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WATER QUALITY AND PHYTOPLANKTON DIVERSITY OF GOPESWAR TEMPLE FRESHWATER POND IN ASSAM (INDIA)

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Abstract

Water quality and phytoplankton diversity were investigated in Gopeswar temple pond of Assam, India. Altogether 45 species of phytoplankton were recorded representing Chlorophyceae (16), Cyanophyceae (10), Bacillariophyceae (14), Euglenophyceae (3), Chrysophyceae (1) and Dinophyceae (1). Phytoplankton peaks were observed in summer and monsoon periods. Correlations of phytoplankton density with different water quality parameters were evaluated and the water body was found to be moderately polluted. Presence of *Microcystis aeruginosa* along with *Navicula cryptocephala* throughout the year also indicated its cultural eutrophication and hence, needs management intervention.

Phytoplankton could be used as the indicator of physicochemical status of any water body (Mittal and Sengar 1991). The communities of phytoplankton are also reported to be affected by the process of cultural eutrophication in aquatic bodies. In India, recently the diversity of phytoplankton in different freshwater wetlands along with their physicochemical characteristics were studied (Veereshakumar and Hosmani 2006, Ravikumar *et al*. 2006, Tiwari and Shukla 2007, Senthilkumar and Das 2008). Though there are more than 3513 inland freshwater bodies including a good number of temple ponds in North Eastern Region of India, a little work have so far, been done on algal diversity of those water bodies (Baruah and Kakati 2009). The present work is an attempt to explore the phytoplankton species, their composition along with their correlation with different physicochemical parameters of the Gopeswar temple pond.

The study was conducted from January to December, 2009 at Gopeswar temple pond, Kamrup District, Assam (India) which is situated between 26°30' N and 91°71' E. The pond is a 600 years old water body associated with an ancient seat of Lord Siva as worship by Hindus and has been regularly using for the day-to-day pursuits of the temple since it was dug by ruler Ahom Kingdom. The water of the pond is also considered as sacred by the people of the region irrespective of caste, creed and religion and used for local treatments of many diseases and, is still a major source of drinking.

The water samples for phytoplankton analysis were collected separately in wide mouth bottles with the help of plankton nets of 55 µm mesh size with some amount of pond water and immediately preserved in 4% formalin solution. The samples were collected from 5 different locations of which 4 were from each corners and the 5th one at centre. Samplings were done in monthly intervals in morning hours and brought to the laboratory and stored in 4 ± 1°C as followed by Mittal and Sengar (1991). The identifications of phytoplankton were made following standard literatures. Algal count was done using Sedgwick Rafter plankton counting cell.

The water samples for physicochemical analysis were collected from the surface in triplicate with the help of 1 litre Nansen sampler. The samples were then transferred into clean 2 litre plastic containers previously rinsed with the pond water. Temperature, pH, free CO_2, DO were determined

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in situ and the other physicochemical parameters were analyzed following APHA (1976). Productivity was estimated by standard light and dark bottle method following Vollenweider (1969). Conductivity and pH was measured with digital meters. Correlation coefficient (r) was determined by putting the data in Excel worksheet and related significant tests were done following Snedecor and Cocharan (1967).

In total 45 species of phytoplankton was recorded belonging to six classes (Table 1). Chlorophyceae with 16 species were found to be dominant in the pond, followed by Bacillariophyceae (14 species), Cyanophyceae (10 species) and Euglenophyceae (3 species), respectively. Chrysophyceae and Dinophyceae were represented by one species each.

A marked seasonal variation in physicochemical conditions of the Gopeswar pond water was observed (Table 2). The phytoplankton density showed maximum count in summer and monsoonal months which may be attributed to the prevailing high temperature of summer season along with high amount of dissolved nutrients in the pond water (Table 2). With the onsetting of monsoon rains from the month of June onwards, phytoplankton density was reported to be decreased with the dilution of pond water. Phytoplankton count was minimum in winter months which may be attributed to low water as well as ambient temperatures in the pond. The results were also in conformity with Sreenivasan *et al. (*1974) and Hujare (2008), who worked on some tropical freshwater bodies in India.

