

Studies on Organic Carbon, Nitrogen & Phosphorus in Sediments of the Cochin Backwater

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Distributions, seasonal changes and ratios of organic carbon, total phosphorus and total nitrogen have been studied in sediments collected from 4 stations in Cochin backwater. The observed high organic carbon contents up to 3.84% in the sediments may be due to river discharge bringing in a large amount of water humus and also to high organic production of the overlying water. Total phosphorus distributions also show higher concentrations (0.9 - 2.4 mg/g), which may be attributed to the influence of domestic waste. Nitrogen/phosphorus ratios indicate that the major portion of phosphorus in the sediments is of abiogenic origin. Correlations between organic carbon and total phosphorus are also discussed.

Cochin backwater forms the northern extension of the Vembanad Lake along the Kerala coast. Comprehensive studies of the sediments and their mineralogy and chemistry have been made¹⁻³. However, no information is available on the organic nitrogen and carbon/nitrogen (C:N) ratio of the sediments, which forms a useful tool in interpreting the data on organic matter and assessing the extent of nutrient regeneration in estuarine sediments. In the present paper data on the seasonal changes in the organic carbon, total nitrogen, total phosphorus and their ratios in the sediments collected in the backwater are given.

Materials and Methods

Sediment samples were collected at monthly intervals from 4 stations (Fig. 1) for the year 1975-76, using a van Veen grab. In the laboratory the samples were dried in a hot air oven around 70°C. Organic carbon was determined by the direct method of El Wakeel and Riley⁴. For the estimation of total nitrogen, microkjeldahl technique as described by Barnes⁵ was followed. For determination of total phosphorus the sample was digested according to Rochford⁶ and the orthophosphate estimated by the single solution method of Murphy and Riley⁷. The data are compared with published information and presented in Table 1.

Results and Discussion

Organic matter—Monthly variations in the organic carbon at different stations are presented in Fig. 2. In general, there is an increase in organic carbon during the southwest monsoon season (June-September) at all

stations. Organic carbon values vary between 7.4 and 38.4 mg/g of dry mud (av. 16.2). Carbon values compare well with those reported by Murty and Veerayya¹. Bhosle *et al.*⁸ have reported organic carbon values for the shelf and slope regions of Cochin as 10.6 and 60 mg/g respectively. Data collected on board *R/V Meteor*⁹ show that the carbon values vary between 2 and 69.0 mg/g for the upper 2 cm of the sediments from the shelf region of Cochin. Cochin backwater is subjected to wide range of hydrographic conditions¹⁰,

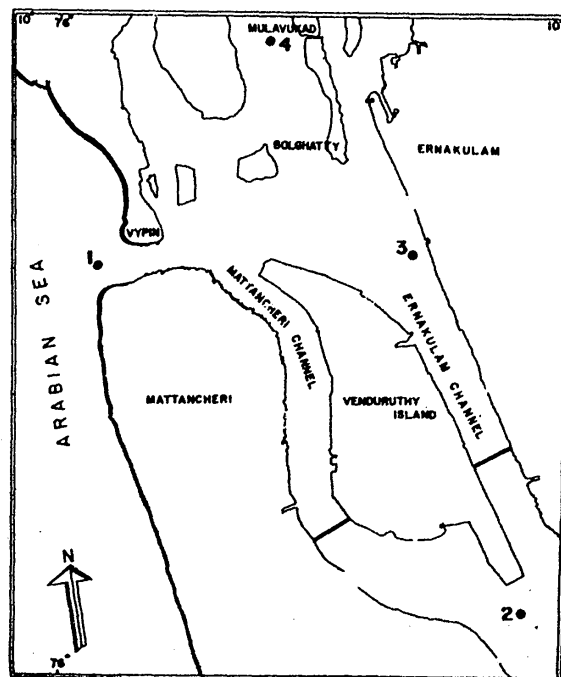


Fig. 1—Station location map

Table 1—Comparison of Present Data with Reported Data for Sediments from Different Areas

[Number in parenthesis indicates reference]

Ranges observed in the present study, mg/g	Values reported mg/g	Remarks
Organic carbon		
7.4 to 38.4; av. 16.2	2 to 69 (9)	For shelf and slope sediments in the upper 2 cm off Cochin in the Arabian Sea
	1.9 and 40.5; av. 14.2 (19)	For sediments of Lake Manzalah, Egypt
Total phosphorus		
0.9 to 2.4	0.69 to 1.2 (18)	For sediments of Santa Monica basin
	0.16 to 1.03 (19)	For sediments of lake Manzalah, Egypt
	0.04 to 1.68 (2)	For muds of Vembanad Lake
	1.3 to 1.9 (13)	For detritus of Cochin backwaters
	1 (6)	For sediments in the Australian estuaries
Total nitrogen		
0.9 and 5.7; av. 3.2	0.4 to 2(14)	In sediments of estuaries and lagoons in USA

