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Limnological environment with respect to conservation aspects of Patna Bird Sanctuary Jalesar, Etah (U.P.)

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Abstract

Patna Bird Sanctuary is located at Jalesar in the Etah district of U.P. It is spread in 108 hectares and has been declared as a Bird Sanctuay in 1991. Patna jheel is a typical rainfed wetland of Gangetic plain. It receives most of its water from north-west monsoon and some water from different nallas entering into jheel. Physico-chemical and biological characteristics of lake were studied during April 2013 to March 2014, to correlate the abundance of different flora and fauna. Study revealed richness in phosphate and nitrate. The main source of this richness in the lake has been traced out due to washing, bathing, agricultural activities and cultivation of trapa and growth of macrophytes. The jheel was marked with date trees (*Phoenix sylvestrix*) and harbors about 2, 00,000 birds belonging to over 200 different species. The border of jheel has been surrounded by *Ipomea carnea* tracts, serving good nesting ground for resident birds. Macrophytes comprising of submerged (*Hydrilla verticillata*, *Ceratophyllum demersum, Vallisnaria spiralis*, Potamogeton *crispus* and *Najas*), free floating (*Salvinia, Azolla, Wolffia* and *Eichhornia*) and rooted floated (*Nymphoides cristata* and *N. indica*). In some parts *Ipomea aquatica* were also observed.

Keywords: Phytoplankton; Zooplankton; Biodiversity; Patna Jheel

1. Introduction

Freshwater biodiversity includes life which is living in freshwater or adapted to live in or around freshwater habitats such as, insects, plankton, macrophytes, zoobenthic invertebrates, fishes, amphibians, reptiles, waterbirds and aquatic mammals. Thus, it provides a variety of ecosystem services embracing food, fiber, recreational and cultural benefits to the people.

Aquatic biodiversity is threatened by human mismanagement of both living resources and ecosystem. Most of the water bodies are getting polluted due to domestic waste, sewage, agricultural runoff and industrial effluents. Water quality assessment involves analysis of physico-chemical and biological parameters which represent trophic status of the ecosystem. Phytoplankton has been long used as an effective bioindicator and act as primary producers in an aquatic environment, convert light energy into carbohydrates through photosynthesis. Zooplankton are one of the most important biotic components affecting functional aspects of aquatic ecosystem such as, food chains, food webs, energy flow and cycling of nutrients. Various previous workers [1 – 21], have made contribution in the field of physico-chemical and biological analysis. The present investigation attempted to study the correlation between physico-chemical parameters and planktonic biodiversity of Patna jheel in Jalesar, Etah.

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2. Material and methods

Patna jheel near Jalesar in Etah district of Uttar Pradesh with the area of 1.09 km square has been declared as a bird sanctuary in 1991. It is a natural freshwater shallow wetland covering an area of 1.0 km square, situated at 27^0 31’5” N, 78^0 16’50” E. Patna jheel is a typical rainfed wetland of gangetic plains. It receives water from north-west monsoon, surface runoff and from different nallas entering into the jheel.

Water samples were collected monthly from April 2013 to March 2014 between 9.00 am to 11.00 am. Air and water temperature were recorded by graduated mercury thermometer. Depth was measured by graduated meter rod. Transparency was observed by Secchi disc. pH was estimated by digital pH meter and conductivity by digital conductivity meter. Water samples were analyzed by adopting the methods of APHA [22]. Preserved samples were brought to the laboratory for quantitative and qualitative analysis of plankton. Counting was done by using a Sedgewick-rafter cell [23] and Lackey’s microtransect method [22]. Identification was done as per description by different workers [16, 24-28]. The densities were expressed as numbers per litre.

3. Results and discussion

The data on various physico-chemical parameters of Patna Lake water are presented in Table-1. Air temperature (AT) and surface water temperature (WT) were varied between 18°C – 42°C and 18°C – 39°C, respectively. Due to shallowness of study sites the water temperature has shown a tendency to closely follow the air temperature. This type of observations was also reported by Singhal *et. al.* [29]. Depth was ranged between 60 cm – 180 cm. Monsoon and inflow of water from watershed may explain the increase in water spread in the month of August. Transparency values were ranged between 25cm (June, 2013) – 58cm (February, 2014) and remained low during May to November and high from December to April. The higher values may be related to the resuspension of soft sediments by biotic interference. Decomposition of submerged macrophytes and increased production of plankton may explain low values recorded in June. The suspended matter was fluctuated between 50 mg/l in March and 140 mg/l in June.

