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Original Research Paper

Phytoplankton Studies in Relation to Physico-Chemical Environment of Some Lakes Around Tumkur City, Karnataka, India

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ABSTRACT

Phytoplankton density and diversity in relation to water quality parameters like temperature, pH, DO, alkalinity and nutrients of seven lakes situated around Tumkur were assessed between the period March and November of 2008. The water samples were collected monthly and analysed for their physico-chemical characteristics. The seasonal variation of phytoplankton density and diversity were monitored and diversity indices calculated. A maximum of 26 species belonging to 18 genera of algae were observed in the samples of April 2008. The density of phytoplankton in all the water bodies was found to be maximum during summer (April), and minimum during monsoon (August), but the diversity was maximum in November. Chlorophyceae was dominant in all the selected water bodies. The *Microcystis,* noticed in water samples of Honnudike and Hebbur lakes, reveals moderate pollution of the lakes. There was a decreasing trend of phytoplankton population from May to August, after which it increased till November. The diversity indices of phytoplankton ranged from 1.32 to 3.34 in the month of April 2008.

INTRODUCTION

The healthy condition of an aquatic system depends upon its physico-chemical and biological characteristics (Cairns & Dickson 1971), which usually fluctuate with season and degree of pollution. The extent of pollution stress and level of degradation of water bodies are better assessed by biological characteristics in addition to conventional chemical methods (Kennish 1992). Phytoplankton is more sensitive to pollution than other organisms (Cairns et al. 1994) and used commonly for water quality characterization (Eva Willen 2001).

The phytoplankton population is influenced by grazing, light, temperature and nutrients (Kalff & Knoechel 1978). Phytoplankton study and monitoring are useful for control of physico-chemical and biological conditions of water (Ariyadej et al. 2004). Species diversity indices when correlated with physico-chemical properties, provide one of the best ways to detect and evaluate the impact of pollution on aquatic communities (Margalef 1968). Certain groups of phytoplankton, especially blue green algae, can degrade recreational value of surface waters and in higher densities can cause deoxygenation of water (Whitton & Patts 2000). As a consequence there has been an interest in monitoring the processes that are influencing the development of phytoplankton communities, particularly in relation to physico-chemical parameters (Akbay et al. 1999, Elliott et al. 2002).

Diversity index values greater than 3, 1-3 and less than 1 characterize non-polluted, moderately polluted and heavily polluted waters respectively (Furhan Iqbal et al. 2006).

It is in this background, an attempt has been made here to assess the water quality, phytoplankton density and diversity in context of physico-chemical environment of selected seven lakes.

STUDY AREA

The study area includes the seven selected water bodies situated around Tumkur (Fig. 1). Rainfall is the main recharge source of these water bodies. However, lakes 1, 5 and 6 have an additional water resource from Hemavathi reservoir. The onset of rain in this region is normally from June to November. Brief geographical features of the selected areas and lakes are given in Table 1.

MATERIALS AND METHODS

The water samples from the seven lakes were collected between 7 am and 9 am every month from March 2008 to November 2008 and analysed for temperature, pH, DO, alkalinity and nutrients following the standard methods outlined in APHA (1995) and Trivedy & Goel (1986). The phytoplankton samples were collected by filtering 10 litre of each sample using nylon bolting net and preserved in 4% formalin. Plankton counts were made using Sedgwick-Rafter counting cell and the results are expressed as No./L. The species were identified with the help of standard monographs (APHA 1995, Philipose 1967). The Margalef diversity index of plankton was calculated using the formula:

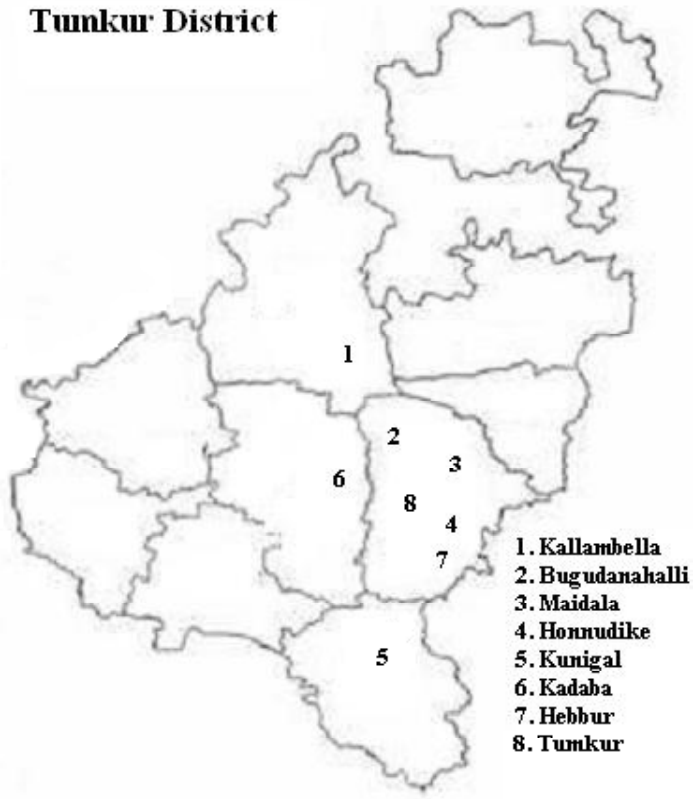

Fig. 1: Seven selected water bodies situated around Tumkur.

