Uttar Pradesh J. Zool. 29(3) :379-387, 2009 ISSN 0256-971X

STUDIES ON THE PHYTOPLANKTON IN PILLI RESERVOIR, NEAR REHAR TOWN (BIJNOR), UTTAR PRADESH

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Distribution of phytoplankton in Pilli Reservoir was studied during 2005-06 to assess the trophic status. The reservoir supported low phytoplankton population. The seasonal abundance of phytoplankton ranked in the following order – winter > summer > rainy season. Total population of phytoplankton varied from 2565 ul^{-1} and 5581 ul^{-1} with lowest and highest population being formed during August and October respectively. A total of 25 species of phytoplankton were collected from all sectors of the reservoir including Chlorophyceae (10), Bacillariophyceae (2) and Myxophyceae (3).

Key words: Seasonal variation, phytoplankton, Pilli reservoir.

INTRODUCTION

Pilli reservoir is situated to the North-East on Rehar town, Dhampur district, Bijnor (U.P.) at Afzalgarh-Jaspur Road near Rehar town at 78^0 46' E longitude and 29^0 24' N latitude at elevation of 288m above the sea level. The reservoir is constructed near Rehar town which is 36 km away from Dhampur. Pilli reservoir was constructed in the year, 1962-66 and its extension reservoir in the year 1969-70. The reservoir is 15.4 km long in between Ramganga and Pilli rivers. The reservoir is fed by three rivers *viz.* Pilli, Dhara and Baneli. All the tributaries of the feeder rivers originate from "Siwalik" ranges. The characteristic feature of the reservoir is hilly. About 25% of the catchment area is used for agriculture and forest. The water of the Pilli reservoir is used mainly for irrigation and rest for production.

Government of India has constructed a large number of reservoirs since 1951-52 for power generation, to increase the area of irrigated agricultural land to control flooding. Limnological investigation of these waters are necessary to evaluate potential fish production and to provide information that could be useful in fisheries developmental planning. Phytoplankton forms the bases of food chain in most of the ecosystems, thus playing a vital role in fisheries. In India attempts have been made by workers like Das and Srivastava (1956), Zafar (1964), Kant & Kachroo (1972), Mishra *et al.* (1976), Zutshi (1981), Pant *et al.* (1985), Mathew (1989), Gupta (1991), Khanna & Singh (2000), Khanna & Bhutani (2003) and Gupta & Sharma (2005).

MATERIALS AND METHODS

For collection and analysis of plankton samples. Methods of APHA (1989) were followed. Fifty litres of water was filtered through botting silk No. 25 (64μ). The surface, column and bottom samples collected from five stations were preserved in Lugo's solution for qualitative and quantitative analysis in laboratory with the aid of Carl Zeigs inverted microscope and a Sedgwick Rafter cell. The data obtained in the present study were processed statistically as per the methods stated by Shastree (1991).

OBSERVATIONS

Total plankton population : The standing crop of plankton of Pilli reservoir varied from 2963 to 62815 μl^{-1} with two peaks of abundance, one in March (5208.5 μl^{-1}) and the other in October (6286.5 μl^{-1}). The autumn peak was more prominent than spring peak. The total population was lowest during rainy season. On an average, phytoplankton formed 90.16% and zooplankton 9.84% of the total population seasonal variation and percent composition among different groups of phytoplankton and zooplankton are graphically represented in Figs 1a & b and 2a & b. A total of 25 species of phytoplankton were collected from all sectors of the reservoir including, Chlorophyceae (10), Bacillariophyceae (12) and Myxophyceae (03). It was observed that there was no notable difference in species composition between lotic and lentic sectors (Table I).

Total population of phytoplankton varied from 2565 μl^{-1} and 5581.5 μl^{-1} with lowest and highest populations being formed during August and October, respectively. Numerically, Myxophyceae were the main contributors to the total phytoplankton population in Pilli reservoir (Table III). The population of blue green algal plankton ranged from 1300 ± 138.8 to 2772.5 ± 1071.3 μl^{-1} and formed 42.4% to 40.6% of the total phytoplankton population, respectively. Two peaks were noted in February (2587.5 ± 823.8 μl^{-1}) and October (2772.5 ± 1071.3 μl^{-1}) whereas the lowest concentration of Myxophyceae was observed during July. The percentage contribution of Myxophyceae varied from 39.3% (March) to 59.6% (August). Diatoms were the next important contributors in phytoplankton population. Two pulses, one in March (2170 ± 396.0 μl^{-1}) and the other in October (1874 ± 302.6 μl^{-1}) were observed and contributed during these two peaks 44.6% and 33.6% of the total phytoplankton respectively. The lowest value of Diatoms was recorded during August (752.5 + 130.8 μl^{-1}) when it formed 29.3% of the total population. Chlorophyceae ranked third in order of abundance, the percent population fluctuated from 11.1% to 21.9% in August and November, respectively. Two peaks were observed, one in March (785.0 ± 191.0 μl^{-1}) and the other in October (935.0 ± 261.6 μl^{-1}) in October (Table II).

