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Assessment of water quality of a pond ecosystem using biological water quality criteria.

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Abstract

The present study evaluated the water quality of Dighali Pukhuri, a freshwater pond ecosystem in Guwahati city, using Biological Water Quality Criteria (BWQC). The study determined water quality class of the sampling site taking into accounts of both Saprobic score and diversity score of aquatic insects using BWQC. Sampling was done in monsoon, post-monsoon, winter and pre-monsoon seasons during the year 2010-11 and 2011-12. Results of the study were compared with BWQC to assign different classes to the study site. The most prevalent biological water quality Class was "B" (slight pollution) which accounted for about 65.5% of the total classes present. It was followed by Class "C" (moderate pollution) which accounted for 25% of the total biological water quality classes. The Class "A" (clean) contributed only 12.5%. The prevalence percentage of different biological classes can be shown as Class "B" > Class "C" > Class "A".

Keywords: Aquatic insect, Saprobic score, Diversity score, BWQC.

1. Introduction

Application of biological methods for assessment of water quality has become more handy in recent years. The biological species especially aquatic insects play an important role for assessment of water quality. The aquatic insects are easily visible due to their size, inhabiting in different substratum of wetlands, demonstrate an integrated effect of pollution, their taxonomy is well developed, highly sensitive to organic load and toxic pollutants. The bio-monitoring study with aquatic insects helps in detection and prediction of ecological effects, and develops strategies to water and water resources from the ever-growing environmental pollution. The present study was designed to carry out investigation on the diversity of aquatic insects of Dighali Pukhuri. This will help to understand the applicability of aquatic insects as biological tool to monitor water pollution.

The aquatic insects have been considered as the most suitable biological parameter to assess water quality of surface water bodies (Semwal *et al*., 2006). Biological assessment of surface water was commenced more than a century ago as the idea of saprobity (the degree of pollution) developed by Kolkwitz and Marsson in 1908-1909 (Rosenberg and Resh 1993), mainly by analyzing the differences of organisms living in polluted water from organisms living in clean water. The use of aquatic insects in biological assessment has been developed due to simplicity of sampling methods, the availability of information on pollution tolerance (Zamora-Munoz *et al*.,1995; Karr, 1999), and the greater degree of accuracy than methods based upon physical and chemical parameters of water quality (Sangpradub *et al*., 1997). According to Carlisle *et al.,* (2007) aquatic insect populations in streams and rivers can assist in the assessment of the overall health of the stream.Studies on aquatic insects as bio indicator of water pollution in India were also reported by Subramanian and Sivaramakrishnan (2007), Sarma and Chowdhary (2011). This present study seeks to investigate the biological water quality classes of Dighali Pukhuri of Guwahati city.

2. Materials and method

2.1 Study area

Guwahati city is located at the intersection of 91°

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34′ E-91° 51′ E longitude and 26° 5′ N-26° 12′ N latitude. Dighalipukhuri derived its name from the word 'dighal' which means long. It is an old rectangular lake of half a mile long originally engraved out from the Brahmaputra. The lake is believed to be dug by King Bhagadutta, the king of Pragjyotishpura. It is also mentioned in the Mahabharata, the great Indian epic. In historical times, it was used by the Ahoms as a naval yard. Its access to the Brahmaputra was eventually closed, and during colonial times, that portion was further filled on which the Circuit House was built. Later, the Gauhati High Court building too was built in the newly filled area. Dighali Pukhuri is a prominent tourist attraction in the heart of Guwahati with boating facilities and recreational activities.

