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Limnological status and plankton dynamics in two fresh water wetlands of Aligarh, North India

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Abstract: *The present study deals with the plankton dynamics and physicochemical variables in two fresh water wetlands of Aligarh. Phytoplankton comprised five major groups, namely Myxophyceae, Chlorophyceae, Desmidiace, Bacillariophyceae and Euglenophyceae, while Zooplankton comprised four major groups, namely Cladocera, Rotifera, Copepoda and Ostracoda. Statistically, G.P.P. and N.P.P. values were found to have significant positive relationship with Chlorophyll 'a' and water temperature in both the wetlands, whereas the relationship with phytoplankton was observed non significant positive at Wetland B and negative at Wetland A.*

Keywords: *Wetlands, Phytoplankton, Zooplankton, G.P.P., N.P.P. , C.R. and Chlorophyll 'a'*

I. Introduction

Wetlands are generally small in area, shallow and rain fed. They perform some useful functions in maintaining ecological balance of the nature (WWF, 1987). Wetlands show a wide spectrum of habitats ranging from extensive peat bogs of northern region to tropical mangrove forest; from seasonal ponds and marshes to flood plains and permanent riparian swamps; from fresh water ponds shallow lakes and large reservoirs to salt lakes, brackish lagoons, estuaries and coastal salt marshes.

The wetlands exhibit very large differences in their habitat characteristics such as hydrological regimes, bottom soil quality and in the nature and diversity of their biota. Wetlands provide people, directly or indirectly, with enormous range of goods and services like staple food, plants, fertile grazing land, and support for coastal and inland fisheries, flood control and breeding grounds for waterfowl, fish etc. Plentiful water and a high productivity have made wetlands among the richest and most diverse ecosystems of the world (WWF, 1992).

The plankton are small and microscopic organisms (Size: < 2 micrometers - 200 micrometers) drifting or floating in the sea or fresh water, consisting chiefly of diatoms, protozoan, small crustaceans, and the eggs and larval stages of larger animals. Phytoplankton are the microscopic plants that act as the primary producers in an aquatic environment, convert acquired light energy into carbohydrates through photosynthesis. Energy not used by the phytoplankton for maintenance is available as food for the animals that consume it. Zooplankton are heterotrophic organisms that consume phytoplankton and others and in turn, they become food for larger, secondary consumer animals and fish.

The productivity in terms of planktonic biomass in fresh water lakes, rivers, ponds or wetlands, is regulated by various physico-chemical factors viz., temperature, transparency, pH, electrical conductivity, hardness, nitrogen and phosphorus.

Unfortunately, rapid urbanization has led to the loss of wetland habitats through encroachment, bad management and pollution from sewage and waste and litter disposal activities. These factors have seriously affected the survival of these water bodies and posed serious threat to the flora and faunal supported by them.

The objective of the present study is to find out the limnological status, i.e., the water quality and plankton productivity in selected wetlands for their future utilization for fish culture.

II. Material and Methods

Study Area:

Aligarh city (North latitude 27^0 28' and $28^0$10' and East longitude $77^0$29' and 78^0 36') and its adjoining areas are richly well off with wetlands which support an extensive and regular fisheries of various kinds. They are surrounded by two river systems, Ganga and Jamuna with their many tributaries. In the present investigation two water bodies have been selected as wetlands to study their limnology, namely Wetland A and wetland B.
Wetland A (WA) is locally termed as Dhobi-ghat, perennial, rectangular, eutrophic sewage fed wetland and used as drainage basin.

Wetland B (W B) is an old age water body having irregular shoreline and the main source of its water supply are the monsoon rains, village drainage and surface runoff from the adjoining areas.

WA

WB

Limnological Analysis:

Different physicochemical parameters were analyzed monthly from January 2000 to December 2001. Samples were collected from 8 am to 11 am. Air temperature and water temperature were recorded by mercury thermometer graduated upon 100°C. Dissolved oxygen analysis was performed at the sites by Winkler's modified technique according to APHA (1998). pH was estimated by Digital pH –meter. Turbidity was measured by Water Analyzer, Model no. WQC- 22A, Electrical conductivity was measured by conductivity meter. TDS was measured with the help of digital TDS meter.

For the estimation of Hardness, Chloride, Sulphate, Nitrate, Phosphate and Slilica, water sample was brought to the laboratory and analysis was done as per the standard methods given by APHA (1998) and Trivedi and Goel (1984).

Primary production was estimated by measuring the changes in dissolved oxygen concentration in light and dark bottles after following methodology of Gaarder and Gran (1927) and described by Strickland and Parsons (1972) and Vollenweider (1969). Chlorophyll 'a' was estimated after following methodology given by Trivedy and Goel (1984).

