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STUDY OF SELECTED TRACE METALS IN THE SEDIMENTS OF THANE CREEK NEAR THANE CITY -ANTAGONISTIC BEHAVIOUR OF ZINC AND COPPER

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ABSTRACT

The trace metals Cd, Pb, Zn and Cu were studied in the sediments of Thane Creek. Cadmium was low and lead showed correlation with pH of water and organic carbon of sediment. Salinity and to some extent sedimental organic carbon play a significant role in governing the concentration of copper and zinc whose fluctuations showed antagonistic pattern.

Key-words: Thane creek, sediment, pH, trace metals, organic carbon.

Trace metals form an important abiotic component of marine ecosystem especially when it is recipient of domestic and industrial effluents and solid wastes. Sahu and Mukherjee (1983) reported approximately 11,000 kg. of copper and 40,00,000 kg. of zinc being discharged per annum in the Ulhas river which has a minor connection with Thane creek. Mohapatra (1987) investigated waste water released from 20 large and medium industries to Thane Creek and reported low amount of cadmium and objectionable amount of copper, lead and zinc. While Sahoo and Khopkar (1985) observed 5 to 10 µg/l copper, 40 to 86 µg/l zinc, 1 to 5 µg/l cadmium and 15 to 50 µg/l lead in the ambient waters of this part of Thane Creek.

These metals may associate with sediment particles either by adsorption or by complexation, forming part of the particle structure, and gradually sink with sediment or they may get released when mixed with marine water due to altered physico-chemical environment (Laxen, 1983). Thus behaviour of metals in relatively shallow waters of coastal zones, estuaries, mangrove swamps and creeks is very complex and depends upon various environmental factors, including metabolism of water and sediment (Harbison, 1986).

The present study discusses behaviour of trace metals cadmium, lead, zinc and copper in the sediments of creek near Thane city.

Thane creek (Lat. 19°00' to 19°15' N and long. 72°55' to 73°00' E) near Bombay is a tide dominated creek and a recipient of industrial effluents and domestic sewage throughout its length. This creek has a minor connection with Ulhas river. It narrows down considerably near Thane city, where the present study sites are located. In this region, the mangrove mudflats divide the watermass into conspicuous two or three sub channels (Fig.1). The first station (stn.1) is situated on the western sub channel near the main sewage reach while stn.2 is on the eastern channel approximately 1 km away on the riverine side from the stn.1.

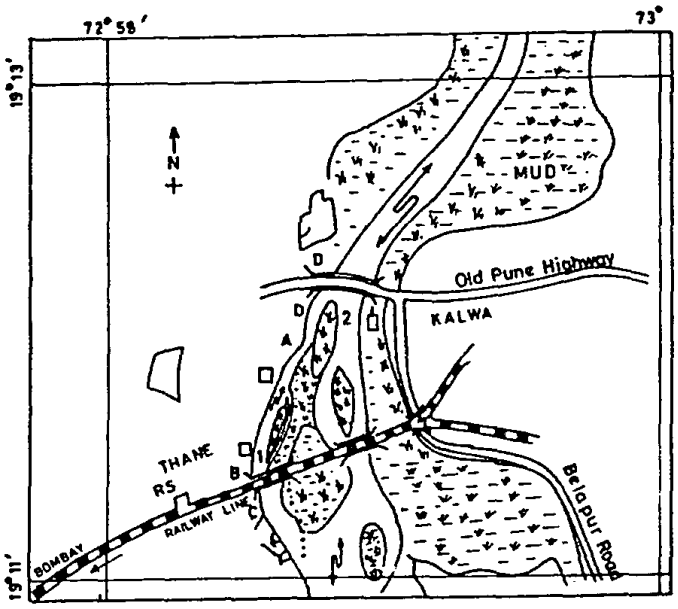


Fig.1. Map showing stn.1, stn.2, sewage reaches A, B, C and solid waste disposal areas D.

