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**PHYTOPLANKTON DIVERSITY IN RELATION TO
PHYSICOCHEMICAL CHARACTERISTICS OF UPPER BASIN
(BHOJ WETLAND), BHOPAL, INDIA**

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ABSTRACT

The diversity of phytoplankton and its relationship to the physico-chemical characteristics was studied in upper basin of Bhoj Wetland, Bhopal. The water quality of Upper Lake is evaluated which is one of the major potable water source of Bhopal city. The present study reveals the assessment of water quality deterioration and the possible reasons of its cause and effect. Physico-chemical parameters measured at two sites revealed alkaline nature of the water. Hundred and five species of phytoplankton were recorded from both sources of study. The recorded phytoplankton species belonged to the following five divisions viz., Chlorophyceae (49 species), Cyanophyceae (29 species), Bacillariophyceae (14 species), Euglenophyceae (12 species), Pyrophyceae (1 species).

Key Words: Plankton Algal Classes, Abiotic Parameters

INTRODUCTION

The study of abiotic and biotic components is complementary to each other. The abiotic components give information about the type of a substance and its concentration, while as biotic components indicate the general effect of the substance. The changes in the physico-chemical conditions of water can be reflected directly in the biotic community of ecosystem. The study of phytoplankton gives the number of kinds and occurrence of phytoplankton in a habitat. Phytoplankton's are primary producers and act as food source directly or indirectly for fishes, besides acting as indicators of water quality.

Upper lake Bhopal is arguably the oldest man-made lake in India, and was created by Raja Bhoj in the 11th century by constructing an earthen dam across the Kolans River. The upper lake is a major source of portable water for the city of Bhopal, Madhya Pradesh, India. Latitude 23° 12' (23.2000) and Longitude 77° 18' (77.3000). The basin has a maximum depth of 11.7m and storage capacity 101.5m, cm and the surface area is 32.29 sq. km. Extent of pollution that has occurred due to urbanization, anthropogenic activities; increased human interventions in the water bodies. Burgeoning population and water scarcity is affecting the quality of life significantly; India is no exception to this. Providing water in adequate quantity and quality for domestic water supply, irrigation and industrial requirements in all parts of the city is a tremendous challenge from several angles economic, technical management and social. Earlier studies on Bhoj wetland by Bajpai *et al.*, (1993) reported the deteriorating effect of idol immersion on water quality of upper lake. Wanganeo *et al.*, (1997) worked on dissolved oxygen regimes and percent deficit distribution with algal blooms on account of enriched nutrient condition. Wanganeo (1998) also evaluated the nutrient budget of the same lake suggesting significance of catchment area of the lake. Pani and Mishra (2000) in their study reported more deteriorating condition of lower lake as compared to upper lake. Garg and Garg (2002) worked on three lakes of Bhopal (Lower lake, Upper Lake and Mansarovar Lake) to assess the potential fertility of lentic waters and analyzed their floral ecology. Vyas *et al.*, (2006) reported about the negative effect of idol immersion on water quality of Bhopal Lake. Parashar *et al.*, (2006) found seasonal variations in physico-chemical characteristics in Upper Lake of Bhopal. Dixit *et al.*, (2007) studied the extent of deterioration in water quality of lower lake and checked the performance of the aeration system in improving the water quality.

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Thus, for its profound economic and socio-cultural importance, it was selected for present study. The main objectives of the study were to determine phytoplankton diversity and water quality in the upper lake and to study the effects of physico-chemical parameters on phytoplankton population.



Figure 1: Site map of present study

MATERIALS AND METHODS

The study was carried out during Jan. 2007 to June 2007. Two sampling stations (comprising of Boat club and Central site) were based on different characteristics such as physicochemical and biological). Physicochemical characteristics such as temperature, transparency, pH, conductivity, TDS, D.O, Free CO₂, alkalinity (total and phenolphthalein), Hardness (total, calcium and magnesium), Chloride, were analyzed using the standard APHA (1995) and Adoni (1985) methods. Biological samples (phytoplankton) were preserved by adding 5 ml of 4% formalin and the identification of phytoplankton was done with the help of standard works viz, Edmondson (1965), Needham and Needham (1966). Plankton samples were collected by plankton net made of bottling silk cloth No. 25 (mesh size 0.064mm) fortnightly.

