrogen in sts 1-3 (0.7-7.4 mg/g) compared to st 4 (0.7-6.95 mg/g) failed to show enrichment in nitrogen at the former, commensurate with organic carbon. The annual average at st 4 (3.9 mg/g) was marginally higher than that at sts 1-3 (3.84 mg/g). Seasonal averages showed appreciable variations, the retting ground

stations maintaining higher values in monsoon. Changes in the pattern of autochthonous contribution at these 2 places might account for the same. Relative rates of loss of nitrogen and carbon²⁵, as well as nitrogen in biological processes²⁶ could also be responsible for the features noted. Proportionately lower nitrogen content with respect to carbon in the retting ground however affects the nutritional value of detritus to deposit feeders.

C/N ratios—Sts 1-3 had an average of 13.6 (3.9-28.5) compared to that of st 4, 5.6 (2.1-14.3). Organic carbon content of the retting ground being high, changes in the nitrogen content did not significantly affect the ratio (Fig. 2), while the reverse was the case in st 4. Though an absolute increase or decrease in carbon or nitrogen

Table 1—Annual Ranges of Environmental Parameters in the Area of Investigation

(Data for retting ground sts 1-3 are pooled)

Temp. (°C)	Sal. (‰)	Oxygen (ml/l)	BOD ₅ (mg/l)	Total sulphides (mg/l)	Silt & clay (%)
Sts 1-3					
25.0–32.6	0.21–25.82	<0.05–4.7	48.8–513.8	1.7–5.0	15.5–55.0
St 4					
24.9–32.5	0.21–25.28	2.4–5.15	16.9–89.3	0.4–0.9	10.0–29.0

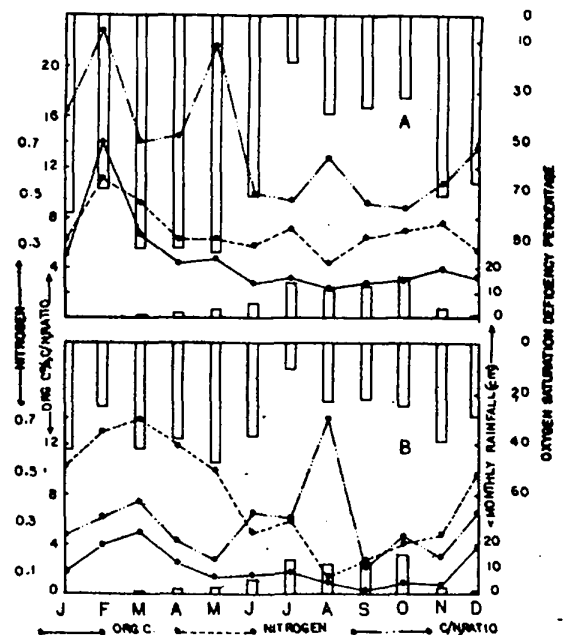


Fig. 2—Seasonal variations in organic carbon, nitrogen, C/N ratio, oxygen saturation and rainfall in the area of study (A—pooled data for retting ground sts 1-3, B—st 4)

content is worthy of note, it is C/N that is considered to be a better index of pollution and nutritional status of the sediment. A ratio of 10 for sediments is considered to be a satisfactory average, in view of the uncertainties in measurements²⁴. C/N ratios in the retting ground show the limitations of sediments and detritus as a food source for bottom fauna especially during the dry months (Fig. 2).

Coefficients of correlation between sediment characteristics and some environmental parameters were calculated. In the retting ground (pooled data) significant positive correlation ($P < 0.001$) was noticed between organic carbon, nitrogen and total sulphides. Nitrogen failed to show significant correlation with any other parameter examined. Silt and clay percentage had positive correlation with BOD_5 ($P < 0.02$), total sulphides ($P < 0.001$), temperature ($P < 0.01$) and negative correlation with bottom oxygen ($P < 0.001$). In the reference station positive correlations at various levels of significance were noted between organic carbon, nitrogen ($P < 0.001$), total sulphides ($P < 0.1$), salinity ($P < 0.01$) and finer fractions ($P < 0.01$). Nitrogen in this station showed significant positive correlation with silt and clay percentage and BOD_5 ($P < 0.01$) as well as total sulphides and salinity ($P < 0.001$). The correlation was negative with oxygen ($P < 0.02$). Finer fractions showed significant correlation with all parameters examined being negative only with oxygen.

