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RESEARCH ARTICLE

Employing "Macroinvertebrate assemblage", to study the Preliminary biotic integrity of freshwater ecosystem with reference to taxa tolerance values, and, Matrices.

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Abstract

A comparative study of two important habitats of lentic ecosystem with the help of aquatic macroinvertebrate fauna to check the biotic integrity of freshwater ecosystem was carried out. The habitat was divided into Littoral and sub littoral zones. Biotic indices were used to assess the ecosystem drivers, based on the concept that certain taxa of aquatic organisms are sensitive to pollution whereas others are much tolerant. A standardized comparison of the selected habitats was done using Family Biotic Index (FBI) and Diversity indices. In particular it was seen that both pollution tolerant as well as pollution sensitive species were seen catering to the need of further analysis.

Introduction:-

The meticulous use of living organisms and their ability to respond against the change in system dynamics to determine the quality of environment is known as Bio-monitoring. Two German scientists R. Kolkwitz and M. Marsson in 1900s pioneered the work on saprobity that gave a pathway to the development of indicator organisms.
A wide variety of biotic groups are used in bio-monitoring. A search of the database from 1993 to July 1998 carried out by Vincent Resh and Norma Kobzina at University of California, Berkeley, confirmed that macro invertebrates are the most popular group used for Biomonitoring **(S.M. Mandaville, 2002)**.The sensitivity towards the environmental quality renders them as an integral part of bio monitoring.

Aquatic macro invertebrates are small animals living among stones, logs, sediments and aquatic plants on the bottom of streams, rivers and lakes. They are large enough to see with the naked eye (macro) and have no backbone (invertebrate).

There are number of advantages offered by macro invertebrates against the use of other groups for bio monitoring such as being ubiquitous in nature, high species richness, dominantly sedentary and long lived thus giving an extent of studying perturbations in altered habitats.

Using macro invertebrates in Biological monitoring is based on the fact that different species react to pollution in different ways. Pollution-sensitive organisms of certain groups (such as mayflies, stoneflies, and caddisflies) are more susceptible to the effects of physical or chemical changes in a system than other organisms. These organisms act as indicators of the absence of pollutants. Pollution-tolerant organisms such as midges and worms are less susceptible to changes in physical and chemical parameters in a stream. The presence or absence of such indicator organisms is an indirect measure of pollution. When a stream becomes polluted, pollution-sensitive organisms decrease in number or disappear; pollution-tolerant organisms increase in variety and number. Thus this community structure has been commonly used as an indicator of the aquatic system, **(Rosenberg and Resh, 1993)**.

Currently more than fifty indices are in existence, which are based on macro invertebrates communities and the number might grow with research inputs. These are either based on grouping of species into different categories or mathematical modeling approach that puts simple data into complex multivariate analyses.
"Biotic integrity" is based on the premise that the status of living systems provides the most direct and effective measure of the "integrity of water" **(Karr, 1997)**

Field Biotic Index **(Hilsenhoff, 1988)**, weighs pollution tolerance values off each taxonomic group, which serves as an exemplar for water quality in regards with higher taxonomic values i.e. species abundance.

The following study was done to investigate preliminary integrity of the selected wetland to carry out further research.

Methodology:-

Macroinvertebrates are recurrent inhabitants of freshwater ecosystem wherein they play an important role in energy transfer throughout food web. Aquatic insects account for the maximum number of taxa present in the system and hence become a viable indicator.

Selection of site:-

Wetlands represent indispensable biological diversity, which is the basis of the production of primary ecological resources and services that makes them exceptionally valuable. The wetland selected in present study; Thol Bird Sanctuary, is a manmade irrigation tank with a catchment area of a spread within 55.95 Sq.km. It is a wetland zone of important socio-cultural, economic, and biological function and hence was declared as a bird sanctuary in 1998 and in 2003 it was declared as eco-tourism site. It is however, understood that these types of declarations, despite their importance for socio-economic development, have adverse impacts on biodiversity and, therefore, on the functioning of wetland ecosystems and their capacity for producing ecological resources and services. It is therefore appropriate to take this aspect into consideration to properly investigate the biological integrity of the wetland and mitigate whatever negative effects seen due to introversions.

Sampling stations:-

Benthic Macroinvertebrates assemblages correspond to distinct habitat types and the sampling stations where thus classified according to unique substrates. The wetland was divided into two basic habitats: Littoral, and, sub-littoral.

Sampling:-

The adult insects were collected using sweep nets (dia. of 12" and 70 X 70 mesh size), and immature, using D- nets (70 X 70 mesh size). Using the nets the invertebrates were collected in a white tray for a better visibility, were washed with distilled water carefully to remove attached debris and then subdivided. The specimens were sorted and stored into 10 ml vials (plastic) for easy transport with 70 % ethyl alcohol and were taken to laboratory for further identification

Frequency and time of sampling:-

There is a non-equilibrium system maintained by material and energy cycling and fresh water Macroinvertebrates are inevitable part of the same. Physical, chemical and biotic factors impinge a lot of inter annual variability in these communities. Thus sampling was done in midsummer (March to May) since that is the time when community structure supports the life forms which culminate in an adult phase during the open-water period. A full season cycle was sampled for a better analysis.