with large freshwater runoff during June-September, when the chlorinity values go below 1‰. Qasim *et al.*¹¹ have reported the planktonic production of the backwater to be about 195 gC/m²/yr and the zooplankton grazers leave a considerable surplus of unconsumed basic food, which sinks to the bottom and becomes part of the sediment. They have also observed high values of primary production from April to August, and low values from September to March. Organic matter in the sediment in the estuary is mainly due to plant and animal matter brought in from land through runoff and deposited from the overlying water. It may be due also to plant and animal matter within the area and from the adjacent ecosystem. Associated with the fresh water runoff the silt in colloidal suspension containing large quantities of soil humates is brought into the estuary and the humic substance precipitates and settles in this region. Therefore, the seasonal variation in the organic carbon content in the sediments may be related to the plankton activity in the overlying water, the humic material brought in from land and also to the oxidation of organic matter by organisms living on the bottom.

Total phosphorus—Knowledge on the phosphorus concentrations in the mud is important, especially in shallow water systems, where mud acts as a reservoir of phosphorus in various forms and is regenerated into the overlying water under suitable conditions.

Monthly variations in the total phosphorus content in the mud are shown in Fig. 2. Total phosphorus content ranges between 0.9 and 2.4 mg/g (av. 1.5). In general, the values are found to be lower during the months June-September, followed by an increase in the following months. Lower values observed during the monsoon months are believed to be due to the leaching of the phosphorus, both the interstitial and adsorbed forms, from the mud to the overlying water. During monsoon months the freshwater flow dominates the system and during the high tide the saline water enters the estuary in the form of a tongue¹² and the intense water circulation during this season might be helping the release of more phosphates from the mud to the overlying water. Murty and Veerayya² have reported phosphorus concentrations in the muds collected from the Vembanad Lake during November/December between 0.04 and 1.68 mg/g (av. 0.42). The variability has been explained to be due to the variability in the texture of the sediments. They have also observed a decrease in the phosphorus content from the estuarine mouth to the freshwater zone.

Qasim and Sankaranarayanan¹³ have reported the total phosphorus variation in the detritus of the Cochin backwater between 1.3 and 1.9 mg/g. The higher total phosphorus content observed during the present investigation in the sediments of the Cochin backwater may be due to the fact that the sampling zone is restricted to the estuarine part of the lake and also due to the effect of the domestic waste which is emptied in the region through canals.

Total nitrogen—Seasonal variation in the nitrogen content at different stations are given in Fig. 2. The values vary between 0.9 and 5.7 mg/g (av. 3.2). Seasonal variation of nitrogen does not follow any definite pattern. The values are slightly higher and the distribution is more or less uniform at station 1, in the marine zone than at other stations. Since hydrographic changes at this station are minimum the organic production in the overlying waters will be more uniform and there may be relatively higher accumulation of organic materials in the sediments from the overlying waters.

Carbon/nitrogen ratio—C/N ratio (by weight) in the backwater sediments varies between 2.5 and 16.9 (av. 6.4). Trask¹⁴ has made analyses of organic carbon and nitrogen in sediments of estuaries, lagoons and oceans throughout the world and reported C/N ratio between 8 and 12. Carbon, nitrogen values estimated from sediment samples collected from the west coast of India during the cruises of *R/V Meteor*⁹ have shown a variation between 1 and 8. High C/N ratio (2.48-37.5) obtained by Bhosle *et al.*⁸, for the shelf sediments of the Arabian Sea has been attributed to the degradation of complex protein. Qasim and Sankaranarayanan¹³