For Phytoplankton analysis, 500 ml water sample was taken and treated with 5.0 ml Lugol's solutions, qualitative and quantitative analysis were made of 20 ml concentrate, which was obtained. The genera of phytoplankton were identified and enumerated following the works of Edmondson (1959), Needham and Needham (1962), Nayar *et al.* (1999) and Tonapi (1980).

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), Needham and Needham (1962), Pennak (1978), Tonapi (1980) and APHA (1998) were utilized and results were expressed in No./L.

Statistical analysis:

The correlation between various physico-chemical parameters of water samples were analyzed with the help of SPSS software (17.0) and Microsoft Excel.

III. Results and Discussions

In the studied wetlands the air temperature ranged from 17C° to 36 ˚C, while water temperature from 14 ˚C to 32 ˚C (Table- 1), free CO_2 was never recorded throughout the study period. The absence of CO_2 is mainly due to its utilization during photosynthesis by algae or carbonates present did not allow the CO_2 to be produced in the bottom and column to reach the surface (Ganapati, 1960). pH ranged from 8.3 to 9.2 during (Table 1). The variations in pH are linked with the chemical changes, species composition and life processes of animal and plant communities inhabiting the system.

Dissolved oxygen ranged from 4.0 mg/l to 9.6 mg/l (Table 2). Maximum values were recorded in June, 2001 and March 2001 in Wetland A. 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 hardness is the concentration of divalent cations expresses as $CaCO_3$. In most waters majority of cations are calcium and magnesium (Boyd, 1998).

The values of total hardness were found to vary between 124.0 mg/l to highest 390 mg/l in these wetlands (Table 2). High values were, especially in Wetland A due to many stains, chemical, dyes and detergents are used by the washer man daily in these water bodies.

TDS values of Wetland B ranged from 600 mg/l to 5600 mg/l, 2 (Table 2). High values may be due to more input of excess of allochthonous material. Chloride content of Wetland B varied from 50.0 mg/l to 318.0 mg/l. The concentration declined in the rains due to dilution of water. Sulphates content varied from 32.0 mg/l to 179.0 mg/l (Table 3). The higher concentrations of sulphates recorded in the study during summer months may be attributed to fast blowing hot and dry winds causing increased evaporations.

Phosphates in the Wetlands 0.191 mg/l to 1.425 mg/l in May, 200,1whereas Nitrates ranged from 0.052 mg/l to 0.278 mg/l. Increased values during summer were mainly due to regeneration of inorganic phosphorous from the organic form during decomposition..

Silicates of Wetland B ranged from 0.0137 mg/l to 0.1887 mg/l in and in Wetland A it varied from 0.0218 mg/l, to 0.1912 mg/l (Table 3). Higher values of silicates during summer months may be due to release of silica during decomposition of organic matter at high temperature.

In the present study, **phytoplankton** comprised five major groups, namely myxophyceae (Blue green algae), Chlorophyceae (Green algae), Desmidiace (Desmids), Bacillariophyceae (Diatoms) and Euglenophyceae (Euglenoids). The Oder of abundance in Wetland A was found to be Myxophyceae> Bacillariophyceae > Chlorophyceae> Euglinophyceae > Desmidiace and in Wetland B it was Chlorophyceae>Myxophyceae> Bacillariophyceae > Euglinopphyceae > Desmidiaceae (Figures1-2). The phytoplankton which could be identified includes 22 genera in Wetland A and 27 genera in Wetland B (Tables 4-5). In Wetland A phytoplankton varied from 51 No/ml (November, 2001) to 122 No/ml (April, 2001) while in Wetland B total number varied from 133 No/ml (July, 2001) to 213No/ml in (September, 2000) and in (Tables 4-5).

Statistically phytoplankton showed significant negative correlation in Wetland A (r = -0.539) only while with nitrate and Phosphate positive in significant correlation in both the ponds. With Silica correlation was found insignificant in both ponds while positive significant with zooplankton, in Wetland B only. Statistically no significant correlation was observed with Gross primary productivity, Net primary and Chlorophyll a. statistically non significant relationship could be due to entry of uncontrolled varied quantum of sewage into these wetlands.

In all the selected ponds *Microcystis* was found to be the most dominant species among myxophyceae followed by Anabaena species. However, *Nostoc* was only found in Wetland A. According to the Palmer (1969), the occurrence of *Anabaena, Nostoc* and *Microcystis* is the indication of organic pollution and eutrophication.

Among Cholorophyceae *Protococus* colonies were the more abundantly found in Wetland B (Tables 4-5). Among Bacillariophyceae *Cyclotella, Amphora* and *Diatoma* mostly occur in Wetland B and showed their irregular presence at Wetland A.

