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Phytoplankton Population of Ananthapura Temple Lake of Kasaragod, Kerala

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Abstract: Background: Diversity indices are used to characterize species abundance relationships in plankton communities. Diversity and abundance of phytoplankton with some physicochemicals of pond water of Temple Lake in Kasaragod district have been studied during January to July 2010. **Aim of the study:** This study was designed to examine some of the seasonal influences of water quality on phytoplankton and to give base-line conditions for assessment of future change and algal biodiversity in the lake. **Result:** A total of 38 phytoplankton genera, 8 belonging to cyanophyceae, 15 to chlorophyceae, 12 to bacillariophyceae and 3 to euglenophyceae were recorded. Temple located barren land, which exert early absorbed temperature at night. The temperature increased in the month of May. High rain fall (421 mm) and other chemical factors such as DO (dissolved oxygen), BOD (biological oxygen demand), free CO_2, TDS (total dissolved solids) and nitrate content values were maximum in summer months and sudden decline in the month of June and July, which may be due to heavy monsoon. Nine diversity indices study shows that, the lake has high diversity with oligo-mesotrophic condition. The PCA biplot of 15 environmental variables of different months and correlation between phytoplankton populations with other parameters were studied. **Conclusion:** The present studied lake has greater the diversity, less is the impact of environmental pollution; while lesser the diversity greater is the impact of pollution.

Key words: Temple lake, physicochemical conditions, plankton population, trophic status, diversity indices

INTRODUCTION

Interestingly Ananthapura is the only lake temple in Kasargod district of Kerala state, though surrounded by barren land all around. It is truely amazing to see a lake and Ananthapura temple in the middle, which is said to be the 'Moolasthanam' (Shrine) of the Ananthapadmanabha Swami (Sri Padmanabha Swami Temple) of Thiruvananthapuram (Head of Kerala). Local tradition has it that Ananthapadmanabha of Thiruvananthapuram had settled down here originally. During the monsoon season, from the barren land water come to the lake and water volume had increased up to the door level of the temple. The lake water is used for irrigation, domestic and temple purpose. The waste material of after pooja, which contains milk, ghee, ash, turmeric water, curd, prasadam and naivedyam of crocodile food, these were the only polluting material comes from temple to lake. Virtually all the dynamic features of lakes such as colour, clarity, trophic state, zooplankton and fish production depend to a large degree on the phytoplankton (Goldman and Horne, 1983). The growth of phytoplankton is regulated by various physical and chemical factors (Komarkova and Hejzlar, 1996; Naselli-Flores and Barone, 2000). The phytoplankton investigation by Kotut *et al.* (1998) revealed that the seasonal changes in phytoplankton biomass, diversity, composition and primary production were mainly influenced by seasonal changes. Diversity of freshwater planktons are based on the fact that interactions in the planktonic environment are highly complex. Ecologists have designed a large range of indices and models for measuring diversity and yet diversity is so hard to define (Maguran, 1983). This is because diversity consist of two components, firstly the variety and second the relative abundance of species. Diversity measures are more useful tool in aquatic ecosystem, which measure a large variety of algal species in general and species diversity within the genera. Generally, seasonal variations in the dynamics of the composition and productivity of phytoplankton population have been shown to depend largely on nutrient concentrations, on the degree of mixing due to turbulence and interactions in food webs (Rhew *et al*., 1999). In large shallow lakes and ponds, physical and chemical factors, mainly wind-driven sediment resuspension and eutrophication levels, are considered more important to influence phytoplankton population (Wu *et al*., 2007). It was recognized early on that phytoplankton composition change with increasing levels of nutrients. Unfortunately no data available on the physicochemical and biological conditions of the Ananthapura temple lake, which led us to design the

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present study. This study was designed to examine some of the seasonal influences of water quality on phytoplankton and to give base-line conditions for assessment of future change and algal biodiversity in the lake. Results of routine monthly sampling of water chemistry and phytoplankton over seven months are reported.