RESULTS AND DISCUSSION

The minimum, maximum, mean and standard deviation results of the physicochemical parameters are presented in (Table1).

Table 1: Range between the physico-chemical parameters of upper basin of Bhoj Wetland, Bhopal

Parameters	Site I Surface	Site II Surface	Middle	Bottom
Air Temp. (°C)	21-41	22-40		
Water Temp. (°C)	24-31	18-29	20-28	16-26
Depth (m)	1-2	6-6.9		
pH	8-9	6.7-9.2	7.6-8.8	7.2-8
Total Dissolved Solids (mg/l)	80-150	80-120	70-130	70-150
Conductivity (µS)	120-200	140-200	140-210	140-220
Dissolved Oxygen (mg/l)	1.9-14	1.25-13	1.1-9.9	0-4
Total alkalinity (mg/l)	96-158	88-122	88-116	98-132
Total hardness (mg/l)	66-94	62-98	74-104	86-108
Calcium hardness (mg/l)	40-65	38-72	50-88	48-88
Magnesium hardness (mg/l)	4.2-8.26	3.4-10.2	2.96-10.2	3.98-12.15
Chloride (mg/l)	14.99-30.99	13.99-22.99	13.99-23.99	16.99-32.99

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One hundred and four species in the five classes of phytoplankton were identified from the samples during the study period at station-I. The relative number of classes in decreasing number was Chlorophyceae (51.08%), Cyanophyceae (29.89%), Bacillariophyceae (10.32%), Euglenophyceae (5.97%) and Pyrophyceae (2.71%). The classwise representation depicted following order of dominance: Chlorophyceae > Cyanophyceae > Bacillariophyceae > Euglenophyceae > Pyrophyceae.

Fortnightly variation at this site depicted the presence of all the species during the months i.e., February, March, April, May and June. And the list of phytoplankton species encountered during the study period at station-II and at three depths. On the basis of percentage contribution of surface waters shows (48.38% Chlorophyceae, 25.16% Cyanophyceae, 16.12% Bacillariophyceae, 7.09% Euglenophyceae and 3.22% Pyrophyceae). In middle the percentage contribution shows 47.72% Chlorophyceae, 18.10% Cyanophyceae, 22.72% Bacillariophyceae, 7.95% Euglenophyceae and 3.40% Pyrophyceae. In bottom waters 54.09% Chlorophyceae, 21.31% Cyanophyceae, 18.03% Bacillariophyceae, 3.27% of Euglenophyceae and Pyrophyceae (Table 2 and 3).

Table 2: Phytoplankton species encountered during the study period of upper basin of Bhoj Wetland, Bhopal

Class and species	Site-I Surface	Site-II Surface	Middle	Bottom
Chlorophyceae		+		
<i>Actinastrum sp.</i>	+++	+		
<i>Ankistrodesmus falcatus</i>	+	+		
<i>Arthrodesmus sp.</i>	++	+		
<i>Closterium acutum</i>	+	+	+	+
<i>Closteriopsis sp.</i>	+	+	+	
<i>Chronococcus elongatus</i>	+	++		
<i>Characium sp.</i>	+			
<i>Closteridium sp.</i>	+	+		
<i>Cosmarium sp.</i>	+	+		
<i>Cladophora sp.</i>	+	+		
<i>Desmidium sp.</i>		+		
<i>Draparnaldiopsis sp.</i>	+			
<i>Ealkatothrix gelatinosa</i>	+			+
<i>Euastrum sp.</i>	+	+		
<i>Gonatozygon sp.</i>	++	+	+	
<i>Gloeotrichia echinulata</i>	+	+		
<i>Gonium compactum</i>	+	+		
<i>Microspora sp.</i>	+	+	+	+
<i>Microstearias sp.</i>		+		+
<i>Mougeotia sp.</i>	++	++	+	+
<i>Oedogonium sp.</i>	+	+		
<i>Oocystis solitaria</i>		+	+	
<i>Ourococcus bicaudatus</i>	+	+		
<i>Pediastrum simplex</i>	+++	+++	++	+++
<i>P. duplex</i>	+	+		+
<i>P. ovatum</i>	+	+	+	+
<i>Schroederia setigera</i>		+	+	
<i>Scenedesmus dimorphus</i>	++	+		
<i>S. carinatus</i>	+	+		
<i>Selenastrum westii</i>	+	+	+	

