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The Plankton as Indicators of Water Quality Assessment: A Case Study in the Pond of Darbhanga, Bihar, India

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Abstract
Planktons are good indicators of water quality but are rarely used in ponds of studies in spite of all level of contamination in the Ponds. In the present study, we aim on the plankton of the Pond of Darbhanga district under Bihar state. Samples are collected in the months of 2009- 2010. The seasonal variations of all phytoplankton populations and monthly variations in percentage composition of various group. In the present study Pond, 23 species of rotifers, 11 species of cladocera and 6 species of copepods have been recorded. The analysis was done based on the standard methods preseribed by APHA. The biological parameters included phytoplankton analysis, invertebrates etc revealed their high density, which are considered to be indicaters of organic pollution. Our study shows that plankton can efficiently be used to evaluate the water quality in ponds.
Keywords: *Plankton, Water quality, Darbhanga.*

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I. Introduction

Palnktonrefers to those microscopic aquatic forms swimming with little or no resistance to currents and living free floating suspended in open or pelagic waters. Planktonic plants are called phytoplankton and planktonic animals are the zooplankton. Phytoplankton(microscopic algae) usually occurs as unicellular, colonial or filamentous forms and is mostly photosynthetic and is grazed upon by the zooplankton and other organisms occurring in the same environment. Zooplanktonprincipally comprise microscopic protozoans. Rotifers, cladocerans and copepods.The species assemblage of zooplankton also may be useful in assessing water quality.

Plankton, particularly phytoplankton, has long been used as indicators of water quality. Because of their short life spans, planktons respond quickly to environmental changes. They flourish both in highly eutrophic waters while a few others are very sensitive to organic and/or chemical wastes. Some species have also been associated with noxious blooms sometimes creating offensive tastes and odours or toxic conditions. Because of their short life cycles planktons respond quickly to environmental changes, and hence the standing crop and species composition indicate the quality of water mass in which they are found. They strongly influence certain non-biological aspects of water quality such as pH, colour, taste, odour and in a very practical sense they are a part of the water quality.

Phytoplankton growth is dependenet on sunlight and nutrient concentrations. An abundance of phytoplankton/algae is indicative of nutrient pollution.Algae is used as indicator organisms because of the following advantages:

(a) Algae have very short life cycles and rapid reproduction.
(b) Algae tend to be most directly affected by physical and chemical environmental factors.
(c) Sampling is easy and inexpensive which requires a few persons for assessment and has a lesser impact on other organisms.
(d) Standard methods exist. **(Plafkin et.al.,1989)**

Zooplankton in freshwaters principally comprises microscopic protozoan, rotifers, cladocerons and copepods, a much greater variety of organisms are encountered in marine waters. They range in size from microscopic protozoan to larger jelly fish of over 10 m long, wherein in freshwater they generally are small and microscopic in size: in salt water, larger forms are observed more frequently. The species assemblage of zooplankton is also used in the assessment of water quality.Zooplankton as indicators for the assessment of water quality has the following advantages:

(a) Zooplankton are sufficiently large easy to identify, but small enough to be handled in large numbers within a limited space.
(b) Samples can be collected easily and processedrapidly.

(c) Their reproductive cycle is short enough to enable the study through several generations in a relatively short time.
(d) Some of the commonly occurring species like Daphnia, Cyclops, Brachionus and Mona can be easily cultured to ensure constant supply for experimental purposes.
(e) They respond more rapidly to environmental changes than fishes, which have been traditionally used as indicators of water quality. The present study is based on one such Pond of Sunderpur area of district Darbhanga, Bihar

II. Materials And Methods

The whole method was arranged in the following five group: (1) Collection, (2) Concentration, (3) Counting, (4) Identification and (5) Long term preservation.

III. Results

The pond under study was found to contain six families of Phytoplanktons and there are as follows:
(a) Cyanophyceae with 9 genera and 10 species
(b) Chlorophyceae with 7 genera and 2 species
(c) Dinophyceae with 2 genera and 2 species
(d) Bacillariophycaeae with 7 genera and 11 species, and
(e) Euglenophycaeae with 2 genera and 4 species.
In this way, altogether 37 species were identified and showed variations in availability in different months of the year **2009-2010.**

The seasonal variations of all Phytoplankton populations and monthly variations in percentage composition of various groups of algae are shown in Table 1 & 2respectively.

Bacillariophycea, Cyanophyceae and Chlorophycea constitute the three major important groups of Phytoplanktons and shared 78.4% of the total planktonic forms available in the present pond. Bacillariophyceae constituted 38% among the major groups of Planktons. Cyanophyceae in the second dominant group constituting 34.4% and chlorophyceae was the third major group constituting 27.9% among the major groups of Plankton Maximum population of Bacillariophyceae was encountered during winter (December) and gradual decreasing trend started from January – June (39.4% -15.6%). The minimum population recorded in the month of July (12%). Out of 11 species, the four species, VizNavicolardiosa, synendra ulna, cymbellatumida and Diatom elongatumWere the most abundant all over the year. The minimum population 11.8 % was recorded in the month of September. In the rest months of the year, there was fluctuation in the percentage of growth.