MATERIALS AND METHODS

Monthly samplings were carried out in Temple lake of Ananthapura, Kerala (Fig. 1) from January-July 2010. The pond size is 42×27×3.5 m length, width and depth, respectively. Pond was received direct sunlight. The procedure for collection, storage and analysis of water samples were followed as described in standard methods (APHA, 1998).

Different sites of pond were visited monthly for a period of (January-July 2010) seven months to study the various ecological parameters such as water temperature, Rain fall, pH, dissolved oxygen, biological oxygen demand, chemical oxygen demand, free carbon dioxide, total alkalinity, total dissolved solids, chloride, silicate, nitrate and phosphate. Collections were made using plastic containers of 2 L capacity. The plastic containers rinsed thoroughly with sampling water before using them. After filling the containers they were sealed and transferred to the laboratory for the estimation of various physicochemical parameters by following standard methods (APHA, 1998).

Water temperature of the lake was recorded on the spot with an ordinary glass mercury thermometer calibrated to tens of a degree centigrade. The hydrogen ion concentration (pH) was measured using pH meter (Elico 120 I). Water samples were taken carefully into 300 mL BOD bottles avoiding air bubbles. The samples collected were fixed separately by using Winkler's method in the field itself for estimation of dissolved oxygen, further estimation was carried out in laboratory with winkler's modified method and the result has been expressed in mg L^{-1} (Viessman and Hammer, 2000).

Carbon dioxide (CO_2) was estimated by titrating samples against sodium hydroxide using phenolphthalein as an indicator. Total alkalinity of the samples was estimated by titrating against sulphuric acid using phenolphthalein and methyl orange as indicators to establish the end point. Total dissolved solids of the water samples were estimated by evaporation method and expressed in mg L^{-1}. Phosphate (PO_4-P) and silicate were measured by APHA (1998).

The phytoplankton samples were collected from the sites using plankton silk net cloth and were fixed with Lugol's iodine solution. Phytoplankton samples were also fixed in 4% formaldehyde solution for proper identification

Fig. 1: Map of the Temple Lake Ananthapura

in the laboratory. Identification of various taxa was done by using the taxonomic keys given in Prescott (1973), Desikachary (1959), Philipose (1967) and John *et al.* (2002). Identification and enumeration were done by a binocular microscope (Nikon Eclipse E 200) and the frequency of phytoplankton species was determined by heamocytometer, based on the percent occurrence of an individual species. The algae were expressed as organisms per ml for the purpose of calculating diversity indices. The data were subjected to a software program PAST (Hammer *et al.*, 2001) which generates nine diversity indices. The formula designed for various index are described below. Dominance index = 1-J, J is evenness of relative diversity (H'/H_{max}) where absolute evenness = 1.00. The Shannon Weiner index (H') assumes all species are represented, sample randomized' = Σpi in pi; pi = proportion of the ith species and natural logarithm. The Simpson (1949) is calculated as Ds = Σ (ni (ni-1/N (n-1) where Ds = Bias corrected from Simpson index, n1 is number of individuals of species 1, N = total number of species in community. As diversity increases index value gets smaller. Pielou (1975) measures equitability and compares the observed Shannon Weiner index against the distribution of individuals between the observed species that would maximize diversity. The index is expressed as J = H'/log(S). Menchinick's index Dmm (Whittaker, 1977) is expressed as Dmm = S/N. Margalef (1968) is expressed as D = (S-1)/In N. The Shannon Equitability index (EH) = H/H_{max} = H/In. The Fisher α index is a parametric index of diversity which assumes that the abundance of species follow the log series distribution. The Berger-Parker Dominance Index is a simple measures of the numerical importance of the most abundant species and is expressed d= Nmax/N.

