

## INDICATOR ORGANISMS OF POLLUTION IN COCHIN BACKWATERS

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### ABSTRACT

Indicator organisms of organic pollution in two localities in the Cochin backwaters are identified. The two sites have different sources of pollution, one from retting of coconut husk and the other from discharge of municipal wastes. *Paraheteromastus tenuis* a capitellid polychaete totally dominated the benthic community of the retting ground maintaining high population densities even during the pre-monsoon season when the adverse effects of pollution are severe. In the area of municipal waste discharge the community was dominated by a spionid worm *Prionospio polybranchiata*. This selective deposit feeder seems to be favoured by the organic enrichment. The two localities though only a few kilometres apart and with similar nature of pollution, the abiotic regime seems to encourage its own characteristic assemblages and indicators.

*Key-words* : Pollution, backwaters, Cochin, invertebrates.

### INTRODUCTION

Indicator organisms are used primarily to identify rather than to measure environmental changes. The cause for these changes may be the result of varying mixture of pollutants or of unknown causes. In stress condition the more sensitive organisms will be eliminated and successful species increase in numbers to dominate the community. These species while indicating pollution help in evaluating the effects of pollution.

The use of marine invertebrate animals or populations as indicators was first suggested by Wilhelmi (1916). Studies on the benthic indicator species of marine and freshwater pollution were carried out by several workers like Blegvad (1932), Gaufin and Tarzwell (1952), Reish (1957), Hynes (1966), Bagge (1969), Henrickson (1969), Butler, Andern, Bonde, Jernelov and Reish (1972), Arlet (1975), Anger (1975) and Philips (1977).

This paper presents indicator organisms of two organically polluted areas in Cochin backwaters.

### MATERIALS AND METHODS

Cochin backwaters receive considerable amount of sewage effluents through a network of large and small canals and by rain washings. These drainages contain turbid liquids with large amounts of putrescible organic material. A retting yard is located about 4 km upstream of barmouth on the

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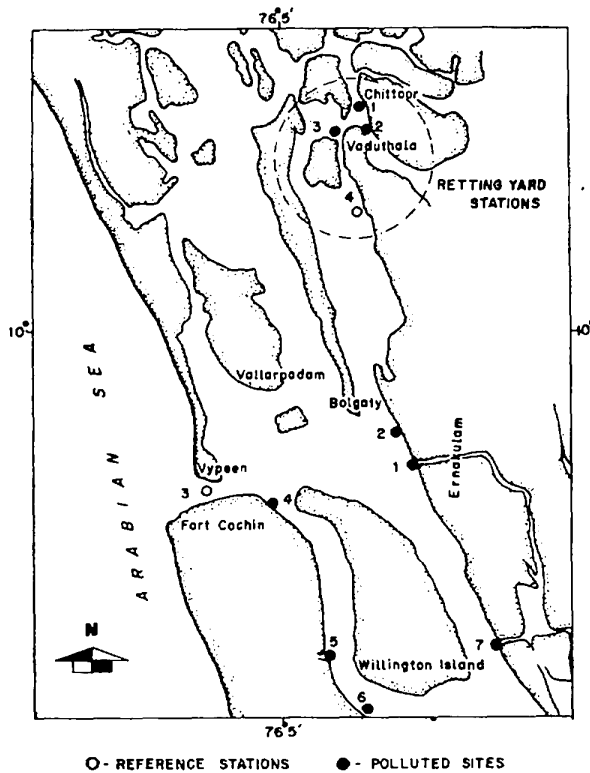


Fig. 1. Station location map.

northern arm of Cochin backwaters. It has an area of about 2,000 m<sup>2</sup> and an average depth of 2.5 m. Wells of about 3 m are sunk here and coconut husk kept for retting for about 7 months. Six stations from the sewage discharge site and one clean station near barmouth; three stations within the retting yard and one reference station away from the area were investigated for one year each (Fig. 1). Fortnightly collections were made from the sewage discharge site during the year 1974-75. Monthly collections were made from retting yard during 1975-76. Water, mud and benthic samples were taken. Van Veen grab (0.048 m<sup>2</sup>) was used for collecting benthos. Macro benthos was separated by a 0.5-mm mesh sieve. Water and mud samples were analysed using standard procedures.

