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EFFECT OF TANNERY WASTES ON THE PHYTOPLANKTON

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ABSTRACT

River Cauvery is among the major perennial rivers of South India and River Bhavani is one of its major tributories. A channel of River Bhavani is diverted from Kalingarayan anicut which forms the Kalingarayan Channel. The total length of the channel is 90 km and the total capacity 580 Cu.secs. Tanneries under investigation are located on the right of Kalingarayan Channel at Bhavani-Erode Main Road. Five sampling stations were fixed covering the unpolluted zone, polluted zone and zone of recovery.

The parameters studied showed a high value at the effluent station, and at the point of admixture of tannery effluent and channel water the values were reduced. Further down, there is a decreased rate indicating either full or partial recovery. The phytoplankton counts clearly indicate that there is a reduction in the number of the species and in the total number of the species, and in the total number at the point of admixture of the effluent and channel water Oscillatoria formosa, Navicula lanceolata and Nitzschia scalaris are pollution tolerant algal species. A pollution index for tannery effluent was also proposed.

INTRODUCTION

Discharging the tannery effluent into the river system in India is very common, as a number of small scale tanneries which utilize considerable amounts of water are situated along side the channel. Tannery is one of the major industries in Tamil Nadu, India and one of the industrial wastes responsible for water pollution. The discharge of the effluent into the stream depletes the dissolved oxygen, destroys the aquatic life and renders the stream unsuitable for community water supply and other beneficial uses.

The present investigation deals with the effect of tannery effluent on the phytoplankton of a channel called Kalingarayan Channel at Erode (Tamil Nadu, India). Kalingarayan Channel branches off from river Bhavani and runs independently parallel to River Cauvery for a distance of 90 km with the capacity of 580 cu.secs. and finally joins River Cauvery. There are about 112 small tannery units on the right of Kalingarayan Channel and the tannery effluent is discharged into this channel. Five different sampling stations were identified to study the impact of pollution and thus station I represents the unpolluted zone, station II effluent, station III admixture of effluent and channel water, station IV and V recovery zones. Analysis of water samples was done as per standard methods (APHA, 1975) and the phytoplankton was identified by using the published monographs.

RESULTS

The results of physico-chemical analysis are given in Table I. Tannery effluent has a characteristic pungent odour due to the presence of certain chemicals, tannin, raw skin and flesh. The colour of the effluent was dark brown to light brown and depends upon the tannery washings. In the present investigation temperature has no significant impact on the biota. Turbidity, pH, bicarbonate, total dissolved solids, chlorides, total chromium, tannin and lignin content of the effluent were always higher than at other stations. Due to the mixing of the channel water at station III, the values were slightly reduced and at down stream there is further reduction showing either partial or complete recovery at station V. The pH was always towards the alkaline side and an alkaline pH is believed to provide the optimal conditions for the favourable growth of Cyanophyta and Chlorophyta, while low pH is responsible for the high percentage of Euglenophyta and desmids. There is always an inverse relationship between the dissolved oxygen and free carbon dioxide. Station II recorded nil value for dissolved oxygen throughout the period of investigation but the value of carbon dioxide was very high. As there is no phytoplankton at this station there is no photosynthetic activity and this is probably the reason for the presence of free carbon dioxide at this station.

Being an important parameter, the BOD value clearly indicates the pollution load at station II, hence it affects the biota directly. The amount of total chromium exceeds the permissible limit of ISI standards, 2 mg/l, (Sastry, 1975) only during March 1982 at station II, but when it mixes with the effluent the value comes down to 2 mg/l. The dark brown colour of the effluent is due to the presence of tannin and lignin, hence it could be considered as an aesthetic pollutant. The stagnation of the effluent near tanneries gives very strong odour. Tannins reduce the available oxygen and this increases the biological oxygen demand.