Lotic sector : Phytoplankton population was scarce in July and thereafter, it attained two peaks, each in spring and autumn respectively. This sector showed maximum number of phytoplankton species during spring (21), followed by summer (19), autumn (17), winter (13) and rainy (12) season (Table I). Myxophyceae was the most dominant group in this sector too, with its population fluctuating from 55.49% in September to 28.60% in March. On an average, it constituted 43.11 % of the total plankton population. Two pulses, one in February (2005 ul^{-1}) and other in September (2630 ul^{-1}) were witnessed (Table III). The species in order of abundance were : Mycrocystis and Oscillatoria.

Bacillariophyceae formed 38.66% of the total phytoplanktonic population in this sector. Two pulses were observed, one in March (2450 μl^{-1}) and the other in October (2088 μl^{-1}) (Table III). A total of 14 species were recorded of this group, mainly represented by *Navicula, Fragilaria, Syneqra, Rhopalodia*, and *Mastogloia.* Chlorophyceae ranked third in order of abundance and its percentage population ranged from 12.76% in September to (920 μl^{-1}) in November. This group showed two pulses, one in March (920 μl^{-1}) and other in October (1120 μl^{-1}) (Table III). The species in order of abundance were *Spirogyra, Podiastrum, Chlorella, Dedogonium* and *Ankistrodesmus.*

Table 1 : List of Phytoplankton Occurrence in different Seasons, 2005-06.

Species	Lotic Sector					Lentic Sector				
	A	B	C	D	E	A	B	C	D	E
Chlorophyceae										
Spirogyra	+	+	+	+	+	+	+	+	+	+
Zygnema	–	+	+	–	–	–	+	–	–	–
Cladophora	–	+	–	–	+	–	+	–	–	+
Oedogonium	–	+	+	–	+	–	+	+	–	+
Pediastrum	+	+	+	+	+	+	+	+	+	+
Volvox	–	+	+	–	+	+	+	+	–	+
Chlorella	+	+	+	+	+	+	+	+	+	+
Closterium	–	+	+	–	–	–	+	+	–	–
Desmidium	–	+	–	–	–	–	+	–	–	+
Bacillariophyceae										
Navicula	+	+	+	+	+	+	+	+	+	+
Fragilaria	+	+	+	+	+	+	+	+	+	+
Diatema	–	–	–	–	+	–	+	+	–	–
Rhopalodia	–	+	+	+	–	–	–	–	–	+
Nitzschia	–	–	+	+	+	–	–	+	–	+
Compnonema	+	+	+	–	–	+	+	–	+	–
Synedra	+	+	+	+	+	+	+	+	+	+
Cymbella	–	+	+	–	+	–	–	–	–	+
Surirella	–	+	–	+	–	–	+	–	+	–
Rhabdonema	+	–	–	+	+	+	–	–	+	+
Denticula	–	–	+	–	+	–	+	–	–	+
Mastogloia	+	+	–	–	+	–	+	–	–	+
Myxophyceae										
Microcystis	+	+*	+	+	+*	+*	+	+	+	+*
Anabaena	+	+	+	+	+	+	+	+	+	+
Oscillatoria	+	+	+	–	+	–	+	+	–	+

A : winter; B : Spring; C : Summer; D : Rainy; E : Autumn; * : Dominant, + : Present, – : Absent

Table II : Quantitative and Percentage Composition of different groups of Phytoplankton in Pilli Reservoir between June 2005 and May 2006

