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THE USE OF THE BENTHIC COMMUNITY AS A WATER QUALITY INDICATOR IN THE CUBATÃO RIVER BASIN

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ABSTRACT

A survey of the benthic macrofauna was performed along the rivers in the Cubatão region of Brazil to evaluate the aquatic environment. Twenty samples were collected in the Pereque, Cubatão, Moji, Piacaguera and Perdido rivers during Spring and Autumn, 1984. Two numerical indices, the Sequential Comparison Index (Cairns Jr. et at., 1968) and Biotic Index (Tuffery and Verneaux, 1968) were calculated using sample data. Density in each sample was determined for each taxonomic group. The index calculations showed that the environment is not in equilibrium at any of the sampling stations. Heavy organic pollution in Cubatão and Piacaguera rivers was indicated. In the Perdido river sediment was contaminated with tar. Pieces of insect larva, also present in the sediment, indicated impacts from toxic substances. At other sampling stations, the low numerical index values were related to the sediment nature (sandy in some stations) or to non-organic pollution which was evaluated using bioassays, Zagatto et al. (1986).

KEYWORDS

Benthos; fresh water biological indicators; macroinvertebrates; Cubatão - SP.

INTRODUCTION

Although a primary interest in pollution effects is the response of flora and fauna, many studies of aquatic pollution have omitted biological studies or relegated the biological issues to a position secondary to chemical analyses. It is generally accepted that biological data does not replace chemical data but both are convergent, complementing one another (Cairns Jr. and Dickson, 1971).

According to Hawkes (1978) running water organisms that best reflect environmental quality are those which have limited or no mobility. Since benthic macroinvertebrates are typically sessile, the structure of benthic macroinvertebrate community is a biological variable which is an important tool used to characterize water courses.

CETESB has been developing improved monitoring tools since 1978 (Johnscher et al., 1979; CETESB, 1981) and has included biological surveys in the Project "Technical Support to Control Activities" in the Program "Environmental Pollution Control in Cubatão", developed in 1984. This paper reviews benthic macroinvertebrate data collected which contributes to the evaluation of environmental quality in the rivers of the Cubatao region and complements data from biological assays performed on water and sediment extracts, Zagatto et al. (1986).

MATERIAL AND METHODS

Benthic community samples were collected from the following stations (Fig. 1):

Station 3: Pereque River - about 500m upstream of industry Q.
Station 4: Pereque River - about 100M downstream of Piacaguera Highway.
Station 5: Cubatão River - about 300m downstream of industry I.
Station 6: Cubatão River - about 300m downstream of industry P.
Station 7: Moji River - about 100m upstream of the Piacaguera-Guaruja Highway.
Station 8: Moji's Tributary - about 50m upstream of the bridge on property of one chemical industry.
Station 9: Perdido River, tributary of Piacaguera River, about 20m downstream of the bridge, next to the Elementary School, on Vila Parisi.
Station 10: Piacaguera River Springs, upstream of the industry Q.
Station 11: Piacaguera River, about 200m upstream of the Piacaguera-Guaruja Highway.

The samples were collected by using an Ekman grab (15 cm x 15 cm). Samples were cooled and returned to the laboratory for analysis. Samples were processed according to the methodology described in the "Standard Methods for the Examination of Water and Wastewater" (APHA, 1980). Organisms were sorted under a stereoscopic microscope, identified and counted. Two biological indices were developed, the Sequential Comparison Index (SCI) (Cairns et al., 1968) and Biotic Index (BI) (Tuffery and Verneaux, 1968) described by Johnscher-Fornasaro et al. (1981).

The density of organisms was estimated in order to assess organic pollution loading, Johnscher et al. (1979). Fewer than 1000 Oligochaeta represent negligible organic pollution; more than 5000 heavy pollution and the intermediate numbers represent moderate organic pollution (Myslinsky and Ginsburg, 1977); the predominance of the most tolerant taxa, Oligochaeta-Tubificidae and Diptera-Chironomidae, indicate heavy organic pollution. A small number of individuals may represent three different situations: occurrence of chemical pollution or physical disturbances which reduce the number of organisms; sandy or rocky sediments on the bottom and rapids, which do not allow the development of benthic communities; and severe organic pollution that prevents the survival of tolerant forms.

Cairns, et al. (1968) suggest an SCI above 12.0 with high density and a stable community is typical of non-polluted rivers. For polluted rivers SCI values are typically below 8.0. SCI values between 12.0 and 8.0 indicate semi-polluted conditions. However, the density of the organisms in samples is critical because small samples produce low SCI values.

