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WATER BODY QUALITY ANALYSIS BY BENTHIC MACRO INVERTEBRATES

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ABSTRACT
The study is focused on the bio monitoring of Kukatpally IDL Lake using Benthic Macro invertebrates. It is a special way of assessing the water quality using Macro invertebrates (Bio-monitoring Working Party) as indicators of pollution. The results have been expressed as Bio-Mapping which denotes visually the level of pollution at different points.

KEYWORDS
Biomonitoring, water quality, Macro invertebrates

INTRODUCTION
Andhra Pradesh has about 27.08% of its urban population in urban areas. The density in Greater Hyderabad is 5,811/km^2 with a population of 3,632,094 (2006) and ranked at 6th position in India. The urban growth rate is far higher than the rural growth rate, showing increasing urbanization. The ponds and water bodies in urban areas are in deteriorating stage. The present study is focused on **Kukatpally IDL Lake which is situated in Hyderabad, Andrapradesh, India.** This Lake is a perennial water body situated close to National Highway. There is one inlet and one outlet to this lake. This lake used for lord Ganesha's idol immersion and also for Bathukamma. This lake is a good habitat for many types of birds.

Water quality monitoring is an important exercise, which helps in evaluating the nature and extent of pollution as well as effectiveness of pollution control measures. It also helps in determining the water quality trends and prioritizing pollution control effort.

Benthic macro invertebrates refer to the organisms that inhabit the bottom substrates (sediments, debris, logs, macrophytes, filamentous algae, etc.) of freshwater habitats, for at least part of their life cycle [1]. They are generally called as invertebrates observed by naked eyes but often are categorized as those retained by mesh size more than 0.2-0.5 mm. Freshwater arthropods including aquatic insects take amount of about 95% of benthic macro invertebrates in terms of species richness and individual abundance. Up to date, 536 species of fresh water arthropods, belonging to 112 families, 18 orders, and 3 classes and including 494 species of aquatic insects in 96 families, are known in Korea, although more intensive taxonomic studies, especially on aquatic flies (Diptera), are needed [2].

Benthic Macro invertebrates as Bio indicators
Benthic macro invertebrates are the most popular and commonly used group of freshwater organisms in assessing water quality. They offer many advantages in biomonitoring although a practice for well-balanced monitoring programs such as quantitative sampling and community analysis is required

[1]. First, they are ubiquitous and thus can be affected by environmental perturbations in many different types of aquatic systems. Second, the large number of species involved offers a spectrum of responses to environmental stresses. Third, their basically sedentary or benthic habit allows effective spatial analyses of pollutant or disturbance effects. Fourth, they have relatively long life cycles compared to other groups of freshwater organisms, which allows elucidation of temporal changes caused by perturbations. As a result, benthic macro invertebrates act as continuous bio indicators of the water body they inhabit, enabling both temporal and spatial analyses of various degrees of aquatic environment.

Bio indicators and Biotic Indices

Various technical developments have been achieved in the use of benthic macro invertebrates as advantageous biomonitors in stream ecosystems. In the beginning time, a relatively simple way of biomonitoring such as appearance or disappearance of selected indicator species was used, but biomonitoring programs have been rapidly developed and more sophisticated techniques such as population and community indices have been introduced [3]. These technical developments are largely due to the developments of quantitative sampling and sample analyses including inexpensive sampling equipments and computer devices, taxonomic and identification references, and supports of ecological and toxicological researches. Since the mid-nineteenth century, limnologists have been aware that aquatic organisms can be used as environmental indicators since they are exposed to various degrees of environmental degradation for their life span. Firstly four-graded saprobic system was introduced in streams using indicator organisms that inhabit typically along the watercourse [4] .

Since then, various biological indices have been invented depending on the organisms and analysis methods such as relative purity, saprobic index, saprobic valency, indicative weight, Trent biotic index, score system, Hilsenhoff biotic index, etc. [1]. The saprobic system was divided into eight-graded system using 2000 species of freshwater organisms [5]. Species diversity index was invented by [6] which was based on [7] information theory and it was adapted to saprobic system in freshwaters [8].

Along with this theoretical development of biological indices, local governments or countries throughout the world have developed their own biological indices based on the native organisms inhabited in the places [9], United Kingdom[10], Germany [11], France (12), Denmark (13), Netherlands (14), Spain (15), and Australia[16] have developed their own biological indices.