RESULTS AND DISCUSSION

Physicochemical conditions of the temple lake are shown in Fig. 2a-o. The water temperature of the lake was ranging from 21.8-29.6°C. Maximum temperature was observed during the month of May and minimum in February (Fig. 2a). High rainfall was observed during the month of June and July (Fig. 2b). Generally, surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling (Desai, 1992; Arthur, 2000). Alkaline nature of the study lake was indicated by pH value, maximum values were observed during the month of May (8.4) and it was declined in July (7.06) (Fig. 2c). Fluctuations in pH values during different seasons of the year are attributed to factors like removal of carbon dioxide by photosynthesis through bi-carbonate degradation, temperature and decomposition of organic matter (Upadhyay, 1988). The arrivals of monsoon in June reduce the pH of water and the complete effect of monsoon make pH level very low during the month of July. Similar result was observed that, low value of pH for surface and bottom water during monsoon (Kaushik and Saksena, 1999; Shastree, 1991). Greater inflow of monsoon rain water from barren rocky land make high volume of water in lake. Dissolved oxygen is a very important parameter of water quality and an index of physical and biological process going on in water. Dissolved oxygen content was fluctuated, the highest value recorded in July (7.52 mg L^{-1}) and lowest value recorded in the month of May (4.0 mg L^{-1}) (Fig. 2d). In Kerala, south west monsoon starts towards the end of May or the beginning of June, due to this heavy rainfall, this favours the solubility of good amount of oxygen in the water. Concentration of DO is one of the most important parameter to indicate water purity and to determine the distribution and abundance of various algal groups. The maximum values of BOD recorded during the month of May (6.2 mg L^{-1}) and it had declined from monsoon (Seenayya, 1971). The minimum concentration was observed in the month of January (1.2 mg L^{-1}) (Fig. 2e). Similar observations were made by Rahman (1992), Sunkad (2002) and Hujare (2005) in their studies. Carbon dioxide is one of the essential constituents of an aquatic ecosystem. The abundance of carbon dioxide exerts certain specific effects on aquatic biota. The temple lake exhibited maximum CO_2 as 22.0 mg L^{-1} during the month of May, whereas the minimum concentration was (6.8 mg L^{-1}) recorded during April (Fig. 2g). Cole (1975) noted that free CO_2 supply rarely limits the growth of phytoplankton. Alternately, the bicarbonates are utilized as a source of carbon by the photosynthetic activity of phytoplankton.

Total alkalinity of the study pond ranged from 26 mg L^{-1} (January) to 60 mg L^{-1} (May) (Fig. 2h). Michael (1969), alkalinity concentration is effected directly by rainfall. In the present investigation also alkalinity level reduced in the post rainy months. Higher level of alkalinity during summer season has been reported by Singh and Saha (1987). Total dissolved solids values ranged from 48 mg L^{-1} (July) to 137 mg L^{-1} (May) (Fig. 2i). The dissolved solids in a lake and reservoir depend on various parameters such as geological character of the water shed, rainfall and amount of surface runoff. Silicate value was low in February (7.5 mg L^{-1}); it increased in May (18.2 mg L^{-1}) (Fig. 2j). In the present study the values of nitrate ranged from 0.05 to 0.41 mg L^{-1} showing highest values in summer months (Fig. 2m). This may be due to the higher planktonic production, decaying macrophytes and concentration of nutrients get off from

