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STUDY OF ANTHROPOGENIC INFLUENCED RECREATIONAL LAKES OF KARACHI-PAKISTAN WITH SPECIAL EMPHASIS ON SEASONAL CHANGES IN BIOLOGICAL COMMUNITIES

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ABSTRACT

The Physico-chemical, plankton (Phyto and Zooplankton) and biological characteristics of Safari park lake (SPL) and Quaid-e-Azam park lake (QPL) provided indirect clue of water quality of recent pollution after analyzing various parameters. It was recorded that the levels of turbidity was relatively high at QPL (216.17 ±166.54 NTU) but the other physical parameter (Temperature and pH) approximately uniform. Seasonal occurrence of biological communities were significantly higher in SPL than QPL (phytoplankton density, 1298.17±945.862 U/L; zooplankton density, 112.66±80.864 U/L and macro-invertebrates, 726.58±109.203 U/L). The presence of *Nephthys oligobranchia*, *Chaetogaster* sp., *Viviparous bengenlsis* and *Physa fontinalis* clearly reflect the low pollution at SPL. *Tubifex tubifex* and *Limnodrillus* sp. are well known for organic pollution indicator. In view of the occurrence of these organisms in QPL water (1 each in number) may be concluded that there was little bit high organic pollution. The monitoring of biological communities can easily indicate the response of any chemical and biological changes by the anthropogenic activities. Periodical assessment of water and soil should be carried out to maintain and develop pleasant environment in our recreational lakes.

Key words: Applied Limnology, Water pollution, Biological communities.

INTRODUCTION

Modern living standards need continuous attentions and it is very difficult to spare time for relaxation. Inspite of great stress, one who wants to relax, prefer to go the place, where environmental conditions are satisfactory. For this purpose different recreational parks and lakes have been made (Edington, 1986). In order to maintain the standards, it is imperative to monitor the biological communities and the effects of human activities on the ecosystem (Abel, 1996). Frequent visits of peoples lead to an increase in the pollution of aquatic ecosystem. The impact of the pollutants in most cases manifest in conpicous changes in abiotic and biotic communities due to which most of the organisms are on the verge of extinction (Lewis, 1979). In this connection, it is very much important to investigate the problem systematically from primary producers to top consumer level (Batish, 1983). The traditional Physico-chemical analysis does not help in determining long-term quality of water (Hynes, 1963) quickly in field studies and provide an indirect indication when its concentration remain very low. However, biological indicators provide a direct clue and quick informations of the system. The most striking advantage of biological monitoring of water quality is that it can integrate many different environmental factors and pollutants over a long period of time and maintain their position in the water.

Many mathematical equations, scales and indices (Shanon and Weaver, 1949; Hynes, 1979; Wilhm and Dorry, 1968) have been developed but unfortunately a general agreement to detect the level of water pollution is still a question. Problems related to these factors to evaluate the water quality is that either they take maximum time period in calculations or vary in their number and composition in an area due to effect of different environmental factors. For the sake of that the following group of organisms i.e. algae (Patrick, 1954; Fjerdingstad, 1964), bacteria (Leibmann, 1951; Sramek-Husek, 1958), protozoa (Hosetti, 1989), benthic macro-invertebrates (Gaufin and Tarzwell, 1956; Kolwitz and Marson, 1998, 1909, Rao *et al*., 1987; Rao and Srivastava, 1989) and other organisms (Bilgrami, 1988) may be employed as pollution thermometer. Qualitative estimation of biotic communities for monitoring work is necessary to assess the pollution load of an aquatic ecosystem.

Planktons reflect recent pollution of an aquatic ecosystem, however, certain macro-invertebrates remain in their inhabitant for longer period which face and survive even in the stress condition and give correct informations of post pollution of the system within a short span of time. Present investigation is an attempt to suggest quick and reliable methodology to assess the quality of water (Vass, 1991).

MATERIALS AND METHODS

Sampling stations

Two sampling stations i.e. Safari park lake (SPL) and Quaid-e-Azam park lake (QPL) located in the city of Karachi (Pakistan). The whole study period have been divided into three different seasons i.e., from July to October as monsoon, from November to February as winter and from March to June as summer season. Water, plankton and benthic macro-invertebrates samples were collected on monthly basis.

Physico-chemical characteristics of water

Water temperature, pH, dissolved oxygen, free carbon dioxide, and bicarbonate alkalinity were estimated at the spot and rest of parameters was determined in the laboratory within five hours of collection. Turbidity was determined by Nephelometric method (Systronic type No. 131). Hydrogen ion concentration of water was determined by highly sensitive strip BDH pH paper. Dissolved oxygen estimated by Wrinkler's modified method (APHA, 1989). Free carbon dioxide and bicarbonate alkalinity were determined by titrimatic method (Welch, 1948). Total hardness was estimated by EDTA titrimatic method. Nitrate nitrogen concentration was determined by chemical test kit.

