The Indian Zoologist, Vol. 13, Nos. 1 & 2, 1989, pp. 79-83.

# Some aspects of Biological studies of an organically polluted urban stream in Ranchi II. Macro benthic fauna

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**Abstract.** The macro benthic fauna of Hinoo river, an organically polluted urban stream, has been studied, and the recorded data have been discussed qualitatively and quantitatively for assessment of pollution. The importance and application of pollution indices based on biological data for stream monitoring have been dealt with including the implementation of indicator species concept.

## Introduction

Pollution concerns us since its adverse effects ultimately affect organisms including man. So far the pollution of streams is concerned, much concern about stream pollution stems from the effects of pollution on the stream biota. Conversely, however, natural changes induced by pollution of stream, biota provide a method for assessment of pollution; biological examination may provide a more accurate picture than physico-chemical examination (Hirsch, 1958; Hynes, 1960; Sarkar and Krishnamoorthi, 1977). In aquatic systems, the benthic macro-invertebrate community is most often investigated for the same due to absence of mobility and sensitivity towards physico-chemical stress.

Several workers have pointed out that benthic organisms provide a valuable indicator of past and present water quality conditions and prove to be the most useful in assessment of pollution (Hynes, 1960; Rama Rao *et al*, 1978) because of their life-cycle length, central position in food chains and ease of sorting and preservation (Mackenthum, 1966; Cairns and Dickson, 1971; Brinkhurst, 1972). Further a relatively clear picture of state of pollution is obtained in numerical terms by computing the biological data for diversity indices. Several diversity indices have been proposed (Fisher *et al*, 1943; Preston, 1948; Good, 1953; Brilloutin, 1960), but one of the most promising indices of species diversity measure is derived from the information theory (Patton, 1962). In estimating the total community diversity, probably the most widely used index is Shannon-Weaver equation (1964), since other indices relate to uncertainty that exists regarding the species of an individual selected at random from a population.

In the present study the community structure of benthic macro invertebrates along with certain physico-chemical parameters has been investigated during winter and summer season of 1980-1981 of a **6** km stretch of the Hinoo river falling in the urban area of Ranchi to evaluate its stream condition from pollutional view point.

*Study Area*

Except in monsoon period the stream has very slow flow with high pollutant load as it has virtually become a repository of sullage, septic tank overflow, domestic wastes and flow of fecal matters with dirty smell. The course of flow of the stream and the six sampling sites have been shown in the Fig. 1.

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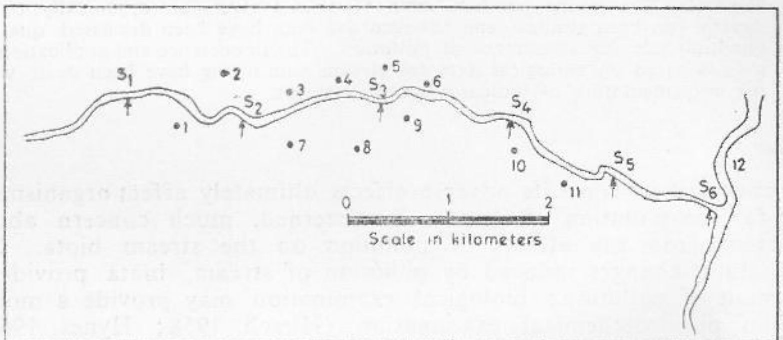
## Materials and Methods

Standard methods were followed (APHA, 1965) for analysis of physico-chemical parameters.