#### RESULTS AND DISCUSSION

Variations in some environmental features in one of the sewage polluted sites and the reference station near barmouth over an year are shown in Fig. 2.

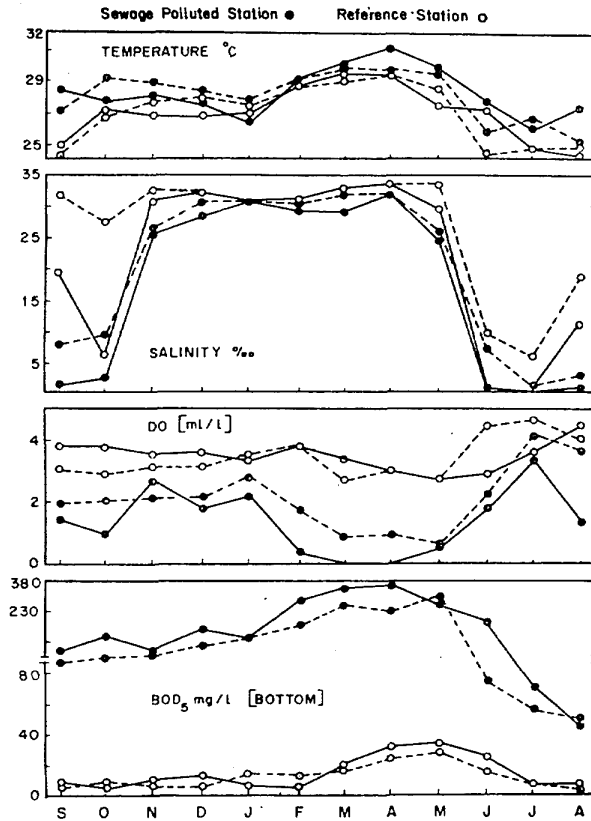


Fig. 2. Seasonal variations of some environmental features at a sewage polluted station and the reference station. (— High tide and - - - Low tide).

Temperature and salinity distribution showed a seasonal cycle that could be expected in a monsoonal estuary. No changes in these parameters, specific to sewage discharge could be noticed. The tidal variations also were not very large. The range of these were

	Discharge site	Reference Station
Temperature (T °C)	28.5-32.2	25.8-30.8
Salinity (S‰)	0.6-32.2	1.0-34.3

Dissolved oxygen was considerably influenced by sewage discharge and so also were BOD<sub>5</sub> and total sulphides. Oxygen values were very low at the discharge site in dry months, the depletion being more marked at low tide. Total sulphides and BOD<sub>5</sub> varied inversely with dissolved oxygen (Unnithan, Vijayan

and Remani, 1975; Vijayan, Remani and Unnithan, 1976). The range of values for these parameters were :

	Discharge site	Reference Station
Dissolved oxygen (ml/l)	0.05-4.4	2.68- 3.81
Bottom BOD <sub>5</sub> (mg/l)	51.00-370	6.84-32.16
Total sulphides (mg/l)	nil-4.9	negligible

At the reference station the dissolved oxygen levels were high and BOD<sub>5</sub> were low. No detectable sulphides were present. Bottom sediments at the polluted sites and the reference station had 35-60% and 20-40% finer fractions respectively (Remani, 1979). Finer fractions were more during the pre and post-monsoon seasons. Colour of the sediment at polluted sites was black or greenish indicating reducing conditions.

From the sewage discharge site 45 species belonging to coelenterata, sipunculoida, crustacea, mollusca and polychaeta were collected. Nineteen species belonging to polychaeta, mollusca and crustacea were collected in and around the retting yard. The benthic fauna of both regions showed characteristic assemblages. The fauna may broadly be categorised into three groups :

Group A : Species of high abundance favoured by pollution.

Group B : Species indifferent to or favoured by lower levels.

Group C : Species which are absent in polluted sites.

