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PHYSICO-CHEMICAL CHARACTERISTICS OF GHARIYARWA POND OF BIRGANJ, NEPAL IN RELATION TO GROWTH OF PHYTOPLANKTON

Goutam Ranjan, N. P. Singh and R. B. Singh
Department of Zoology, T.R.M. Campus, Tribhuvan University, Birganj, Nepal
Department of Zoology, M. S. College, Motihari, Bihar, India
Department of Botany, M. S. College, Motihari, Bihar, India

ABSTRACT

Birganj is a sub-metropolitan town and headquarters of Parsa district (Nepal) situated at about 6 km distance towards north of Raxaul, the Indian border. There is an important water body situated in heart of the town, known as Ghariyarwa pond. An ecological study of this famous pond was made with respect to its physico-chemical characteristics and growth of planktonic algae. Physico-chemical analysis of the pond water exhibited good amount of alkalinity, chloride and phosphate which favour growth of phytoplankton. Chlorophyceae and Cyanophyceae were observed maximum during rainy season, while Bacillariophyceae during winter.

INTRODUCTION

Stagnant water bodies have a more complex and fragile ecosystem in comparison to running water bodies as they lack a self-cleaning ability, hence readily accumulate more and more pollutants. In recent years increasing anthropogenic influence in and around aquatic systems and their catchment areas have contributed to a large extent toward deterioration of water quality leading to accelerated eutrophication. The physico-chemical characteristics and phytoplankton biomass of water bodies is not constant and fluctuate with seasonal variation as well as degree of pollution.

Ghariyarwa pond of Birganj (Nepal) is a lentic and perennial water body, situated in the heart of this town and is at about 6 km from Raxaul, the Indian territory. Birganj is a sub-metropolitan city and is the headquarters of Parsa district, Nepal. It lies between 26°0' and 27°4'N latitude, and 84°0' and 84°55' E longitude (Prasad 2006). The temperature of the area ranges from 18°C to 41°C with average rainfall of about 1767mm. Ghariyarwa pond occupies an area of about 3.5 ha. The seasonal water depth of the pond ranges from 2m to 5m in the middle. The pond is surrounded by a masonry embankment from all sides and has residential buildings around it. The pond is also important from religious point of view due to presence of a "God Sun Temple" in the middle of the pond. Normally it is a rainfed pond, but water level may be maintained with the provided boring. Being an important pond of the city it has not so far been systematically analysed so for as it is getting polluted day by day due to anthropogenic influence.

MATERIALS AND METHODS

The present investigation was conducted with a view to study the seasonal variations in the physico-chemical characteristics of the pond in relation to density and growth of phytoplankton.

The water samples were analysed seasonally, i.e., during summer, rainy and winter seasons in the year 2003 following standard methods (APHA 1995). For these studies water samples from the surface of three fixed spots were collected fortnightly and brought to the laboratory to analyse the

physico-chemical properties. Temperature and pH of the pond water samples were recorded at the spot with the help of a thermometer and pH meter respectively. The dissolved oxygen (D.O.) in water samples was estimated in the laboratory by Winkler's titrimetric method.

Phytoplankton population was enumerated and identified in the laboratory with the help of standard literature.

RESULTS AND DISCUSSION

The physico-chemical analysis of water of Ghariyarwa pond during the three seasons is depicted in Table 1. Twenty species of phytoplankton observed during the study period are given in Table 2.

The quality of an aquatic ecosystem depends upon the physical and chemical characteristics as well as on its biological diversity (Cairns & Dickson 1971). Temperature is an important factor in controlling the planktonic flora (Hutchinson 1957). The seasonal cycle of phytoplankton of an aquatic system may be affected by temperature (McCambie 1953), especially in temperate zones. Temperature is a key factor for the seasonal periodicity of phytoplankton as observed in the present study, and also by Jana (1973) and Chari (1980). In the present study it was also observed that the phytoplankton have a positive correlation with temperature where maximum number of the phytoplankton observed during rainy season (1137/mL) and minimum in winter season (764/mL).

The transparency of water is negatively correlated with primary productivity. In the present study, highest value of transparency was recorded during winter season (146cm) and lowest (105cm) during rainy season. The value of correlation coefficient (r) of transparency was positive with Bacillariophyceae but negative with Cyanophyceae and Chlorophyceae (Table 3).

The average value of alkalinity varied between 130 and 200mg/L. Higher concentration of bicarbonate in the summer season might be due to decrease in water level of the pond due to evaporation, while decreased value of bicarbonate in rainy season might be due to increase in water level of the pond causing dilution. Higher value of bicarbonate is related with higher productivity. In this study correlation coefficient value of alkalinity was positive with Cyanophyceae and Chlorophyceae but negative with Bacillariophyceae.

The pH value of water ranged from 7.10 to 7.60, with maximum value during winter season and lowest during rainy season. Negative correlation of pH was recorded with Cyanophyceae and Chlorophyceae and positive with Bacillariophyceae. Similar results have also been reported by Chari (1980), Biswas (1980) and Bhatt et al. (1999).