For studying the macro benthic invertebrates the collections were made at six centres by means of Ekman's dredge (523 sq. cm). Three dredgings constituted a sample of macro fauna, which was sieved through a metallic guage (256 meshes/ sq. cm). The residual organisms were sorted out and enumerated group-wise and expressed as number per metre sp. and computed for results.




| SAMPLING SITES | • IMORTANT PLACES OF URBAN AREA ALONG HINOO RIVER | |
|---|---|---|
| $S_1$ – Site I | 1 Railway Bridge | 7 Hinoo Chowk |
| $S_2$ .. II | 2 Ispat Hospital | 8 Hinoo Township |
| $S_3$ .. III | 3 Nirmala College | 9 Kadru Township |
| $S_4$ .. IV | 4 Darji Mohalla | 10 B.S.E.B. Rest House |
| $S_5$ .. V | 5 Doranda Bazar | 11 Chutia Township |
| $S_6$ .. VI | 6 Doranda | 12 Subarnarekha River |

Fig. 1 Map showing Hinoo River and adjucent locality & sampling Sites

## Results

The most common types of benthic fauna found during the investigation and their percentage composition has been presented in Table 1. The data obtained have been computed for species diversity index by Shannon Weaver & Margalef equation and has been set in Table 2, while Table 3 includes the data on certain physico-chemical characteristics of stream water.

The percentage of population shows that the invertebrate macro benthic fauna of the stream has been dominated by *Chironomus* larvae and Oligochaets. The Oligochaets were mainly represented by the family Tubificidae.

## Discussion

A number of authors have stressed the importance of changes in the whole benthic communities in organic pollution studies (Patric, 1950; Hawkes, 1962; Fjerdingstad, 1964; Cairns *et al*, 1972).

The decreased species richness and the dominance of benthic community by an oligochaet *Limnodrilus hoffmeisteri* and *Chironomus* larvae as has been recorded during the present study are indicative of organic pollution. Further the abundance of worm relative to other organisms as well as the relative abundance of a worm species (here *Limnodrilus hoffmeisteri*) is self-evident case of high organic pollution (Brinkhurst, 1972; Johnson and Brinkhurst, 1971).

**Table 1.** Occurrence of most abundant benthic macrofauna expressed in terms of percentage; symbol + denotes presence less than 1%.

| Benthic forms | Site I | Site II | Site III | Site IV | Site V | Site VI |
|---|---|---|---|---|---|---|
| *Aeolosoma bengalensis* | 5.9 | 10.2 | | 6.2 | 11.3 | 6.8 |
| *Limnodrilus hoffmeisteri* | 32.6 | 30.4 | 38.2 | 21.5 | 28.3 | 10.3 |
| *Tubifex tubifex* | 22.5 | | 16.4 | 6.6 | 9.2 | 9.6 |
| *Pherelima* sp. | 1.2 | | | + | | 2.1 |
| *Hirudo biranica* | 3.4 | | 1.6 | 2.3 | 3.2 | |
| *Hirudinaria* sp. | | 2.1 | | 2.3 | 1.8 | 2.3 |
| *Viviparus bengalensis* | + | | 1.2 | + | | 1.9 |
| *Lymnea palustris* | 1.6 | 2.3 | – | – | – | 3.4 |
| *Lymnea acuminata* | + | + | | + | 1.8 | + |
| *Sphaeridium* sp. | + | + | 1.8 | + | + | 7.2 |
| *Digoniostoma pulchella* | 1.9 | | | | | 4.3 |
| *Indoplanoribs exustus* | | 1.2 | | | 1.2 | 4.6 |
| *Planorbis sp.* | 2.3 | | | | 1.2 | 9.8 |
| *Pila globosa* | | 2.4 | | | | |
| *Pleurocerca sp.* | | | 2.4 | + | 3.2 | – |
| Margaritifera sp. | | 1.8 | | + | | 1.2 |
| Chironaus larvae | 22.3 | 40.4 | 37.8 | 53.4 | 31.3 | 19.4 |
| Phryganea sp. | | 3.2 | + | | 1.7 | 1.2 |
| Dythemis sp. | 1.2 | 1.2 | + | + | 2.4 | 1.7 |
| Demselfly nymph | 1.2 | | 2.1 | + | | 1.6 |
| Mayfly nymph | + | 3.2 | + | + | 4.2 | 1.2 |
| Dragonfly nymph | 1.3 | | + | | + | 1.3 |