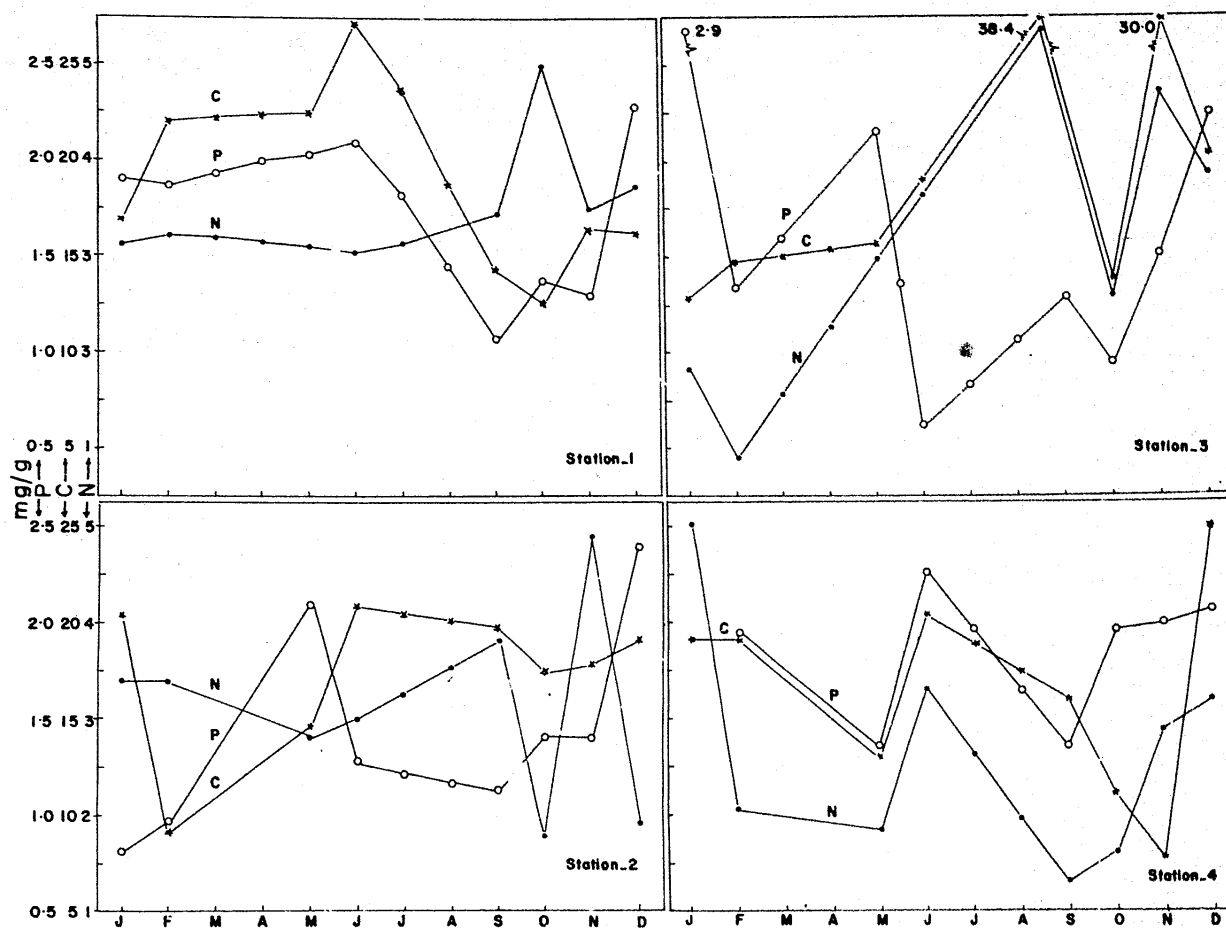


Fig. 2—Distribution of total phosphorus(P), total nitrogen(N) and organic carbon(C) at stations 1 to 4

have reported a C/N ratio between 5 and 10.5 with an average of 7.6 for the detritus of the Cochin backwater. Seasonal variation in the C/N ratio of the sediments of the Cochin backwater may be attributed to the changes in the physico-chemical characteristics caused by the freshwater discharge bringing in lot of organic matter, considerably high in humic materials, from land during the monsoon months and also to the more stable conditions during the premonsoon season, which are favourable for a good plankton population. Provasoli¹⁵ suggested that sea water containing humic material of freshwater origin has a high C/N ratio, nearer to 10:1, which is the ratio in "Water humus".

Carbon/phosphorus ratio—C/P ratio varies between 2.25:1 and 27.41 (av. 10.67:1). For the detritus in the Cochin backwater a C:P of 22.61 to 60.4:1 an average of 41:1 has been reported by Qasim and Sankaranarayanan¹³. Qasim and Sankaranarayanan¹³ have made a comparative study of the various chemical constituents in the detritus and in the sediments and concluded that the uppermost layer of the sediment is mostly of settled detritus. Lower C:P observed presently indicates the increase in

the phosphorus content in the sediments, probably due to the effect of domestic sewage.

Nitrogen/phosphorus ratio—The weight ratios of total nitrogen to total phosphorus in the sediments vary between 1.2 and 4.07 (av. 1.51). This is lower than that of plankton. Grasshoff¹⁶ has reported N:P in plankton as 13.3:1 and Sen Gupta *et al.*¹⁷, have reported N:P for natural plankton as 13.8:1 and for culture plankton as 18.2:1. Rittenberg *et al.*¹⁸ have reported relatively low N:P values for the sediments of Catalina, Santa Barbara and Santa Monica basins as 5.8:1, 3.3:1 and 1.4:1 respectively. The low N:P observed in the Cochin backwater indicates that the major portion of the phosphorus in the sediments is of abiogenic origin.

The present study indicates that, apart from hydrographic changes, humic material brought down by river discharge plays an important role in the cycle of organic matter in sediments in Cochin backwater. It is also clear from the organic carbon content as well as the ratios with other constituents like nitrogen and phosphorus that the degradation of organic matter is quite rapid. Low N:P and C:P ratios indicate

significant contribution of phosphorus by sewage effluents and other sources in the environment.

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