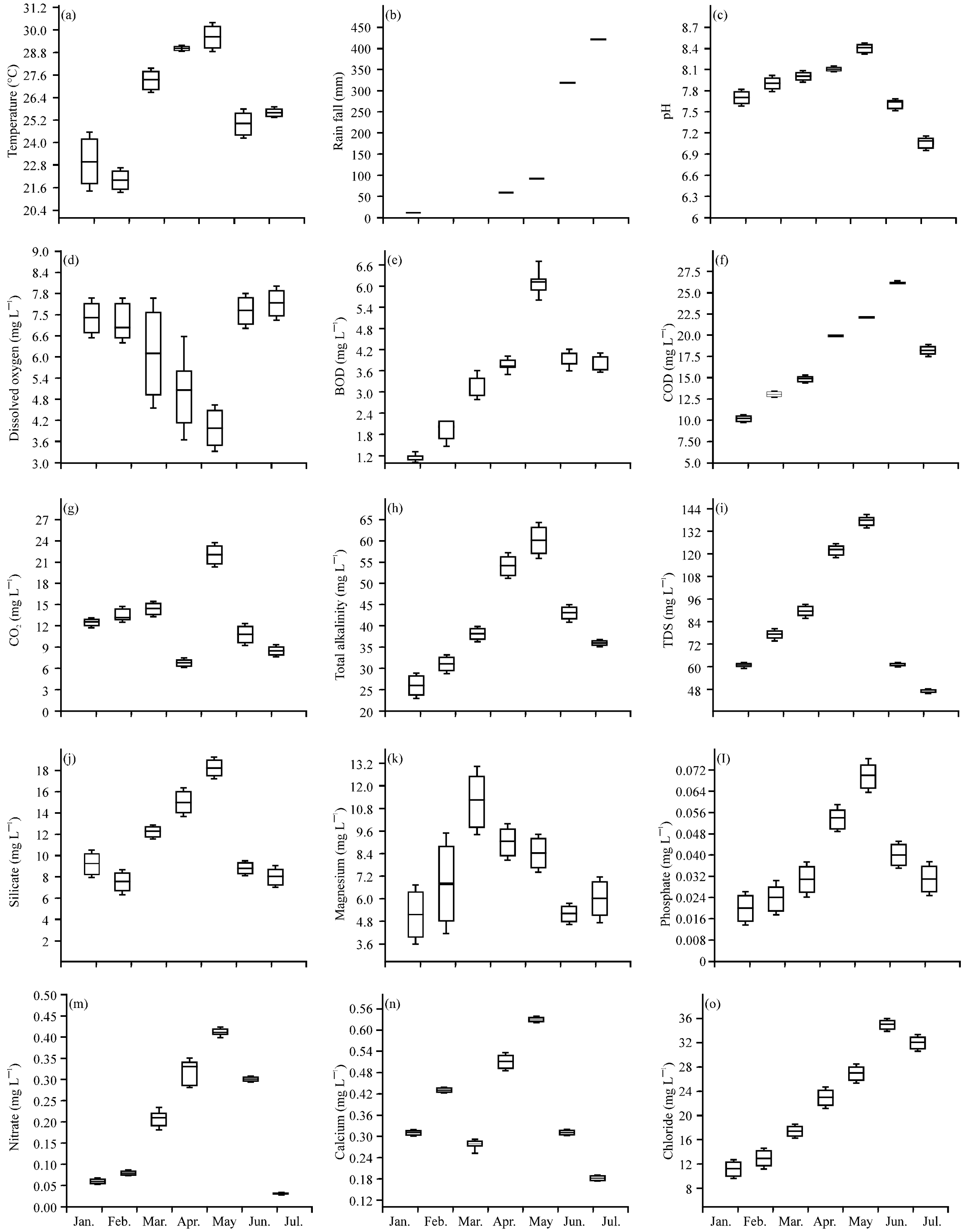

Fig. 2(a-o): Box plots showing monthly variation of different physicochemical parameters (a) Temperature, (b) Rainfall, (c) pH, (d) Dissolved oxygen, (e) BOD, (f) COD, (g) CO_2, (h) Total alkalinity, (i) TDS, (j) Silicate, (k) Magnesium, (l) Phosphate, (m) Nitrate, (n) Calcium and (o) Chloride contents of Temple Lake Ananthapura temple and other nutrients owing to the evaporation of lake water with subsequent increase in nitrate value (Epistein, 1972). Low level of nitrate may be due to the utilization of phytopolankton for their luxuriant growth. The amount of calcium was varied in all months, the highest calcium amount present during the month of May (Fig. 2n). Chloride values were found ranging from 11.2 to 35 mg L^{-1} (Fig. 2o) of which maximum value was noticed in the month of June and minimum value in January may be due to dilution effect of post monsoon period (Chourasia and Adoni, 1985). The amount of phosphate on lake water was observed probably due to the presence and decomposition of aquatic vegetation which release phosphate. Phosphate was found only in smaller amount, the low concentration of phosphate affects the growth of aquatic flora as it is very essential plant nutrient. The concentration of phosphate was more in the month of May (0.07 mg L^{-1}) and less in the month of January (0.02 mg L^{-1}) (Fig. 2l). The estimation of COD is great importance for waters having unfavorable conditions for the growth of microorganisms; it measures pollution in aquatic ecosystem (Saxena, 1994). COD value of pond water ranged from 10.2 to 26.2 mg L^{-1} (Fig. 2f). Higher concentration of COD in summer and rainy season may be due to high temperature and higher concentration of dissolved solids.

The distribution of species indicates that the lake has highest (29) number during the month of February and June, least distribution was (21) during the month of April (Table 1). Chlorophyceae were represented in higher numbers. Gonzalves and Joshi (1964) observed maximum chlorococcales during summer months. The important

