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Effect of Seasonal Variation on the Biotic and Abiotic Factors of Dighi Pond at Darbhanga (North Bihar), India

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Abstract

Biotic and abiotic factors of Dighi pond (small lake) spread over a circumference of seven kilometers previously a tributary of river Kamla Balan was investigated in four different seasons viz. pre-monsoon (March—May), monsoon (June—September), retreating monsoon (October—November) and winter (December—February) during 2005-2006. The temperature of the lake varied from 12 C to 38 C ; pH was slightly alkaline (7.5–8.10). Dissolved oxygen was low in summer and high in winter. Free $CO_2$was high in summer and spring, total hardness and calcium hardness were high in summer and low in winter. Carbonate alkalinity and bicarbonate alkalinity were inversely related. Phosphate and nitrate were higher in monsoon and lower in winter. Sulfate concentration increased in monsoon. BOD and COD increased in summer and spring ; 28 genera of phytoplanktons and 18 of zooplanktons were recorded.
Key words : Plankton, Biotic, Abiotic, Physico-chemical factors.

Darbhanga town in North Bihar in known for its natural lakes, Jheels and ponds, which are being used for the cultivation of makhana and fish. Lakes are more complex and fragile ecosystem as they do not have self cleaning system, as a result these bodies are easily polluted as reported by Bhuyan (1). With the advancement in the study of ecology it reveals that the abiotic and biotic components are not only interrelated to each other but also function in an orderly manner as a definite system (2). The present investigation therefore was made to study seasonal variation of abiotic and planktonic population of Dighi pond because fish population and other aquatic organisms which largely depnd upon its quality of water.

Methods

From this lake, water samples were collected during four different periods viz. March—May, June—September, October—November, and December—Feburary during 2005-06. The parameters like plankton population (u/g), temperature, pH, dissolved oxygen, free carbondioxide, total hardness, calcium hardness, carbonate alkalinity, phosphate, nitrate, sulphate, chloride, calcium, magnesium, BOD, COD and silica were studied. These parameters play important role in the growth of biotic components. The analytical procedure for these parameters were followed as described by APHA et al. (3). Some of the abiotic parameters like temperature, pH, dissolved oxygen, free CO_2 and alkalinity were recorded at the work site. Water samples were collected from the lake and brought to the laboratory for test. Plankton samples were collected by filtering 100-200 liters of small lake water using no. 28 mm mesh nylobolt plankton net.

Results and Discussion

Physico-Chemical Parameters of Water

Quality of water depends on its abiotic and biotic components which greatly influence the aquatic flora and founa. The aquatic flora and founa have their own adaptability for different water bodies. Functioning of an aquatic ecosystem is regulated by the chemical and biological components of the system ; apart from this, physical factors also play important role in the productivity of the water body.

In the present investigation the temperature of

the lake varied from 12.0—38.5 C, minimum during winter and maximum in summer. It may be due to the reason that smaller water body reacts more quickly with the change in the atmospheric temperature (4). The pH of water varied from 7.50 to 8.10. The higher pH value was found during rainy season and in summer showed narrow limit of variation (5). Dissolved oxygen content was found between 6.50 to 7.50 ppm, which was lower in summer and higher in winter. Oxygen dissolves poorly in water, but their solubility decreases with increase in temperature. In the present investigation dissolved oxygen was low. It means that degree of self purification of water would be low. Thus removal of hazardous organic compounds from water by microorganism is not possible from the pond. An inverse relationship was observed between dissolved oxygen and free CO_2. Free carbondioxide was found to be more in summer and spring because of rise in temperature, which is responsible for active decay of organic matter (6). Total hardness and the calcium hardness showed a direct relation as both were observed to be higher in summer, but calcium hardness was found to be less than total hardness. Carbonate and bicarbonate alkalinity were inversely related. The bicarbonate alkalinity was found to be maximum during pre-monsoon period, which appeared suitable for the psiculture (7). These together are responsible for alkalinity of water. In the present investigation bicarbonate alkalinity is highest during retreating monsoon followed by monsoon. During this period water is not fit for human consumption and for irrigation. It is also harmful for aquantic animals. Phosphate and nitrate are important nutrients for the growth of flora of lake which depend mainly on geochemical condition. Both phosphate and nitrate showed direct relation showed maximum concentration during summer and minimum during winter. These are primary nutrients which act as fertilizers for phytoplankton. Both phosphate and nitrate showed direct relation showing maximum concentration during summer and minimum during winter. It is due to the reason that phosphate and nitrate supply is low in areas of increased photosynthesis, where oxygen is produced at the expense of carbon dioxide. When the plant cells die, they sink below the photosynthesis zone (winter) and decompose. Phosphorus is also conducive for growth of algae, which has been collaborated in the present case. Oxygen is consumed in the decomposition process and carbon dioxide is produced. The same process liberates nutrients and returns them in water soluble forms. Sulfate showed maximum concentration after rain which may be because surface run off brings suspended materials and soluble salts from the catchment areas. The organic contents were found to be more during summer and pre-monsoon and lowest in winter. This is due to the reason that in absence of oxygen as an energy source, the sulfate bacterial reduction process supplies the energy for life process. Sulfate bacterial reduction is a process in which microorganism use the oxygen of sulfate ions to oxidize organic matter, producing hydrogen sulfide as a bi-product. BOD and COD both showed increasing trend during summer and lowest during winter. This exhibited that large amount of oxygen was needed by microorganism to cause biodegradation of a part of organic and inorganic pollution (such as sulfides, sulfites and ferrosions) in summer. BOD is an indicator of the quantam of pollution load. If the pollution load is large, then high amount of dissolved oxygen shall be consumed and consequently BOD shall be high. Low value of BOD is indicative of relatively pure water. For drinking water the biochemical oxygen demand should be in the range of 0.75—1.5 ppm. Thus the water of Dighi pond is not fit for consumption although BOD level is not too high. This may be due to the presence of organic and inorganic compounds which are resistant to microbial oxidation. These, therefore, do not contribute to the biochemical oxygen demand, yet their presence makes water unfit for consumption. Sometimes COD is preferred over BOD, because if water body may contain toxic compounds, like biocides, which may poison the microorganisms even before they can act on pollutants. In the present case COD variationis similar to BOD. Similarly higher concentration of COD indicates the presence of detergents and some toxic compounds like biocides. Silicates were found to be lesser in winter but increased in spring ranging from 17—28 mg/liter. Silicates are also classified as nutrients, since these are required for building exoskeletons of the phytoplanktons and are used during spring season.