The oxygen content of water bodies is one of the important parameters in water quality assessment. Its presence is essential in aquatic ecosystems to keep the organisms in balance. It also affects the solubility and availability of many nutrients, hence the productivity of an aquatic ecosystem (Wetzel 1983). In the present study maximum concentration of dissolved oxygen (D.O.) was observed in winter (7.3mg/L), while minimum during summer (3.3mg/L). The low value of D.O. shows organic pollution of the water body. The reason for decrease in concentration of D.O. during summer might be due to its utilization in the decomposition of organic matter (Bedge & Verma 1985). A little increase in value of D.O. during rainy season might be due to inflow of surrounding rain water after monsoon rain (Hannan 1979). Similar results have also been obtained by Thapa (1994), Udash (1996), Shivanikar et al. (1999) and Bhatt et al. (1999). In the present study the correlation of D.O. was found to be positive with Chlorophyceae and Bacillariophyceae, and negative with Cyanophyceae.

The concentration of phosphate (as orthophosphate) in the present study was found to be highest

Table 1: Physico-chemical characteristics of water of Ghariyarwa pond in 2003.

Parameters	Summer season	Rainy season	Winter season	Mean ± S. D.
Av. Temperature, °C	28.4	28.8	22.0	26.4 ± 3.ll
Transparency (cm)	126	105	146	125.7 ± 16.73
Conductivity (mmhos/cm)	0.3	0.2	0.2	0.23 ± 0.046
pH	7.35	7.10	7.60	7.35 ± 0.20
Total Alkalinity (mg/L)	200	130	140	156.66 ± 30.91
Dissolved Oxygen (mg/L)	3.3	5.4	7.3	5.33 ± 1.63
Free CO_2 (mg/L)	6.8	6.3	3.7	5.6 ± 1.35
Phosphate-P (mg/L)	0.48	0.55	0.41	0.48 ± 0.057

Table 2: Phytoplankton composition and density (per mL)of Ghariyarwa pond.

S.No.	Phytoplankton	Class	S	R	W
1.	*Cosmarium* sp.	Chlorophyceae	22	28	68
2.	*Chlorella* sp.	”	21	35	22
3.	*Zygnema* sp.	”	102	112	31
4.	*Spirogyra* sp.	”	140	135	28
5.	*Ulothrix* sp.	”	55	68	115
6.	*Volvox* sp.	”	84	111	12
7.	*Tetraspora* sp.	”	32	45	74
8.	*Chlamydomonas* sp.	”	82	102	22
9.	*Oedogonium* sp.	”	55	18	101
10.	*Oscillatoria* sp.	Cyanophyceae	85	80	30
11.	*Nostoc* sp.	”	41	32	12
12.	*Anabaena* sp.	”	84	65	11
13.	*Spirulina* sp.	”	-	48	-
14.	*Microcystis* sp.	”	65	51	24
15.	*Melosira* sp.	Bacillariophyceae	10	15	45
16.	*Diatoma* sp.	”	-	42	-
17.	*Synedra* sp.	”	21	24	68
18.	*Cymbella* sp.	”	55	65	42
19.	*Cyclotella* sp.	”	12	20	44
20.	*Navicula* sp.	”	25	41	15
		Total	991	1137	764

during rainy season (0.55mg/L) and lowest during winter season (0.41mg/L). Increase in phosphate concentration might be due to decaying organic matter and concentration of animal excreta (Heron 1961).

Altogether 20 taxa of phytoplankton were found during the study period, out of which nine taxa belong to Chlorophyceae, six to Bacillariophyceae and five to Cyanophyceae (Table 2). Maximum population density of phytoplankton was recorded during rainy season and minimum during winter season. The total number of phytoplankton was recorded to be 2892 per mL of which 1720 (59.47%) belongs to Chlorophyceae, 628 (21.71%) to Cyanophyceae and 544 (18.81 %) to Bacillariophyceae. Increasing trend of phytoplankton in the present study was noticed from June to September. A sudden rise in phytoplankton population was observed from October to November and a decreasing trend from December to January.

Among Chlorophyceae, *Spirogyra, Zygnema, Volvox, Chlamydomonas* and *Chlorella* species were recorded in higher quantity during rainy season, whereas *Cosmarium, Tetraspora, Ulothrix* and *Oedogonium* species were higher during winter season. *Chlorella* and *Ulothrix* were present in

Table 3: Correlation coefficient (r) values between physico-chemical parameters and phytoplankton of Ghariyarwa pond.

S.No.	Parameters	Correlation coefficient (r) with		
		Cyanophyceae	Chlorophyceae	Bacillariophyceae
1.	Temperature	0.786	0.846	-0.842
2.	Transparency	-0.716	-0.243	0.584
3.	pH	-0.410	-0.421	0.158
4.	Alkalinity	0.074	0.744	-0.182
5.	Dissolved oxygen	-0.896	0.942	0.946
6.	Phosphate	0.321	0.976	0.682
7.	Conductivity	0.892	-0.561	-0.721

good quantity throughout the year.

Among Cyanophyceae, *Microcystis, Oscillatoria* and *Anabaena* species were noticed throughout the year, whereas *Spirulina* was found only during rainy season. *Microcystis* was dominant in all the seasons. Vashisht & Sra (1979) have reported that dominance and regular presence of *Microcystis* as an indicator of pollution and eutrophication of water body.

Among Bacillariophyceae *Navicula* was observed throughout the year whereas *Melosira*, *Cyclotella* and *Synedra* were common during winter season. *Cymbella* was observed most commonly during rainy and summer seasons. The results of phytoplankton study of Ghariyarwa pond suggest that the pond is moderately polluted and showing a trend of increasing eutrophication. The physico-chemical characteristics of the pond are favourable for the growth of phytoplankton. Dominance of Chlorophyceae throughout the year, Cyanophyceae in summer and rainy seasons and Bacillariophyceae during winter showed distinct seasonal variation in the distribution of phytoplankton.

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