Table 1: Phytoplankton population distribution during the study period (cells mL^{-1})

	Months						
Phytoplankton	Jan.	Feb.	Mar.	Apr.	May	June	July
Cyanophyceae							
Anabaena aequalis	6	3	2	8	6	2	14
Aphanacapsa delicatissima	0	0	0	0	1	3	2
Chlorococcus sp.	4	6	7	1	3	9	5
Lyngbya aesturarii	9	11	14	22	19	9	10
Microcystis aeruginosa	0	0	0	0	6	4	1
Merismopedia glauca	0	0	2	3	1	6	4
Oscillatoria angusta	2	3	8	2	9	12	5
Spirulina sp.	0	0	0	0	1	1	0
Chlorophyceae							
Ankistrodesmus falcatus	12	14	17	21	23	11	9
Chlorella vulgaris	9	4	0	11	19	26	15
Closterium sphaericum	0	2	0	0	6	3	1
Closterium acerosum	0	6	2	3	8	11	9
Cosmarium contractum	0	1	2	2	3	2	1
Cosmarium lundelli	0	0	1	2	0	1	2
Euastrum spinulosum	0	2	0	1	0	4	0
Oocystis elliptica	0	2	0	0	5	7	4
Pediastrum duplex	1	2	0	0	1	2	0
Pediastrum simplex	0	4	7	6	0	1	2
Pediastrum leonensis	7	2	4	6	12	5	19
Scenedesmus dimorphus	2	5	2	3	7	14	3
Scenedesmus quadricauda	6	11	5	2	8	4	1
Tetraedon muticum	10	3	4	8	2	3	0
Zygnema sp.	0	2	1	0	4	7	3
Bacillariophyceae							
Amphipleura	4	1	1	2	0	0	0
Cymbella verticosa	11	3	0	0	0	5	2
Cyclotella sp.	5	3	0	0	0	0	0
Diatoma vulgare	6	4	0	0	0	0	0
Gomphonema acuminatum	2	2	1	0	0	0	1
Fragilaria sp.	9	4	0	0	0	5	3
Navicula viridula	1	2	0	0	1	0	0
Navicula membranacea	0	2	3	7	1	6	9
Nitzschia bilobata	4	7	2	0	2	0	0
Nitzschia sigmoidia	6	4	1	0	0	0	0
Pinnularia viridis	18	12	7	3	0	0	0
Synedra ulna	2	0	3	9	7	6	4
Euglenophyceae							
Euglena acus	0	0	0	0	6	3	0
Euglena gracilis	0	0	0	0	3	0	0
Phacus sp.	0	0	1	4	11	14	3

factors responsible for the formation of blue green algae forms than euglenoids were increased oxidable organic matter, CO_2, phosphate and calcium (Ramaswamy and Somashekar, 1982). The genera belonging to class Bacillariophyceae attained their maximum development during the month of January and February and low or totally absent in some months like April and May due to their inability to sustain higher temperature and they might have produced autotoxin resulting their abrupt disappearance. In the present study euglenophyceae were poorly represented probably due to low carbon dioxide in waters.