The water of the pond is alkaline. Correlation study however, revealed no significant relationship of pH and conductivity with the algal density (Table 3) whereas Secchi disc transparency had significant negative relationship with the algal density in the study pond (Table 3). Though total solids (TS) and dissolved solids (TDS) had no significant relationship, total suspended solids (TSS) related significantly with the algal density (Table 3). Presence of *Oscillatoria* sp., *Pediastrum* sp. and *Scenedesmus* sp. in the pond may be attributed to moderate to high quantity of dissolved solid (TDS) which is in concurrence with the result of Sengar and Sharma (1987). Hardness showed no significant impact on algal growth in the pond. The total alkalinity values in the study pond showed positive significant correlation with algal density (Table 3).

Dissolved oxygen content showed positive significant relation, whereas, free CO_2, BOD, COD, GPP and NPP were indifferent of algal density. Seasonal mean GPP in pre-monsoon and monsoon yielded almost similar value (Table 2). Lowest mean seasonal GPP was recorded in winter (Table 2). Long daylight was perhaps the prime factor contributing to the higher value of GPP particularly in the summer months along with high water/ambient temperature (Table 2). Result also revealed that total nitrogen and total phosphate showed significant positive correlation with algal density and that of magnesium, sodium and calcium showed significantly negative correlation with algal density during the study periods (Table 3). Potassium and chloride showed no significant relationship with the algal density. The study thus showed that the water quality parameters like TSS, DO and dissolved nutrients including nitrogen and phosphate as a whole, play a decisive role in the variation of the phytoplankton in the studied temple pond.

The study on phytoplankton in Gopeswar temple pond also revealed the moderate pollution therein and showed a trend in increasing eutrophication. Presence of *Euglena, Oscillatoria, Scenedesmus, Navicula, Nitzschia* and *Microcystis* (Table 1) also supported the view which is in concurrence with the result of Nandan and Aher (2005) in Haranbaree dam and Mosam river of Maharashtra (India). *Microcystis aeruginosa* is associated with the highest degree of civic pollution (Shashi Shekhar *et al.* 2008) and may be considered as the best single indicator of organic pollution in any water body. Year round occurrence of *M. aeruginosa* (Table 1) reflected the human generated pollution too in the study pond.

Table 1. Monthly occurrence of algal species in Gopeswar temple pond, Assam (India).