Table 1: Geographical features of selected areas/lakes.

Areas and Lakes	1	2	3	4	5	6	7
Latitude	13°37'00"	13°03'00"	13°16'35"	13°12'30"	13°01'30"	13°14'00"	13°09;00"
Longitude	75°56'00"	77°03'00"	77°11'25"	77°17'50"	77°02'30"	76°52'20"	
77°03'20"							
Population	4677	1625	1368	2982	30,343	3479	5951
Atchkat Area (Ha)	680	318	466	133.6	1321	682	321
Av. Annual Rainfall (mm)	570	889	640	702	700	711	711
Source for	Irrigation & Drinking	Irrigation & Drinking	Irrigation & Drinking	Irrigation	Irrigation	Irrigation	Irrigation

Lakes: 1. Kallambella; 2. Bugudanahalli; 3. Maidala; 4. Honnudike; 5. Kunigal; 6. Kadaba; 7. Hebbur

Diversity index = $S\text{-}1/\log_e N$

Where, S and N are total number of phytoplankton species observed and total number of phytoplankton observed respectively .

RESULTS AND DISCUSSION

The minimum and maximum values of physico-chemical parameters for the water samples are presented in Table 2. The diversity of algae found in the samples of the lakes for the month of April are given in Table 3. A total of 26 species belonging to 18 genera were identified. The phytoplankton abundance was found to be maximum in the month of April 2008, and minimum in the month of August 2008. A decreasing trend of phytoplankton was noticed from May to August, but the samples from September to November showed an increasing trend. Such observations are similar to the findings of Shastry (1992) and Sushma Das Guru (2007), who have reported two peaks of phytoplankton density, summer peak (April) and winter peak (December). The seasonal trend of total phytoplankton was found to be more in summer than in monsoon, which is similar to the reports of Verma et al. (2001).

Phytoplankton found in the lakes were represented mainly by Chlorophyceae indicating healthy water quality (Anitha Devi & Singara Charya 2007). The presence of *Microcystis* can be attributed to stagnation of water and pollution (Hujare 2008). The genus *Spirogyra* is considered to be inhabitant of unpolluted waters (Bold & Wyne 1978). Jose et al. (2008) revealed that the occurrence of some desmids like *Closterium, Cosmarium* and *Staurastrum* indicate a better water quality of the water bodies. Based on these observations, Honnudike and Hebbur lakes, though having more Chlorophyceae, may be considered as moderately polluted.

The temperature is one of the vital factors which control the abundance of phytoplankton in lentic ecosystems (Nazneen 1980). The summer maxima can be attributed to the effect of temperature and light (Sreenivasan et al. 1974, Armugon & Furtado 1980). Bharadwaja (1940) was of the opinion that temperature and light are responsible factors for higher plankton density. Generally, different planktonic species can tolerate different ranges of temperature as well as having light and nutrient limitations. These tolerance levels determine the dominance of species at different times and seasons (Fogg 1975). Minimum number of phytoplankton was normally encountered during the rainy season because of dilution effect.

The importance of pH in the distribution of phytoplankton in freshwater systems is revealed by Venkateshwaralu (1969). Many biological activities can occur only within a narrow pH range. Any variation beyond acceptable range will affect the phytoplankton density and diversity. The pH of the

Table 2: Range of physico-chemical characteristics of the seven lakes during the study period (Numbers given to lakes as per study area).

Parameters	1	2	3	4	5	6	7
Temperature, °C	27-38°C	26-36°C	27-37°C	26-38°C	26-36°C	27-38°C	26-37°C
pH	7.2-8.2	7.2-8.3	7.1-8.0	7.4-8.3	7.1-8.1	7.1-8.2	7.3-8.2
Tot Alkalinity, mg/L	162-246	52-148	83-252	84-226	72-180	114-236	128-184
DO, mg/L	5.6-9.0	6.4-8.8	4.0-7.6	5.9-8.6	7.0-8.2	5.8-8.6	3.2-5.4
Nitrate, (mg/L)	0.8-9.6	.0-5.6	0.6-6.2	2.2-10.4	2.1-5.8	0.66-7.2	1.9-7.2
Phosphate, (mg/L)	0.03-0.06	0.03-0.05	0.02-0.06	0.02-0.08	0.03-0.08	0.03-0.06	0.02-0.06

Table 3: Occurrence of phytoplankton in different lakes in the month of April 2008.