2.2 Collection of insect fauna

Aquatic insects were collected from May, 2010 to April, 2012 for two years, covering four seasons Monsoon (June-August), Post-monsoon (September-November), winter (December-February) and Pre-monsoon (March-May) of year. Sampling was standardized by restricting collection from an area of about 15/m^2 for 30 minutes. A nylon pond net (mesh 250 µm, diameter 30 cm; depth 60 cm) and a nylon kick net (mesh opening: 180 µm) were used to collect the aquatic insects on water surface. The samples were collected by submerging the net and sweeping it through water column. To dislodge and collect the organisms from the sediment the net was bumped against the bottom substrate. Five samples were collected from the sampling site and their average counts were recorded (Trivedy and Goel, 1984). After collection organisms were washed and scrubbed from the larger substrate materials, concentrated by use of a No. 30 U.S. Standard sieve and were preserved in 70% ethyl alcohol. In the laboratory the organisms were sorted from the finer residual debris by elutriation and hand picking from white enamel pan and transferred to fresh preservative. The surface and bottom water insects were preserved in 70% ethyl alcohol. Under the binocular dissecting microscope and binocular compound microscope the taxonomic identification of both surface and bottom sample was performed following the works of Needham and Needham (1962), Pennak (1978), Pillai (1986), Croft (1986), Subramanium and Sriramakrishnan (2007). Each taxon of the collected sample was recorded and enumerated. Insect density estimated is reported as number of individuals per square meter.

2.3 Biological water quality assessment

Biological water quality assessment was done using the standard method developed by Central Pollution Control Board (APHA, 1999).

Central Pollution Control Board during the development and validation of Bio-monitoring methodology, established the fact that among all the biological components of the aquatic ecosystem, aquatic insects are best suitable for evaluation of water quality.

Two methods for biological water quality evaluation have been adopted, Sequential comparision for diversity score and the Biological Monitoring Working Party (BMWP) for the saprobic score. The combination of the range of saprobic score with the diversity score indicates the ecological health of the water body.

Saprobic score (BMWP): This methodology involves inventory of the presence of benthic macro-invertebrate fauna up to the family level. All possible families having saprobic indicator value are classified on a score of 1-10 according to the preference for saprobic water quality (Table.1). The saprobic scores of all the families are registered and averaged to produce BMWP score (Akolkar *et al*., 2001).

Table.1. Biological Monitoring Working Party (BMWP) Score of Dighali Pukhuri.

Taxonomical Group	Taxonomical families	Genus	BMWP Score
Hemiptera	Gerridae	*Neogerris* *Gerris* *Limnogonus*	5
	Pleidae	*Plea liturata*	5
	Belostomatidae	*Diplonychus*	5
	Hydrometridae	*Hydrometra*	5
Coleoptera	Nepidae	*Ranatra*	5
	Gyrinidae	*Dineutus*	5
	Dytiscidae	*Hydrovatus sp.* *Laccophilus guttatus* *Laccophilus sp.* *Hydrocoptus sp.*	5

Taxonomical Group	Taxonomical families	Genus	BMWP Score
Diptera	Chironomidae	*Chironomous*	2
	Culicidae	*Culex*	5
Coleoptera	Hydrophilidae	*Amphiops Hydrophilus*	5
Odonata	Libellulidae	*Orthetrum Trumea*	8
	Aeshnidae	*Anax*	8
Trichoptera	Polycentropodidae	*polycentropus*	7

Diversity score (Sequential Comparison Index or SCI): This methodology involves pair wise comparison of sequentially encountered individuals and the difference of the two benthic animals up to the species level. The diversity is the ratio of the total number of different animal species (runs) and the total number of organisms (of all species) encountered. The ratio of diversity has a value between 0 and 1 (Dutta *et al*., 2001, Zwarta *et al*., 1994).

For biological water quality evaluation, the diversity of the benthic animals is compared with the saprobic score with the help of BWQC (Biological Water Quality Criteria) (Table.2).

Table 2 : Biological Water Quality Criteria (BWQC)

Sl.No	Taxonomic groups	Range of saprobic score (BMWP)	Range of diversity score	Water quality characteristics	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, Odonata, Diptera 6-7	0.5-1		Slight pollution	B	Light Blue
3	**Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Odonata, Crustacea, Mollusca, Polychaeta, Coleoptera, Diptera, Hirudinea, Oligochaeta**	**3-6**	**0.3-0.9**	**Moderate pollution**	**C**	**Green**
4	Mollusca, Hemiptera, Coleoptera, Diptera, Oligochaeta	2-5	0.4 and less	Heavy pollution	D	Orange
5	Diptera, Oligochaeta, or No macro-invertebrates	0-2	0.-0.2	Severe pollution	E	Red

3. Result and discussion

The study of aquatic insects analysis of Dighali Pukhuri is presented in Table.3 and 4. The aquatic insects communities comprised of 20 genera and 13 families of which seven genera belong to Order Coleoptera, seven to Order Hemiptera, three to Order Odonata , two to Order Diptera and one genera belong to Order Trichoptera.