The pH of Patna jheel was alkaline, ranged from 7.4 (August) to 8.8 (Dec - Jan). Singhal *et.al.* [29] Reported 7.4 to 8.2 pH in Central Inland Fisheries Research Institute (CIFRI) ponds, Karnal. While Saify *et.al.* [30] Observed 7.3 to 8.7 pH for Motia pond in Bhopal. Conductivity (Cond) values were minimum in July (210 micromhos per cm) and maximum in February (480 micromhos per cm). Golder and Chattopadhyay [31] also reported minimum and maximum values in the same months.

Dissolved oxygen (DO) in Patna jheel was varied between 4.0 mg/l (July) – 12.4 mg/l (December). DO concentration remained low during April to September and higher from October to March. Winter rise has also been reported by other workers [32-33]. Absence of free carbon dioxide (FCO_2) from October to March appears as an additional factor for increase in DO. Free carbon dioxide values were ranged from 0.0 to 19.2 mg/l. April to September presence of free carbon dioxide was related to rise in temperature accelerating the decomposition of organic matter and its influx through rain water. The carbonate (CO_3^{--}) values were expressed between 0.0 – 24.8 mg/l, showed inverse relationship with free carbon dioxide. Similar observations were also reported by other workers [13, 34]. The values of bicarbonate (HCO_3^-) were varied between 60.0 mg/l (March) - 130.0 mg/l (June) with second highest value 118.0 mg/l in the month of October. Similar observations were also reported by Kumar [35].

The values of calcium (Ca^{++}), magnesium (Mg^{++}) and total hardness (TH) were observed between 7.5 mg/l (January) – 12.0 mg/l (June), 6.40 mg/l (June) – 12.8 mg/l (January) and 120.0 mg/l (Dec-Jan) – 180.0 mg/l (June) respectively. Previously, higher concentration of calcium and total hardness were also reported during summer season [29]. Phosphate (PO_4^{-3}) content were maximum 0.7 mg/l (March) and minimum 0.1 mg/l (September). The nitrate (NO_3^{-2}) content was maximum during July (1.85 mg/l) and minimum in November (0.1 mg/l). Similar findings were observed in earlier studies also [31].

Table 1 Descriptive statistics for various physico-chemical parameters

Parameters	AT	WT	Depth	Tr.	SPM	pH	Cond.	DO	FCO_2	CO_{3-2}	HCO^{3-}	Ca^{+2}	Mg^{+2}	TH	PO_4^{-3}	NO_3^{-2}
Mean	30.25	28.33	120.42	41.10	86.50	8.10	395.00	7.59	5.60	8.01	92.00	8.13	9.76	143.00	0.38	0.85
Standard Error	2.11	1.73	9.73	3.11	7.26	0.13	28.11	0.80	2.03	2.76	6.56	0.65	0.58	5.63	0.06	0.20
Median	31.00	28.00	129.00	40.00	82.00	8.00	435.00	7.45	2.40	3.10	94.00	8.25	10.24	137.00	0.35	0.50
Standard Deviation	7.33	5.99	33.72	10.78	25.16	0.46	97.37	2.77	7.04	9.57	22.74	2.26	2.01	19.51	0.19	0.70
Sample Variance	53.66	35.88	1136.99	116.16	632.82	0.21	9481.82	7.67	49.57	91.66	517.09	5.10	4.03	380.73	0.04	0.49
Kurtosis	-0.54	0.05	-0.10	-1.20	0.65	-1.03	0.07	-1.27	-0.68	-1.17	-1.27	-0.85	-0.82	-0.72	-1.08	-1.84
Skewness	-0.28	0.18	-0.28	0.08	0.80	0.32	-1.24	0.29	0.90	0.69	0.14	0.10	-0.26	0.59	0.33	0.41
Range	24.00	21.00	120.00	33.00	90.00	1.40	270.00	8.40	19.20	24.80	70.00	7.50	6.40	60.00	0.60	1.75
Minimum	18.00	18.00	60.00	25.00	50.00	7.40	210.00	4.00	0.00	0.00	60.00	4.50	6.40	120.00	0.10	0.10
Maximum	42.00	39.00	180.00	58.00	140.00	8.80	480.00	12.40	19.20	24.80	130.00	12.00	12.80	180.00	0.70	1.85
Confidence Level (95%)	4.65	3.81	21.42	6.85	15.98	0.29	61.87	1.76	4.47	6.08	14.45	1.43	1.28	12.40	0.12	0.45