The Euglenophyceae group was represented by only two genera, namely *Euglena sp.* and *Phacus sp*. were found in quite good numbers, reflecting the idea that they may be highly resistant to the changing environmental conditions and moderate supply of nutrients for their growth and development (Tables 4-5).

In the present study, **zooplankton** abundance in Wetland A was found to be Cladocera > Copepoda > Rotifera and in Wetland B it was Cladocera >Copepoda >Rotifera > Ostracoda (Tables 6-7).

The group cladocera is represented by *Daphnia pulex, Daphnia parvula, Daphanosoma sp., Moina sp. Ceriodaphnia sp, Alonella sp., Leptodora sp., Simocephalus sp and Bosmina sp.* Highest Cladocera density was recorded in Wetland B followed by Wetland A (Tables 6-7; Figures 3-4).

The Copepoda represented by *Cyclops sp., Canthocamptus sp., Diaptomus sp*.,and *Limnocalanus sp*. Among all *Cyclops sp*. dominated followed by *Diaptomus sp.* in both the ponds. *Limnocalanus sp.*, was only recorded in Wetland A. Later on after one and half decades Ahmad (2016) has also reported *Diaptomus sp*. in abundance throughout the period of investigations in Macrophyte infested waterbodies.

In the present study, Ostracods were only found and represented by *cypris sp*., in Wetland B. Different developmental stages of zooplankton were counted together as nauplii and eggs (Tables 6-7).

Primary production includes gross primary productivity (G.P.P), the rate of transformation of radiant energy to chemical, the total production (i.e. production as well respiration), net primary productivity (N.P.P.), the net production left after expenditure in respiration and community respiration (C.R.), the rate of loss of fixed energy in respiration. The values of N.P.P., G.P.P, Community respiration (C.R.) and Chlorophyll ‘a’ pigment for both ponds are given in Table 9.

It is clear from the table, the values of gross primary production were always found higher than the values of net primary production. The variations in the rates of production as noted might be due to favourable and unfavourable physico chemical condition during the different months. Higher rates indicate that these water bodies are primarily rich in nutrients with enough lighted zone and energy content.

Statistically, G.P.P and N.P.P values were found to have a significant positive relationship with Chlorophyll ‘a’ and with water temperature in both the water bodies but with phytoplankton, it showed a non significant correlation in both Wetlands (Table 8).

Community respiration did not show any relationship with plank tonic organisms in both the ponds. It may be because of high rate of decomposition of organic matter in the water bodies and some turbid conditions during different months.

The high values of chlorophyll ‘a’ were recorded when transparency values was low and vice versa. The high values of Productivity (G.P.P. and N.P.P.) were obtained at the time of high concentration of Chlorophyll ‘a’ and vice-versa (Table 9).

Table -1. Monthly variations in Air temperature, Water temperature, pH and Transparency in selected Wetlands

Months	**Air temp (^{0}C)**		**Water temp (^{0}C)**		**pH**		**Transparency (cm)**	
	W A	W B	W A	W B	W A	W B	W A	W B
Aug.2000	32.0	30.0	30.0	29.0	9.2	8.4	15.2	17.3
Sep.	30.0	30.0	28.0	28.0	9.1	8.4	17.2	17.2
Oct.	28.0	29.0	26.0	28.0	8.8	8.4	21.1	18.3
Nov.	28.0	28.0	25.0	27.0	8.8	8.4	33.2	16.3
Dec.	19.0	22.0	17.0	21.5	8.9	8.5	28.2	28.2
Jan.2001	15.0	18.0	20.0	17.0	8.8	9.1	13.1	28.3
Feb	18.0	20.0	20.0	19.0	8.7	9.0	13.5	38.3
Mar.	21.0	23.0	22.0	21.0	8.4	8.7	15.5	35.4
Apr.	23.0	25.0	23.0	17.0	8.7	8.7	14.2	26.5
May	26.0	33.0	30.0	19.0	8.6	9.2	26.2	13.5
Jun.	32.0	33.0	32.0	21.0	8.7	9.1	32.2	9.1
July	36.0	32.0	32.0	23.0	8.9	9.1	35.3	14.5
Aug.	32.0	32.0	32.0	29.0	8.3	9.1	36.5	13.5
Sep.	36.0	32.0	30.0	30.0	9.3	8.4	38.1	22.5
Oct.	31.0	32.0	25.0	28.0	9.1	8.4	29.5	25.3
Nov.	19.0	30.0	18.0	17.0	8.8	8.4	34.5	25.5
Dec.	19.0	20.0	18.5	15.0	8.6	8.6	17.5	30.5

Table -2. Monthly variations in DO, TDS, Hardness and Chloride in selected Wetlands