Biological characteristics

Plankton

Plankton samples were collected through bolting silk net No. 20. Samples were mixed and concentrated in bottles by adding 4% formalin and brought to the laboratory for analysis. Identification was made with the help of monographs and other relevant literatures.

Benthic macro-invertebrates

Soil samples was placed in white enameled pans, diluted by adding water and finally the specimens alongwith organic detritus were sieved with a brass sieve (mesh size 425μ) as described by Charles and Smol (1994). The specimens were sorted under dissecting microscope (APHA, 1985). For preservation of samples, organisms were kept in Petridishes having 5% formalin and few drops of methanol for three hours and finally in sprit. The specimens were mounted in glycerin and observed under Nikon microscope and confirmed by comparing with the type specimens. The numbers of macro-invertebrates were computed per square meter by the following formula:

$$N = n/ah$$ (Welch, 1948).

Where,

N= No. of macro-invertebrates/ meter^2

a= Area sampled

n= No. of macro-invertebrates per sampled area

h= No. of hauls.

RESULTS AND DISCUSSION

Physico-chemical characteristics of water

Physico-chemical characteristics of study area showed a marked seasonal variation (Table 1). Turbidity was maximum at Quaid-e-Azam park lake (QPL) i.e. 530 NTU. During monsoon it was maximum possibly due to a lot of allochthonous organic wastes. But the level of turbidity was minimum during rest part of the year may be people avoid to visit the lakes. pH was slightly alkaline at QPL (7.15 during winters). Free carbon dioxide was minimum at SPL (2.42 mg/l ±1.01) followed by QPL (3.62 mg/l ±1.27), however a reverse trend was observed for dissolved oxygen and bicarbonate alkalinity. Recorded maximum concentration of dissolved oxygen at SPL may be due to low turbidity value, higher phytoplankton density and maximum light penetrations mat evolved oxygen during the process of photosynthesis. Average value of total hardness, chloride and nitrate nitrogen was observed in QPL.

Phytoplankton

Table 2 showed the monthly record of phytoplankton density, which was highest at SPL (3080/L), followed by QPL (2568/L). Overall 143 algal species were recorded in both sampling stations belonging to Bacillariophyceae, Cynophyceae, Cholorophyceae, Desmidaceae and Euglenophyceae (Table 3). Dominant algal forms at SPL were *Cymbella affinis*, *Fragilaria capucina*, *Melosira granulata var. mazzanensis*, *M.islandica*, *M.juerguensis*, *Surirella capronioides*, *S.robusta f. minor*, *Synedra ulna*, *Chlorella vulgaris* and *Spirogyra* sp. Algal species dominant at QPL

were *Melosira granulata, M. islandica var. helvetica, Synedra ulna var. helvetica, Synedra ulna var. biceps* and *Oscillatoria limosa*.

Table 1. Seasonal variations in Physico-chemical characteristics of water of recreational lakes of Karachi-Pakistan.

Parameters	Safari Park Lake (SPL)				Quaid-e-Azam Park Lake (QPL)			
	Monsoon	Winter	Summer	Range and average	Monsoon	Winter	Summer	Range and average
Physical								
Water temperature (°C)	26.90	19.15	28.92	17.5-30.0 24.99±4.28	26.70	19.57	29.27	17.6-30.2 25.18±4.37
Turbidity (NTU)	394.5	96.76	69.75	60.0-420 187.0±147.67	470.0	130.0	75.40	75-330 216.17±166.54
pH	6.90	7.07	6.85	6.5-7.2 6.94±0.17	6.72	7.15	6.82	6.5-7.2 6.9±0.26
Chemical								
Dissolved oxygen (mg/l)	6.60	7.80	7.05	6.2-7.9 7.15±0.56	6.27	7.32	6.60	6.0-7.6 6.73±0.57
Free Carbon dioxide (mg/l)	2.62	2.37	2.25	0.4-4.0 2.42±1.01	3.72	3.47	3.67	1.5-5.8 3.62±1.27
Bicarbonate alkalinity (mg/l)	153.92	194.07	135.10	120-200.5 161.03±29.408	140.05	178.17	138.40	93.7-190.6 152.21±30.08
Total hardness (mg/l)	76.52	92.27	115.65	53-125 94.82±19.62	88.52	98.4	127.42	71.0-139.7 104.78±20.69
Chloride (mg/l)	13.32	11.67	12.97	10-18.6 12.66±2.50	15.22	13.15	14.55	10.4-20.5 14.31±2.82
Phosphate (mg/l)	0.093	0.103	0.039	0.03-0.121 0.078±0.032	0.118	0.112	0.058	0.032-0.148 0.096±0.035
Nitrate (mg/l)	1.85	1.91	3.11	1.62-3.32 2.29±0.622	2.16	2.29	3.34	1.8-3.64 2.59±0.59

Table 2. Seasonal variations in biological communities.