In India Central Pollution Control Board took initiation in biomonitoring methodology in 1988, in collaboration with Dutch experts.

MATERIALS AND METHODS

The materials that we have used in our present project are, 2 Fishing Nets,1 no Scientific Sieve, Hand gloves, Forceps, Magnifying glass, 50ml or 100ml transparent bottles for sample storage, Metal tray having 100 square boxes drawn, Small plate to put organism for identification, Wading boots or other tall waterproof boots & Formaldehyde.

Site selection

First of all the sampling site has to be keenly observed and the sampling points have to be selected so as to cover the whole periphery of the lake and the results has to represent the complete lake's situation. The main motto of taking sample from the periphery is to obtain data which will help us to draw the bio-mapping of the particular lakes.

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Sampling method

After selecting the site the sampling team has to carry the required equipments to the site and for each sampling point check the water dept level to 2' to 3'. For easy samples and for lower depths scientific sieves have to be used and for difficult sites and larger depths the fishing nets has to be used. Take suitable net and dip in to the water the water will be drained out and the organisms will be retained on the sieve, collect the organism and transfer into the sampling bottles and preserve the organism in formaldehyde solution.

Frequency of sampling

As per the CPCB guidelines we need to collect the organisms at an interval of one month. For the present project we have taken the samples for the frequency of one month for one season.

Identification is done following the manual of cpcb

Brief Procedure

(i) Benthic macro-invertebrates are the best suitable biological parameter, among the biotic communities in aquatic ecosystem, for bio-mapping of water body.

(ii) Locations on a stream basin map are selected for biological sampling.

(iii) Biological sampling is undertaken at a water depth of less than one meter, with the help of hand net, hand picking, uprooting the plants, shovel etc. and by Eckman grab and artificial substratum at a depth of more than one meter depth.

(iv) Taxonomic identifications of benthic macro-invertebrates up to family level.

(v) Biological water quality evaluation through:

a) Saprobic score

b) Diversity score

(vi) Assigning the water quality class, to each sampling locations, with respect to combinations of saprobity and diversity score of the biological sample using Biological Water Quality Criteria (BWQC).

(vii) Translating the biological water quality class of each location on river basin map into respective colors assigned in Biological Water Quality Criteria (BWQC).

(viii) Preparation of the colored Bio-map of entire river basin for identification of pollution control strategies rationally.

Saprobic score (BMWP)

This methodology that involves inventory of the presence of benthic macroinvertebrate fauna level up to the family level with taxonomic precision. All possible families having saprobic indicator value are classified on a score-scale of 1 to10 according to their preference for saprobic water quality. The saprobic scores of all the families are registered to produce BMWP score. **Evaluation Criteria.** The biological water quality evaluation criterion is through saprobic score and diversity score.

Saprobic Score (BMWP)

it involves inventory of the presence of benthic macro-invertebrate up to the family level with taxonomic precision. All possible families having saprobic indicator value are classified on a score-scale of 1 to10 according to their preference for saprobic water quality. The saprobic scores of all the families are to produce Bio-Monitoring Working Party (BMWP) index, which is as follows.

Bio Monitoring Working Party INDEX (BMWP INDEX)		
Taxanomical Class	**Taxanomical Families**	**BMWP Score**
Ephemeroptera	Heptageniidae, Leptophlebiidae, Ephemerellidae, Ephemeridae, Pothaminthidae, Siphonuridae	10
Plecoptera	Leuctridae, Capniidae, Periodida, Perlidae, Taeniopterygidae	10
Hemiptera	Aphelocheiridae	10
Trichoptera	Leptoceridae, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidae	10
Odonata	Lestidae, Gomphidae, Cordulegsteridae, Aeschnidae, Corduliidae, Libellulidae, Plathyenemididae	8
Trichoptera	Psychomyliidae, Philopotamidae	8
Ephemeroptera	Caenidae	7
Plecoptera	Nemouridae	7
Trichoptera	Rhyacophilidae, Polycentropodidae, Limnephilidae	7
Mullusca	Ancylidae, Hydrobiidae, Neritidae, Viviparidae, Thiaridae, BithynidE, Unionidae	6
Trichoptera	Hydroptilidae	6
Crustacea	Palaemonidae, Atydae, Bammaridae	6
Polycheata	Nereidae, Nephthyidae	6
Odonata	Coenariidae, Agriidae	6
Hemiptera	Mesovelidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Veliidae, Hebridae, Belestomatidae	5
Coleoptera	Haliplidae, Hygrobidae, Dytiscidae, Gyrinide, Hydrophilidae, Noteridae, Helodidae, Dryopidae, Elminithidae, Psephenidae	5
Trichoptera	Hydropsychidae	5
Diptera	Tipulidae, Culicidae, Blepharoceridae, Simulidae	5
Planaria	Planariidae, Dendroceolidae	5
Ephemeroptera	Baetidae	4
Megaloptera	Sialidae	4
Hirudinea	Piscicodedae	4
Mullusca	Lymnaedae, Planorbidae, Sphaeridae	3
Hirudinea	Glossiphonidae, Hirudidae, Erpobdellidae	3
Planaria	Dugesiidae	3
Crustacea	Asselidae	3
Diptera	Chironomidae, Syrphidae	2
Oligocheta	All Families	1

