BIO-MONITORING OF SURFACE WATERS USING MACRO-ZOOBENTHOS AS INDICATOR ORGANISMS

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ABSTRACT : In Riverine system, the ecological concept comprises of abiotic and biotic components. The scientific approach in water quality assessment in its entirety involves the analysis of physical (temperature, colour, odour etc.), chemical (pH, DO, BOD, COD etc.), biological (plankton, benthic macro-invertebrate, fish etc.) and microbiological parameters (Total Coliform, Faecal Coliform and Faecal Streptococci). Aquatic biota assessment provides the information about the biological integrity of aquatic ecosystem. Biological surveillance of benthic macro-invertebrate communities with special emphasis on characterizing taxonomic richness and composition, is the most sensitive tool for river health assessment and is essential to identify the biological responses of river to human activities.

KEY WORDS : River, Ecosystem, Macro-zoobenthos, Bio-monitoring, Indicator organisms.

INTRODUCTION

The first major attempt to conserve and protect the environment at the international level was the Stockholm Declaration, 1972, according to which, legislative measures were required to be adopted by the States to protect and improve the environment. Accordingly, 02 Articles were inserted by the Indian Parliament in the Constitution of India in 1976:

1. Article 48A- Rightly directs that the State shall endeavour to protect and improve the environment and safeguard forests and wildlife of the country.
2. Article 51A- Clause (g) of Article 51A imposes a duty on every citizen of India, to protect and improve the natural environment including forests, lakes, river, and wildlife and to have compassion for living creatures.

The cumulative effect of Articles 48A and 51A (g) seems to be that the 'State' as well as the 'Citizens' both are now under constitutional obligation to conserve, perceive, protect and improve the environment (Agarwal, 2005).

Rivers are the dynamic physical, chemical and biological entities (Norris and Thoms, 1999) and these are among the most endangered ecosystems worldwide. Therefore, comprehensive methods are required to evaluate the actual state of riverine ecosystems and to monitor their rate of changes (Li *et al*., 2010). Conventional methods for water quality monitoring are based on the use of physico-chemical attributes such as Dissolved oxygen, pH, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), mercury etc., but are considered insufficient as it only monitors the physico-chemical aspect of river neglecting the complex ecosystem itself (Selvanayagam and Abril, 2016). Moreover, a particular chemical cannot be termed as pollutant unless and until it is not causing any deleterious effect on the biota. That is why, the physico-chemical parameters are called as cause parameters and the biological parameters are termed as effect parameters. The integrated and comprehensive assessment of riverine ecosystem health involves the evaluation of both physico-chemical and biological parameters in correlation with each other.

A range of biological groups including lower trophic level organisms like algae or benthic macro-invertebrates and higher trophic level organisms like fishes can be used for the purpose. The biological group to act as indicator of water quality should not only indicate the long-term interaction of several environmental conditions, but also react to a sudden change of the important factors (Kenney *et al.,* 2009). An "ideal" indicator at least should have the characteristics as follows: (a) taxonomic soundness (easy to be recognized by non-specialist); (b) wide or cosmopolitan distribution; (c) low mobility (local indication); (d) well-known ecological characteristics; (e) Numerical abundance; (f) suitability for laboratory experiments; (g) high sensitivity to environmental stressor (s); (h) high ability for quantification and standardization (Rosenberg and Resh, 1993; Hilty and Merenlender, 2000; Füreder and Reynolds, 2003).

Aquatic macroinvertebrates being sedentary, long lived, ubiquitous, and sensitive to environmental changes, react strongly and predictably to the sudden environmental conditions. (Weber, 1973). Also, these organisms form the basis of the trophic level and any negative effect caused by pollution in the community structure can in turn affect trophic relationships. Benthic macro-invertebrates convert low quality low energy detritus into high quality high energy food for larger consumers in complex food webs (Thoker *et al*., 2015). These features make them the good indicators of water quality.

The method required to carry out biological assessments on routine basis using indicator organisms, should be: i). rely only on identification to the family level, ii) not specific to any single river catchment or geographical area, iii) less effort and iv) less taxonomic expertise. One such method, the Biological Monitoring Working Party score (BMWP) has been standardised by the International Organization for Standardization (ISO).

The Principle of this method is to collect benthic macro-invertebrates from different habitats (e.g. boulders, cobbles, pebbles, gravels, sand, silt, clay, detritus, macrophytic vegetation etc.) from a particular site of fresh water body and identify them to the required taxonomic level (normally family level). According to the sensitivity to environmental stress, each taxon is assigned a score between 1 and 10 (Table 1). The most sensitive organisms, such as Ephemeroptera, Plecoptera and Trichoptera, score 10 and the least sensitive, such as Oligochaete worms, score 1. The scores for each family observed in the sample are then summed to give the BMWP score. In order to reduce the effects of sample size, sampling effort and sampling efficiency on the results obtained by this method, the Average Score Per Taxon (ASPT) should also be taken into consideration. This is obtained by dividing the BMWP score by the total number of taxa (families) in the sample. The number of taxa present is indicative of the diversity of the community. A BMWP score greater than 100, together with an ASPT value greater than 4, generally indicates good water quality (Chapman and Jackson, 1996).

Table 1: The biological scores allocated to groups of organisms by the Biological Monitoring Working Party (BMWP) score

Score	Groups of organisms
10	Siphlonuridae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Potamanthidae, Ephemeridae,Taeniopterygidae, Leuctridae, Capniidae, Perlodidae, Perlidae, Chloroperlidae, Aphelocheiridae, Phryganeidae, Molannidae, Beraeidae, Odontoceridae, Leptoceridae, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidae
8	Astacidae Lestidae, Agriidae, Gomphidae, Cordulegasteridae, Aeshnidae, Corduliidae, Libellulidae, Psychomyiidae (Ecnomidae), Phylopotamidae
7	Caenidae, Nemouridae, Rhyacophilidae (Glossosomatidae), Polycentropodidae, Limnephilidae
6	Neritidae, Viviparidae, Ancylidae (Acroloxidae) Hydroptilidae Unionidae Corophiidae, Gammaridae (Crangonyctidae), Platycnemididae, Coenagriidae

Score	Groups of organisms
5	Mesovelidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Haliplidae, Hygrobiidae, Dytiscidae (Noteridae), Gyrinidae, Hydrophilidae (Hydraenidae), Clambidae, Scirtidae, Dryopidae, Elmidae Hydropsychidae Tipulidae, Simuliidae, Planariidae (Dogesiidae), Dendrocoelidae
4	Baetidae, Sialidae, Pisicolidae
3	Valvatidae, Hydrobiidae (Bithyniidae), Lymnaeidae, Physidae, Planorbidae, Sphaeriidae, Glossiphoniidae, Hirudinidae, Erpobdellidae, Asellidae
2	Chironomidae
1	Oligochaeta

Source: Chapman & Jackson, 1996.

Effective implementation of the water quality-based approach requires that various monitoring techniques be considered within a larger context of water resource management. Both biological and chemical methods play critical roles in a successful pollution control program. They should be considered complementary rather than mutually exclusive approaches that will enhance overall program effectiveness when used appropriately.

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