Months	**DO (mg/l)**		**TDS (mg/l)**		**Hardness (mg/l)**		**Chloride (mg/l)**	
	WA	W B	WA	W B	WA	W B	WA	W B
Aug.2000	6.2	8.0	1980.0	1260.0	240.0	142.0	52.00	56.00
Sep.	4.2	9.3	1925.0	820.0	242.0	147.0	50.00	57.00
Oct.	4.8	6.4	1850.0	685.0	272.0	186.0	50.00	76.00
Nov.	5.4	6.2	1300.0	1120.0	284.0	196.0	65.00	67.00
Dec.	6.2	6.4	1910.0	1017.0	376.0	188.0	52.00	83.00
Jan.2001	6.4	6.9	2490.0	1180.0	356.0	296.0	56.00	84.00
Feb	6.2	4.0	2515.0	800.0	334.0	276.0	61.00	125.00
Mar.	9.4	5.0	2800.0	600.0	366.0	320.0	157.00	107.00
Apr.	5.0	6.4	5600.0	1200.0	354.0	292.0	136.00	168.00
May	5.6	8.0	1350.0	2170.0	376.0	312.0	136.00	78.00
Jun.	5.0	9.6	2400.0	1733.0	390.0	244.0	318.00	423.00
July	4.4	7.0	3000.0	1000.0	218.0	162.0	263.00	288.00
Aug.	4.2	6.8	2120.0	1500.0	244.0	124.0	149.00	138.00
Sep.	5.2	8.8	2010.0	720.0	294.0	188.0	170.00	153.00
Oct.	6.4	4.4	2000.0	1069.0	374.0	264.0	199.00	170.00
Nov.	8.0	6.0	1700.0	1170.0	390.0	260.0	214.00	306.00
Dec.	8.2	7.0	1950.0	1060.0	380.0	275.0	213.00	318.00

Table -3. Monthly variations in Sulphate, Nitrate, Phosphate and Silica in selected Wetlands

Months	Sulphate (mg/l)		Nitrate (mg/l)		Phosphate (mg/l)		Silica (mg/l)	
	W A	W B	W A	W B	W A	W B	W A	W B
Aug.2000	51.00	33.00	0.157	0.117	0.586	0.635	0.0450	0.0950
Sep.	40.00	34.00	0.081	0.087	1.040	0.785	0.0387	0.1887
Oct.	57.00	32.00	0.081	0.112	0.586	0.541	0.0450	0.0825
Nov.	48.00	32.00	0.134	0.056	0.586	0.570	0.0460	0.0887
Dec.	43.00	32.00	0.182	0.052	0.419	0.707	0.1031	0.0825
Jan.2001	57.00	38.00	0.122	0.092	0.620	0.550	0.1587	0.0137
Feb	87.50	82.00	0.146	0.071	0.695	0.695	0.0225	0.0150
Mar.	153.00	42.00	0.117	0.156	0.761	0.761	0.0218	0.0825
Apr.	164.00	55.00	0.123	0.117	0.812	0.965	0.1912	0.0425
May	153.00	104.00	0.161	0.086	1.425	0.941	0.1862	0.0475
Jun.	142.00	179.00	0.151	0.081	0.867	1.090	0.1887	0.1887
July	100.00	57.00	0.195	0.161	0.470	0.586	0.0975	0.0925
Aug.	88.00	51.00	0.135	0.131	0.359	0.321	0.0725	0.1350
Sep.	97.00	34.00	0.267	0.175	0.390	0.234	0.0837	0.0762
Oct.	100.00	49.00	0.179	0.170	0.490	0.290	0.1662	0.1187
Nov.	108.00	53.00	0.278	0.240	0.460	0.226	0.1775	0.1012
Dec.	135.00	43.00	0.176	0.086	0.656	0.191	0.1887	0.0637

Table-4. Monthly abundance and distribution of Phytoplankton (No/ml) in Wetland A