Group A is dominated by polychaetes. To this group belongs, *Prionospio polybranchiata*, *Paraheteromastus tenuis*, *Lycastis indica*, *Dendronereis aestuarina*, *Scyphoproctus djiboutensis* and a tanedacean *Apsedes chilensis*. To group B belongs polychaetes like *Nephtys polybranchia*, *N. oligobranchia*, *Lunbriconereis polydesma*, *L. simplex* and the bivalve *Pendora flexuosa*. Group C has *Diopatra neapolitana*, *Sthenalis bou* and *Lepidonotus tenuisetosus*, all polychaetes and the isopod *Cirolina fluviatilis* along with sea anemones, brittle stars and crustaceans. A similar grouping could be applied to the retting yard fauna also with appropriate changes in species involved. Bagge (1969) refers to a similar type of classification of benthic animals in relation to pollution in Saltkallefjord (West Sweden). He noticed indifferent species which showed an incomplete affinity to polluted habitat though they were not totally absent in the polluted area. This leads to the conclusion that even though they tolerated pollution effects to some extent, they preferred a cleaner environment.

Twentythree species of crustaceans were collected of which only *Apsedes chilensis* (Tanedacea) was common to both polluted and clean water. The most dominant group was polychaetes of which there were 20 species. Four species were absent at polluted sites. Thus a reduction in the number of species was noted in the area of discharge and lower diversity. At the discharge site the contribution of polychaetes to the total fauna was 18% as against 1.2% at the reference station. Among the polychaetes epibiotic suspension feeders seemed to suffer from changes in the substratum. Deep burrowing limivorous



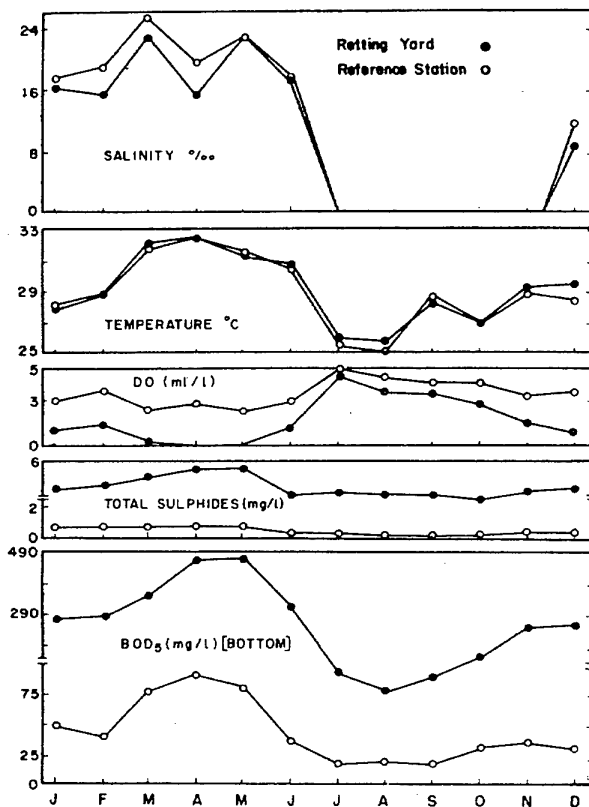


Fig. 3. Seasonal variations of some environmental features at the retting yard (●) and the reference station (○).

salinity liberated more organic matter into the medium in dry months. The trends of variations of these parameters were similar at the reference station where salinity was slightly higher, and oxygen,  $BOD_5$  and total sulphides were less than that of the retting yard. The bottom deposits in the retting yard also showed predominance of finer fractions (70–80%), enrichment in organic matter and high C/N ratios (Remani, Venugopal, Sarala Devi and Unnithan, 1981). The annual ranges of environmental parameters are:

	Retting Yard	Reference Station
T (°C)	25.6–32.5	24.9–32.5
S (‰)	0.21–22.9	0.21–25.9
D.O (ml/l)	0.30– 4.7	2.4– 5.2
Bottom $BOD_5$ (mg/l)	77 – 478	17 –89.3
Total Sulphides (mg/l)	2.36–4.6	0.32– 0.96

Crustaceans, molluscs and polychaetes constituted the benthic fauna in the area of study. The crustacean fauna comprised of one species of tanadacean, 2 gammarid amphipods and 2 crabs. Of these only the tanadacean, *Apseudes chilensis* occurred in fair numbers at the retting yard. Occasionally the amphipod *Grandidiierella gilesi* was also seen. Crabs were totally absent here. Of the 3 species of molluscs only *Pendora flexuosa* was present in good numbers during the premonsoon. Out of the 11 species of polychaetes, 7 were either absent or present only in very small numbers at the retting yard. Polychaetes formed 48% of the fauna at the retting yard while their contribution at the reference station was only 2%.