Table.3.Seasonal fluctuations of different Aquatic insect species (org. /m^2) recorded in Dighali Pukhuri of Guwahati City during 2010 -11.

Taxa/ Genera	Monsoon	Post monsoon	Winter	Pre monsoon	Total
Hemiptera					
Family: Gerridae					
Neogerris parvula	06	11	01	17	35
Gerris gracilicornis	04	00	00	19	23
Limnogonus nitidus	00	06	00	00	06
Family: Pleidae					
Plea liturata	00	04	09	00	13
Family: Belostomatidae					
Diplonychus rusticus	00	06	02	04	12
Family: Hydrometridae					
Hydrometra greeni	02	05	06	00	13
Family: Nepidae					
Ranatra Filiformis	05	06	01	00	12
Coleoptera					
Family: Gyrinidae					
Dineutus unidentatus	6	1	0	6	13
Family: Dytiscidae					
Hydrovatus sp.	3	1	0	3	07
Laccophilus guttatus	3	0	2	1	06
Laccophilus sp.	0	2	2	0	04
Hydrocoptus sp.	7	1	0	0	08
Family: Hydrophilidae					
Amphiops sp.	2	0	6	0	08
Hydrophilus sp.	0	2	0	3	05
Diptera					
Family: Chironomidae					
Chironomous sp.	0	7	5	2	14
Family: Culicidae					
Culex sp.	8	3	11	13	35

Taxa/ Genera	Monsoon	Post monsoon	Winter	Pre monsoon	Total
Odonata					
Family: Libellulidae					
Orthetrum sabina	0	1	5	0	06
Tramea sp.	2	0	0	1	03
Family: Aeshnidae					
Anax sp.	5	2	0	2	09
Trichoptera					
Family: Polycentropodidae					
Polycentropus sp.	2	1	5	0	08

Table.4.Seasonal fluctuations of different Aquatic insect species (org. /m^2) recorded in Dighali Pukhuri of Guwahati City during 2011-12.

Taxa/ Genera	Monsoon	Post monsoon	Winter	Pre monsoon	Total
Hemiptera					
Family: Gerridae					
Neogerris parvula	03	07	00	15	25
Gerris gracilicornis	01	05	03	07	16
Limnogonus nitidus	00	02	05	00	07
Family: Pleidae					
Plea liturata	00	01	07	02	10
Family: Belostomatidae					
Diplonychus rusticus	00	01	05	03	09
Family: Hydrometridae					
Hydrometra greeni	02	01	05	00	08
Family: Nepidae					
Ranatra Filiformis	00	02	05	00	07

Taxa/ Genera	Monsoon	Post monsoon	Winter	Pre monsoon	Total
Coleoptera					
Family: Gyrinidae					
Dineutus unidentatus	01	04	00	05	10
Family: Dytiscidae					
Hydrovatus sp.	02	02	01	04	09
Laccophilus guttatus	00	01	00	02	03
Hydrocoptus sp.	01	00	02	00	03
Family: Hydrophilidae					
Amphiops sp.	07	00	00	02	09
Hydrophilus sp.	00	00	02	05	07
Diptera					
Family: Chironomidae					
Chironomous sp.	00	00	07	05	12
Family: Culicidae					
Culex sp.	05	02	13	09	29
Odonata					
Family: Libellulidae					
Orthetrum sabina	00	05	00	02	07
Tramea sp.	01	00	03	00	04
Family: Aeshnidae					
Anax sp.	03	02	00	03	08

The Saprobic score and diversity score of Dighali Pukhuri is presented in Table.5. The maximum Saprobic score value (7.1) was attributed to post-monsoon 2011-12 and minimum (5.5) to winter 2010-11 (Fig.1a). The diversity score ranged from (0.20-0.51) (Fig.1b). The maximum value was recorded during post-monsoon 2010-11 and the minimum value was recorded during pre-monsoon 2010-11 and winter 2011-12 respectively.