Groups	Aug. 00	Sep	Oct	Nov	Dec	Ja01	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Myxophyceae																	
Microcystis sp.	4	3	4	2	3	7	5	8	6	5	10	3	5	4	5	3	3
Anabaena sp	12	10	12	4	5	4	5	9	6	6	5	13	16	11	13	5	5
Oscillatoria sp.	1	0	0	1	0	4	2	5	7	1	3	1	1	1	0	0	0
Spirullina sp.	4	3	3	4	2	5	3	5	9	3	8	5	4	4	5	3	2
Nostoc sp.	2	4	2	4	4	3	4	3	4	4	7	2	3	5	3	5	5
Total	23	20	21	15	14	23	19	30	32	19	33	24	29	25	26	16	15
Choloeophyceace																	
Scenedesmus sp.	2	2	3	4	2	5	3	5	5	11	7	4	3	3	4	5	3
Coelastrum sp.	3	3	4	0	5	6	5	5	6	9	8	3	4	4	5	0	6
Spirogyra sp.	2	0	2	3	0	3	3	4	5	6	4	3	3	0	3	4	0
Zygnema sp	2	2	2	0	2	3	2	6	6	2	3	2	3	3	3	0	3
Microspora sp.	1	1	1	2	3	4	1	3	3	5	6	2	2	2	2	3	4
Selenastrum sp.	3	2	3	2	2	5	4	7	10	5	5	5	4	3	4	3	3
Total	13	10	15	11	14	26	18	30	35	30	33	19	19	15	21	15	19
Desmidiaceae																	
Closterium sp.	2	1	2	1	2	2	2	2	2	1	2	1	2	1	2	0	1
Cosmarium sp.	2	2	1	2	3	4	5	3	2	3	2	1	2	1	0	0	1
Desmidium sp.	1	1	1	2	1	2	1	1	2	2	1	0	1	1	0	2	2
Total	5	4	4	5	6	8	8	6	6	6	5	2	5	3	2	2	4
Bacillariophyceace																	
Navicula sp.	4	2	5	4	3	6	9	11	9	7	5	5	5	3	6	5	3
Nitzchia sp.	3	4	6	1	1	4	7	7	9	4	4	3	4	5	7	0	2
Synedra sp.	4	3	4	3	3	7	6	8	12	8	6	4	5	4	5	4	4
Cyclotella sp.	2	1	2	2	2	3	2	4	5	4	4	1	3	0	3	3	5
Diatoma sp.	1	1	0	0	1	3	4	2	2	3	2	2	2	2	2	0	0
Total	14	11	17	10	10	23	28	32	37	26	21	15	19	40	23	12	14
Euglenophyceace																	
Euglena sp.	8	10	6	8	10	8	6	4	8	6	4	2	8	6	4	4	6
Phacus sp.	4	5	6	4	5	4	3	2	4	3	2	1	4	3	2	2	3
Total	12	15	12	12	15	12	9	6	12	9	6	3	12	9	6	6	9
GT	67	60	69	53	59	92	82	104	122	98	98	63	84	66	78	51	61

Table- 5. Monthly abundance and distribution of Phytoplankton (No/ml) in Wetland B

Groups	**Aug. 2000**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan 01**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Myxophyceae																	
Microcystis sp.	62	66	47	32	16	15	32	48	62	62	54	50	60	62	46	30	14
Anabaena sp	4	5	6	4	3	3	6	3	5	7	4	3	3	4	5	3	2
Oscillatoria sp.	1	2	2	3	4	3	3	3	2	6	4	2	1	1	1	2	3
Spirullina sp.	1	0	0	1	0	3	4	2	4	4	3	1	2	0	1	1	1
Total	68	73	55	40	23	24	45	56	73	79	19	56	66	67	53	36	20
Cholorophyceace																	
Pediastrum sp	4	3	2	1	4	3	2	5	4	3	2	1	3	2	1	0	3
Crucigenia sp	9	11	12	9	7	7	10	11	13	16	12	8	7	10	11	8	6
Ankistrodesmus sp	8	8	3	14	11	13	11	12	11	13	8	7	7	7	2	12	10
Scenedesmus sp.	16	11	8	16	6	7	22	6	9	6	4	5	12	10	7	12	5
Protococcus sp	14	12	16	18	13	14	15	11	17	18	14	12	12	15	17	12	13
Coelastrum sp.	2	2	1	2	1	1	2	3	3	2	3	1	1	1	0	1	0
Chlorella sp	2	2	0	2	0	0	2	3	3	2	3	2	0	1	1	0	1
Tetraspora sp	1	4	3	2	5	1	0	0	11	1	0	1	0	3	2	1	4
Spirogyra sp.	4	1	4	5	3	2	3	3	1	1	2	1	3	0	3	4	2
Ulothrix sp	3	3	2	4	3	1	0	3	1	0	0	1	2	2	1	3	2
Zygnema sp	3	3	2	2	0	0	0	2	0	1	1	0	0	2	1	1	1
Microspora sp.	2	2	2	1	2	2	0	0	0	1	1	0	1	1	2	1	2
Total	68	62	55	76	55	51	67	59	73	64	50	39	48	54	48	55	49
Desmidiaceae																	
Closterium sp.	7	5	4	3	5	4	3	3	2	5	5	6	4	7	3	4	4
Cosmarium sp.	3	2	4	2	3	2	3	4	2	5	4	3	2	1	3	1	2
Genicularia sp.	2	2	3	3	1	1	4	3	2	2	1	0	1	1	2	2	0
Total	12	9	11	8	9	7	10	10	6	12	10	9	7	9	8	7	6
Bacillariophyceace																	
Navicula sp.	11	14	16	5	12	17	13	4	15	6	3	4	10	12	15	4	10
Nitzchia sp.	12	13	14	4	7	18	8	3	6	7	4	7	11	12	13	3	6
Synedra sp.	5	8	9	11	8	9	7	4	6	5	4	3	4	7	8	10	7
Cyclotella sp.	3	4	3	2	4	3	4	2	3	4	2	1	2	3	2	1	3
Amphora	3	4	4	4	6	4	4	3	2	3	2	1	2	3	3	2	5
Diatoma sp.	2	3	3	3	4	3	4	2	2	5	3	2	1	2	2	1	3
Total	36	46	49	29	41	54	40	18	34	30	18	18	30	39	43	21	34
Euglenophyceace																	
Euglena sp.	8	8	10	10	19	19	9	10	14	5	3	8	7	6	9	10	18
Phacus sp.	10	15	16	17	15	15	8	7	10	8	5	3	9	12	15	16	13
Total	18	23	12	27	34	34	17	17	24	13	8	13	16	18	24	26	31
GT	202	213	196	180	162	170	179	160	210	198	148	133	167	187	176	145	140