Diversity Score (Sequential Comparison)

The diversity score is the ratio of the total number of different animals (runs) and the total number of organisms encountered. The ratio of diversity has a value between 0 and 1.

Sequential comparison diversity index (SCT) = $\frac{\text{(x) No. of runs}}{\text{(y) No. of organisms}}$ =

Saprobity Index =
Total saprobity score =
No. of classes identified =

Biological Water Quality Criteria (BWQC)						
S.No.	Taxonomic Group	Range of Saprobic Score	Range of Diversity Score	Water Quality characteristic	Water quality class	Indicator colour
1.	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Diptera	7 and more	0.2 - 1	Clean	A	Blue
2.	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Diptera, Odonata	6 - 7	0.5 - 1	Slight pollution	B	**Light blue**
3.	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Diptera, Odonata, Coleoptera, Crustacea, Mollusca, Polychaeta, Hirudinea, Oligochaeta	3 - 6	0.3 - 0.9	Moderate pollution	C	**Green**
4.	Hemiptera, Diptera, Coleoptera, Oligochaeta Mollusca,	2 - 5	0.4 & less	Heavy pollution	D	**Orange**
5.	Diptera, Oligochaeta No animals	0 - 2	0 - 0.2	Severe Pollution	E	**Red**

Diversity score (Sequential Comparison)

The methodology involves pair wise comparison of sequentially encountered individuals and difference of two benthic animals can be observed up to the species level, where no taxonomic skill is required. The diversity is the ratio of the total number of different animals (runs) and the total no of organisms encountered. The ratio of diversity has a value between 0 and 1.

RESULTS & DISCUSSION

Six different samples (S1, S2, S3, S4, S5, S6) were collected from six different sites and studied pollution levels based on Sequencial Comparision Diversity Index (SCT) and Saprobic Index (SI). The results were presented in 6 tables.the results shows that S2 is with more SCT Index and SI i.e 0.79 and 6.5 which indicates slight pollution of the site. Rests of the sites are moderately polluted.

Assessments of water quality in two freshwater bodies at Tiruvannamalai from April 2000 to March2001. [17].Results showed that the bio-monitoring approaches with the chemical analysis for a 12 months period intwo water bodies produced many significant correlations indicating 32 of the 40 comparisons between biological pollution indices (5 kinds) and chemical analysis (8 parameters) were statistically significant (r >0.316; p £ 0.05). The Nyggard's index and biological index were significantly correlated with all physicochemical parameters (r>0.356; p £ 0.05). Shannon - Weiner index was significantly (r > 0.415 and 0.327) associated with phytoplankton population density in all combinations. Nutrient salts like Nitrate – N, Phosphate - P and calcium attained its maximum values during the rainy months due to inflow of rain water and its minimum value was observed during summer months showing negative correlation with phytoplankton population [18]. 110 sediment samples were collected in the lakes and 153 in the rivers. Sediment organic matter contents and granulometric composition analysis were also done. Shannon-Wiener diversity and Pielou evenness indices were calculated and the U-test

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of Mann-Whitney was used to evaluate whether there were differences on density (ind.m-2) and taxonomic richness values between the studied periods. In the rivers, sediment granulometric composition presented a mixture of particles and fractions. Lake sediments were organic and showed high percentages of silt and clay [19]. Biomonitoring is a vital and rapidly growing field. Freshwater Biomonitoring and Benthic Macroinvertebrates presents a state-of-the-art look at the use of benthic macroinvertebrates (aquatic insects, molluscs, crustaceans, and worms) in the biological assessment of water quality in lakes and streams. The use of these organisms has increased dramatically in the past two decades in both North America and Europe.

