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Studies on the diversity of phytoplankton in the relation to physico-chemical parameters with respect to pollution status

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Abstract
The water body is receiving domestic discharge leading to large amount of nutrient inputs and high amount of phosphate and nitrate in the water body indicates that water is eutrophic in nature. Continuous presence of Asplanchna, Brachionus, Keratella, Fillinia, Cyclops and Diaptomus is an indicator of organic pollution. The present study conducted during the year 2008 deals with zooplankton population and chemical characteristics of a sewage fed pond of Darbhanga. Sampling was done monthly between 8 am and 11 am from January to December 2008 to work out parameters such as air and water temperature, transparency, dissolved oxygen, total dissolved solids, pH, alkalinity, hardness, calcium, magnesium, hydroxide, carbonate, bicarbonate and conductivity.

Keywords: phytoplankton and physico-chemical

Introduction
Zooplanktons play an important role as indicators of trophic condition in both cold temperate and tropical waters (Sharma, 1998) [10, 13]. The most common and severe problem is the enrichment of water by a nutrient that increases the biological growth and renders the water bodies unfit for diverse uses. Nutrients that are present in fertilizers as well as in domestic and industrial wastewater have been identified as main cause for changing the trophic status of water bodies from oligotrophic to mesotrophic to eutrophic. Although zooplankton exists under a wide range of environmental condition, yet many species are limited by dissolved oxygen, pH, salinity and other physico-chemical factors. George (1962) [5] and Hutchinson (1967) [6] have reported several other factors like dissolved oxygen, pH, alkalinity, and temperature light and grazing affecting zooplankton population. Therefore, this work aimed to study the zooplankton population in relation to physico-chemical factors of sewage fed pond in Darbhanga.

Materials and Methods
Present study was carried out on a fresh water body of Darbhanga. The pond is a sewage fed used as drainage basins into which the surface runoff water and sewage from the surrounding catchments area enter. Different physico-chemical parameters were analyzed monthly from January 2018 to December 2018. Samples were collected from 8 am to 11 am. Air and water temperature were recorded by mercury thermometer graduated upon 100°C. pH of water was determined at the sites by using a portable electronic digital pH meter. Dissolved oxygen analysis was performed at the sites by Winkler's modified technique according to APHA (1998) [1].

For zooplankton analysis, samples were collected from each water body on a monthly basis. About 100 liters of water is filtered by passing water through plankton net made up of bolting silk cloth having mesh size of 25 micrometer. Samples were then washed into wide mouth bottles and were preserved by adding 5% formaldehyde solution. Further analysis was done by putting 1 ml of the preserved sample on a Sedgwick-Rafter cell and studying it under an inverted microscope. For qualitative analysis, the keys given in Edmondson (1959) [4], Needham and Needham (1962) [8], Pennak (1978) [9], Tonapi (1980) and APHA (1998) [1, 12] were utilized and results were expressed in No./L.

Results and Discussion

The air temperature ranged from 15-37 °C while water temperature from 15-35 ºC (Table 1), free CO_2 was never recorded throughout the study period. pH ranged from 8.3 during May to 9.1 during December 2018. Dissolved oxygen ranged from 1.6 mg/l to 9.2 mg/l. Higher values of dissolved oxygen during some months might be due to increased photosynthetic activity while lower values might be because of its utilization in decomposition of organic matter and respiration by micro and macro organisms. Total alkalinity ranged from 250 mg/l in June to 725 mg/l in September 2018. Varying alkalinity was found to be related with the fluctuations in the photosynthetic rate of phytoplankton. According to Alikunhi (1957) [2], water with alkalinity greater than 100 mg/l is productive. Hardness ranged from 212 mg/l in June to 300 mg/l in September 2018. Higher values of hardness might be due to the evaporation of water at higher temperature during summer months while lower values during monsoon months might be attributed to dilution of water body by rainwater. Phosphate ranged from 0.435 mg/l in March to 1.02 mg/l in November 2018, nitrate value varied from 0.106 in March to 0.198 in June 2018. Higher values of phosphate and nitrate during the study period were due to the incoming sewage including household detergents, kitchen waste, human excreta etc. In the present study, Total Dissolved Solids (TDS) ranged from minimum 298 mg/l in June to maximum 662 mg/l in August 2018 (Table 1 a, b).