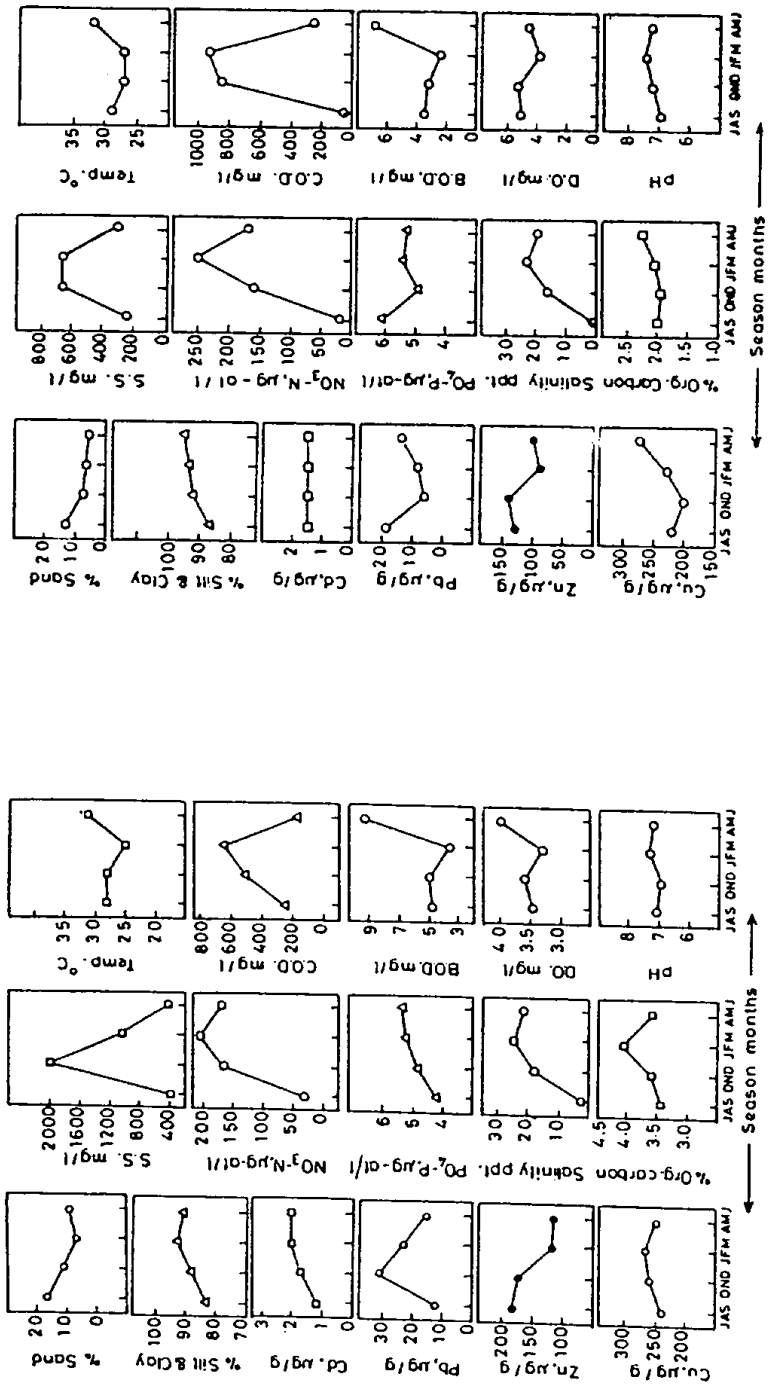
Water and surface sediment samples were collected during low tide twice in a month from June 1984 to June 1985. The data has been consolidated seasonwise as monsoon (July to September), post-monsoon (October to December), winter (January to March) and summer or pre-monsoon (April to June).

Water analysis was done following standard methods (APHA, AWWA and WPCF, 1981). Sediment texture was determined by Beaker method as suggested by Piper (1942). Organic carbon in the sediment was estimated by Walkley and Black method (1934). Samples for metal detection were digested with concentrated HNO_3, H_2SO_4 and $HClO_4$ for complete removal of organic matter and were analysed by Differential Pulse Anodic Stripping Voltametry (Burangey, Zarapkar, Dhaneshwar and Sankar Das, 1985) at Bhabha Atomic Research Centre, Trombay.

The present investigation revealed higher concentration of zinc and copper in the sediments while a negligent amount of Zn, Cu, Pb and Cd has been reported from ambient water of this region by Pejaver (1987). Seasonal variations at different parameters at stn.1 and stn.2 are shown in Figs.2 & 3 and the correlation coefficients ('r') between the metals and the parameters of water and sediment are given in Table I.

Cadmium

Relatively low amount of cadmium (1.2 to 2 ppm and 1.5 ppm at stn.1 and stn.2 respectively) was observed in the marine sediments near



Figs.2 & 3. Seasonal variations in different parameters at stn.1 & 2 respectively.

Table I. Correlation coefficients ('r') between sediment metals and some physico-chemical parameters.

	Copper		Zinc		Lead	
	Stn.1	Stn.2	Stn.1	Stn.2	Stn.1	Stn.2
Salinity	0.88	0.78	-0.79	-0.27	-	-
pH	1.33	0.23	-0.83	-0.26	-0.33	-0.40
PO_4-P	0.85	0.02	-0.85	-0.06	-	-
NO_3-N	0.89	0.22	-0.71	-0.61	-	-
Suspended solids	-	-	-	-	0.97	-0.94
% silt-clay in sediment	0.86	0.51	-0.85	-0.54	0.40	-0.60
% organic carbon in sediment	0.98	0.98	-0.49	-0.44	0.26	0.28

Thane city. This has been corroborated by Mohapatra (1987) and Sahoo and Khopkar (1987) who reported insignificant amount of cadmium in the industrial effluents and sediment of this region respectively. Cadmium shows no significant correlation with water and sediment parameters probably due to its low values.