Months	Chlorophyceae		Bacillariophyceae		Myxophyceae	
	Average SD μl^{-1}	%	Average SD μl^{-1}	%	Average SD μl^{-1}	%
June '05	517.5 ± 130.8	15.7	950±106.1	28.7	1841.5± 125.2	55.6
July	353.0 ± 94.8	13.2	982.5 ± 130.8	36.9	1330 ± 396.0	49.9
Aug.	285.0 ± 28.3	11.1	752.5 ± 144.9	29.3	1527.5± 396.0	49.9
Sept.	507.5 ± 137.9	12.3	1267.5±335.9	30.9	2330±424.3	56.8
Oct.	935.0±261.6	16.8	1874±302.6	33.6	2772.5±1071.3	49.6
Nov.	722.5±208.6	21.9	1015±148.5	30.7	1565±629.3	47.4
Dec.	452.5±95.5	13.8	1120±431.3	34.1	1710±226.3	52.1
Jan. '06	462.5±46.0	15.2	1065±304.1	35.1	1507±604.6	49.7
Feb.	537.5±215.7	11.8	1460±268.7	31.8	2587.5±823.8	56.4
March	785.0±191.0	16.1	2170±396.0	44.6	1915.0±799.0	39.3
April	527.0±67.2	17.2	1240±268.7	40.4	1300±138.8	42.4
May	676.0±213.5	18.6	1176±76.4	32.4	1775±148.5	49.0

Table III : Total group composition of phytoplankton (μl^{-1}), 2005-06.

Months		Lotic Sector			Lentic Sector		
		CHL	BAC	MYX	CHL	BAC	MYX
June '05	a	610	875	1753	425	1025	1930
	b	18.84	27.02	54.14	12.57	30.33	57.10
July	a	420	1075	1050	286	890	1610
	b	16.50	42.24	41.26	10.27	31.95	57.78
Aug.	a	305	855	1205	265	650	1850
	b	12.90	36.15	50.95	9.58	23.50	66.90
Sept.	a	605	1505	2630	410	1030	2030
	b	12.76	31.75	55.49	11.82	29.68	58.50
Oct.	a	1120	2088	2015	750	1660	3530
	b	21.44	39.98	38.58	12.63	27.95	59.43
Nov.	a	870	1120	1120	575	910	2010
	b	27.98	36.01	36.01	16.45	26.04	57.51
Dec.	a	520	1425	1550	385	815	1870
	b	14.88	40.77	44.35	12.54	26.55	60.91
Jan. '06	a	495	1280	1080	430	850	1935
	b	17.33	44.84	37.83	13.37	26.44	60.19
Feb.	a	690	1650	2005	385	1270	3170
	b	15.88	37.97	46.15	7.98	26.32	65.70
March	a	920	2450	1350	650	1890	2480
	b	19.49	51.91	28.60	12.95	37.65	49.40
April	a	575	1430	1170	480	1050	1430
	b	18.11	45.04	36.85	16.22	35.47	48.31
May	a	827	1122	1880	525	1230	1670
	b	21.60	29.30	49.10	15.33	35.91	48.76
Mean Average	a	663	106	1567	464	1106	2126
	b	18.23	38.66	43.11	12.55	29.92	57.53

a : Units per litres; b : Percentage.

Lentic sector **:** All 25 species were present in this sector. Maximum number of phytoplankton were observed during spring (21), followed by autumn (19), summer (15), rainy (12) and winter (11) seasons. Myxophyceae were the most abundant component of phytoplankton population. It showed highest proportion of phytoplankton population in August (66.90%) and lowest in April (48.31%), Numerical abundance fluctuated from 1430 μl^{-1} (April) to -3530 μl^{-1} (October). On an average, it constituted 57.53% of total phytoplankton density in this sector. During two peaks, one in February (3170 μl^{-1}) and other in October (3530 μl^{-1}) Microcystis showed blooms (Table III).

A total of 12 species of Bacillariophyceae were found in this sector. Diatoms constituted 29.82%, of the total phytoplankton. The percentage contribution of this group varied from 23.5% (August) to 37.7% (March). Two pulses were noted one in March (1890 μl^{-1}) and the other in October (1660 μl^{-1}) (Table III). In order of abundance, *Navicula* was most important, which was followed by *Fragilaria, Synedra, Gomphonema, Rhabdonema* and *Surirella*. Chlorophyceae were represented by 11 species *Spirogyra, Pediastrum, Chlorella, Ankistrodesmus* and *Closterium* were the dominant species. The percentage population of this group ranged from 8.0% (February) to 16.5% (November). On an average, it constituted 12.55% of the total phytoplankton in

the sector. Two peaks one in March (650 μl^{-1}) and the other in October (750 μl^{-1}) were recorded during this period (Table III).