Sl. No	Name of the Species	1	2	3	4	5	6	7
1	*Staurastrum* sp.	+	+	+	-	+	+	-
2	*Scenedesmus bijugatus*	-	-	-	+	-	-	+
3	*Scenedesmus acuminatus*	-	-	-	+	-	-	+
4	*Scenedesmus quadricauda*	-	-	-	-	-	+	-
5	*Ankistrdesmus falcatus*	-	+	+	-	+	+	+
6	*Ankistrdesmus convolutus*	-	+	+	+	+	-	-
7	*Closterium* sp.	+	+	+	-	+	+	-
8	*Ulothrix* sp.	+	+	+	-	+	+	-
9	*Chlorella* sp.	+	+	+	-	+	+	-
10	*Tetraedron* sp.	+	+	+	-	+	+	-
11	*Volvox* sp.	+	+	+	-	+	-	-
12	*Cosmerium* sp.	+	+	+	-	+	+	-
13	*Cosmerium tenue*	+	+	+	-	-	-	-
14	*Spirogyra* sp.	+	+	+	-	+	+	-
15	*Synedra* sp.	-	+	-	+	-	-	+
16	*Stauroneis*	+	+	+	-	+	+	-
17	*Melosira* sp.	-	-	-	+	-	+	+
18	*Navicula* sp.	-	-	-	+	-	-	+
19	*Navicula protracta*	-	-	-	-	-	+	-
20	*Pinnularia* sp.	-	-	-	+	-	-	+
21	*Nitzschia* sp.	-	+	-	-	+	-	-
22	*Spirulina major*	+	+	+	-	+	+	-
23	*Spirulina laxa*	+	+	-	-	+	-	-
24	*Oscillatoria obscura*	+	-	-	-	-	-	-
25	*Oscillatoria* sp.	+	+	-	+	-	-	+
26	*Microcystis aeruginosa*	-	-	-	+	-	-	+

samples in the present study ranged between 7.0 and 8.4 and such a condition may be suitable for the phytoplankton growth.

Dissolved oxygen levels of the samples were maximum in monsoon. The lower DO values during summer are due to the increased rate of its utilization by phytoplankton and microorganisms at high temperature (Abdel-Aziz Radwan 2005). Aquatic systems with heavy blooms of phytoplankton exhibit wide shifts in dissolved oxygen concentrations from day to night. DO is an important parameter in water quality assessment, and reflects the physico-chemical and biological processes prevailing in water. It also affects the solubility and availability of many nutrients and, thus, has the impact on the productivity of an aquatic ecosystem (Wetzel 1983). In the present study, DO of the samples

Table 4: Diversity indices of phytoplankton of selected lakes in the month of April 2008.

Sl. No.	Name of the lake	Number of species (S)	Total number of phytoplankton N	Diversity index = S-1/1n N
1	Kallambella	14	74	3.01
2	Bugudanahalli	17	120	3.34
3	Mydala	13	50	3.07
4	Honnudike	8	200	1.32
5	Kunigal	14	70	3.06
6	Kadaba	13	61	2.92
7	Hebbur	8	110	1.49

ranged between 4.0 and 9.0 mg/L; lowest being in lake 4 for the month of April, and hence, its higher density of phytoplankton.

Higher alkalinity favours the growth of phytoplankton. In the present study high values of alkalinity of the samples were associated with high density of phytoplankton coinciding with Radwan (1994).

The essential nutrients for algal growth are nitrates and phosphates. The nutrient concentration normally limits the growth and production of phytoplankton (Williams 1972). Kumar (1994) pointed out that an appreciable rise of nitrate during April-May may be due to excess activity of decomposition in the water bodies. Reid & Wood (1976) have reported that an increase in nitrate concentration during October-November may be due to rainfall. In the present study, the highest phytoplankton diversity of the samples was found in November corresponding to higher concentrations of nitrate. Phosphate exhibited its inverse relation with the growth rate of planktonic organisms indicating its consumption to some extent and the results are in harmony with the findings of Patra & Azadi (1987) and Chowdhury et al. (2007).

The diversity indices of phytoplankton for the month of April 2008 are presented in Table 4. The results of the samples have revealed that the lakes 4 and 7 are moderately polluted and the rest of the lakes are less or non-polluted in this month.

CONCLUSION

The species belonging to Chlorophyceae are dominant in all the samples of selected lakes throughout the study period. The pollution tolerant species found in lakes 4 and 7 may be due to the stagnation of waters for most of the period and limited water recharges. Based on diversity indices of the samples all the lakes can be categorized as non-polluted except Honnudike and Hebbur lakes which are moderately polluted.

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