Table – 1: BIO – MONITORING ANALYSIS OF KUKATPALLY IDL LAKE

Sampling – I Sample Code: S-1 Point No: 1 Date of Analysis: 16/05/11

S.No	1	2	3	4	5	6	7	8	9	10	X	Y	Class	Family	Score		
1					1		0				1	2	Odonata	Gomphidae	1	*8	=8
2													Coleoptera	Haliplidae	1	*5	=5
3							1	0			1	2		Hydrophilidae	1	*5	=5
4													Hemiptera	Corixidae	1	*5	=5
5						1		0			1	2					
6					1						1	1					
7			1								1	1					
8				1					0		1	2					
9							1	0			1	2					
10																	
Total											7	12		4			23

(K) Sequential comparison diversity index (SCT) = $\frac{\text{(x) No. of runs}}{\text{(y) No. of organisms}}$ = 7/12=0.59

(L) Saprobity Index = $\frac{\text{Total saprobity score}}{\text{No. of classes identified}}$ = 23/4=5.75

Result: 1. Water quality class = C
2. Water quality Charecteristics = Moderate Pollution
3. Indicator color = Green

Table – 2: BIO – MONITORING ANALYSIS OF KUKATPALLY IDL LAKE

Sampling – II   Sample Code: S-2   Point No: Date of Analysis: 16/05/11

S.No	1	2	3	4	5	6	7	8	9	10	X	Y	Class	Family	Score		
1													Odonata	Gomphidae	1	*8	=8
2									1		1	1	Coleoptera	Hydrophilidae	1	*5	=5
3								1			1	1					
4																	
5																	
6																	
7		1			0						1	2					
8								1	0		1	2					
9																	
10		1									1	1					
Total											5	7		2			13

(K) Sequential comparison diversity index (SCT) = $\frac{\text{(x) No. of runs}}{\text{(y) No. of organisms}}$ = 5/7= 0.71

(L) Saprobity Index = Total saprobity score = 13/2= 6.5
No. of classes identified

Result: 1. Water quality class = B
2. Water quality Charecteristics = Slight Pollution
3. Indicator color = Light Blue

Table – 3: BIO – MONITORING ANALYSIS OF KUKATPALLY IDL LAKE

Sampling – III   Sample Code: S-3   Point No: 3   Date of Analysis: 16/05/11

S.No	1	2	3	4	5	6	7	8	9	10	X	Y	Class	Family	Score		
1													Hemiptera	Corixidae	1	*5	=5
2							1				1	1		Belestomatidae	1	*5	=5
3					1	0					1	2	Coleoptera	Hydrophilidae	1	*5	=5
4										1	1	1	Odonata	Gomphidae	1	*8	=8
5				1	1						2	2					
6				1							1	1					
7					1	0					1	2					
8			1								1	1					
9				1		0					1	2					
10				1							1	1					
Total											10	13		4			23

(K) Sequential comparison diversity index (SCT) = $\frac{\text{(x) No. of runs}}{\text{(y) No. of organisms}}$ = 10/13=0.77

(L) Saprobity Index = Total saprobity score = 23/4=5.75
No. of classes identified

Result: 1. Water quality class = C
2. Water quality Charecteristics = Moderate Pollution
3. Indicator color = Green

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Table – 4: BIO – MONITORING ANALYSIS OF KUKATPALLY IDL LAKE

Sampling – IV Sample Code: S-4 Point No: 4 Date of Analysis: 16/05/11

S.No	1	2	3	4	5	6	7	8	9	10	X	Y	Class	Family	Score		
1		1		0							1	2	Hemitera	Corixidae	1	*5	=5
2														Belestomatidae	1	*5	=5
3													Coleoptera	Haliplidae	1	*5	=5
4																	
5																	
6					1					0	1	2					
7																	
8				1							1	1					
9					1	1					2	2					
10						1					1	1					
Total											6	8		3			15

(K) Sequential comparison diversity index (SCT) = (x) No. of runs / (y) No. of organisms =6/8=0.75

(L) Saprobity Index = Total saprobity score / No. of classes identified = 15/3=5

Result:
1. Water quality class = C
2. Water quality Charecteristics = Moderate Pollution
3. Indicator color = Green