The water at this sampling site remained clean, that is of "A" class only once during post-monsoon 2011-12 and moderately polluted quality, class "C" during monsoon 2010-11 and winter 2010-11 and 2011-12 respectively. During rest of the entire sampling period, it was of slightly polluted quality i.e., class "B" (Fig.1c).

The most prevalent biological water quality Class was "B" (slight pollution) which accounted for about 65.5% of the total classes present. It was followed by Class "C" (moderate pollution) which accounted for 25% of the total biological water quality classes. The Class "A" (clean) contributed only 12.5%. The prevalence percentage of different biological classes can be shown as Class "B" > Class "C" > Class "A" (Fig. 1d).

Table 5 : Biomonitoring of Dighali Pukhuri during 2010-2012.

	Seasons	Saprobic Score	Diversity Score	Biological water quality class	Biological water quality	Indicator colour
2010-2011	Monsoon	6.8	0.30	B	Slight pollution	Light Blue
	Post monsoon	6.5	0.51	B	Slight pollution	Light Blue
	Winter	5.5	0.29	C	Moderate pollution	Green
	Pre monsoon	6.6	0.20	B	Slight pollution	Light Blue
2011-2012	Monsoon	7.0	0.38	B	Slight pollution	Light Blue
	Post monsoon	7.1	0.37	A	Clean	Blue
	Winter	6.0	0.20	C	Moderate pollution	Green
	Pre monsoon	6.8	0.25	B	Slight pollution	Light

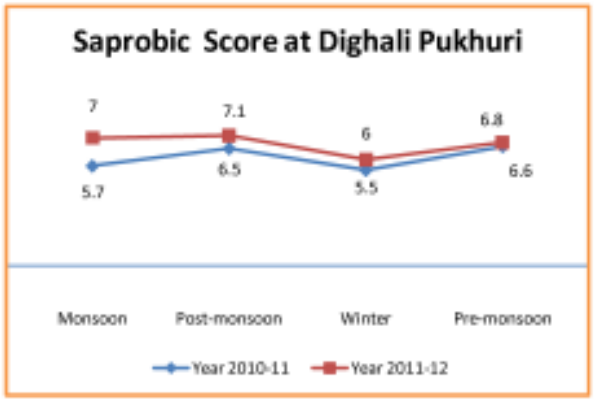


Fig.1a. Saprobic Score at Dighali Pukhuri.

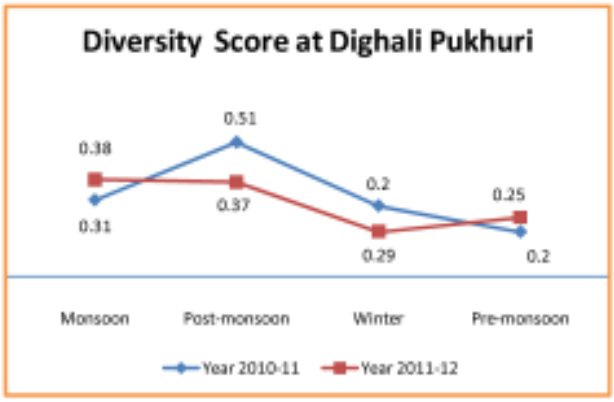


Fig.1b. Diversity Score at Dighali Pukhuri.

