

## Seasonal Distribution of Organic Matter in Mangrove Environment of Goa

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Water and sediments were studied for the distribution of suspended matter, organic carbon and nitrogen. Suspended matter ranged from 3-373  $\text{mg. l}^{-1}$  while particulate organic carbon (POC) from 0.03-9.94  $\text{mg. l}^{-1}$ . POC value showed significant correlation with suspended matter. Particulate organic nitrogen (PON) values, however fluctuated in the range of 0.01-3.4  $\text{mg. l}^{-1}$ . Organic carbon in the sediments (SOC) varied from 1.7-54  $\text{mg. g}^{-1}$  with an average value of 45.6  $\text{mg. g}^{-1}$  organic matter. The values of total nitrogen in the sediments (STN) ranged from 0.3-19.3  $\text{mg. l}^{-1}$ . The data indicate that there is marked spatial and temporal variations in the distribution of organic matter in the mangrove environment. The mangroves and its associated biota contribute major portion of organic matter in the mangrove environment.

In the tropical mangrove ecosystem, the vegetation and its associated biota, play a major role in contributing organic matter. Only limited data are available<sup>1</sup> on organic carbon and nitrogen from the mangrove ecosystems in India. In the present investigation attempts have been made to study the distribution of (i) organic carbon and total nitrogen from the mangrove sediments and (ii) particulate organic carbon and particulate organic nitrogen from the overlying water, in the mangrove environments of Goa.

### Materials and Methods

Monthly samples of water and sediment (top 2 cm) were collected (March 1983 - March 1984) from 9 stations (Fig.1) from the mangroves in the Terekhol, Zuari and Mandovi estuaries of Goa.

Suspended matter in the waters was determined following the method of Strickland and Parsons<sup>2</sup>. Water samples (250 ml) from each station were filtered under vacuum (1/3 atm. pr.) through preheated (450°-500°C for 2 h) glass fibre filters (Whatman GF/C) for the analysis of particulate organic carbon (POC) and particulate organic nitrogen (PON). For POC, 2 ml of  $\text{Na}_2\text{SO}_4$  solution (4.5%) was added repeatedly at the end of filtration. Filters were dried and used for analysis. POC was estimated by wet oxidation<sup>2</sup> of carbon with dichromate and PON was estimated by determining the nitrogen by micro-kjeldahl's nesslerisation. In each case duplicate samples were analysed and the mean values are expressed in  $\text{mg. l}^{-1}$ .

Sediment samples were air dried and ground to a fine powder, stored in airtight polythene bottles in a dessicator until analysis. They were analysed for organic carbon (SOC) by oxidation of carbon with dich-

romate<sup>3</sup>. Sediment total nitrogen (STN) was estimated by the method of Johnson<sup>4</sup>. The sediment organic matter (SOM) was calculated<sup>5</sup> by multiplying the SOC values by a factor 1.724. For each station duplicate samples were analysed and the results expressed as  $\text{mg. g}^{-1}$ .

### Results

*Suspended matter, POC and PON*— The suspended matter (Fig. 2) was in the range of 3-373  $\text{mg. l}^{-1}$  and was generally high from April to August. In the

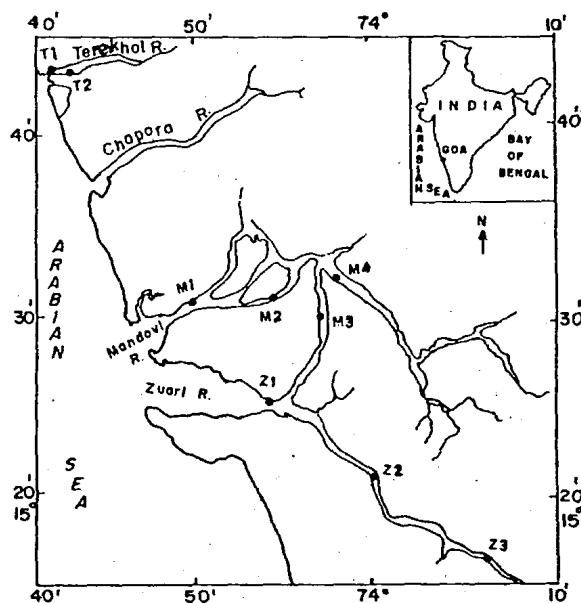


Fig. 1— Sampling locations in the mangrove environments of Goa

Terekhol mangrove waters, the suspended matter ranged 3-266 mg. l<sup>-1</sup>. In Zuari it varied from 3-272 mg. l<sup>-1</sup> while in Mandovi it was in the range of 20-373 mg. l<sup>-1</sup>.

POC values showed considerable seasonal fluctuation at all stations (Fig. 3). In the mangrove environment of Mandovi, POC ranged from 0.06-9.94 mg l<sup>-1</sup>. In Zuari mangroves, the highest (7.45 mg. l<sup>-1</sup>) values of POC observed at st. Z1, in May and low (0.03 mg. l<sup>-1</sup>) during June while POC values in Terekhol mangroves ranged between 0.06 and 8.28 mg. l<sup>-1</sup>.