Cyanophyceae represented the second important major groups of phytoplankton and shared 27% of the total planktonic forms available in the pond. Maximum population of it recorded in winter (January) and shared 61% growth but its higher density started from post Monsoon period and winter (56.6% - 58.6%). The minimum growth recorded in summer (32%). Its lower population was recorded in Monsoon period. The most abundant species of Cyanophyceas were Microcystisaeruginosa, Oscilatorialimosa, and Anabaena sp. Other species showed variations in the growth in different months of the year. Chlorophyceae shared the third major groups of Phytoplankton, sharing 21.6% of the total Pytoplankton population available in the pond. The maximum population was recorded 16.6% in July but its availability started in the spring and grew well during Monsoon period. Its growth started decreasing from post Monsoon period and in winter months showed its non-availability. The minimum growth (6%) recorded in spring (March). Test rest Phytoplanktons, Euglenophyceae shared 10.8%, Dinophyceae 5.4% and Desmidaceae 5% of the total planktons. The peak month June was recorded for Euglenophyceae sharing 28.2% of its population while

Dinophyceae and Desmioceae recorded 5.4% in June – July and 16.2% in March respectively. Dinophyceae was not available in winter season (November- January) and in early spring (February- March). Rare growth of species Ceratiumhirundinella(Dinophyceae) recorded throughout the year. The two species of Euglenophyceae- Euglena acus and Euglenaaxyuriswere commonly available during Monsoon period and the rest species in the rest period of the year either there were absent or had rare and frequent growth as investigated presently.

Table 1
Biological Seasonal Diversity and Effect on Ecosystem in Phytoplanktonic Population of Pond under Study
(March 2009-February 2010)

Phytoplanktonics	Months											
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	1	2	3	4	5	6	7	8	9	10	11	12
(a) Cyanophyceae												
Anabeena sp.	A	A	A	A	A	A	A	A	A	A	A	A
Aphanocupee sp.	-	-	-	-	-	-	F	R	R	R	R	R
Arthropspira sp.	-	-	-	-	-	-	R	R	F	F	R	R
Ceslosphaerium sp.	F	F	R	R	R	R	F	F	F	R	R	R
Meriosmepediaclongana	F	F	R	R	R	R	C	C	C	F	F	F
M.Puntata	R	R	F	F	F	F	C	C	C	C	F	F
Microcystisceruginosa	A	A	A	A	A	A	A	A	A	A	A	A
Oscillatorislimosa	C	C	C	C	A	A	A	A	A	C	C	C
Nostoc sp.	R	R	R	F	F	C	C	C	C	C	F	R
Spirulina major	F	F	F	F	R	R	R	F	F	F	R	R
(b) Chlorophcea												
Ankistrodesmos	R	R	F	F	F	F	F	F	-	-	-	R
Chorella sp.	F	F	F	F	A	A	A	F	-	-	-	F
Cosmerium sp.	R	R	R	R	C	C	C	C	-	-	-	R
Pandorina sp.	R	R	R	R	C	C	C	C	-	-	-	R
Spirogya sp.	R	R	F	F	A	A	A	A	-	-	-	R
Scanodesmusarmatus	-	-	-	-	C	C	C	C	-	-	-	R
Scanodesmusquadricauda	-	-	-	-	F	F	F	F	-	-	-	-
Ulothrix sp.	-	-	-	-	C	C	C	C	-	-	-	-
(c) Dinophyceae												
Ceratiumhirundinella	R	R	R	R	R	R	R	R	-	-	-	R
Peridinium sp.	R	R	R	F	F	R	R	R	-	-	-	R
(d) Bacillariophyceae												
Diatom elongates	A	A	A	A	A	A	A	A	A	A	A	A
Diatom vulgaris	C	F	F	F	A	C	C	C	C	C	C	C
NitzschiaClosterius	C	C	F	F	C	C	C	F	F	R	R	R
Synendra ulna	A	A	A	A	A	A	A	A	A	A	A	A
Cymbellatumida	A	A	A	A	A	A	A	A	A	A	A	A
Comfonesisacuminatus	R	R	R	R	R	N	N	N	F	F	F	F
Navicularadiosa	A	A	A	A	A	A	A	A	A	A	A	A
Naviculaconfervacea	F	F	F	R	R	R	R	F	F	C	C	F
Navicula cuspidate	R	R	R	R	F	F	F	C	C	C	C	F
Pinnularia sp.	F	F	F	F	R	R	R	R	-	-	-	F
(e) Euglanophyceae												
Euglena acus	-	-	-	C	C	C	C	C	F	F	R	R
Euglena oxyuris	-	-	-	C	C	C	C	C	F	F	R	R
Phacusongiccueda	-	-	-	R	R	F	F	R	-	-	-	-
PhacusPseudosuirenkoi	R	R	R	F	F	F	F	R	-	-	-	R