Organic matter—Total organic matter at the retting ground (range 4.3–24.2%), was consistently higher (Fig. 3) compared to the reference station (range 0.6–9.2%) and published reports^{13–18}. The annual average of 8.43% at sts 1–3 was about twice the average for st 4. The annual average uncorrected for nitrogen (8.1%) also showed a 2 fold enrichment compared to st 4 (3.5%). This average value at st 4 is also higher compared to the reported average²⁶ of 2.55% for Cochin backwaters. Sediments of the northern limb of Cochin backwaters yielded an annual average of 2.53% for an estuarine station some distance upstream of the present area of work and a value of 3.5% for sediments of barmouth¹³. Obviously considerable enrichment of the sediments in organic matter occurs with retting. Work on water quality of the area also has shown high organic loads in the medium.

Bacterial biomass calculated from nitrogen values and their contribution to total organics is given in Fig. 3. Bacterial biomass values, higher at the reference station during premonsoon, registered a steep fall with the monsoon, while sts 1–3 still had higher standing stocks (Fig. 3). Bacterial contribution to total organics however, presents a different picture. Annual average of bacterial contribution to total organics was 32.59% for sts 1–3 and 72.55% for st 4. The nonliving-portion

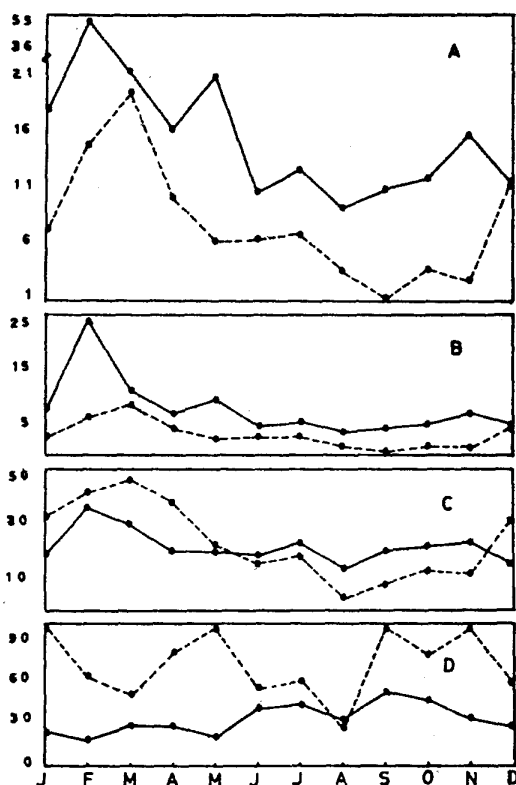


Fig. 3—A—energy content J/g $\times 100$, B—total organics (%), C—bacterial biomass (mg/g) and D—bacterial contribution to total organics (%) [— st 4, --- sts 1–3]

constituted the bulk of the material in the retting yard while the living material (represented by bacterial biomass) formed the major part at st 4 (Fig. 3). This variation noted probably indicates that a better utilization of materials in terms of resynthesis is achieved at st 4.

It may also be mentioned that organic matter computed from nitrogen values²⁷ gave lesser values for the retting yard compared to that derived from organic carbon values while the opposite was the case in the reference station. Organic matter content was over an order of magnitude higher in sts 1–3 compared to st 4, whichever way it was measured.

Energy content—The retting yard sediment had an annual range of 224–7949.4 J/g dry weight of mud as opposed to a range of 124.5–1982 J/g at the reference station (Fig. 3). The pooled annual average of 1819 J/g at the retting ground is higher compared to the reported figures^{6,7,22,28}. The average energy content of sediments of retting ground and the reference station were 7.79% and 3.43% respectively of the reported value for aquatic detritus²⁹. The annual average value of energy content at the reference station (801.3 J/g) is largely comparable to the reported values cited above.

Sediments of the retting yard though rich in organic content and energy, the adverse effects of retting pose several problems to benthic communities, resulting in low diversity³⁰. The low level of tidal mixing and seasonal monsoonal dilution in the retting ground are not adequate to enable self purifying mechanisms to operate successfully. The horizontal gradient in organic load, noted in the present study and earlier work³⁰, indicates that better dilution can to a considerable extent combat the high organic loads.

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