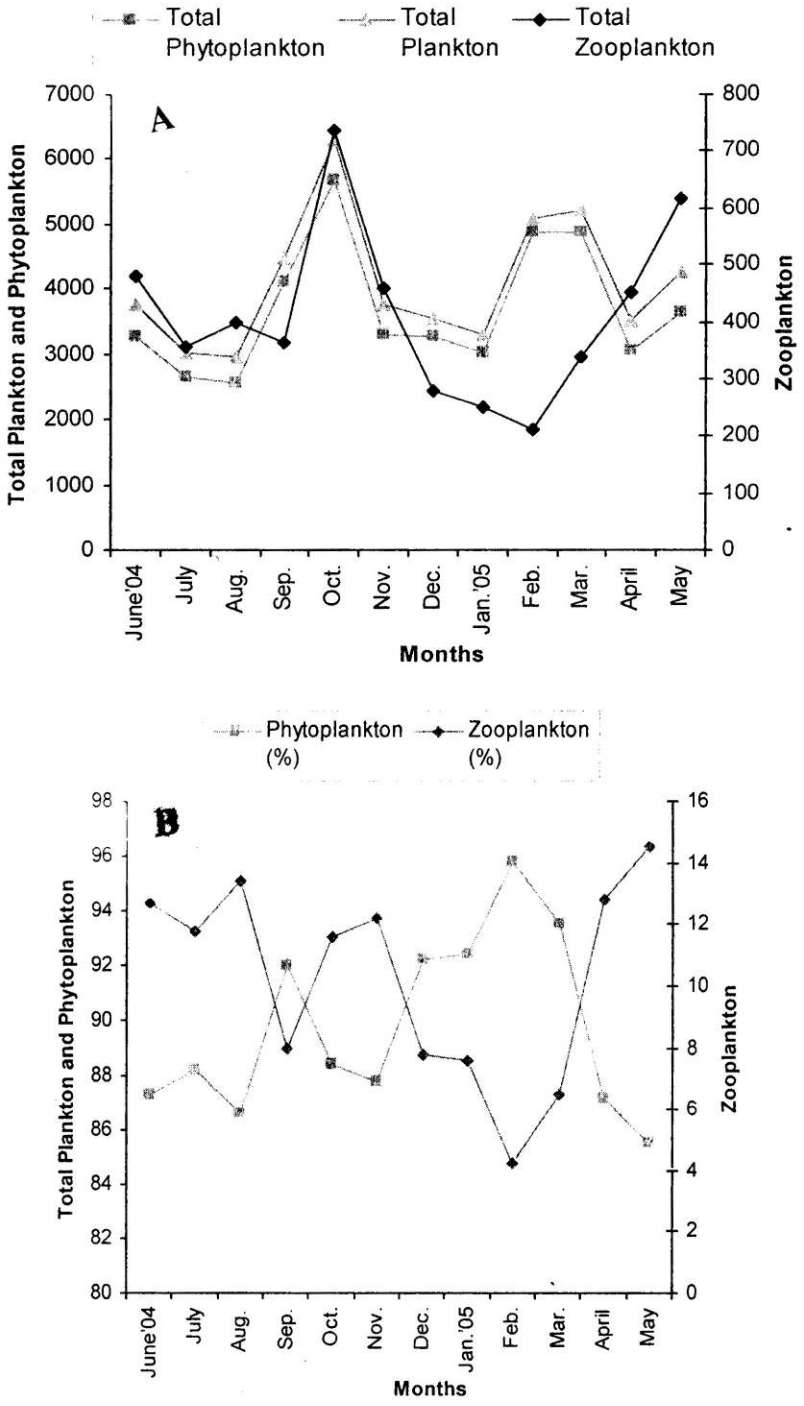

Fig. 1 : (A) Seasonal variations in total plankton, phytoplankton and zooplankton; **(B)** Relative proportions of phytoplankton and zooplankton.