During the period of investigation algae belonging to four major divisions namely Cyanophyta, Cholorophyta, Bacillariophyta and Euglenophyta were encountered (Table II). Totally 18 species of algae comprising 3 species of Cyanophyta, 7 species of Chlorophyta including 2 desmids, 7 species of Bacillariophyta and 1 specie of Euglenophyta were recorded. Their proportions, however, varied monthwise and stationwise. Generally the Cyanophyta and Bacillariophyta constituted the bulk of algal population while Chlorophyta showed some fluctuation depending upon the water quality, Euglenophyta represented by a single species formed approximately 1% of the total algal population. The algal flora was generally rich at station I, and at station III species diversity was always less with a few dominant tolerant algal species, while at station V the algal content was more or less similar to that of station I.

Among Chlorophyta, the occurrence of Spirogyra Parodoxa was closely parallel with the occurrence of Chlorophyta. Ulothrix

TABLE I

Physico-Chemical Characteristics of Kalingarayan Channel

	Physico-chemical Factors	Sampling Stations I	II	III	IV	V
1.	Turbidity	8-20 NTU	120-180 NTU	96-120 NTU	32-80 NTU	8-68 NTU
2.	pH	7.2-8.5	7.6-8.6	7.4-8.5	7.3-8.5	7.4-8.5
3.	Bicarbonates	90-240	130-620	112-500	90-370	30-330
4.	Dissolved oxygen	5.96-8.22	NIL	0-6.8	2.5-6.9	3.69-7.2
5.	Free carbon dioxide	2-8	4-16	2-10	2-10	2-8
6.	Total dissolved solids	100-2780	460-5635	205-3645	100-3325	100-2780
7.	Chlorides	17.73-42.56	95.76-1344.31	35.47-319.23	24.83-63.84	19.02-46.11
8.	Total chromium	0-0.6	0.1-2.4	0-2.0	0-1.8	0-1.5
9.	Tannin and Lignins	15-99	82-1818	52-292.5	20-232.5	15-201
10.	Biochemical oxygen demand	-----	3000-4000	-----	-----	-----

All values, except for the pH, are expressed in mg/l.

TABLE II

List of the Species Encountered with Frequency of Occurrence at Various Stations

Algal genera and species	Sampling Stations		
	I	III	V
1. Oscillatoria formosa	0 - 1500	0 - 990	0 - 1410
2. Oscillatoria curvicebs	0 - 510	0 - 430	0 - 490
3. Phormidium ambiquum	0 - 20	NIL	NIL
4. Scenedesmus quadricauda	0 - 10	NIL	NIL
5. Tetraspora gelatinosa	0 - 10	0 - 10	0 - 10
6. Ulothrix tenerrima	0 - 120	0 - 20	0 - 30
7. Opedogonium nodulosum	0 - 260	0 - 20	0 - 70
8. Spirogyra paradoxa	0 - 1510	0 - 1100	0 - 930
9. Closterium acerosum	0 - 80	NIL	0 - 40
10. Cosmarium subspeciosum	0 - 10	NIL	NIL
11. Tabellaria flocculosa	0 - 100	0 - 70	0 - 90
12. Terposinoe musica	0 - 20	NIL	NIL
13. Fragillaria capucina	0 - 400	0 - 120	0 - 160
14. Pinnularia viridis	0 - 70	0 - 20	0 - 40
15. Navicula canceolata	0 - 820	0 - 420	0 - 800
16. Navicula spicula	0 - 110	0 - 70	0 - 110
17. Nitzschia scalaris	0 - 210	0 - 180	0 - 190
18. Euglena viridis	0 - 90	0 - 30	0 - 60

tenerrima, Oedogonium nodulosum were rare in occurrence while Cosmarium subspeciosum Nordet and Closterium acerosum Ehrenb were identified at station I and were completely absent at station III and rarely found at station V.

Cyanophyta was found throughout the period of investigation except in July 1981 when filamentous algae were totally absent. This group was represented by Oscillatoria formosa Bory ex Gomont and Oscillatoria Curviceps Ag. ex. Gomont and rarely by Phormidium ambiguum Gomont.

