

Organic carbon in the sediments of Mandovi estuary, Goa

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Total organic carbon (TOC) in surficial sediments in Mandovi estuary varies widely from 0.1 to 3% (av. 1.05%). Highest values of TOC (2.4-3%) lie close to the mouth region and indicate no definite trend in its variation in the estuarine region. The values of TOC tend to decrease significantly in the upstream during major part of the year. Seasonal variation shows high TOC (av. 1.22%) in the estuary during premonsoon and low during monsoon (av. 0.94%) and the postmonsoon (av. 0.95%). During monsoon, spatial variation shows increasing values of TOC in the upper reaches of the estuary. Sewage discharges, primary production and land derived material are considered to be the source of organic carbon.

Sediments play a very important role in the aquatic systems. Investigations on the organic matter in sediments indicate the extent of biological activity and indirectly the fertility of overlying seawater as well as the status of pollution of the waters.

Comprehensive studies on the physico-chemical, biological and mineralogical aspects have been made in the sediments of Mandovi estuary¹⁻⁶. Shirodkar and Kamat Dalal⁷ while studying boron, have also studied organic carbon in relation to its impact on boron distribution and behaviour, and given a brief outline of the distribution of total organic carbon (TOC) in the sediments of Mandovi estuary. However, no detailed information is available on the organic carbon of sediments, which form a useful tool in interpreting the data on organic matter and which can help in the assessment of the extent of nutrient regeneration in the estuary. An attempt has, therefore, been made to study the distribution and seasonality of sediment organic carbon and its impact on the estuarine environment of Mandovi estuary.

Surface sediments were collected every month using a van Veen grab from 5 stations in the Mandovi estuary during January to December 1985 (Fig. 1). They were then transferred to clean and dry polyethylene containers and kept in deep freeze, prior to analysis. The sediment samples were dried in the hot air oven maintained at 80°-90°C and then finely powdered in an agate mortar. Organic carbon was estimated by the method of El-Wakeel and Riley⁸.

Spatial variation of TOC (Table 1) indicates its values varying from 0.1 to 3%. Most of the higher values (2-3%) were found near the mouth region followed by an alternate increase and a decrease in the

upper reaches of the estuary, indicating no definite trend in the distribution of TOC along the estuary. At sts 4 and 5 high values of TOC (1-2.4%) were observed in June-August.

TOC gradually decreases from mouth towards upstream and this decrease was sharp in the upper reaches of the estuary during premonsoon (February-May) and the monsoon (June-September). A sudden increase in TOC in the upper reaches of the estuary during monsoon indicated a reverse trend in its distribution as compared to the non-monsoon seasons. The postmonsoon (October-January) season, however, did not show any significant variation in TOC along the estuary, its values remaining almost nearly the same at all stations.

Mandovi estuary is a very dynamic estuary and shows changes in its physico-chemical properties with respect to seasons⁹. The differences observed in the organic carbon content of sediments can be due to various reasons as given by Sverdrup *et al.*¹⁰. The high

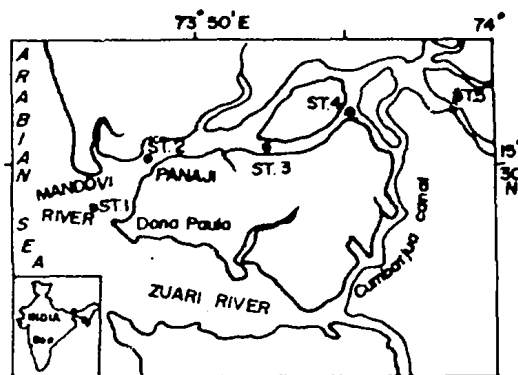


Fig. 1 - Sampling stations

Table 1—Total organic carbon (% dry wt) of sediments in Mandovi estuary during 1985

	Stations				
	1	2	3	4	5
Jan.	1.6	2.9	1.9	0.4	1.0
Feb.	3.0	3.0	0.9	1.6	0.7
March	1.2	1.7	1.1	0.7	N.A
April	2.4	1.3	0.4	0.7	0.7
May	2.4	N.A	0.3	1.0	0.2
June	0.9	0.1	0.1	2.4	0.5
July	0.7	0.6	0.7	1.7	1.0
Aug.	2.8	0.3	0.6	0.3	1.6
Sept.	0.9	1.9	0.2	0.6	0.9
Oct.	0.6	0.5	0.2	1.8	0.4
Nov.	2.4	0.1	0.8	0.9	1.0
Dec.	0.3	0.4	1.1	0.3	0.3

N.A. — Not analysed

organic matter at the mouth region in the present study can be ascribed to high productivity of the overlying waters¹¹, sewage discharges and clayey nature of sediments⁶.