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<i>Sirogonium sp.</i>	+	+		
<i>Sorastrum sp.</i>		+	+	+
<i>Sphaerotilus notans</i>	+	+		
<i>Spirotaenia sp.</i>	+++	+	+	+
<i>Spirogyra sp.</i>	+	+		
<i>Staurostrum manfeldti</i>	+		+	+
<i>Stigeoclonium sp.</i>	+	+		
<i>Tetrahedron trigonum</i>	+	++	+	+
<i>T. regulatase</i>			+	
<i>T. hastulam</i>	+		+	
<i>T. victorieae</i>		+		+
<i>Trigonium victorieae</i>	+			
<i>T. proteiforme</i>	+			
<i>Triploceros sp.</i>	+		+	
<i>Treubaria triappendiculata</i>	+		+	
<i>Ulothrix sp.</i>	+++	+	+	+
<i>Uronema sp.</i>	+	+		
<i>Volvox sp.</i>	+	+	+	+
<i>Zygnema stelinum</i>	++	+	+	
Cyanophyceae				
<i>Anabaena sp.</i>	++	+		
<i>Anabaenopsis naviculoides</i>	+	++		
<i>Aphanocapsa castagnei</i>	+	+	+	
<i>Aphanizomenon sp.</i>	+			
<i>Chronococcus elongatus</i>		+		
<i>Lyngbya borgerti</i>	++	+	+	+
<i>Merismopedia punctata</i>	+			
<i>Microcystis aeruginosa</i>	+++	++	+	++
<i>Nostoc sp.</i>	+	+		
<i>Netrium sp.</i>	+	+		
<i>Oscillatoria amphigranulata</i>		+	+	+
<i>O. princeps</i>	+			
<i>O. chalybea</i>	+			+
<i>O. limnetica</i>		+	+	
<i>O. prolifica</i>	+			+
<i>O. subbrevis</i>		+	++	+
<i>O. curviceps</i>	+	+		
<i>O. lemmernannii</i>	+			
<i>O. acuminata</i>	+			
<i>O. amphibian</i>		+	+	
<i>O. jasorvensis</i>	+			
<i>O. perornata</i>	+	+		
<i>O. pseudogeminata</i>	+	+		
<i>O. chlorine</i>	+			
<i>O. ornata</i>		+		
<i>O. quadripunctulata</i>		+		
<i>O. rebbescens</i>		+	+	
<i>O. splendida</i>	+	+	+	+
<i>Spirulina major</i>	+	+	+	+

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<i>Phormidium</i> sp.	+	+		
<i>Raphidiopsis indica</i>	+	+		
Bacillariophyceae				
<i>Achnanthes minutissima</i>	+	+		+
<i>Amphora microcephala</i>	+	+	+	
<i>Asterionella</i> sp.	+	+	+	
<i>Caloneis</i> sp.		+	+	
<i>Cocconies</i> sp.		+	+	+
<i>Cymbella</i> sp.	+	+	+	
<i>Fragilaria construens</i>	+	+	+	+
<i>Frustula</i> sp.		+	+	
<i>Gomphonema sphareophora</i>		+	+	
<i>Melosira granulata</i>	+	+	+	+
<i>Navicula subrhyncocephala</i>	+	+	+	
<i>Nitzschia</i> sp.	+	+	++	+
<i>Synedra</i> sp.	+	+	+	++
<i>Tabellaria</i> sp.	+	+	+	
Euglenophyceae				
<i>Euglena caudate</i>	+	+	+	
<i>E. lemnophila</i>	+	+	+	
<i>E. vagans</i>			+	
<i>E. gracilis</i>				
<i>Phacus helikaoides</i>	+	+		
<i>P. mammilates</i>		+	+	+
<i>P. pyrum</i>	+		+	+
<i>P. pleutroneus</i>	+	+		
<i>P. robusta</i>	+	+		
<i>P. wettsteinii</i>		+		
<i>Trachelomonas armata</i>	+	+	+	
<i>T. robusta</i>	+	+		
Pyrophyceae				
<i>Ceratium</i> sp.	+++	+++	++	+