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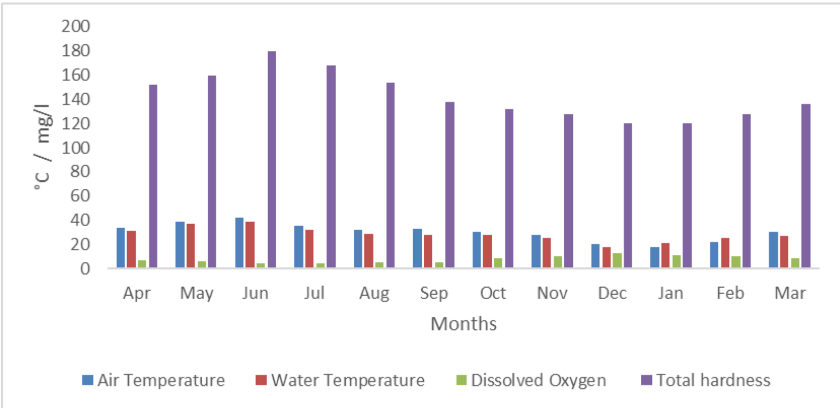

Figure 1 Relationship among Air Temperature, Water Temperature, Dissolved Oxygen and Total Hardness

Various statistical analyses applied to determine the relationship among different physico-chemical parameters and their correlation matrix are given in Table-1 and Table-2, respectively. Relationships among different physico-chemical parameters are depicted in Figures 1 – 4.

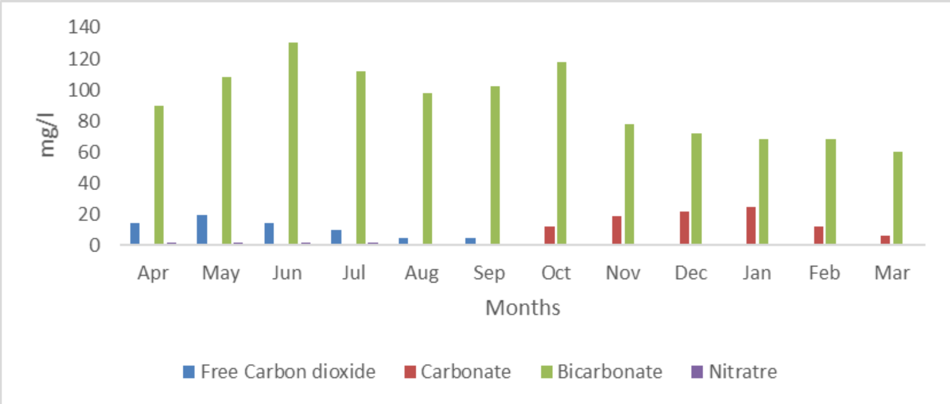

Figure 2 Relationship among Free Carbon Dioxide, Carbonate, Bicarbonate and Nitrate

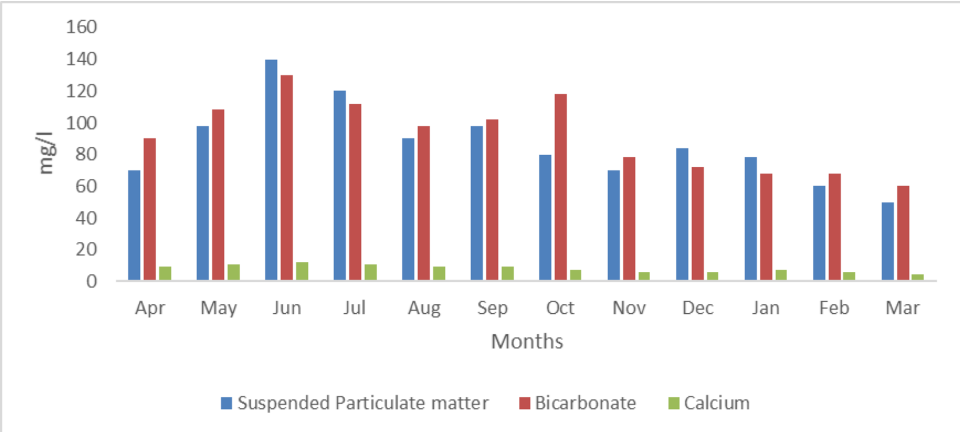

Figure 3 Relationship among Suspended particulate matter, Bicarbonate and Calcium