Table 1a: Monthly variations in various physico-chemical parameters in Medical Pond

Parameter Months	Air temperature ^{0}C	Water temperature ^{0}C	Transparency (cm)	Dissolved oxygen (mg/l)	TDS (mg/l)	pH	Conductivity (µs cm^{-1})	Carbon dioxide (mg/l)
Jan. 18	18	16	15.4	9.1	318	9.1	2697	–
Feb. 18	17	15	15.3	8.6	311	8.4	2524	–
Mar. 18	23	21	15.6	4.6	349	9.0	2527	–
Apr. 18	24	22	19.1	5.1	398	8.6	2167	–
May 18	34	32	18.1	2.1	328	8.2	2009	–
June 18	36	34	19.1	1.4	2.97	8.6	2049	–
July 18	34	32	18.1	3.1	4.89	8.7	2198	–
Aug. 18	33	31	19.1	4.1	661	8.6	2339	–
Sep. 18	30	28	19.4	4.4	593	8.4	2397	–
Oct. 18	29	27	16.1	5.1	384	8.5	2457	–
Nov. 18	26	24	15.1	5.3	562	8.6	2597	–
Dec. 18	21	18	16.1	7.1	580	9.0	2651	–

Table 1b: Monthly variations in various physico-chemical parameters in Medical Pond

Parameter Months	Hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total Alkalinity (mg/l)	Carbonate (mg/l)	Bicarbonate (mg/l)	PO_4–P (mg/l)	NO_3–N (mg/l)
Jan. 18	264	53	30	479	218	268	0.719	0.131
Feb. 18	251	49	26	388	148	239	0.601	0.118
Mar. 18	239	66	24	549	178	268	0.434	0.105
Apr. 18	235	64	28	651	154	494	0.574	0.134
May 18	289	84	35	569	168	398	0.461	0.157
June 18	298	94	24	724	118	524	0.468	0.197
July 18	221	100	14	458	120	258	0.501	0.121
Aug. 18	248	96	18	319	101	218	0.702	0.131
Sep. 18	211	78	14	248	148	144	0.862	0.167
Oct. 18	228	71	11	296	186	108	0.921	0.144
Nov. 18	258	78	8	318	118	198	0.102	0.174
Dec. 18	266	79	25	314	108	203	0.967	0.142

TDS and phytoplankton showed positive but insignificant correlation (r = 0.125). TDS showed variations mainly caused by the addition of dissolved substances and utilization by organisms and other aquatic plants and animals during different months. Higher values of TDS during the monsoon period due to incoming surface runoff and drainage water containing large amount of silt, clay and other material, which increased turbidity of water inhibiting light penetration in the water body. Lower values might be due to loss of nutrients into sediments and their utilization by plankton and other aquatic plants. According to Trivedy and Goel (1984), an excess amount of TDS in water tends to disturb the ecological balance due to suffocation in aquatic fauna even in the presence of fair amount of dissolved oxygen.

The total zooplankton number fluctuated from 54-254 No./ml and zooplankton showed polymodal occurrence. Interspecific and intraspecific factors influence the distribution and abundance of zooplankton. The availability of phytoplankton affects the zooplankton by affecting female fertility. The fresh water zooplankton fauna of these water bodies comprised of four major groups i.e. the cladocerans, copepods rotifers and ostracoda. Among zooplankton, rotifers formed the dominant group and cladocerans were the second dominant group during the study period.

A total of 11 genera were recorded belonging to Rotifers i.e. *Brachionus calciflourous*, *Brachionus bidentata*, Brachionus angular, *Brachionus plicatilis*, *Asplanchna priodonta*, Keratella, *Notholca*, Monostyla, *Rotaria* and *Fillinia longisita* (Table 2).

Table 2: Distribution and abundance of zooplankton population (No/L) in Medical Pond during 2018

Months Genera	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
CLADOCERA												
Daphnia sp	46	19	18	9	7	4	12	6	32	26	19	24
Moina sp	22	8	2	4	5	7	-	-	2	-	11	19
Bosmina sp	8	11	10	28	18	10	3	7	8	-	23	35
Cerodaphnia sp	4	12	11	5	9	-	1	-	2	5	8	16
Total	80	50	41	46	39	21	16	13	44	31	61	94
COPEPODA												
Cyclops sp	9	21	8	15	6	10	32	11	24	6	10	13
Diaptonus sp	11	2	1	1	4	-	-	-	9	5	2	-
Mesocyclops sp	2	15	7	3	1	3	2	15	19	10	7	10
Total	22	38	16	19	11	13	34	26	52	21	19	23
ROTIFERA												
Brachionus bidentata	23	31	12	19	8	4	1	1	7	2	2	3
Brachionus plicatilis	21	42	18	22	6	9	2	1	2	-	2	-
Brachionus calciflorus	9	18	12	10	5	-	-	-	1	3	5	10
Brachionus quadridentata	6	14	20	2	-	-	3	1	1	5	3	5
Brachionus angularis	26	15	11	18	12	-	2	-	1	13	9	9
Keratella sp	2	3	2	2	1	-	2	2	1	-	17	24
Asplanchna sp	6	6	2	2	1	1	1	-	2	10	3	5
Filinia longisita	19	11	9	2	-	4	1	2	-	-	2	4
Notholca sp	3	3	2	14	8	2	-	-	-	9	5	7
Rotataria sp	2	2	3	6	1	5	8	2	2	2	9	2
Total	117	139	91	97	42	25	19	9	17	44	57	69
OSTRACODA												
Cypris sp	6	4	2	9	2	1	1	-	2	3	7	2
Cypriodopsis sp	19	10	12	21	-	2	4	3	2	3	2	2
Total	25	14	14	30	2	3	5	3	4	6	9	4
NAUPLII	3	2	2	2	3	4	2	-	2	3	3	2
Eggs	7	2	4	3	5	7	5	3	3	5	-	-
Grand Total	254	235	168	197	98	67	77	54	115	80	149	192