Table – 5: BIO – MONITORING ANALYSIS OF KUKATPALLY IDL LAKE

Sampling – V Sample Code: S-5 Point No: 5 Date of Analysis: 16/05/11

S.No	1	2	3	4	5	6	7	8	9	10	X	Y	Class	Family	Score		
1				1			0				1	2	Odonata	Gomphidae	1	*8	=8
2													Diptera	Chironomidae	1	*2	=2
3													Coleoptera	Hydrophilidae	1	*5	=5
4													Mullusca	Bithynidae	1	*6	=6
5																	
6																	
7				1						1	2	2					
8																	
9																	
10										1	1	1					
Total											4	5		4			21

(K) Sequential comparison diversity index (SCT) = (x) No. of runs / (y) No. of organisms =4/5=0.8

(L) Saprobity Index = Total saprobity score / No. of classes identified = 21/4=5.25

Result :
1. Water quality class = C
2. Water quality Charecteristics = Moderate Pollution
3. Indicator color = Green

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Table – 6: BIO – MONITORING ANALYSIS OF KUKATPALLY IDL LAKE

Sampling – VI Sample Code: S-6 Point No: 6 Date of Analysis: 16/05/11

S.No	1	2	3	4	5	6	7	8	9	10	X	Y	Class	Family	Score		
1				1		0					1	2	Odonata	Gomphidae	1	*8	=8
2													Hemiptera	Belestomatidae	1	*5	=5
3		1				0					1	2		Corixidae	1	*5	=5
4				1					0		1	2	Coleoptera	Hydrophilidae	1	*5	=5
5			1				0				1	2					
6						1					1	1					
7		1			0						1	2					
8					1				0		1	2					
9		1			1						2	2					
10				1		0					1	2					
Total											10	17		4			23

(K) Sequential comparison diversity index (SCT) = $\frac{\text{(x) No. of runs}}{\text{(y) No. of organisms}}$ = 10/17=0.58

(L) Saprobity Index = $\frac{\text{Total saprobity score}}{\text{No. of classes identified}}$ = 23/4=5.75

Result:
1. Water quality class = C
2. Water quality Charecteristics = Moderate Pollution
3. Indicator color = Green

Table-7- Biomonitoring analysis for Benthic Macro invertebrates

	S-1	S-2	S-3	S-4	S-5	S-6
Sequential Comparison Diversity Index(SCT)	0.59	0.79	0.77	0.75	0.8	0.58
Saprobity index	5.75	6.5	5.75	5	5.25	5.75
Water quality Class	C	B	C	C	C	C
Water quality characteristics	Moderate Pollution	Slight pollution	Moderate pollution	Moderate pollution	Moderate pollution	Moderate pollution
Indicator Colour	Green	Light Blue	Green	Green	Green	Green

The detailed study for one season for Macro invertebrates has been given **in Table 7**. From the table it was observed that the Saprobity index is not more than 5.75 in almost six sites indicate that water quality is with slight and moderate pollution. As per these results the water quality more polluted at the last station near outlet. And good condition at the rest of the sampling station. On the basis of obtained result Bio-map of Kukatpally IDL Lake is as follows.

CONCLUSIONS

Bio monitoring is good tool for the assessment of water body. It needs no chemicals means ecofriendly, cost effective and moderately accurate. And this study also help in studying aquatic invertebrates i.e., biodiversity of invertebrates.

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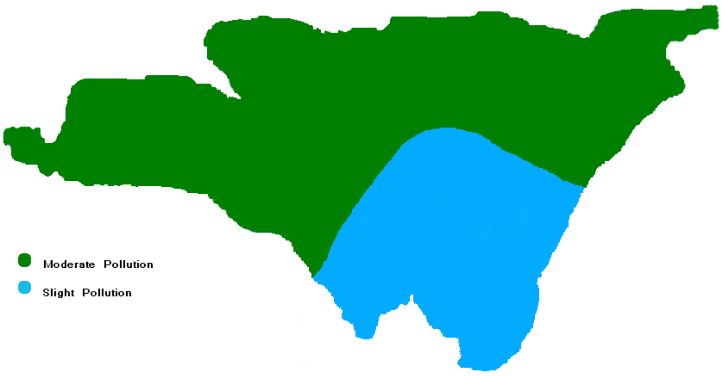