PON values ranged from 0.03-3.4 mg. l<sup>-1</sup>, 0.01-0.97 mg. l<sup>-1</sup> and 0.03-2.5 mg. l<sup>-1</sup> in the mangrove waters of Mandovi, Zuari and Terekhol respectively. The average PON value at st M1 was very high (0.92 mg. l<sup>-1</sup>) compared to the average PON value (0.36 mg. l<sup>-1</sup>) at other stations in Mandovi. However the average PON value of 0.35 mg. l<sup>-1</sup> was calculated for the mangrove environment of Zuari. No significant difference was recorded in PON values, among the 3 stations of Zuari. In the Terekhol mangrove waters, the average PON values ranged from 0.53-0.7 mg. l<sup>-1</sup>.

**SOC and STN**— Organic carbon in the sediments varies from 1.7 mg. g<sup>-1</sup> in December at st T1 to 54 mg. g<sup>-1</sup> in October at st Z2. Distribution of SOC did not show a definite trend at any station (Fig. 4). The average SOM calculated from SOC values ranged from 37.2 at st M1 to 51.8 mg. g<sup>-1</sup> at st Z3 with an overall average of 45.6 mg. g<sup>-1</sup>. SOC ranged from 10.7-38.6, 6.2-54 and 1.7-34.5 mg. g<sup>-1</sup> in the sediments of Mandovi, Zuari and Terekhol respectively.

The values of STN from mangrove sediments ranged from 3-13.2, 1.7-19.3 and 3-15.2 mg. g<sup>-1</sup> in the Mandovi, Zuari and Terekhol respectively (Fig.5).

**C:N ratio**— In the sediments from mangrove environments of Goa C:N ratio ranged from 2.2:1 to 84.5:1 and the average from 7.7:1 to 13.4:1 (Table 1).

**Discussion**

The overlying waters in the mangrove ecosystems of Goa showed high values of POC and PON compared to estuarine<sup>6,7</sup> and coastal<sup>8,9</sup> waters of India. The seasonal variation in POC (Fig.3) and PON may be attributed to changes in the biological, physico-chemical conditions caused by freshwater discharge, domestic and agricultural seepage.

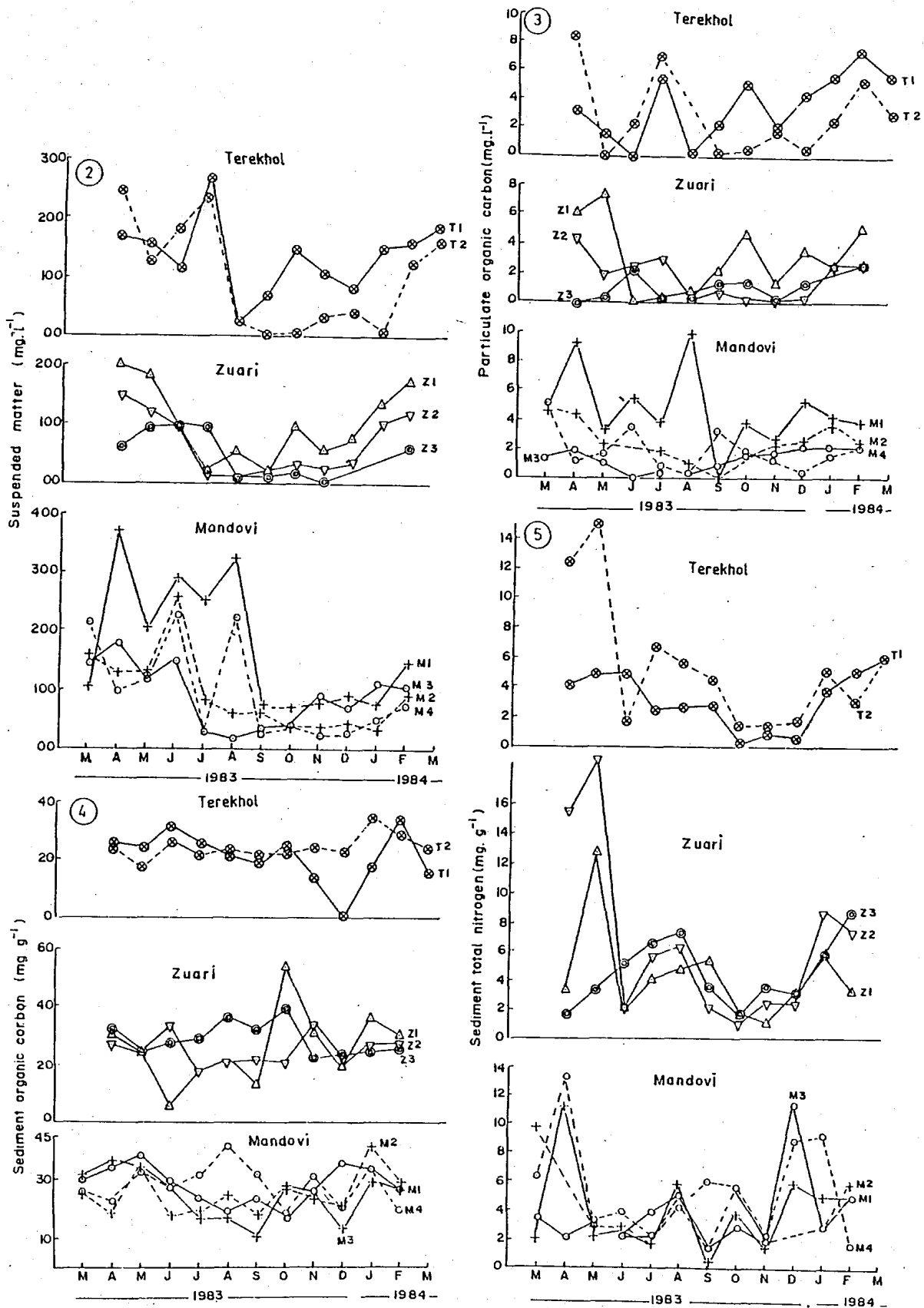
POC values in the mangrove environment showed a significant correlation with suspended matter at sts M1, M2, Z1, T1 and T2. Microscopic observations of suspended matter showed considerable amount of detritus and plant debris. Therefore, high POC and PON values in the mangrove waters may be due to the mangrove and terrestrial detritus present in the suspended matter. Waters of mangrove environment are generally turbid because they are shallow regions and subjected to action of tides, waves and currents. The constant wave action and currents disturb surface sediments in the mangrove substratum, resulting in a high suspended matter in the mangrove ecosystem (Fig.2). The periodic resuspension of the sediments probably was largely responsible for the high organic matter in the mangrove ecosystem. During the monsoon, terrestrial runoff contributed high levels of particulate matter to the mangrove environment.