Lead

Lead in the sediment exhibited station-wise and season-wise variations. Stn.2 experienced a rise in lead (19 ppm) during monsoon probably due to high amount of metal carried with run off from the adjacent land. However, stn.1 which is not far from land, did not have high quantities of lead during monsoon. Instead a peak (31 ppm) in post-monsoon was observed. It was noticed that the mud flats in stn.1 got partially destabilised during monsoon due to relatively faster currents and were reestablished in post-monsoon which explains the above observation.

Lead is reported to form complex with particulate matter (Valenta, Nurenberg, Klahre, Rutzel, Merks and Reddy, 1983) and hence, its positive correlation with suspended solids at stn.1 is suggestive. According to Venugopal, Sarala Devi, Ramani and Unnithan (1982), trace metals are associated with colloidal and fine matter in suspension. Contradictory behaviour of lead at stn.2 can be attributed to different nature of suspended solids caused by proximity with river and distance from sewage reach. A moderate positive correlation with organic carbon in the sediments at both the stations indicates important role of organic matter in retaining lead. A slight negative correlation of lead with pH (Table I) suggests its higher precipitation at lower (acidic) pH as was noted by Dean, Bosqui and Ianoutti (1972).

Zinc

High levels of zinc were observed at stn.1 (av. 169 ppm) as compared to stn.2 (av.115 ppm) which might be due to the proximity of the former

with the sewage outfall as described by Halcrow, Mackay and Thorton (1973) and Venugopal, Sarala Devi, Ramani and Unnithan (1982). These values are low as compared to 3164-6740 ppm of zinc in the polluted Mahim river estuary near Bombay (Sabnis, 1984).

A careful study of behaviour of zinc at both the sites reveals its negative correlation with salinity vis-a-vis silt and clay fraction, pH, nitrates and phosphates of ambient water (Table I). High concentration of zinc in sediments during monsoon (inspite of partial destabilization of mud flats in stn.1 as described before) suggests land runoff as its source. The creek waters are rich in nitrates and phosphates due to high sewage load throughout the year except during monsoon when they get diluted. Hence, their values fluctuate concurrently with the salinity gradient. Slight fall in pH values can also be attributed to the influx of fresh water. These observations lead to the conclusion that Zn in sediment is significantly influenced by salinity rather than the other parameters.

The correlation of zinc with sediment organic carbon is negative in the present investigation contrary to the observation made by Sabnis (1984) in Mahim river estuary.

Copper

The sediment under study showed an average concentration of 231 ppm at stn.2 and slightly higher concentration (av.253 ppm) at stn.1 due to proximity with sewage reach. According to Laxen (1983), 91% of copper attached to solids does not get dissolved in marine water. Hence, copper in the sediments of Thane creek increased with salinity, thus showing positive correlation with phosphates, nitrates in water and silt-clay fraction of sediment, all of which fluctuated seasonally with the freshwater influx. This antagonistic behaviour of copper with zinc has resulted in negative correlation between the two metals at both the stations (Figs.2 & 3).

Besides, relation of copper is positive with organic carbon. Sabnis (1984) reported similar relation to the sediments of Mahim river estuary with high enrichment (700 to 2916 ppm) of sediment copper. According to Hansen, Inguorsen and Jargensen (1978), microbial degradation of high organic matter in the mud flats removes oxygen from the sediments below surface layers. During night when the photosynthetic activity ceases, H_2S diffuses upwards in water due to which free metals and metal humates are deposited as sulphides. Thus, the sediments of Thane creek showed enrichment of trace metals copper and zinc, moderate lead and low cadmium. Their concentrations at the two stations were comparable probably due to predominance of fine sediment at both the stations. According to Harbison (1986), fine sediments harbour high amount of metals irrespective of their proximity to any source.

The variations in the sediment metal concentrations were largely seasonal and it is very difficult to single out a factor responsible for them. However, it is significant that zinc and copper exhibited antagonistic correlations (Table I) under similar sets of conditions. Venugopal, Sarala Devi, Ramani and Unnithan (1982) and Sabnis (1984) observed in Cochin

backwaters and Mahim river estuary near Bombay respectively, synergetic action between copper and zinc under anoxic conditions which were marked by absence of biota. This might not be applicable under relatively aerobic conditions such as in the Thane Creek.

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