Subsampling:-

Generally while sampling macroinvertebrates, the size of sample is high in number, hence to minimise handling time the samples were sub sampled and homogenous mixtures of known portions were made. Sample splitting method **(Marchant, 1989)** was used wherein samples were split into 25 cells and then counting was stopped.

Field Protocols:-

Weather conditions play an important role in invertebrate sampling. Standard protocol was followed in which the selected lake was divided into different field stations and the periphery was evenly estimated for substrate composition. For example 50% of the sampling stations contained sand, hence sand was chosen as basic substrate representing the variety of habitats.

Data Analysis:-

Once the organisms were collected they were transferred to laboratory for identification and taxon classification on the basis of adult form, however immature forms were considered for analysis. **Merritt and Cummins (1996)** review field-based and laboratory rearing methods for major insect groups were used for the identification.

Three different types of ecological studies were done: A Pilot study, Community characteristics study and differential study between populations. Each of the study had its own data analysis requirement. Sub-sampling of 25specimens was enough to calculate ANOVA for pilot study. Multivariate indices such as Shannon' H index and Simpson' D index were calculated for diversity distinguishing studies.

Results/Discussion:-

Aquatic macroinvertebrate assemblage of freshwater corresponds to specific habitat types and thus responds differently in different habitats. The Littoral habitat supported larger and more diverse population in comparison to Sub littoral zone since the vegetation and heterogeneous substrate which provided high number of micro habitat and niches to enhance invertebrate production. It supported large population of pollution tolerant species, 65 versus 45 **(Table 1)** as seen in sub littoral zone giving an idea of fringe contamination due to human activities present at the site. Compared to sub-littoral zone, littoral habitat had a greater total abundance however the average abundance per sample was three times as seen in sub-littoral then in littoral **(p=0.00014 ; based on the samples from each sampling station's T-test)** since it is less subjected to the perturbations and influences of littoral zone and is rarely exposed to severe hypoxia. The species evenness and diversity seen as Simpson' D were nearly similar for both the field stations i.e. **0.90 & 0.92 and 0.94 & 0.93** respectively for Littoral and Sub-littoral zones. Keeping in mind all these, the overall biotic integrity of the site was satisfactory **(FBI=1.3) (Table 2)** which showed less overall organic pollution. Inspite of the fact that both the field stations had similar taxon diversity, there was a visible difference between abundance and composition of the macro invertebrate fauna. The presence of taxa tolerant species also showed if not major organic pollution but at least fringe line pollution and helped in giving in the picture of the same, rooting to management strategies. One could efficiently use the invertebrate fauna to describe the overall biotic integrity of the fresh water ecosystem.

Table 1:-Macroinvertebrate taxa collected at littoral and sub-littoral Sampling stations with their tolerance value (Hilsenhoff, 1988) for calculating FBI

Order	FAMILY	SITE	
		LITORAL	SUB LITORAL
Plecoptera			
	Capniidae	10	5
	perlidae	5	2
	Nemouridae	4	2
Ephemeroptera			
	Baetidae	11	8
	Caenidae	4	3
	Ephemerellidae	1	0
	Ephemeridae	6	1
	Heptageniidae	2	1
Hemiptera			
	Corixidae	20	7
Odonata			
	Aeshnidae	11	9
	Libellulidae	25	12
	Coenagrionidae	12	7
	Macromiidae	8	5
	Gomphidae	18	9
	Lestidae	9	3
Megaloptera			

	Sialidae	1	0
Coleoptera			
	Elmidae	3	0
Diptera			
	Blood-red Chironomidae	28	19
	Pink Chironomidae	2	0
Amphipoda			
	Gammaridae	7	2
	Hyalellidae	2	1
Isopoda			
	Asellidae	1	0
Mollusca			
	Lymnaeidae	7	3
	Physidae	18	12
	Planorbidae	8	8
	Viviparidae	14	16
	Pleuroceridae	3	9
	Bithyniidae	4	6
	Hydrobiidae	1	3
	Valvatidae	9	7

Table 2:-Interpretation of FBI scores Hilsenhoff, 1988

Biotic index	water quality	Remarks
0.00–3.50	Excellent	No apparent organic pollution
3.51–4.50	Very good	Possible slight organic pollution
4.51–5.50	Good	Some organic pollution
5.51–6.50	Fair	Fairly significant organic pollution
6.51–7.50	Fairly poor	Significant organic pollution
7.51–8.50	Poor	Very significant organic pollution
8.51–10.0	very poor	Severe organic pollution

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