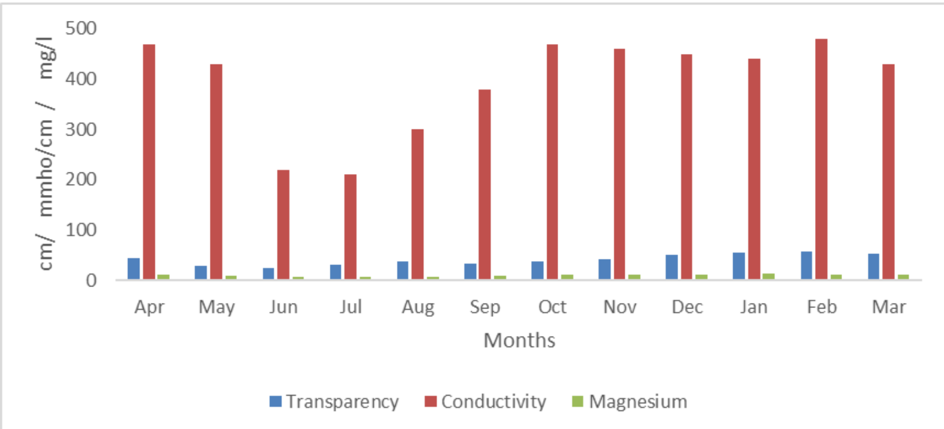

Figure 4 Relationship among Transparency, Conductivity and Magnesium

Table 2 Correlation Matrix for different Physico-chemical Parameters

	AT	**WT**	**Depth**	**Tr.**	**SPM**	**pH**	**Cond.**	**DO**	**FCO_2**	**CO^{3--}**	**HCO_3-**	**Ca^{++}**	**Mg++**	**TH**	**PO4---**	**NO_3--**
AT	1.000															
WT	0.953	1.000														
Depth	-0.433	-0.494	1.000													
Tr.	-0.877	-0.811	0.239	1.000												
SPM	0.622	0.621	-0.199	-0.836	1.000											
pH	-0.249	-0.223	-0.491	0.039	0.201	1.000										
Cond.	-0.579	-0.556	-0.055	0.672	-0.835	0.129	1.000									
DO	-0.867	-0.844	0.053	0.798	-0.651	0.488	0.740	1.000								
FCO2	0.808	0.852	-0.581	-0.711	0.589	0.000	-0.407	-0.707	1.000							
CO3--	-0.875	-0.827	0.174	0.677	-0.456	0.591	0.558	0.930	-0.726	1.000						
HCO3-	0.787	0.772	-0.183	-0.917	0.823	-0.073	-0.614	-0.750	0.621	-0.611	1.000					
Ca++	0.757	0.800	-0.269	-0.852	0.882	0.013	-0.704	-0.817	0.830	-0.663	0.855	1.000				
Mg++	-0.826	-0.745	0.060	0.907	-0.850	0.194	0.856	0.843	-0.622	0.734	-0.836	-0.814	1.000			
TH	0.904	0.922	-0.354	-0.811	0.754	-0.205	-0.786	-0.889	0.832	-0.834	0.757	0.857	-0.875	1.000		
PO4---	-0.547	-0.421	-0.197	0.675	-0.420	0.318	0.246	0.624	-0.437	0.566	-0.706	-0.592	0.602	-0.402	1.000	
NO3--	0.649	0.776	-0.461	-0.478	0.508	-0.169	-0.484	-0.649	0.830	-0.667	0.475	0.698	-0.509	0.812	-0.146	1.000

Table 3 Percentage Composition of Phytoplankton

Phytoplankton	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Chlorophyceae	55.50	45.57	44.72	60.00	57.46	97.48	87.09	68.31	85.08	34.89	50.70	66.77
Cyanophyceae	22.94	23.29	19.72	17.25	14.91	1.21	2.40	0.70	0.21	2.94	4.88	7.93
Bacillariophyceae	11.93	22.53	23.62	5.10	4.82	0.29	10.51	30.99	14.71	62.18	41.86	18.29
Desmidiaceae	4.59	4.56	6.42	7.06	3.07	0.00	0.00	0.00	0.00	0.00	2.56	7.01
Euglenophyceae	5.05	4.05	5.50	10.59	19.74	1.02	0.00	0.00	0.00	0.00	0.00	0.00