Table 3. Overall class wise species distribution of phytoplankton population

Class	Genus	Species	Percent
Chlorophyceae	42	49	45.79 %
Cyanophyceae	14	31	28.97 %
Bacillariophyceae	14	14	13.08 %
Euglenophyceae	4	12	11.21 %
Pyrophyceae	1	1	0.93 %
Total	75	104	100

S=surface M=Middle, B=Bottom

Table 4. Vertical distribution of species at site-II.

Class	S	M	B
Chlorophyceae	40	22	17
Cyanophyceae	22	10	8
Bacillariophyceae	14	12	6
Euglenophyceae	9	7	2
Pyrophyceae	1	1	1
Total	86	52	34

Phytoplankton are regarded as the chief primary producers of any aquatic environment (Wetzel, 1975), which fix solar energy by the process of photosynthesis, assimilating carbon dioxide, to produce carbohydrates, thus serve as an important link between the abiotic factors and the biota in the aquatic system (Saha *et al.*, 2000). Phytoplankton has great importance from ecological point of view. Some

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develop noxious or toxic conditions resulting in animal death or human illness to those who consume this water (Hosetti, 2002).

Chlorophyceae dominance has been attributed to eutrophic nature of the lake. These lakes are highly enriched and productive water bodies. The dominant group among the phytoplankton are *Ankistrodesmus*, *Closteriopsis*, and *Pediastrum simplex*, *Spirotaenia* and *Ulothrix* species were dominant are recoded in appreciable number at site-I (Boat club) and *Pediastrum simplex* were also dominant at each depth site-II. Which could be indicated as pollution tolerant genera, Palmer (1980) and Mishra and Saksena (1993) have also reported these genera as the bioindicator of organic pollution.

Bacillariophyceae – following genera were found to be present, *Nitzschia*, *Synedra*, and *Fragilaria* species. Diatoms are usually abundant in alkaline waters having pH > 8 (Kamat, 1965) and as per Round (1981), *Nitzschia* can be dominant in the plankton when water is rich in organic nutrients. Diatoms are preferred food of many aquatic organisms in the upper trophic level and thus form the basis of productive fisheries. Ryther (1969) diatoms constitute the most important group of algae even though most species are sessile and associated with littoral substrate, Wetzel (1983).

Cyanophyceae, they are more efficient in utilizing CO₂ at high pH level and thus their abundance indicates the Eutrophic nature of the studied water bodies. Cyanophyceae considered to be highly adaptive and colonized even in polluted water at higher temperature. In the present investigation 12 species have been recorded among which *Anabaena*, *Lyngbya*, *Microcystis* and *Oscillatoria* species are dominant at the study period. Temperature has found to play a key role in the periodicity of this group. This statement has also been supported by Mishra and Saksena (1993), Unni (1984) and Wanganeo (1980).

Euglenophyceae, algal species belonging to this group show higher tolerance to organically polluted areas, Palmer (1969) thus can be used as biological indicator of organic pollution. *Euglena* and *Phacus* were found. These groups have shown very poor distribution, an observation made by Gonzalves and Joshi (1946), Singh (1960) and Seenayya (1971).

Pyrophyceae species belonging to this group was present throughout the study period at both sites. According to Findenegg (1971) and Rawson (1956), *Ceratium* is a mesotrophic form and represents an intermediate stage in the evolution from oligotrophy to eutrophy. Reynolds (1973) reported *Ceratium* from nutrient rich waters.

The present study revealed that the Upper Lake is of a better quality, although there is a need to continuous monitoring in order to maintain the quality of drinking water. However government needs to take cognizance in order to prevent the decline and eutrophication of the lake. The result showed that Upper Lake water is a suitable source for the supply of water for drinking, irrigation and fish culture. The distribution and population density of phytoplankton species depend upon the physico-chemical factors of the environment.

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