Table 2 shows phytoplankton diversity indices of lake Ananthapura during the study period. The dominance index in the present study lake the highest dominance of planktonic species was found during the month of April (0.09) and least in the month of February (0.05). The genera *Ankistrodesmus*, *Chlorella* and *Scenedesmus* were the dominant forms in chlorophyceae throughout the study, whereas *Lyngbya*, *Pediastrum* and *Synedra* were found to be the other subdominant forms. The Simpsons index is often used to quantify the biodiversity of habitats. It takes into account the number of species present as well as the abundance of species. The greater the value greater is the sample diversity. According to the Simpson's index, species are not evenly distributed the values range from 0.90 to 0.94 (Table 2).

Shannon and Weiner (1949) represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. This index also determines the pollution status of a water body. Normal values range from 0-4. Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, 1-3 are moderate pollution and value less than 1 are characterized as heavily polluted. According to this index during the month of February (3.1), the value was indicates that the lake more diversity, the members like *Cyclotella*, *Navicula* sp. and *Ankistrodesmus* sp. were considered as the indicators of clean water. Whereas during the month April (2.5) the value showed less diversity.

Both the Menhinick's and Magalef's indices measures richness of species in an ecosystem. Menhinick's index was low (1.86) in the month of January and reaches high values in the month of May (2.57). Similarly Margalef's index shows higher value (5.78) was during the month of April and lower value was during the month of (4.13) January (Table 2). The Shannon equitability index is a measure of the evenness with which individuals are divided among the taxa present. In the present study which indicates that individuals of the community in all the months were not evenly distributed with value range 0.87 to 0.92.

Fisher *et al*. (1943) is a mathematical calculation for determining diversity within a population. It describes the mathematical relationship between the number of species and the number of individuals of those species. The index was very low in the month of April (7.1) and was highest during the month of February (11.7), it indicates that abundance of species in the month of February. Berger Parkar dominance index (1970) is the number of individuals in the dominant taxon divided by number of individuals (n). It is the largest species proportion of all species in a community. This index is most strongly influenced by evenness of the indices (Shannon and Weiner, 1949). The highest value was observed in the month of April (0.18) and lowest value was observed in the month of February (0.11).

The Pielou (1975) states that species evenness is diversity index, a measure of diversity that quantifies how equal the community is numerically. The index E is a constraint between 0 and 1. Frequent variation in communities between the species, the higher the values of E. Various diversity measures have potential application in aquatic ecosystems, mainly in conservation. It is often understood that species rich communities.

Maximum abundance and diversity of Cyanophyceae (*Anabaena*; *Oscillatoria* and *Lyngbya*) and euglenophyceae (*Euglena* and *Phacus*) were recorded in the months of April and May when phosphate and BOD values were highest, indicating that the study lake were rich in nutrients in those months. Chlorophyceae genera

Table 2: Phytoplankton diversity indices of lake Ananthapura during the study period

Indices	Jan.	Feb.	Mar.	Apr.	May	June	July
Taxa_S	22	29	23	21	27	29	25
Individuals	136	127	97	126	175	186	132
Dominance index	0.07	0.055	0.08	0.09	0.07	0.06	0.07
Simpson index	0.93	0.94	0.91	0.90	0.93	0.94	0.92
Shannon index	2.80	3.10	2.70	2.50	2.90	3.00	2.80
Pielou's index	0.80	0.77	0.68	0.69	0.69	0.75	0.69
Menhinick's index	1.86	1.87	2.33	2.04	2.57	2.12	2.17
Margalef's index	4.13	4.27	4.80	5.78	5.03	5.35	4.91
Equitability index	0.92	0.92	0.87	0.87	0.89	0.91	0.88
Fisher's alpha index	7.40	11.7	9.50	7.10	8.90	9.60	9.10
Berger-Parker index	0.13	0.11	0.17	0.18	0.13	0.13	0.14