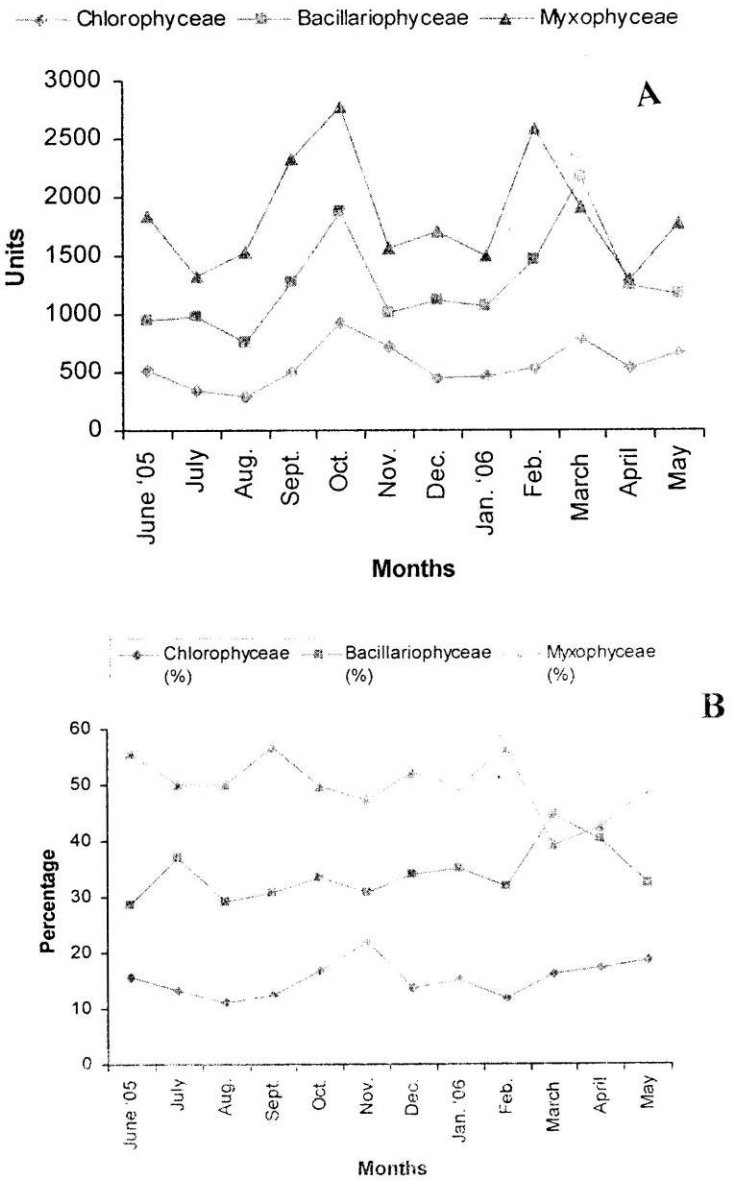

Fig. 2 : (A) Monthly variations in the density of phytoplankton groups; **(B)** Seasonal variations in the percentage composition of phytoplankton group in Pilli Reservoir.

RESULTS AND DISCUSSION

A total of 25 species of phytoplankton were collected from all sectors of the reservoir including Chlorophyceae (10), Bacillariophyceae (12) and Myxophyceae (3). It was observed that there was no notable difference in species composition between lentic and lotic sectors. Total population of phytoplankton varied from 2565 μl^{-1} and 5581.5 μl^{-1} with lowest and highest populations being formed during August and October respectively. Numerically, Myxophyceae were the main contributors to the total phytoplankton population in Pilli reservoir. The population of blue green algae plankton ranged 1300 ± 138.8 to 2772.5 ± 1071.3 μl^{-1} and formed 42.4% to 40.6% of the total

phytoplankton population respectively. Two peaks were noted in February 2587.5 ± 823.8 μl^{-1} and October 2772.5 ± 1071.3 μl^{-1} whereas the lowest concentration of Myxophyceae was observed during July. The percentage contribution of Myxophyceae varied from 39.3% (March) to 59.6% (August).

Diatoms were the next important contributors in phytoplankton population. Two pulses, one in March (2170 ± 396.0 μl^{-1}) and the other in October (1874 ± 302.6 μl^{-1}) were observed and contributed during these two peaks 44.6% and 33.6% of the total phytoplankton respectively. The lowest value of diatoms was recorded during August (752.5 ± 130.8 μl^{-1}) when it formed 29.3% of the total population. Chlorophyceae ranked third in order of abundance, the present population fluctuated from 11.1% to 21.9% in August and November respectively. Two peaks were observed, one in March (785.0 ± 191.0 μl^{-1}) and the other in October (935.0 ± 261.6 μl^{-1}) in October.