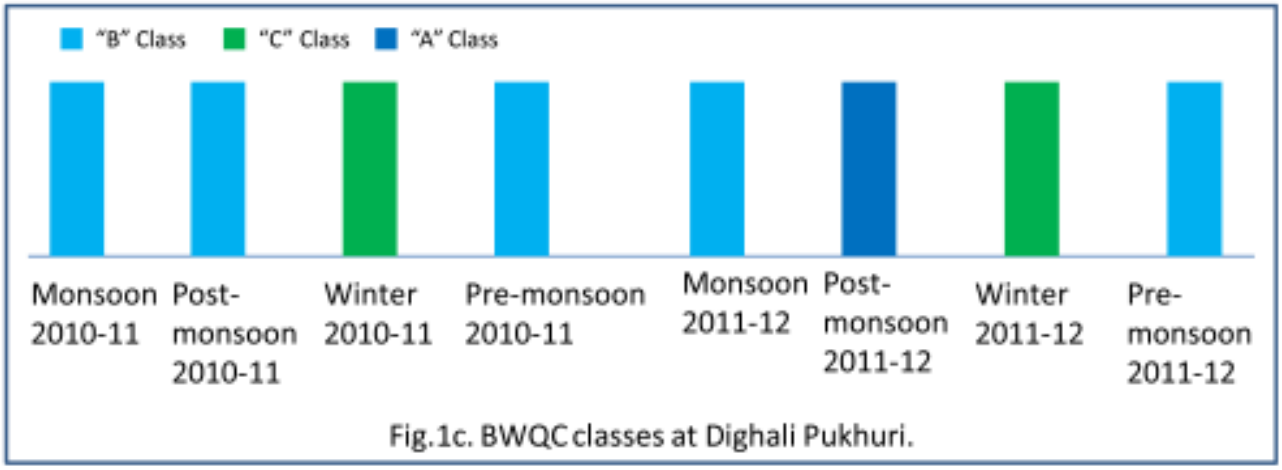
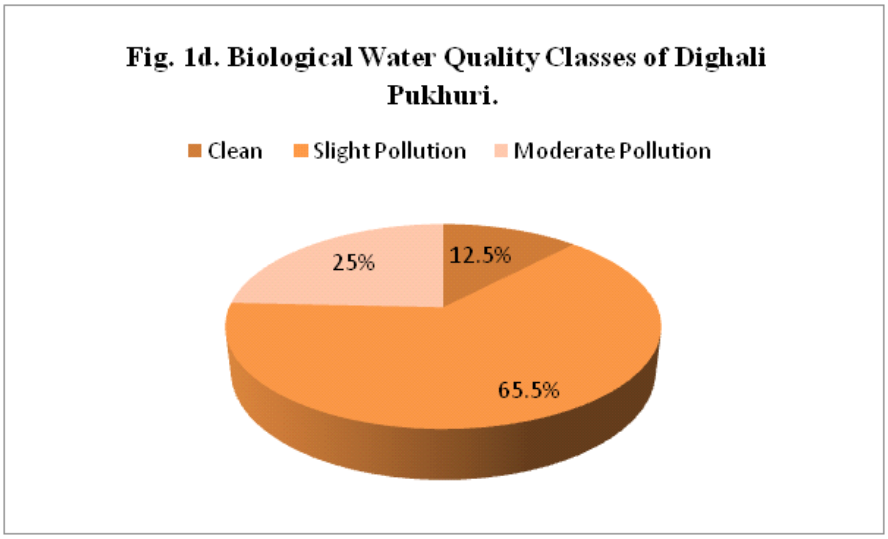


Fig.1c. BWQC classes at Dighali Pukhuri.



The overall BMWP score for a site is the sum of all of the scores of each family present at that sampling site. Score values for individual families reflect their pollution tolerance based on the current knowledge of distribution and abundance. Pollution intolerant families have high BMWP scores, while pollution tolerant families have low scores (Sivaramakrishnan, 1992). The Saprobic score value between7 – 10 indicate clean water quality (CPCB, 1999). This clean water quality was due to the total absence of insect taxa Chironomidae during post-monsoon season of 2011-12. The Saprobic score value between 6 -7 indicate slight pollution of water quality (CPCB, 1999). Slight pollution of water also recorded from Dighali pukhuri during the monsoon, post-monsoon and pre-monsoon seasons of 2010-11 and during monsoon and pre-monsoon seasons of 2011-11. This water quality was experienced due to the availability of most pollution sensitive insect taxa Trichoptera. In Dighali Pukhuri moderate pollution of water quality was observed during winter season of the study period. Due to the dominance of insect taxa Hemiptera and Coleoptera.

The present study clearly showed that aquatic insects can be used effectively and accurately to assess water quality to any wetland ecosystem. Hence with application of pollution index viz. BMWP score, aquatic insect community determine the water quality states of wetland.

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