The upstream region of the Mandovi estuary is mainly characterised by low productivity, weak tidal currents¹² high oxygen¹³ and sediments of the type sandy-silt to sand-silt-clay. The above factors are detrimental to the ample supply and the accumulation of organic matter in sediments, which leads to low organic carbon in the sediments upstream at sts 4 and 5, during pre and postmonsoon seasons. However, during monsoon, high values of TOC from 1-2.4 % at these stations which accounts for 1-1.25% of the pooled values of TOC during June-August show a reverse trend in the distribution. This is because, though during monsoon the productivity is low, the estuary gets flooded as its tributaries bring in large amount of fresh water from the watershed⁹. This water carries lots of land driven organic matter that is finally deposited in the river channel. Though the conditions are not favourable for the accumulation of organic matter in sediments the effect of land drainage and the possible organic supply from tributaries in the upstream region, account for high organic carbon in these sediments at sts 4 and 5 during monsoon. Shirodkar and Kamat Dalal⁷ while working in the Mandovi estuary observed high values of TOC in the upstream during monsoon and attributed it to the land drainage.

The middle reaches of the estuary at st 3, shows an annual average of 0.69% TOC which is considerably

less as compared to stations on either side. Though factors such as high productivity, clayey-silt and sandy-silt nature of the sediments are favourable for high organic carbon content at st 3, strong tidal currents in this region continuously drain out available suspended organic matter to the sea without allowing sufficient time for its deposition during the outflow of water. The sediments at st 3 therefore get depleted of large potential source of organic matter leading to low organic carbon in sediments at the middle reaches of the estuary.

In most of the unpolluted estuaries, TOC content of the bottom sediments is < 5% except where bottom waters are anaerobic or vegetal matter such as peat is abundant. However in areas, where organic pollutants are high¹⁴, TOC often exceeds 5%. Highest TOC, in sediments in the present study was 3% (av 1.05%) which is much less than the proposed limit for a polluted estuary.

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References

- Murthi C S, Das P K, Nair R R, Verrayya M & Varadachari V V R. *Indian J Mar Sci*, 5 (1976) 9.
- De Sousa S N. *Chemical characteristics of Mandovi-Zuari river system*, Ph D thesis, University of Bombay, 1983.
- De Sousa S N, Sen Gupta R, Sanzgiri S & Rajagopal M D. *Indian J Mar Sci*, 10 (1981) 314.
- Singhal S Y S. *Mahasagar-Bull Natn Inst Oceanogr*, 9 (1976) 27.
- Dehadrai P V & Bhargava R M S. *Indian J Mar Sci*, 1 (1972) 52.
- Shirodkar P V & Sen Gupta R. *Indian J Mar Sci*, 14 (1985) 196.
- Shirodkar P V & Kamat Dalal V N. *Mahasagar - Bull Natn Inst Oceanogr*, 21 (1988) 45.
- El-Wakeel S K & Riley J P. *J du Cons Perm Int Explor Mer*, 22 (1956) 180.
- Qasim S Z & Sen Gupta R. *Estuar Coast Shelf Sci*, 13 (1981) 557.
- Sverdrup H U, Johnson M W & Fleming R H. *The oceans*. (Prentice Hall, New York) 1962, pp 1087.
- Devassy V P. *Plankton ecology of some estuarine and marine regions of the west coast of India*, Ph D thesis, University of Kerala, 1983.
- Anon. Master plan for pollution control of the rivers Zuari - Mandovi, Tech Report No 02. (Nat Inst Oceanogr, Goa, India) 1979.
- Shirodkar P V & Anand S P. *Mahasagar-Bull Natn Inst Oceanogr*, 18 (1985) 439.
- Folger D W, in *Environmental frame work of coastal plain estuaries*, edited by B W Nelson. (The Geological Society of America, Columbia, USA) 1969, 619.