Sl. No.	Phytoplankton	Months of the year											
		J	F	M	A	M	J	J	A	S	O	N	D
	Cyanophyceae												
1.	*Anabaena circinalis*	−	−	+	+	+	+	+	+	+	−	−	−
2.	*A. spiroides*	−	−	+	+	+	+	+	+	+	+	−	−
3.	*Gleocapsa magma*	−	−	+	−	−	−	−	−	+	+	−	-
4.	*Gleocystis ampla*	−	−	−	−	+	+	−	−	−	−	−	−
5.	*Lyngbya allorgi*	−	−	−	−	−	−	−	+	+	+	+	−
6.	*Microcystis aeruginosa*	+	+	+	+	+	+	+	+	+	+	+	+
7.	*M. flosaquae*	−	+	+	+	+	+	+	+	+	+	+	+
8.	*Oscillatoria limnosa*	−	+	+	+	+	−	−	−	+	+	+	−
9.	*O. princeps*	−	+	+	+	+	+	−	−	−	−	−	−
10.	*Phormidium calcicola*	−	+	+	+	+	+	+	−	+	−	−	−
	Chlorophyceae												
11.	*Ankistrodesmus falcatus*	−	+	+	+	+	+	+	+	+	−	−	−
12.	*Chlorella vulgaris*	−	+	+	+	+	+	−	−	−	+	+	−
13.	*Cladophora* sp.	−	−	−	−	+	+	+	+	+	−	−	−
14.	*Closterium diane*	−	−	+	+	+	−	−	−	−	+	−	−
15.	*C. elegans*	−	+	+	−	−	−	−	−	−	−	−	−
16	*C. lenceolatus*	−	−	+	+	−	−	−	−	−	−	+	−
17.	*Monoraphidium arcuatum*	−	+	+	−	−	−	−	−	−	−	−	−
18.	*Mougeotia scalaris*	−	−	+	+	+	+	+	+	−	−	−	−
19.	*Netrium digitus*	−	+	+	−	−	−	−	−	−	−	+	−
20.	*Pediastrum tetras*	−	−	−	+	+	−	−	−	−	−	−	−
21.	*Scenedesmus armatus*	−	+	+	+	+	+	−	−	−	−	−	−
22.	*S. quadricauda*	−	−	−	+	+	+	−	−	−	−	−	−
23.	*Spirogyra macrospora*	+	+	+	+	+	+	+	+	+	+	−	−
24.	*S. singularis*	−	−	−	−	+	+	+	+	+	+	+	−
25.	*Ulothrix limnetica*	−	−	−	−	−	−	−	−	−	+	+	−
26.	*Zygnema subcylindricum*	−	−	−	−	−	−	+	+	+	+	−	+
	Bacillariophyceae												
27.	*Achanthes granulata*	−	−	−	−	+	+	−	−	−	−	−	−
28.	*Cyclotella glomerata*	−	−	+	+	−	−	−	−	+	−	−	−
29.	*Cymbella affinis*	−	+	+	+	+	+	+	−	−	+	+	−
30.	*C. lenceolata*	−	+	−	+	+	−	−	+	+	−	−	−
31.	*Diatoma vulgare*	−	−	−	−	+	+	+	−	−	−	−	−
32.	*Fragillaria crotonensis*	−	−	+	+	+	−	−	−	+	+	+	−
33.	*Gomphonema lenceolatum*	−	−	−	+	+	+	+	+	−	−	−	−
34.	*G. parvulum*	−	+	+	+	+	+	+	+	+	−	−	−
35.	*Melosira varians*	−	−	−	−	−	+	+	+	+	−	−	−
36.	*Navicula cryptocephala*	+	+	+	+	+	+	+	+	+	+	+	+
37.	*Nitzschia commutata*	−	−	−	−	−	−	+	+	−	−	−	−
38.	*Pinnularia gibba*	−	−	−	+	+	+	+	−	+	+	−	−
39.	*P. major*	−	−	−	−	−	−	+	+	+	−	−	−
40.	*Synedra ulna*	−	−	−	−	−	−	−	−	−	+	+	−
	Euglenophyceae												
41.	*Euglena acus*	−	−	−	+	+	+	+	+	+	+	−	−
42.	*E. elastic*	−	−	+	+	+	+	+	+	+	−	−	−
43.	*Phacus nordstedtii*	−	−	+	+	+	−	−	−	+	+	−	−
	Chrysophytceae												
44.	*Dinobryon cylindricum*	−	−	−	+	+	+	+	−	−	−	−	−
	Dinophyceae												
45.	*Ceratium hirudinella*	−	−	−	−	−	−	−	+	+	−	−	−

Table 2. Water quality data and algal density of Gopeswar temple pond in four seasons.