Seasonal variation in SOC and STN (Figs 4 and 5) levels in the mangrove sediments could be attributed to their oxidation and living organisms (meiofauna, macrofauna, bacteria and algae, etc.) present in the

Table 1— Seasonal Variation in the C:N Ratio from the Mangrove Sediments

	Stations									
	M1	M2	M3	M4	Z1	Z2	Z3	T1	T2	
										1983
March	14.40	3.1	8.66	4.16	—	—	—	—	—	
April	3.24	3.07	15.52	1.73	9.39	1.80	19.05	6.17	1.91	
May	15.36	11.50	11.70	10.03	1.91	1.28	7.50	4.88	1.14	
June	11.32	7.45	12.61	7.35	3.20	15.36	5.41	6.40	15.41	
July	10.17	10.72	6.21	14.14	4.30	3.27	4.43	10.24	3.29	
Aug.	2.92	5.37	3.81	9.93	4.89	3.50	4.96	8.40	4.25	
Sept.	36.90	10.64	16.64	5.35	2.38	9.91	8.86	6.92	4.82	
Oct.	8.95	6.06	6.03	2.77	27.05	18.61	23.26	84.48	15.66	
Nov.	18.32	11.72	13.10	13.52	27.57	13.37	6.34	16.38	17.34	
Dec.	2.22	3.63	3.15	2.35	6.28	8.95	7.75	2.98	13.25	
										1984
Jan.	7.04	14.51	11.89	3.63	6.32	6.22	—	4.89	6.94	
Feb.	6.39	4.92	5.31	11.76	9.38	3.72	3.14	6.80	11.60	
March	—	—	—	—	—	—	—	2.79	4.32	
Av.	11.44	7.73	9.56	7.22	9.33	7.82	9.07	13.44	8.32	

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Figs 2-5— Seasonal variation in suspended matter (2) and POC (3) in overlying waters and organic carbon (4) and total nitrogen (5) in sediments from the mangrove environments of Goa

top few centimeters of sediment at the time of sampling. The average SOM of  $45.6 \text{ mg. g}^{-1}$  in the mangrove environment was comparatively higher than the values reported<sup>6,10-12</sup> for the estuarine and mangrove sediments along the east coast of India. High SOM in the mangrove ecosystem could be attributed to decomposition of mangrove litter, which leads to anoxic conditions. Further, it was also suggested that low oxygen content of water lying immediately above the bottom sediments favoured<sup>5</sup> the preservation of organic matter in the mangrove sediments. The levels of SOC and STN from the mangrove ecosystem were strikingly high compared to organic carbon and nitrogen contents in the sediments of nearshore<sup>8,9</sup> waters. The richness of mangrove environments as regards SOC and STN have been attributed to muddy<sup>13</sup> (clay) nature of water which does not easily flush away organic matter from the sediments. C:N ratio in the mangrove sediments fluctuated, even when freshwater discharge was greater or poor during the monsoon and post monsoon periods. This indicates that besides terrigenous organic matter brought in by freshwater discharge, mangroves and associated biota continuously add detritus to the mangrove ecosystem. The amount of detritus and its further decomposition, influence the carbon and nitrogen contents in the mangrove sediments. C:N ratio in the mangrove sediments is considered<sup>14</sup> to be an important factor influencing its value as a primary food source.

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