Table-6. Monthly abundance and distribution of Zooplankton (No. /L) in Wetland A

Genera	Aug00	Sep	Oct	Nov	Dec	Jan01	Feb	Mar	Apr	May	Jun	July	Aug	sep	Oct	Nov	Dec
Rotifera																	
Brachionuscalciflorus	6	10	2	4	8	6	7	6	2	4	9	6	5	7	5	4	3
Rotaria sp	2	3	4	12	1	1	0	0	0	1	2	1	0	2	3	6	1
Keratella sp	0	4	2	1	6	2	1	0	0	1	0	0	0	2	3	8	4
Filinia sp	10	4	5	3	5	4	5	3	5	7	12	16	25	28	18	16	8
Notholca sp	4	3	3	2	1	0	1	1	0	1	1	1	3	2	1	2	1
Total	**22**	**24**	**16**	**22**	**21**	**13**	**14**	**12**	**9**	**19**	**28**	**33**	**36**	**31**	**28**	**28**	**13**
Cladocera																	
Daphnia sp	12	10	15	13	13	10	8	20	25	15	10	14	18	22	23	25	21
Ceriodaphnia	1	1	0	0	0	0	0	0	0	0	0	0	3	5	0	0	0
Moina sp	3	2	4	2	3	0	5	5	7	3	2	4	2	5	9	7	2
Simocephalus sp	6	7	8	8	9	4	5	6	7	4	5	4	6	6	7	7	8
Bosmina sp	1	2	1	0	0	0	1	0	0	0	0	0	0	3	4	2	1
Total	**23**	**22**	**28**	**23**	**25**	**14**	**19**	**31**	**39**	**22**	**17**	**22**	**32**	**42**	**45**	**40**	**32**
Copepoda																	
Cyclops sp	15	18	13	10	8	3	4	11	9	11	17	22	18	22	11	12	11
Canthocampus sp	0	0	0	0	0	0	2	0	1	0	2	5	0	0	0	1	0
Diaptomus sp	7	13	5	6	4	8	4	6	8	7	13	15	14	15	10	2	3
Limnocalanus sp	3	4	2	2	3	2	4	2	3	1	8	13	4	3	4	1	2
Total																	
Eggs	5	4	5	3	8	5	2	3	2	4	6	6	10	4	4	3	2
Nauplii	5	6	13	12	8	6	7	3	4	5	6	7	11	15	10	6	5
Grand total	**80**	**91**	**82**	**78**	**77**	**51**	**56**	**68**	**75**	**72**	**97**	**123**	**125**	**133**	**112**	**94**	**69**