For the BI, values of 5 or lower indicate communities affected by pollution. For non-polluted environments values above 5 are obtained. As in the case of SCI, the BI is influenced by sample density. The predominance of tolerant taxa should also be taken into account because the BI is not based on the number of individuals of each taxa.

In the following analyses the following data limitations were recognized:

- The total number of samples per station was low;
- sampling stations were not ecologically similar, bottom substrate, stream width and flow velocity varied between stations;
- methods developed in temperate climates were applied without adaption to tropical rivers;
- seasonal sampling was not possible at all stations;
- multiple waste discharges, domestic and industrial, were present as well as physical disturbances.

RESULTS

The results obtained in the analysis of benthic samples are presented in Table 1. The SCI and BI values were low for all samples. The use of indices alone suggest all stations were similar and heavily polluted. Further analysis considered that only the high density of resistant organism (Oligochaeta-Tubificidae and Diptera-Chironomidae) confirmed high levels of pollution.

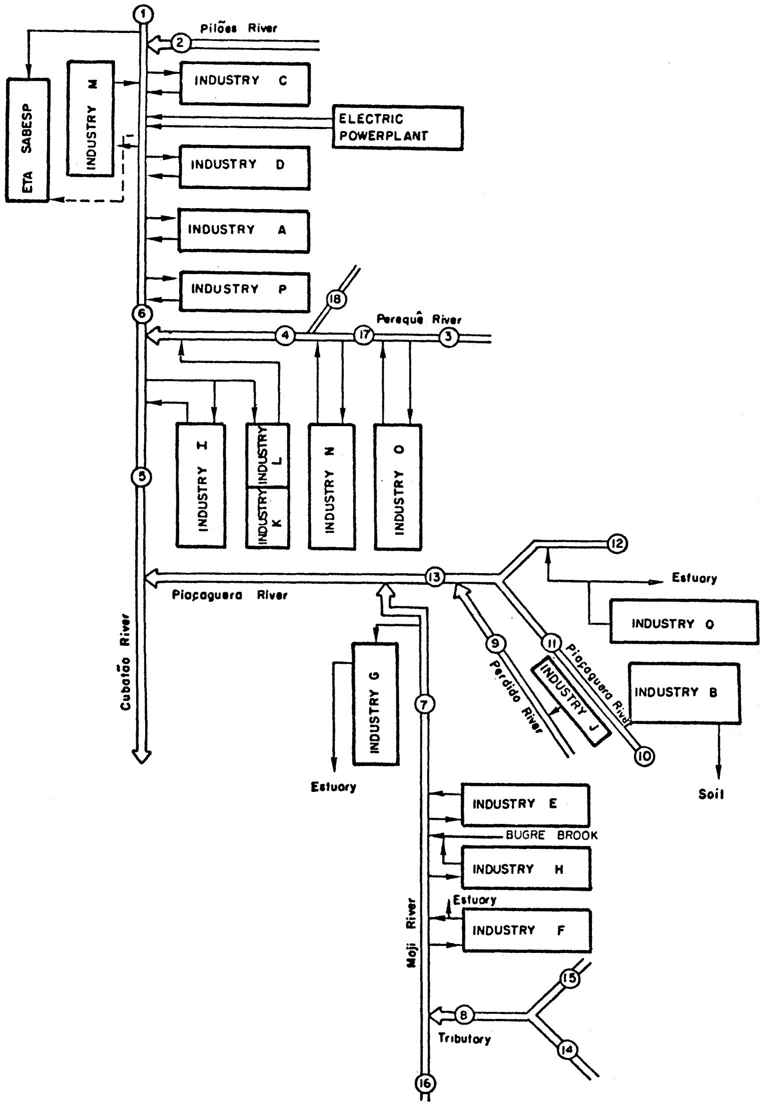

Fig. 1. Diagram of Cubatão River Basin, showing site of industries and sampling stations

DISCUSSION

Pereque River - The SCI obtained for the sample from Station 3, although very low, was much higher than all other samples. SCI is influenced by low density and, in this instance, density may be related to the type of sediment (medium to coarse sand with high percentage of gravel). Station 3 was dominated by moderately tolerant taxa. This station is considered to be a natural site. Results from Station 4 (spring sample) identified the predominance of taxa tolerant to pollution indicating the effect of effluents discharged into Pereque River, between station 3 and 4 alter the environmental quality.