Parameters	Safari Park Lake (SPL)				Quaid-e-Azam Park Lake (QPL)			
	Monsoon	Winter	Summer	Range and average	Monsoon	Winter	Summer	Range and average
Phytoplankton Density (U/L)	406.25	1241.50	2246.76	268-3080 1298017±945.862	336.00	998.50	1731.00	208-2568 1021.83±742.656
Zooplanktons Density (U/L)	34.50	90.25	213.25	20-285 112.66±80.864	32.25	80.75	172.75	19-210 95.25±62.015
Macro-Invertebrate Density (U/L)	271.75	646.50	1311.25	119-1385 726.58±469.203	255.25	1438.50	1589.00	149-1928 1094.25±665.495

Zooplankton

Zooplankton density varied from 2 to 258/L at SPL; from 19 to 210/L at QPL (Table 2). Maximum zooplankton density was observed during summer season and was minimum during monsoon season at both sampling stations. After post monsoon period they proliferate very fast and reach their zenith during summer season. Average value disclosed that it was maximum at SPL, which may be possibly due to suitable environmental conditions, while QPL fall under moderate conditions. Overall recorded zooplanktons comprising 50 texa in five groups belonging to

amoeba and nil ciliates (protozoa), rotifera, cladocera and copepoda in both sampling stations. The number of total specie identified was 31 at SPL and 25 at QPL (Table 3). Recorded zooplanktons species, which are indicator of water pollution i.e. *Arcella vulgaris*, *Difflugia lebes*, *Branchoinous angularis*, *Keratella cochlearis*, *Asplanchna priodonta*, *Philodina roseola* and *Cylop vicinus* at QPL.

Table 3. Number and composition of planktons.

Planktons	Safari Park Lake (SPL)		Quaid-e-Azam Park Lake (QPL)	
	Numbers	Percentage	Numbers	Percentage
Phytoplanktons				
Bacillariophyceae	79	55.2	69	50.36
Cyanophyceae	32	22.37	42	30.65
Cholorophyceae	28	19.58	20	14.59
Desmidaceae	2	1.39	5	3.64
Euglenophyceae	2	1.39	1	0.72
Total	**143**		**137**	
Zooplanktons				
Amoeba	4	12.90	7	28.00
Ciliates	2	6.45	----	----
Rotifera	14	45.16	9	36.00
Cladophora	5	16.12	3	12.0
Copepoda	6	19.35	6	24.00
Total	**31**		**25**	

Table 4. Occurrence of macro-invertebrates in recreational lakes of Karachi-Pakistan.

Macro-Invertebrates	Safari Park Lake (SPL)		Quaid-e-Azam Park Lake (QPL)	
	Numbers	Percentage	Numbers	Percentage
Annelida				
a. Polychaeta				
Nephthys oligobranchia	2	50.00	3	42.85
N.polybranchia	1	25.00	1	14.28
Namalycastis indica	----	----	1	14.28
b. Oligochaeta				
Tubifex tubifex	----	----	1	14.28
Limnodrilus sp.	----	----	1	14.28
Chaetogaster sp.	1	25.00	----	----
Total	**4**		**7**	
Artropoda				
a. Insecta				
Chironomous plumosus	3	12.00	4	14.81
Mesogomphus lineatus	2	8.00	2	7.40
Notonecta sp.	8	32.00	12	44.44
Dragon fly nymph	12	48.00	9	33.33
Total	**25**		**27**	
Mollusca				
a. Pelcepoda				
Lamellides marginalis	2	8.33	1	3.70
b. Gastropoda				
Viviparous bengalensis	4	16.66	2	7.40
Lymnaea acuminata	6	25.00	8	29.62
Physa fontinalis	12	50.00	16	59.25
Total	**24**		**27**	

Macro-invertebrates

Seasonal variation in macro-invertebrates in benthic sediments of sampling stations is depicted in Table 4. During summer season the concentration was very high. The macro-invertebrates comprised into three phyla i.e. annelida (Polycheata, Oligochaeta), arthropoda (Insecta) and mollusca (Pelcepoda; Gastropoda) were recorded in both sampling stations.

Polychaeta are by large marine annelida but few forms have also been encountered in freshwater systems. They are predatory or detritivores (Uskakov, 1972) and inhabit in mild polluted zone where decay organic matter is in plenty. Altogether, 185 polychaetes were recorded belonging to two-genus viz. *Nephthys* (*Nephthys oligobranchia* and *N. polybranchia*) and *Namalycastic indica.* Of this population *N. oligobranchia* was found to be maximum. A total of 160 *N. oligobranchia* was collected from both sampling stations and suggests that there were low pollutants load.

Tubifex tubifex and *Limnodrillus* sp. are well known for high organic pollution indicator. The occurrence of these organisms reflects the low pollution in both sampling stations. Besides these, different benthic macro-invertebrates i.e., *Chaetogaster* sp., *Viviparous bangalensis* and *Physa fontinalis* well known for the indicator of clean water quality, were frequent at SPL and QPL. Thus, macro-invertebrates constitute heterogeneous assemblage of animal phyla and the members respond to adverse conditioned and stresses caused due to pollutants (Nazneen *et al*., 1999).

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