Table II shows the frequency of occurrence and percentage contribution of polychaetes at the retting yard. The dominance of capitellid polychaete *Paraheteromastus tenuis* in terms of frequency of occurrence and percentage would be obvious. The density of *P. tenuis* varied from 270–5100/m<sup>2</sup>. *Prionospio polybranchiata*, the next most common form failed to achieve the dominance that *P. tenuis* exerted.

Table III presents the correlation coefficients between the polychaete species and the environmental factors. *Paraheteromastus tenuis* showed positive correlation with all the parameters, the correlations being significant only in the case of salinity, organic carbon and organic nitrogen ( $P < 0.01$ ,  $P < 0.5$ ,  $P < 0.01$ ). At reference stations, the species showed significant positive correlation with temperature, salinity, organic carbon and silt and clay at different levels. In the case of dissolved oxygen significant negative correlation was observed. Organic nitrogen also showed low negative correlation. It was significant to note that *Prionospio polybranchiata* was positively correlated with all parameters except dissolved oxygen which showed high negative correlation, but showed significant positive correlation with dissolved oxygen ( $P < 0.001$ ) at the reference station.

Table II. Frequency of occurrence and percentage contribution of Polychaetes at Retting Yard (Stns 1-3) and Reference Station (Stn 4).

Names of species	Stn 1		Stn 2		Stn 3		Stn 4	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
<i>Lumbriconereis polydesma</i>	0 12	0	0 12	0	0 12	0	2 12	0.5
<i>L. simplex</i>	0 12	0	0 12	0	0 12	0	1 12	2
<i>Glycera alba</i>	1 12	1.3	1 12	0.3	2 12	0.7	4 12	15
<i>Scyphoproctus djiboutiensis</i>	5 12	4	4 12	3.5	6 12	10	0 12	0
<i>Dendronereis aesturina</i>	4 12	4	5 12	3.2	5 12	14	2 12	1.5
<i>Perenereis cavifrons</i>	0 12	0	0 12	0	2 12	1.5	7 12	36
<i>Nephtys polybranchia</i>	1 12	0.2	1 12	0.2	1 12	1.3	6 12	9
<i>N. oligobranchia</i>	0 12	0	0 12	0	1 12	1	6 12	4
<i>Paraheteromastus tenuis</i>	12 12	68	12 12	61	8 12	40	7 12	21
<i>Prionospio polybranchiata</i>	11 12	16	10 12	25	7 12	21	6 12	7
<i>Owenia</i> sp.	2 12	1.5	2 12	1.3	1 12	0.5	6 12	3.5

Table III. Correlation coefficients between indicator organisms and some abiotic

Abiotic factors	Paraheteromastus tenuis		Prionospio polybranchiata	
	Retting Yard Stations	Reference Station	Sewage Polluted Stations	Reference Station
Temperature (°C)	+ 0.224	+ 0.990 <sup>d</sup>	+ 0.979 <sup>d</sup>	+ 0.833 <sup>a</sup>
Salinity (‰)	+ 0.935 <sup>d</sup>	+ 0.969 <sup>d</sup>	+ 0.889 <sup>b</sup>	+ 0.958 <sup>c</sup>
Dissolved Oxygen (ml/l)	+ 0.687	- 0.979 <sup>d</sup>	- 0.982 <sup>d</sup>	+ 0.998 <sup>e</sup>
Bottom BOD <sub>5</sub> (mg/l)	+ 0.149	+ 0.267	+ 0.996 <sup>e</sup>	+ 0.408
Total Sulphides (mg/l)	+ 0.096	+ 0.017	+ 0.983 <sup>d</sup>	—
Organic Carbon (mg/g)	+ 0.892 <sup>b</sup>	+ 0.999 <sup>e</sup>	+ 0.917 <sup>b</sup>	+ 0.206
Silt & Clay (%)	+ 0.680	+ 0.984 <sup>d</sup>	+ 0.974 <sup>d</sup>	+ 0.958 <sup>c</sup>
Organic Nitrogen (mg/g)	+ 0.973 <sup>d</sup>	- 0.044	—	—

a → P < 0.1;    b → P < 0.05;    c → P < 0.02;    d → P < 0.01;    e → P < 0.001

Thus the two areas in Cochin backwaters a few kilometres apart from one another with the same type of pollutant load encourages two different species to proliferate. The subtle pressures exerted by the environment could be responsible for this.

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