**Table 2.** Species diversity indices based on Shannon-Weaver and Marglef equations.

| Site | No. of Species | No. of individual | Shannon-Weaver diversity index | Pollutional status | Marglef diversity index = D | Pollutional status |
|---|---|---|---|---|---|---|
| I | 18 | 1727 | 1.5 | Moderately polluted | 2.280 | Commonly D = 1.0-5.0, the larger the index a more healthy body of water. When D tends towards 1.0 pollution is increased and a damage should be suspected. |
| II | 12 | 1835 | 0.6 | Heavily polluted | 1.463 | |
| III | 11 | 2010 | 0.5 | do | 1.347 | |
| IV | 13 | 2225 | 0.4 | do | 1.556 | |
| V | 12 | 2115 | 0.3 | do | 1.436 | |
| VI | 24 | 789 | 1.7 | Mod. polluted | 3.714 | |

**Table 3.** The range of variation in some physico-chemical characteristic of the stream at different sites. (in mg/l)

| Parameters | Sites | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| Temperature °C | 17–32 | 18–31 | 17–33 | 18–32 | 18–33 | 17–31 |
| pH | 6.2–7.0 | 6.0–7.0 | 6.9–7.5 | 6.6–7.8 | 6.4–7.4 | 6.2–7.3 |
| Dissolved oxygen | 6.0–7.5 | 4.0–6.5 | 3.2–6.6 | 2.5–5.6 | 2.8–5.9 | 4.6–7.8 |
| B. O. D. | 40.0–60.0 | 48.0–85.0 | 90.0–130.0 | 120.0–130.0 | 98.0–135.0 | 60.0–80.0 |
| Total Alkalinity | 50.0–110.0 | 80.0–136.0 | 110.0–220.0 | 105.0–260.0 | 90.0–250.0 | 80.0–90.0 |
| Suspended Solids | 150.0–210.0 | 180.0–340.0 | 210.0–38.0 | 190.0–350.0 | 250.0–410.0 | 150.0–180.0 |

Richardson (1928) after his studies of Illinois River subjected to increasing amounts of raw sewage and other forms of organic pollution presented a provocative list of macro benthic fauna in the approximate order of species tolerant to the varying degree of organic pollution from sewage and sulges. The category of species described as pollutional included *Tubifex tubifex Limnodrilus hoffmeisteri, Tendipes decorus* and *Limnodrilus claparedianus*. He got the maximum concentration of Tubificidae (chiefly *Limnodrilus hoffmeisteri*). The high concentration of *Limnodrilus hoffmeisteri* is hence indication of high organic pollution, *per se*, and may be taken as an indicator organism in Indian conditions.

Prediction of pollution condition by species diversity is taken as one of the reliable methods of biomonitoring. Species diversity indices are theoretically based on combination of species richness and species evenness components (Pielou, 1969), thus containing two of the elements altered by pollution. Pielou (1969) reported that the Shannon-Weaver equation never gave an unbiased approximation of diversity, but diversity was only estimated. According to Bowman *et al* (1976) the diversity calculated by this method approximates normal distribution and routine statistical interference are justified. Based on the diversity index, so derived, Wilhm and Dorris (1966) have proposed a relationship between species diversity and pollutional status of the sampling sites. Staub *et al* (1970), however, have also proposed the state of pollution based on the scale of species diversity.

On the basis of both the scales (Wilhm and Dorris, 1966; Staub *et al*, 1970) site I and site VI are moderately polluted while the rest sites are heavily polluted. The spectrum of species richness at different sites is in accordance with the findings of Gaufin and Tarzwell (1956) and Wilhm (1970) who reported a high value of species richness as synonymous of clean water and a low richness as indicative of polluted situation.

The high BOD together with the low concentration of dissolved oxygen has been found to be characteristics of high organic pollution. A similar physico-chemical condition was recorded during the present study. Under such condition bacterial activities are high and the bacteria in turn become the food of oligochaets forming the base of their dominance.

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