They are valuable bioindicators (Sladecek, 1983; Berzins and Pejler, 1987) [11]. Rotifers are also essential food source for Indian major carps. Cladocerans formed the second most abundant group of zooplankton represented by Daphnia, Moina, Bosmina and Cerodaphnia while Copepoda was represented by three genera i.e. Cyclops, Diaptonus and Mesocyclops and Ostracoda was represented by two genera i.e. Cypris and Cypriodopsis (Table 2). Regression lines showing correlation between zooplankton with NO_3-N and PO_4-P in Medical and Dighi pond have been given in Figure 1.

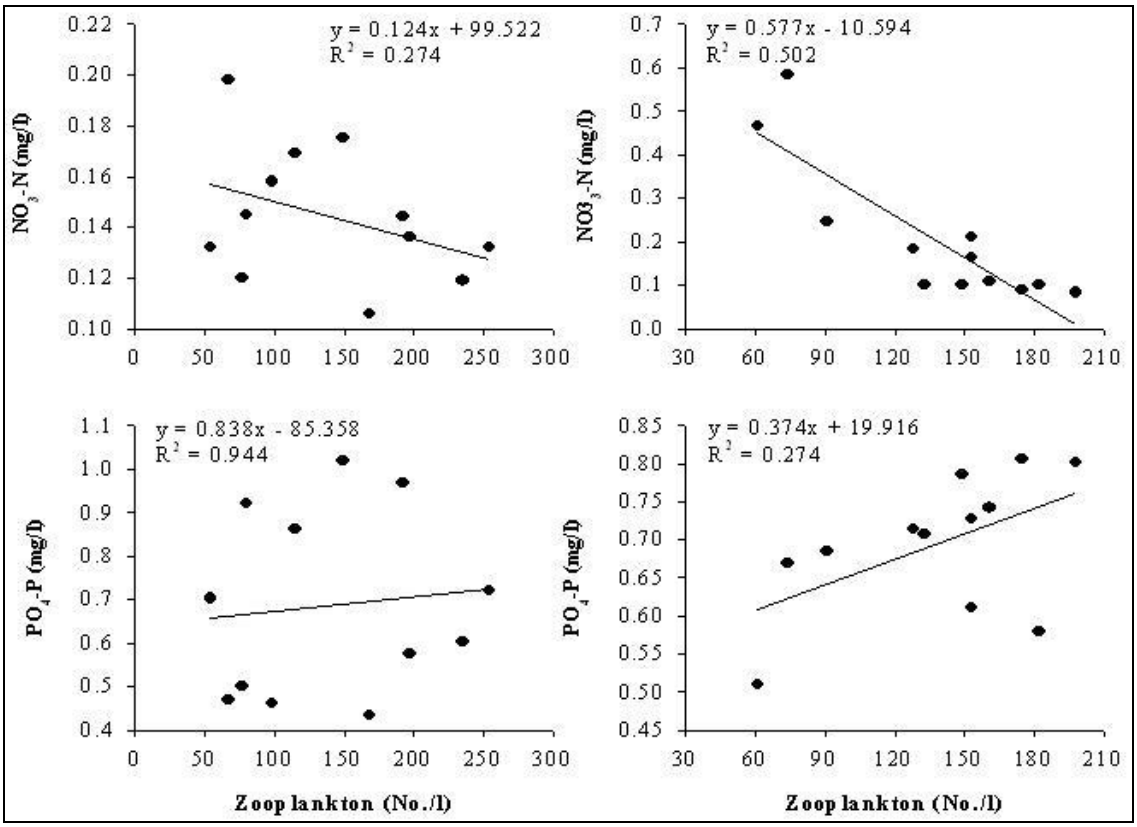

Fig 1: Regression lines showing correlation between zooplankton (No. /l) with NO3-N (mg/l) and PO4-P (mg/l) in Medical and Diggi pond

Conclusion

In both the ponds, water temperature follows the trend of air temperature and is always found to be less than air temperature. Carbon dioxide never found during the study period. pH was always alkaline. Higher values of dissolved oxygen during some months might be due to increased photosynthetic activity while lower values may be because of its utilization during decomposition of organic matter and respiration by micro and macro organisms. Higher values of phosphate and nitrate during the study were due to the incoming sewage. Zooplankton showed polymodal occurrence. Interspecific and intraspecific factors influence the distribution and abundance of zooplankton. Rotifers, Cladocera, Copepoda and Ostracoda constitute the zooplankton population and contributed significantly to secondary production of the pond. Zooplanktons Asplachna, Brachionus, Keratella, Fillina, Cyclops and Diaptomus indicate organic pollution in the ponds studied.

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