Table 3: Simple correlation coefficient test between phytoplankton groups and physicochemical parameters of Ananthapura temple lake

	Temp.	Rain	pH	DO	BOD	COD	CO_2	TA	TDS	SIO_4	Mg	PO_4	NO_3	Ca	Cl
Temp.	1														
Rain	-0.039	1													
pH	0.563	-0.740	1												
DO	-0.737	0.475	-0.895**	1											
BOD	0.818*	0.357	0.324	-0.617	1										
COD	0.535	0.580	0.070	-0.211	0.789*	1									
CO_2	0.236	-0.365	0.613	-0.681	0.387	0.006	1								
TA	0.903**	0.063	0.591	-0.775*	0.885**	0.731	0.288	1							
TDS	0.810*	-0.481	0.902**	-0.962**	0.592	0.276	0.475	0.835*	1						
SIO_4	0.915**	-0.318	0.792*	-0.919**	0.706	0.350	0.489	0.870*	0.943**	1					
Mg	0.668	-0.488	0.606	-0.605	0.359	-0.026	0.243	0.431	0.651	0.613	1				
PO_4	0.871*	0.051	0.607	-0.810*	0.883**	0.696	0.389	0.987**	0.838*	0.887**	0.356	1			
NO_3	0.821*	-0.106	0.716	-0.737	0.760*	0.723	0.366	0.915**	0.808*	0.828*	0.428	0.898**	1		
Ca	0.538	-0.476	0.872*	-0.898**	0.445	0.250	0.533	0.725	0.900**	0.780*	0.309	0.768*	0.720	1	
Cl	0.382	0.864*	-0.319	0.065	0.721	0.899**	-0.151	0.517	-0.035	0.115	-0.188	0.489	0.403	-0.090	1
CYN	0.638*	0.655*	0.001	0.513	0.910**	0.929**	0.121	0.737	0.273	0.427	0.081	0.718	0.647	0.159	0.934**
CHL	0.755*	-0.398	-0.176	0.427	-0.901**	-0.747	-0.126	-0.759*	-0.454	-0.519	-0.519	-0.694	-0.625	-0.213	-0.719
BAC	0.337	0.530*	0.109	-0.277	-0.726*	0.892**	0.280	0.642*	0.246	0.302	-0.278	-0.675*	0.631	0.386	0.791*
EUG	0.494	0.345	0.313	-0.551	0.788*	0.844*	0.480	0.716	0.403	0.502	-0.098	0.761*	0.767*	0.476	0.688

Temp.:Temperature, DO: Dissolved oxygen, BOD: Biological oxygen demand, COD: Chemical oxygen demand, CO_2: Carbon dioxide, TA: Total alkalinity, TDS: Total dissolved solids, SIO_4: Silicate, Mg: Magnesium, PO_4: Phosphate, NO_3: Nitrate, Ca: Calcium, Cl: Chloride, CYN: Cyanophyceae, CHL: Chlorophyceae, BAC: Bacillariophyceae, EUG: Euglenophyceae, *Correlation is significant at 0.05 level (2-tailed), **Correlation is significant at 0.01 level (2-tailed)

were rare in the months of April and May. Phytoplankton population in Ananthapura Temple Lake was found to be maximum during summer; moderate during winter and minimum during monsoon due to heavy rain (Saify *et al.*, 1986; Sunkad, 2002; Hujare, 2005).