Parameters	Winter	Pre monsoon	Monsoon	Post monsoon
Air temp. (°C)	19.50 ± 3.71	32.83 ± 0.38	30.53 ± 0.95	28.50 ± 0.38
Water temp. (°C)	17.40 ± 4.40	30.20 ± 0.38	29.77 ± 0.80	23.83 ± 3.75
Transparency (cm)	30.47 ± 3.41	20.63 ± 7.34	11.30 ± 0.44	23.00 ± 4.09
TS (mg/l)	278.67 ± 12.47	321.07 ± 16.31	306.80 ±17.22	323.53 ± 27.82
TDS (mg/l)	121.00 ± 5.16	175.93 ± 6.04	155.83 ± 8.50	120.20 ± 17.04
TSS (mg/l)	157.67 ± 20.95	145.13 ± 17.43	150.97 ± 13.82	203.33 ± 26.33
pH 8.91 ± 0.25	8.07 ± 0.47	8.97 ± 0.25	8.92 ± 0.31	
Conductivity	170.67 ± 7.02	174.00 ± 2.65	162.00 ± 3.61	170.33 ± 4.93
DO (mg/l)	8.93 ± 1.63	8.60 ± 3.47	11.20 ± 0.40	8.00 ± 0.60
Free CO_2 (mg/l)	2.59 ± 0.51	2.53 ± 0.72	2.00 ± 0.46	3.93 ± 1.30
Hardness (mg/l)	79.00 ± 17.69	80.00 ± 9.17	77..33 ± 14.05	61.67 ± 5.03
Total alkalinity (mg/l)	71.37 ± 25.45	76.50 ±14.73	80.17 ± 1.05	80.67 ± 3.31
Ca (mg/l)	16.83 ± 0.81	22.45 ± 0.68	20.65 ± 2.12	17.17 ± 1.32
Cl (mg/l)	21.76 ± 3.76	23.13 ± 5.91	22.45 ± 0.82	21.82 ± 1.42
Mg (mg/l)	12.49 ± 4.12	14.68 ± 2.45	8.79 ± 0.79	13.31± 3.09
Na (mg/l)	27.95 ± 2.27	28.75 ± 1.04	28.40 ± 0.74	26.34 ± 1.51
K (mg/l)	1.02 ± 0.05	1.07 ± 0.02	1.06 ± 0.01	1.00 ± 0.02
Total Kjeldahl N (mg/l)	2.48 ± 0.049	3.55 ± 0.036	3.41 ± 0.05	2.88 ± 0.057
Total phosphorus (mg/l)	3.29 ± 0.06	3.34 ± 0.02	4.33 ± 0.03	3.22 ± 0.03
BOD (mg/l)	2.00 ± 0.20	1.73 ± 0.15	1.70 ± 0.10	1.87 ± 0.06
COD (mg/l)	27.97 ± 2.57	23.67 ± 0.71	25.03 ± 1.03	28.03 ± 1.64
GPP (mg/l)	1.80 ± 0.04	3.50 ± 0.08	3.40 ± 0.09	2.60 ± 0.08
NPP (mg/l)	1.00 ± 0.04	1.20 ± 0.05	1.50 ± 0.08	1.60 ± 0.06
Algal density ($\times 10^3$)	2334.60 ±77.18	3805.33 ± 617.6	3268.33 ± 192.1	2852.67± 340.5

Table. 3. Correlation between physicochemical parameters and algal density.

Parameters	Correlation coefficient	Parameters	Correlation coefficient
Air temp.	–0.572	Calcium	–0.733*
Water temp.	–0.075	Chloride	0.180
Transparency	–0.651*	Magnesium	–0.733*
TS	0.560	Sodium	–0.721*
TDS	0.109	Potassium	–0.364
TSS	0.660*	Total nitrogen	0.775*
pH	0.377	Total phosphate	648*
Conductivity	–0.522	BOD	–0.159
DO	0.788*	COD	0.311
Free CO_2	0.464	GPP	0.511
Hardness	–0.511	NPP	0.257
Total alkalinity	0.841*		

*Significance at 0.05% level. 1 = Units in mg/l except temp. (ºC), transparancy (cm) and conductivity (µS/cm).

The Gopeswar temple pond is not only a culturally acclaimed sacred water body of North Eastern Region of India, it has also a great historical value too. Considering the belief of the local people as well as the devotees, it has therefore, been suggested to reduce the deposition of organic load in the pond water to avert any health hazards among the beneficiaries.

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