The total plankton crop normally increased with the fall in outflow and inflow. Large inflow of flood waters during monsoon season resulted in the decline of standing crop of plankton. Welch (1952) reported that the inflowing water due to its scantier plankton, dilutes the plankton of standing waters. Similarly Sugunan (1980) reported that the sudden influx of flood water caused a steep decline in plankton qualitatively and quantitatively in Nagarjuna Sagar reservoir during July-August. The reservoir sectors in order of plankton abundance were lentic and lotic. The high plankton population of lentic sector must be due to better conditions, such as less turbidity and residue, higher transparency and low water currents. Similar findings have been reported by Sugunan (1980). Welch (1952) has also opined that the deep areas of lake show greater plankton growth than the shallow points.

Temperature is considered to be the most important factor for determining the composition and fluctuations of plankton (Byars, 1960). In the present investigation, temperature range, 15.7 ± 1.2 to 32.5°C, appeared to be favourable for the growth of plankton population; there were two peaks of plankton population, one in June (32.5°C) and the other in January (15.7°C). Govind (1978) stated that temperature above 25°C appeared favourable for zooplankton abundance in Tungabhadra reservoir. However, Mathew (1978) reported that the temperature does not appear to be responsible for the seasonal - fluctuations of plankters in Govindgarh lake.

In the present study it was found that -plankton population decreased during rainy season due to high turbidity and silt. After monsoon period residue started to settle down. Therefore, transparency and plankton both started to increase. Phytoplankton developed peak population during the period of maximum transparency in spring season. In all 25 genera belonging to chlorophyceae (10), bacillariophyceae (12) and myxophyceae (3), were found in the phytoplankton community of Pilli reservoir. Lewis (1978) found that mean number of phytoplankton of ten tropical lakes was 21 as compared to 36 in ten temperate lakes. The present water body, having 25 genera, is therefore, nearer to tropical lakes than temperate ones. Munawar (1974) and Munawar & Munawar (1976) reported about 100 and 150 species of phytoplankton in two temperate lakes *viz.* Ontario and Erie, respectively.

The standing crop of phytoplankton showed two peaks, one each during autumn (5,581 μl^{-1}) and spring (4885 μl^{-1}) respectively. Obviously, improved light regime during

spring and autumn lead to the peak growth of phytoplankton population. Additionally, phytoplankton peak during postmonsoon (autumn) develops after the influx of nutrient rich surface run-off from the forested catchment area during south-west monsoon. Govind (1969) also observed a spurt in phytoplankton immediately after the south-west monsoon in Tungqbhadra reservoir. Increase of phytoplankton, population in spring is a characteristic feature of many lakes. This phenomenon, is described either as "spring outbrust" or "vernal blooming" (Sharma, 1980). The phytoplankton maxima during spring in Pilli reservoir may be due to conducive environmental features including high level of nutrients, increasing day lengths and light intensities. Similar findings have been given by Hutchinson (1967) and Gupta & Sharma (2005).

The characteristic feature of phytoplankton community of Pilli reservoir is the blooming. of blue-green algae (*Microcystis* sp.) during autumn and spring seasons in the lentic sector. Sugunan (1980) reported that blooming of *Microcystis* is a common phenomenon in many of the Indian reservoirs and some (Amaravati, Aliyal and Sandynulla) have permanent algal blooms. Sreenivasan (1971) found that the diatoms and blue-green algae are the dominant algal groups in hard water reservoirs. Abundant populations of phytoplankton reaching upto bloom level are a characteristic feature of eutrophic water bodies (Pant *et al.*, 1980). Therefore, Pilli reservoir resembles, to eutrophic water bodies on the basis of phytoplankton community. Govind (1978) observed that phytoplankton especially myxophyceae seemed to thrive well in temperature range of 25.0 to 26.0^{0}C in Tungabhadra reservoir. In Pilli reservoir the temperatures during peak populations of Microcystis during spring and autumn were 21-22^{0}C and 24-25^{0}C, respectively.

ACKNOWLEDGEMENT

Authors are thankful to Dr. Ashok Kumar, Principal, and Dr. R.M. Saxena, Head, Department of Zoology, D.A.V. (PG) College, Dehradun for providing necessary laboratory facilities.

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