Navicula lanceolata Kutz, Navicula spicula, cleve, Nitzschia scalaris (Shr) W.sm., Fragilania capucina desmaziers, Tabellaria flucculosa (Roth) Kutz, Pinnularia viridis (Nitzsche) Ehr Terpsinoe Terpsinoe musica Ehr. were species of Bacillariophyta recorded during the course of investigation. At all the sampling stations Navicula lanceolata and Nitzschia scalaris were present. Fragilaria Capucina was the only type of diatom and phytoplankton present in July 1981 and it was absent from September to December 1981 from all stations. Tabellaria flucculosa (Roth) Kutz, Pinnularia Viridis (Nitzsche) Ehr., Terpsinoemuscia Ehr., were rarely found. The diatoms were epiphytic on the filaments of Oscillatoria formosa from March to May 1981. When the flow of water in the channel was resumed after the dry period in June 1981, only diatoms made their appearance. Euglenophyta was very rare and represented by Euglena viridis Ehr. The diversity index (Gleason 1922) shows a low value at the polluted zone.

DISCUSSION

Algae were recognized as indices of organic pollution by Kolkwitz (1950), Pavalovska (1950), Liebmann (1951), Uherkovich (1962, 1964), Fjerdingstad (1962,1964), Palmer (1963,1969), Breitig (1970), Hortobagyi (1973) and Hosmani and Barati (1980).

In the present study, station I is comparable to the Katharobic Zone characterized by clean water, nil pollution load, saturated dissolved oxygen and rich algal flora. Station II is a polysaprobic zone with a high degree of pollution, nil oxygen content and free of algae. Station III with its strong but diminishing pollution load owing to dilution and decreased oxygen content could be compared to the mesosaprobic zone. This station is biologically important as it showed the pollution tolerant algal species such as Oscillatoria formosa, Navicula lanceolata and Nitzschia scalaris. Station IV and V could be compared to the oligosaprobic zones with weak or nil pollution load, improved dissolved oxygen and recovery and establishment of algal flora as that of station I. The pollution index of Kalingarayan Channel cannot be calculated using the indeces suggested by the previous workers (Nygaad 1949, Hortobagyi, Horaswas and Govindan 1981) as their studies were based on a totally different system. The unique feature of the present site of study is that it affords a good example for single point pollution with effluent from a single industry. From the results it is clear that Cyanophyta and Bacillariophyta are tolerants of tannery effluent pollution as practically as species belonging to those groups are found at station III. Several species of Chlorophyta and Euglenophyta are sensitive to tannery effluent and therefore, at station III, the Chlorophyta shows not only a reduction in total number but also in

TABLE III

Pollution Index for Tannery Effluent on Kalingaryan Channel

Stations	Number of Species Encountered				
	Cyanophyta	Bacillariophyta	Chlorophyta	Euglenophyta	Pollution Index
I	31	39	59	11	1.8
III	29	13	50	2	5.3
V	30	30	56	10	2.15

the number of species while the single species of Euglena was absent. Based on the above observations a pollution index for tannery wastes may be obtained as follows:

$$\text{Pollution index} = \frac{\text{No. of species of Cyanophyta + Bacillariophyta}}{\text{No. of species of Chlorophyta and Euglenophyta}}$$

The pollution index calculated by the total count of species encountered in different months of study is given in Table III. When the pollution index exceeds 2 the station is considered to be a polluted zone.

The periodicity and distribution of Cyanophyta was associated with high temperature and low dissolved oxygen and thus this group serve as indicators of pollution. Distribution of diatoms has been considered to reflect the average ecological conditions and where there is higher concentration of dissolved oxygen. Thus the number of Chlorophyta decreased when there was a high pollution load and less dilution. The limitations in the existence of desmids may be due to the greater population of Cyanophyta and high alkalinity. An inverse relationship was proposed between Bacillariophyta and Euglenophyta. Members of Euglenophyta are scarce in fast flowing water. The high pH value might have been a limiting factor for Euglenophyta.

Thus this study affords a good example for single point pollution with effluent from a single industry.

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