Table-7. Monthly abundance and distribution of Zooplankton (No./L) in Wetland B

Genera	Aug00	Sep	Oct	Nov	Dec	Jan01	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Rotifera																	
Brachionus angularis	4	4	7	5	3	3	2	2	3	4	4	2	4	3	6	4	5
Brachionuscalciflorus	4	6	7	5	3	3	2	2	3	4	4	2	3	5	6	5	3
Keratella s tropica	2	1	1	2	2	1	2	1	2	0	0	1	1	1	2	2	2
Filinia sp	5	4	3	2	3	2	3	3	3	2	6	5	4	3	2	2	3
Testudinella sp	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Asplanchna sp	1	0	1	1	2	2	1	2	1	1	0	0	2	1	0	2	2
Lecane sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Notholca sp	2	3	2	1	0	0	3	1	3	2	1	3	2	3	2	2	1
Total	**19**	**19**	**21**	**16**	**13**	**11**	**13**	**11**	**15**	**13**	**15**	**13**	**16**	**16**	**20**	**17**	**17**
Cladocera																	
Daphnia pulex	9	10	16	13	13	16	15	12	16	9	6	5	9	11	15	12	12
Daphnia parvula	2	6	5	7	3	4	1	1	1	1	0	0	2	4	3	6	3
Daphnia magna	11	16	13	13	16	15	11	16	9	6	5	8	10	12	11	12	11
Daphnia carinata	2	4	5	7	3	3	1	1	2	1	2	1	0	1	2	4	3
Ceriodaphnia	4	3	2	3	3	2	3	2	3	2	2	2	1	2	3	1	2
Moina sp	5	5	4	5	3	4	4	3	4	2	1	1	2	1	2	2	3
Diaphnosoma	4	5	4	3	5	6	5	6	4	3	2	2	3	4	3	4	5
Alonella sp.	3	4	3	4	4	3	4	3	4	2	3	1	0	2	3	2	3
Simocephalus sp	1	0	2	1	2	1	3	2	2	0	0	0	0	0	0	2	1
Leptodora sp	2	2	1	2	3	1	2	3	2	1	0	0	1	1	0	1	2
Total	**43**	**55**	**51**	**58**	**55**	**49**	**49**	**49**	**47**	**27**	**21**	**20**	**28**	**38**	**42**	**46**	**45**
Copepoda																	
Cyclops sp	11	12	13	11	9	2	12	12	15	9	6	7	9	10	11	10	8
Canthocampus sp	4	3	2	2	1	3	4	0	0	1	0	0	3	2	1	1	1
Diaptomus sp	7	13	9	11	8	11	13	9	7	4	3	5	6	12	8	10	9
Ostracoda																	
Cypris sp	4	3	2	2	3	1	4	3	2	3	2	2	3	2	1	1	2
Total	22	28	24	24	24	18	16	29	21	22	14	9	12	25	21	21	18
Eggs	1	2	1	1	2	1	2	1	1	3	2	1	0	1	2	1	1
Nauplii	3	2	1	0	2	3	1	2	3	31	1	1	2	1	0	1	1
Grand total	**92**	**109**	**100**	**101**	**93**	**87**	**98**	**87**	**90**	**61**	**50**	**49**	**68**	**83**	**85**	**87**	**84**

Table -8. Statistical brief (P< 0.05) of various water quality parameters in Wetland B and Wetland A

Parameters	**Parameters**	**Ponds**	Coefficient of Correlation **'r'**
Air Temperature	WaterTemperature	WB	0.987
		WA	0.843
WaterTemperature	Transparency	WB	-0.737
		WA	-0.639
	D.O.	WB	0.453
		WA	-0.656
	Zooplankton	WB	-0.254
		WA	0.240
	Phytoplankton	WB	0.256
		WA	-0.539
	Total Dissolved Solids	WB	0.090
		WA	0.116
Dissolved oxygen	Zooplankton	WB	-0.685
		WA	-0.623
	Phytoplankton	WB	-0.419
		WA	0.538
	Cladocera	WB	0.411
		WA	0.183
PO_4–P			
	Copepods	WB	0.603
		WA	-0.798
	Ostracoda	WB	-0.631
		WA	-0.327
	Euglenophycea	WB	-0.577
		WA	-0.100
	Rotifer	WB	0.223
		WA	0.289
	Mxyophyceae	WB	-0.236
		WA	-0.534
	Chlorophyceae	WB	-0.459
		WA	-0.511
	Bacillariophyceae	WB	0.000
		WA	-0.495
	Descmidiacea	WB	-0.349
		WA	-0.592
NO_3–N	Phytoplankton	WB	-0.798

		WA	-0.357
	Mxyophyceae	WB	-0.631
		WA	-0.327
	Chlorophyceae	WB	-0.377
		WA	0.078
	Bacillariophyceae	WB	0.446
		WA	0.361
	Descmidiacea	WB	0.330
		WA	0.652
	Zooplankton	WB	0.546
		WA	0.224
Chloride	Mxyophyceae	WB	0.193
		WA	0.474
	Chlorophyceae	WB	0.364
		WA	-0.022
	Bacillariophyceae	WB	0.075
		WA	0.150
	Descmidiacea	WB	0.334
		WA	-0.504
	Phytoplankton	WB	-0.027
		WA	0.491
Gross Primary Productivity	Chlorophyll a	WB	0.887
		WA	0.536
	Phytoplankton	WB	0.005
		WA	-0.138
Net Primary Productivity	Phytoplankton	WB	0.044
		WA	-0.162
	Chlorophyll a	WB	0.865
		WA	0.497

Table -9. Monthly variations in Primary Productivity, Community Respiration and Chlorophyll 'a' in selected Wetlands