The PCA biplot of axis 1 against axis 2 derived from 15 environmental variables of different months were studied. Figure 3 shows that the first axis was highly correlated with, nitrate, silicate and TDS, to a lesser extent, calcium, magnesium and pH. Therefore, this axis contrasts high nitrate and silicate season, e.g., April and May on the right of the diagram, with low nutrients in January and February, on the left of the diagram. Axis 2 was strongly correlated with the rain fall, COD and chloride, contrasting nutrient rich month, e.g., June at the top of the diagram, with nutrient poor months e.g., January, February at the bottom. Mg_2, pH and CO_2 appeared to be negatively correlated with axis 2. The difference in the relative size of axis 1 and axis 2 were small (eigenvalues 9.0 and 3.7, respectively).

The simple correlation coefficient test (Table 3) revealed that the cyanophyceae member was positively correlated with temperature (r = 0.638), phosphate (r = 0.718), nitrate (r = 0.647) biological oxygen demand (BOD; r = 0.910), chemical oxygen demand (COD; r = 0.929) and chloride (r = 0.934) at 0.01 significant level. Whereas it was negatively correlated with DO (r = -0.512). Natural factors like alkalinity, nitrate, phosphate are responsible for the luxuriant growth of cyanophyceae which in turn attributed abundance of cyanophyceae to higher values of pH, temperature, nitrate, phosphate (Michael, 1969). Microcystis are found in polluted waters

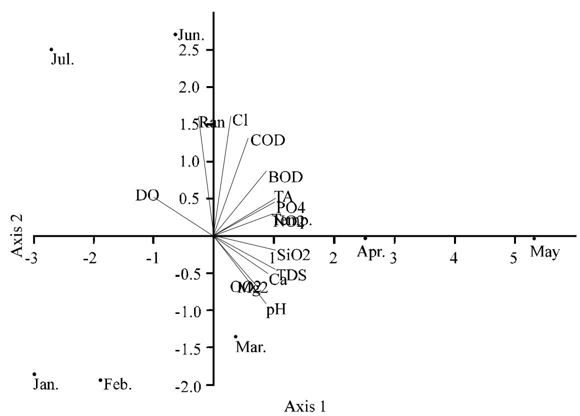

Fig. 3: PCA biplot of physicochemical variables of temple lake Ananthapura

producing obnoxious odours as well as toxins. In the present study, very less population of these genera was observed indicating that the water is free from pollution. The chlorophyceae members were positive correlation with temperature (r = 0.755), Dissolved Oxygen (DO; r = 0.527) whereas it was negatively correlated with BOD (r = -0.901), Total Alkalinity (TA; r = -0.759) at 0.05 and 0.01 level of significant during the study period (Table 3). In the present study the Mg_2 content in lake was found between 5.15 to 11.2 mg L^{-1} (Fig. 2k) which may have inhibited the growth of desmids.

Bacillariophyceae members have been considered to be the best indicators of quality and trophic status of the water. They were positively correlated with rainfall (r = 0.530), COD (r = 0.892), TA (r = 0.642) and chloride (r = 0.791) at 0.05 and 0.01 significant level. Whereas, it was negatively correlated with BOD (r = -0.726) and PO4 (r = -0.675) at 0.01 level of significant. Maximum bacillariophyceae population during rainy and winter season was reported by Sunkad (2002). Euglenophyceae were positively correlated with BOD (r = 0.788), COD (r = 0.844), phosphate (r = 0.761) and nitrate (r = 0.767) at 0.05 significant level. Whereas it was negatively correlated with DO (r = -0.551) at 0.05 significant level (Table 3). High level of phosphate and nitrate are influence the growth of euglenophyceae. In the present study the population of Euglenophyceae was very less compared to all other forms.

CONCLUSION

In conclusion, the present study revealed that the Ananthapura Lake is of a better quality, although there is a need to continuous monitoring for drinking, irrigation and other purposes. The distribution and population diversity of phytoplankton species depend upon the physicochemical factors of the environment. The nine diversity indices explained that the lake showed low level of pollution with high diversity and presence of different species. So greater the diversity, less is the impact of environmental pollution; while lesser the diversity greater is the impact of pollution.

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