BIOMAP OF THE KUKATPALLY IDL LAKE

REFERENCES

1. Yoon, I.B., Bae, Y.J., Lee, H.C., and Lee, S.J. "Long-term change of aquatic insect community in the Wangsuk Creek near Seoul caused by environmental change in the drainage area." *Korean J. Environ. Biol.*, Vol. 11, No. 2, pp. 97-109,(2001) .
2. Yoon, I.B. and Bae, Y.J.. "Indicator organisms and biological indices in freshwater ecosystems." *Nature Conserv.*, Seoul, Vol. 82,pp. 23-27,(1993) .
3. Kolkwitz, R. and Marsson, M. "Grundsätze für die biologische Beürteilung des Wassers nach seiner Flora and Fauna." *Mitt.Prüfungsanst. Wasserversorg. bwasserreinig*, Vol. 1, pp. 33-72,(1902).
4. Sladecek, V. "System of water quality from the biological point of view." *Arch. Hydrobiol.*, Vol. 7, No. 1-4, pp. 1-218,(1973a) .
5. Wilhm, J.L. and Dorris, T.C. "Biological parameters for water quality criteria." *Biosci.*, Vol. 18, pp. 477-481,(1968).
6. Margalef, R. "Temporal succession and spatial heterogenity in natural phytoplankton." In: *Perspectives in marine biology*, Univ. California Press, CA, pp. 323-349,(1958).
7. Staub, R., Appling, J.W., Hofstetter, A.M., and Haas, I.J. "The effects of Memphis and Shelb County on primary plankton producers." *Biosci.*, Vol. 20, pp. 905-912, (1970).
8. Resh, V.H., Norris, R.H., and Barbour, M.T. "Design and implementation of rapid assessment approaches for water resource monitoring using benthic macro invertebrates." *Australian J. Ecol.*, Vol. 20, pp. 108-121,(1995).
9. Sladecek, V. "The reality of three British biotic indices." *Wat. Res.*, Vol. 7, pp. 995-1002, (1973b).
10. Zelinka, M. and Marvan, P. "Zur Präzisierung der biologischen klassifikation der Reinheid fliessender Gewässer." *Arch. Hydrobiol.*, Vol. 57, pp. 389-407(1961).
11. Tuffery, G. and Verneaux, J. "Methode de determination de la quality biologique des eaux courantes." Ministere de l'agriculture, France, pp. 1-23(1968).
12. Anderson, M.M., Riget, F.F., and Sparholt, H. "A modification of the Trent index for use in Denmark." *Water Res*., Vol. 18, pp. 145- 151,(1984).
13. Klapwijk, S.P. "Biological assessment of the water quality in South-Holland (the Netherlands)." *Int. Rev. Ges. Hydrobiol.*, Vol. 73, pp. 481-510, (1988).
14. Zamora-Munoz, C. and Alba-Tercedor, J. "Bioassessment of organically polluted Spanish rivers, using a biotic index and multivariate methods." *J. North Am. Benthol. Soc.*, Vol. 15, No. 3, pp. 332-352, (1996).
15. Crowns, J.E., Chessman, B.C., Jackson, J.E., and Ross, D.G. "Rapid assessment of Australian rivers using macro invertebrates: cost and efficiency of 6 methods of sample processing." *J. N. Am. Benthol. Soc.*, Vol. 16, No. 3, pp. 682-693, (1997).
16. N. Ramakrishnan bio-monitoring approaches for water quality assessment in two Waterbodies at Tiruvannamalai, Tamil Nadu India in Martin J. Bunch, V. Madha and T. Vasantha Kumaran, eds., Proceedings of the Third International Conference on Environment and Health, Chennai, India, 15-17 December, Chennai:Department of Geography, University of Madras and Faculty of Environmental Studies, York University. Pages 374 – 385,(2003).

17. Kumar,A and N.K. Singh, Phytoplanktors of a pond at Deoghar, India 1b. phytoplankton standing crop in relation to abiotic factors. *Phykos 39 (1&2)* 21-33, (2000).
18. Moretti, M. S. & Callisto, M. Biomonitoring of benthic macroinvertebrates in the middle Doce River watershed. Acta Limnol. Bras., 17(3):267-281, (2005).
19. David M. Rosenberg , Vincent H. Resh, Freshwater Biomonitoring and Benthic Macro invertebrates Book: December 31, Amezon publishers (1992)

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