Percentage composition of phytoplankton of Patna jheel is presented in Table-3. Twenty-seven species of phytoplankton comprising five major groups were observed. The order of abundance was found to be Chlorophyceae >Cynophyceae >Bacillariophyceae >Desmidiaceae >Euglenophyceae. As observed in Table-3, maximum phytoplanktonic diversity occurred in the month of May and June, which may be related to maximum solar illumination, high temperature and increase in bicarbonate, calcium, hardness and dissolved organic matter enrichment during decomposition of macrophytes. Highest number of Chlorophyceae were observed in January with *Zygnema* sp. (3154 nos. /l) and in September with *Spirogyra* sp. (990 no. /l) and *Zygnema sp*. (970 nos. /l). The minimum Chlorophycean density were observed in April (121 nos. /l). Cynophyceae were reported highest (92 nos. /l) in June and lowest in November (3.0 nos. /l). Bacillariophyceae were ranged maximum (560 nos. /l) in January and minimum (6 nos./l) in September. Desmidiaceae were observed from February to August and Euglenophyceae from April to September. Maximum phytoplanktonic density (3807 nos. /l) were observed in December and minimum (218 nos./l) in April. Maximum density may be related to optimum conditions of low temperature (18^0C), high DO (12.4 mg/l), rise in pH (8.8), low bicarbonate, calcium, and hardness stimulating the growth. September peak may be attributed to the nutrient enrichment from flooding and surface run off during monsoon. Similar observations were also observed by earlier workers [36].

Table 4 Percentage Composition of Zooplanktons

Zooplankton	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des	Jan	Feb	Mar
Protozoa	29.45	33.28	9.07	16.29	6.55	5.53	52.35	55.34	48.94	41.96	34.80	21.97
Rotifera	9.53	20.25	15.88	12.50	66.84	90.78	38.26	5.83	3.25	8.70	2.64	2.05
Cladocera	17.37	25.12	22.49	10.42	3.66	3.69	9.40	4.85	31.40	27.83	33.26	19.30
Copepoda	43.64	21.35	37.97	50.95	11.99	0.00	0.00	5.34	1.56	8.04	19.16	50.10
Ostracoda	0.00	0.00	14.60	9.85	10.97	0.00	0.00	28.64	14.85	13.48	10.13	6.57

In the present study, zooplankton abundance (twenty-nine species) was found to be Rotifera> Cladocera> Copepoda> Protozoa> Ostracoda (Table-4). The group Rotifera were represented by ten species with highest density (837 nos. /l) in September and minimum (12 nos. /l) in November and February. The Cladocera were reported eight species with maximum density (228 nos. /l) in June while, minimum density (10 nos. /l) in November.

The Copepoda were represented by four species with Nauplius and Metanauplius larvae showed highest peak (385 nos. /l) in June with complete absence in September and October. Among Protozoa (five species), *Difflugia oblonga* was observed throughout the year.

Maximum density of Protozoa in December (386 nos. /l) and May (212 nos. /l) and minimum (51 nos. /l) were reported in September. In the present study Ostracoda were only represented by two species. Overall total zooplankton exhibited June (1014 nos. /l) and August (1176 nos. /l) bimodal peak. Minimum density of 149 nos. /l were observed in October. These results are in agreement with previous workers [36- 41].

Macrophytes comprising of submerged (*Hydrilla verticillata, Ceratophyllum demersum, Vallisnaria spiralis, Potamogeton crispus* and *Najas*), free floating (*Salvinia, Azolla, Wolffia* and *Eichhornia*) and rooted floated *(Nymphoides cristata* and *N. indica*). In some parts *Ipomea aquatica* were also observed. The entire lake area gets covered by profuse growth of water hyacinth and *Potamogeton* species during summer.

About two lakhs birds of more than 200 species frequently observed in this sanctuary during winter. More than 100 species of migratory and resident birds are known to have their resting and breeding habitats around the lake. Among other animals Nilgai, Jackal, Monitor lizard, Jungle cat, Porcupine, few snakes were also observed.

The conservation aspects in Patna Lake should be considered as follows:

- There should be minimum interference in the jheel (undisturbed as possible).
- Tree plantation should be banned on the jheel sides.
- Boating should be strictly prohibited. Bunds and dykes should not be built so that, it can receive natural water. Jheel area could be deepened in the centre.
- Livestock grazing should be allowed only in summer months.
- Sanctuary should be clean and litter free.
- Polythene, plastics and non-degradable material should be strictly banned.
- Aquatic weeds should be removed carefully and completely.

4. Conclusion

The study revealed that biological diversity of phytoplankton and zooplankton are well represented in this lake. This is highly productive showing plankton abundance during summer and post monsoon months. Inter-relationships between physico-chemical characteristics and their impact on biodiversity of plankton were well established. Therefore, on the basis of present findings, it is concluded that this lake being productive in nature can be used for developing better pollution control strategies and their ecological and fisheries status.

Compliance with ethical standards

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