Biotic Communities

Planktons

Phytoplanktons were represented by several

Table 1. Abiotic components of pond showing seasonal variation.

	Parameter	Pre-monsoon (Mar-May)	Monsoon (Jun-Sep)	Retreating monsoon (Oct-Nov)	Winter (Dec-Feb)
1.	Temperature (C)	20 – 38	35 – 32	29 – 22	12 – 16
2.	pH	7.75 ± 0.12	7.76 ± 0.21	8.10 ± 0.26	7.65 ± 0.21
3.	Dissolved oxygen	6.87 ± 0.21	6.62 ± 0.19	7.65 ± 0.25	6.68 ± 0.20
4.	Free CO_2	54.5 ± 4.23	45 ± 2.94	40 ± 2.98	50.42 ± 4.25
5.	Total hardness	89.80 ± 6.92	108.65 ± 6.35	89.95 ± 5.92	88.12 ± 6.85
6.	Calcium hardness	48.28 ± 4.10	68.95 ± 3.55	42.60 ± 3.92	43.15 ± 3.95
7.	Carbonate alkalinity	6.90 ± 0.48	12.75 ± 0.30	5.86 ± 0.44	6.18 ± 0.42
8.	Bicarbonate alkalinity	90.35 ± 5.95	118.36 ± 6.85	126.65 ± 7.95	80.35 ± 6.92
9.	Phosphate	0.38 ± 0.04	0.06 ± 0.04	0.66 ± 0.05	0.36 ± 0.04
10.	Nitrate	0.38 ± 0.04	0.46 ± 0.03	0.32 ± 0.02	0.28 ± 0.04
11.	Sulfate	3.65 ± 0.34	2.72 ± 0.28	3.95 ± 0.35	3.33 ± 0.28
12.	Chloride	16.85 ± 1.99	25.75 ± 2.08	21.95 ± 2.05	13.25 ± 2.10
13.	Calcium	25.35 ± 1.20	45.25 ± 0.08	26.18 ± 1.15	21.10 ± 1.30
14.	Magnesium	9.65 ± 0.46	11.75 ± 0.41	9.87 ± 0.34	8.35 ± 0.33
15.	Organic contents	3.15 ± 0.13	6.11 ± 0.25	2.25 ± 0.13	1.96 ± 0.17
16.	BOD	3.40 ± 0.26	4.46 ± 0.28	3.10 ± 0.22	2.10 ± 0.17
17.	COD	3.62 ± 0.38	7.00 ± 0.51	5.85 ± 0.30	3.25 ± 0.39
18.	Silica	30	25	21	26

members of Chloropyceae, Cyanophyceae, Bacillariophyceae and few members of Euglenophycae. The growth of phytoplanktons were maximum during later part of monsoon and winter and declined during spring which may be due to the variation in different abiotic parameters (8) Phytoplanktons fix carbon by photosynthesis and passes from each organism to the other in form of organic molecules of precise architecture and rich diversity. The phytoplanktons dominated over the zooplanktons throughout the sampling season, which is in accordance with the findings of Govind (9), in other Indian water bodies. The zooplanktons were represented by Copepoda, Cladocera, Rotifera, Protozoa and species of ostracode. Zooplanktons were observed in peak during winter season and lowest during the summer. The following groups of planktons were observed.

Phytoplanktons. Chlorophycea : Spyrogyra, Hydrodictyon, Volvox, Actinastrum zygenma, Oocystis, Closterium, Mougeotia, Tetredron, Ankistrodesmus, Chlomydomondas, Ulothrix. Cyanophyceae : Microcoleus, Nostoc, Oscillationa, Andcystis, Spirulina, Rivularia. Bacillophyceae : Gomphonema, Navicula, Nitichia, Cocconis, Diatomus, Cymbella. *Bacillariophyceae:* Gomphonema, Navicula, Nitichia, Cocconis, Diatoma, Cymbella. Euglenophyceae : Euglena, Phacus, Tracelomonas.

Zooplanktons. Copepoda Cyclops, Mesocyclops, Nauplius, Neo-diaptomus, Diaptomus. Cladocera : Platyias, Brachionus, Asplanchan monostyla. Protozoans : Paramecium, Euglypha. Ostracoda : Stenocypris.

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