Table 2
Biological Seasonal Diversity and Effect on Ecosystem in Percentage Composition of Phytoplanktons of the Pond under Study
(March 2009- February 2010)

Months	Cyanophyceae	Chloro-phyceae	Dinophyceae	Bacillari-ophyccae	Eugeno-phyceae
March 2009	49.5	6.0	0.0	35.04	1.0
April 2009	43.2	9.0	5.0	29.5	3.5
May 2009	32.0	11.6	6.5	24.0	21.7
June 2009	34.5	13.5	5.4	18.6	28.2
July 2009	36.4	16.6	5.4	12.0	27.3
August 2009	38.5	14.6	5.3	16.2	27.5
September 2009	45.7	14.5	1.0	11.8	24.6
October 2009	56.6	5.6	0.5	24.9	8.6
November 2009	57.5	4.9	0.0	29.6	6.4
December 2009	58.6	0.0	0.0	44.7	0.0
January 2010	61.0	0.0	0.0	39.4	0.0
February 2010	50.2	0.0	0.0	36.7	5.5

IV. Discussion

Limnologists regarding the phytoplanktonic population are conflicting. While the present author during the course of work on diversity and ecosystem effect of polluted pond water has observed 11 genera of algae, Kumar et.al. (2005)recorded 34 genera of algae from a fish pond of Orissa. On the other side, Shashi S.B and Kumar (2007)has recorded 60 genera of algae in a lake and 95 genera in Kumaon lakes. On the other side Khathavkar et.al. (2004)have noticed 32 phytoplanktons in Kerala lakes, and 24 from a fish pond at Thiruvananthapuram. Formar scientists adesaluet. al (2005)have also recorded 60 phytoplanktons in a lake, Washington. Whereas the present study showed the dominance of blue green during post monsoon and winter months indicating that these months are the peak periods for blue green to flourish well in low light and low temperature. In this way the present findings contradict the findings of Mathivanan et.al (2005)who considers high temperature and large amount of Co_2 and less dissolved O_2 content favourable to the abundance of blue green. The dominance of blue green of the present study is in conformity with the findings of Pradeep et.al. (2010),Jaiswal et.al (2003)in sewage and different lakes of U.S and Dixit et.al (2007)in a pond at Bhagalpur (Bihar). The present author suspects the abundance of blue green due to rich calcium. Also in the pond Euglenophyceae flourished well during summer-monsoon months and dwindled in winter. Similar observations were noticed by Tripathyet.al (1989), Singh et.al (2005).Bhatt et.al (1999)have pointed out that Euglenophyceae are associated with change in D.O. and free CO_2 content. Such association is not observed in the present study. It, however, appears that high temperature favours the increase in these forms. The poor presence of Dinophycea was recorded during summer, while the remaining months showed its absence. This finding of the present study showed agreement with the findings of Sahu et.al. (2006).

The starting of winter peak and fall in summer- monsoon in the present pond showed remarkable point. Srivastava and Sinha(1991)have reported the luxuriant growth of Diatoms during sommer-monsoon in Nainitallake (U.P). While Salpathy R.K (1996) put forward that diatoms prefer to colonise during warmer part of the year and they have lean population during winter in one lake. In atmospheric temperature, the plants showed maximum gregarious growth. The fate of one species P. mucronatuswas peculiar. It disappears with the advent of summer and in monsoon and again the growth started in the advent of winter and was available till late spring and again started in monsoon. The luxuriant growth of macrophytes in spring might be due to an increase in nutrients that were ; produced as a result of decomposition of dead and decaying parts of plants present in the adjoining bank of the pond. Actually the growth of macrophytes depends upon the water quality. Minerally enriched water are helpful for proper maintenance and growth of the plants (APHA, 1998).

V. Conclusion

The studied Manth Pondof Sunderpur of district Darbhanga was extremely polluted, as revealed by its physic-chemical and biological parameters. It displayed permanent microcystic bloom with a degree of seasonal variation. The reason behind the complete absence of all submerged and floating macrophytes was, perhaps, a complex interaction between various abiotic and biotic factors. The Phytoplanktons directly affects the abundance and distribution of zooplankton. The seasonal and spatial distribution of the plankton in this study showed that the seasonal and spatial distribution of the plankton in this study shows the they are sensitive to changes in levels of nutrients and other interactions with one another and with other factors. As such the plankton can be good indicators of water quality.

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CONFLICT OF INTEREST

Authors declare no conflict of interest regarding publication or any other activity related to this article.

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