Moji River - Samples from the only mainstream station,Station 7,indicated only taxa tolerant to organic pollution. Physical disturbance was observed at this station. Sand mining was observed both upstream and downstream. In addition, other studies indicated low pH in waters from this location (Zagatto et al., 1986), which may also account for community conditions.

SEASONS	SAMPLING STATIONS \ GROUPS	ANNELIDA-OLIGOCHAETA		MOLLUSCA-GASTROPODA	ARTHROPODA-ARACHNIDA	ARTHROPODA-INSECTA						TOTAL	SCI-Sequential Comparison Index	BI - Biotic Index
		Tubificidae	Naididae	Not identified	Acarina	Collembola	Hemiptera - Corixidae	Trichoptera	Diptera(larva)-Chironomidae	Diptera(pupa)-Chironomidae	Not identified			
AUTUMN	4-C	154	329						110			593	2,67	2
	5-MD	159650	11404									171054	0,22	2
	5-ME	145177	3290	132							44	148643	0,28	4
	6-C	702										702	0,03	1
	7-MD	3114	88						44			3246	0,28	2
	7-ME											*		
	9-ME	175										175	0,25	1
	11-C	439							113159	10526	439	124563	0,92	2
SPRING	3-C				22				22	11	11	66	3,33	**
	4-MD	88										88	0,50	1
	4-ME	482	44									526	0,55	2
	5-MD	58334										58334	0,001	1
	5-ME	98904	219									99123	0,01	2
	7-MD											*		
	7-ME	1930										1930	0,02	1
	8-MD	88						44	307			439	1,80	2
	9-MD					132	44					176	1,25	3
	9-ME	132				88						220	1,20	2
	10-ME								44			44	1,00	**
	11-ME	88							921			1009	0,85	2

MD = sample collected on the right margin of the river

ME = left margin of the river

C = center of the river

* = Sample without organisms

** = The BI was not estimated, due to absence of indicator organisms required by the method.

Table 1. Density of benthic organisms (number/m2), Sequential Comparison Index (SCI) and Biotic Index (BI) for each sample

Station 8, located on a small tributary of Moji River (upstream of station 7), had sediment characteristics similar to Station 3. The benthic community at Station 8 was dominated by taxa tolerant to organic pollution but density was increased. This result suggests Station 8 is unbalanced, not severely polluted.

Perdido River - The results of SCI and BI were low at Station 9 but the occurrence of organic pollution is not indicated. The observation of fragments of organisms (a large number of carapaces of aquatic insects) and tar residues in the sediment indicate that a chemical factor affects the local environment.

Piaçaguera River - The low density of the organisms present in the single sample collected at Station 10 does not permit analysis of water quality. Sediment conditions were coarse sand, and gravel. The samples collected in Station 11, downstream from station 10, indicated serious organic pollution. Tolerant taxa in high density were observed, particularly in the Fall.

Cubatão River - The samples collected in Station 6 were dominated by Oligochaeta-Tubificidae, indicating organic pollution. Although sediment characteristics are favorable for the development of a community with high density, this was not observed. Station 6 may also be influenced by chemical pollution. Station 5, downstream from Station 6, had a benthic community dominated by tolerant taxa but density was high. This indicates possible recovery of benthic communities between Station 5 and Station 6.

Summary - At stations 5 and 11, where the Tubificidae and Chironomidae density was very high, from the four toxicity tests that were carried out with water and sediment, only one of them showed acute toxicity. So, the bottom fauna results indicated that the organic pollution probably predominates in these locations.

The Tubificidae density at station 7 showed less organic waste pollution than at station 5. Two factors may be interfering with organism density at that place: the sand dredging activity and the high toxicity of water and sediment.

At stations 4, 6, 8 and 9, besides the low indexes and low pollution tolerant forms density, the toxicity tests results were positive. At station 9, where the highest toxicity result was obtained, the presence of a large amount of carapaces of dead aquatic insects larvae was found in the sediment. One can infer that the adverse ambiental conditions according to the toxicity test results probably have a relevant role, limiting the benthic community development even for the most resistant organisms.

The low SCI and BI values obtained for stations 3 and 10 are probably due to physical factors, as no toxicity has been detected either in water or in sediment samples.

Benthic macrofauna studies were complementary to toxicity studies since organic pollution was clearly evident in some sampling stations (5 and 11). So we consider that this first attempt to correlate both biological approaches, ambient toxicity tests and bottom fauna studies was very positive and promising.

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