Months	Net Productivity g C/m^3/hr		Gross Primary productivity g C/m^3/hr		Community Respiration g C/m^3/hr		Chlorophyll 'a' (mg Pigment/L)	
	Wetland A	Wetland B	Wetland A	Wetland B	Wetland A	Wetland B	Wetland A	Wetland B
August 00	1.437	1.628	2.115	1.717	0.089	0.678	3.317	2.452
September	1.322	1.329	1.473	1.492	0.163	0.151	2.683	2.708
October	1.472	1.482	1.561	1.693	0.211	0.089	3.685	3.262
November	1.622	1.632	1.734	1.952	0.320	0.112	2.945	3.252
December	1.351	1.121	1.442	1.242	0.121	0.091	2.545	1.348
January 01	0.892	0.687	1.064	0.823	0.136	0.172	2.075	0.831
Feburary	0.564	0.923	0.675	1.023	0.100	0.111	0.786	0.562
March	1.320	1.372	1.421	1.419	0.047	0.101	2.832	2.610
April	1.532	1.572	1.604	1.713	0.141	0.0072	2.715	2.920
May	1.746	1.638	1.834	1.823	0.186	0.088	3.146	3.130
June	1.260	1.725	1.673	2.130	0.405	0.413	3.340	3.210
July	1.836	1.523	2.240	1.813	0.290	0.404	2.351	3.070
August	1.448	1.617	2.106	1.816	0.199	0.658	3.328	2.561
September	1.331	1.219	1.462	1.501	0.282	0.131	2.784	2.819
October	1.482	1.391	1.572	1.581	0.190	0.090	3..798	3.151
November	1.732	1.732	1.842	1.831	0.099	0.011	1.735	3.261
December	1.242	1.142	1.286	1.231	0.089	0.044	2.473	1.437

Figure1 Percent composition of phytplankton in Wetland A

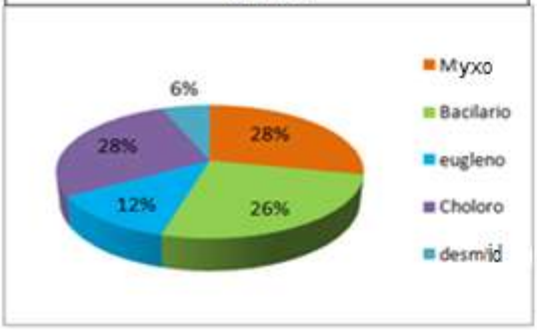


Figure 2 Percent composition of Phytoplankton in Wetland B

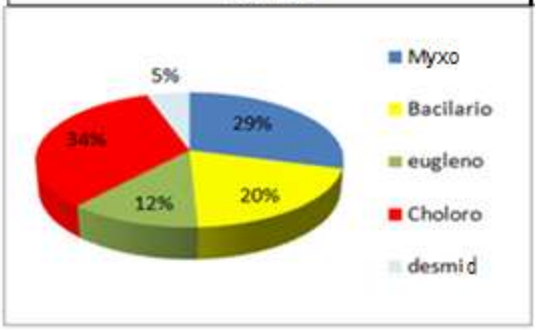


Figure 3- Percent composition of zooplankton in Wetland A

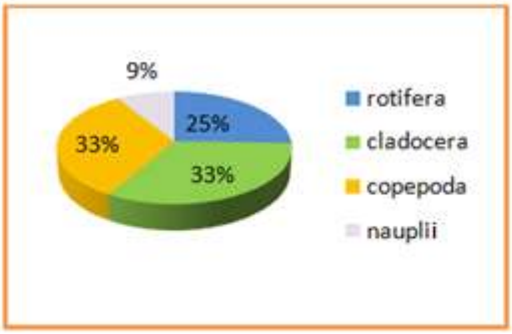
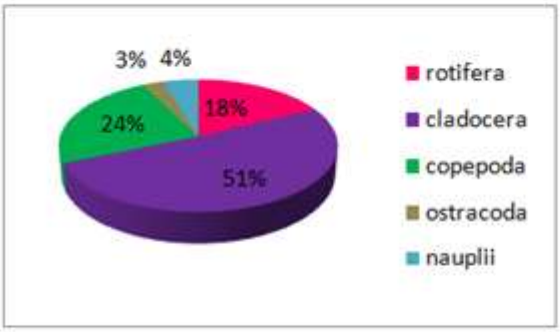


Figure 4- Percent composition of zooplankton in Wetland B



IV. Conclusion

Study revealed that plankton; both phytoplankton and zooplankton are well represented in these wetlands. The studied wetlands are highly productive showing plankton abundance during summer and post monsoon months. These are primarily rich in nutrients with enough lighted littoral zone and energy content. On the basis of present findings it is concluded that these wetlands being productive in nature can be used for pisciculture or for integrated fish farming.

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