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Phytoplankton Diversity Indices and Seasonal Variations of Koramagudda Kere in Lakkavalli Range of Bhadra Wild life Sanctuary Karnataka

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Abstract
This present paper deals with analysis of phytoplankton diversity indices and seasonal variations in koramagudda kere of lakkavalli range of bhadra wild life sanctuary for a period of 2 years from 2007 - 2009. Phytoplankton population composed of 4 major groups' viz., chlorophyceae, bacillariophyceae, cyanophyceae and euglenophyceae. A total of 26 genera and 40 species of phytoplankton were recorded. Similarly insignificant correlation was observed .the various diversity indices have revealed different values the shannon-weiner diversity index reveals the highest index value (1.219). The shannon's equitability index was also followed the similar pattern (4.688). The simpson's equitability index also follows the same pattern of simpson diversity index.

Key words: *diversity, seasonal, phytoplankton, bhadra*

Introduction

Wetlands hold high density of phyto and zoo plankters, which form the food for other animals. Hence they form an important baseline link of the food chain in the wetland ecosystem. Plankton as both producers and consumers play an important role in transformation of energy from lower to higher trophic level. Plankton population in small water bodies are subjected to extreme fluctuations (Hosetti, 2002). Quantity of potable water is as important as its quality. Planktonic studies are very useful tools for the assessment of water quality in any type of water-body and also contribute to an understanding of the basic nature and general economy of the wetland.

Phytoplankton's are ecologically significant as they form the basic link in the food chain of all aquatic animals (Mishra et al., 2001). The number and species of phytoplankton serves to determine the quality of a water body. The structure of aquatic communities is important in monitoring the water quality. Plankton is strongly influenced by certain non-biological aspects of water quality such as pH, colour, taste and odour (Nagarathna and Hosmani, 2002). Phytoplankton, which includes green algae, blue-green algae, diatoms, desmids, euglenoids, etc., is important among the aquatic flora. They are of greater importance as they form the basic link in the food chain of all aquatic animals, these organisms along with other aquatic and terrestrial plants make up biodiversity and also sustain life by providing food, shelter, oxygen and play a fundamental role in regulating global climate (Dwivedi and Pandey, 2002). The planktonic community occupies an important position in the aquatic world for their indispensable role in the ecosystem, small or microscopic in the size; their absence might lead the entire life process to a halt. The plant originated plankton (Phytoplankton) play the vital role in synthesizing the light energy with the utilization of carbon dioxide and water into food. Generally different planktonic species can tolerate different ranges of temperature as well as having light and nutrient limitations. These tolerance levels determine the dominance species at different localities and seasons. In a multi-species algal community, the growth among different species is likely to be limited by the resources, including different nutrients (Wetzel and Likens, 2001). Physico-chemical characteristics of water play a significant role in determining abundance and periodicity of plankton. Environmental factors such as temperature, pH and proper supply of oxygen, CO2 and essential elements like nitrate, phosphate and chloride influence plankton diversity and density (Ahmed and Singh, 1993).Recently, many workers have published their work of aquatic ecosystem and ecology of phytoplankton in fresh water (Sirsat *et al.*, 2004; Pandey *et al.*, 2006 and Pawar *et al.*, 2006). Diversity of plankton population is fairly dependent on quality of water and climatic factors. Various physico-chemical and biological characteristics must be simultaneously taken into consideration for understanding the fluctuations of plankton population (Davis, 1955). Therefore the present investigation attempts to present the bench mark information on phytoplankton seasonal variations and Diversity indices.

Materials and Methods

The study was carried out in Lakkavalli range of Bhadra Wildlife Sanctuary, consisting an area of 223.17 km2 (13° 34' to 13° 46' N and 75° 29' to 75° 45' E) in the Karnataka state of Southern India. The altitude varies from 650 to 1875 m above sea level

(masl) with a general elevation of 1200-1500 m. The sanctuary is located in the Malnad region of Karnataka about 50 km to the east of Western Ghats. The temperature in the valley ranges from 9-35°C. The region receives an annual rainfall of 1600 to 2000 mm during the southwest monsoon between June and September (Sathisha 2007). A distinct rainfall gradient results in a variation in vegetation types from semi-evergreen forest and moist deciduous forest through dry deciduous forest shoals and grassland type forest. It supports more than 19 waterholes that support a diversity of species including plants, animals, phytoplankton, many microorganisms and macro invertebrates and vertebrates which are endemic. In view of this we have selected, Koramagudda kere that lies in (13° 37' 173" N and 75° 39' 095" E)(Map-1&2) and as a result PhytoPlankton Diversity and Seasonal Variations was made over a period of two years.

Collection of Plankton samples

For qualitative and quantitative analysis of phytoplankton one liter of composite water samples at surface level were collected at interval of 30 days one liter of sample was fixed with 20 ml of percent Lugol's iodine solution and kept 24 hours for sedimentation. 100 ml of sample is subjected to centrifugation at 1500 rpm for 20 minutes and used for further investigation. Identification of plankton up to species level was done by referring standard manual Smith (1950), Patrick and Reimer (1966), Prescot (1962) and APHA (2005). Quantitative estimation of phytoplankton was done using by a Sedgewick Rafter counting cell.

Data Analysis

The data were subjected to detail analysis.

Species richness (S): Total number of species in the study area.

Simpson's diversity index (D): This index represents the abundance ratio of individual species to that of total abundance values. It was calculated using the following formula

$D = 1/\sum pi2$

Where; 'pi' is the proportion of the ith species to total abundance value.

Simpson's equitability index (E): The chance of occurrence of individual species in one sample can be understood using this index, calculated using the formula

$E = D/S$

Where; 'D' is the Simpson's diversity index and 'S' is the species richness.

Shannon-Wiener's diversity index (H'): This index value was calculated by using the formula

$H' = - \sum pilnpi$

Where; pi is the proportion of the ith species to total abundance value.

Shannon-Wiener's equitability index (J): It was calculated using the formula

$J = H'/lnS$

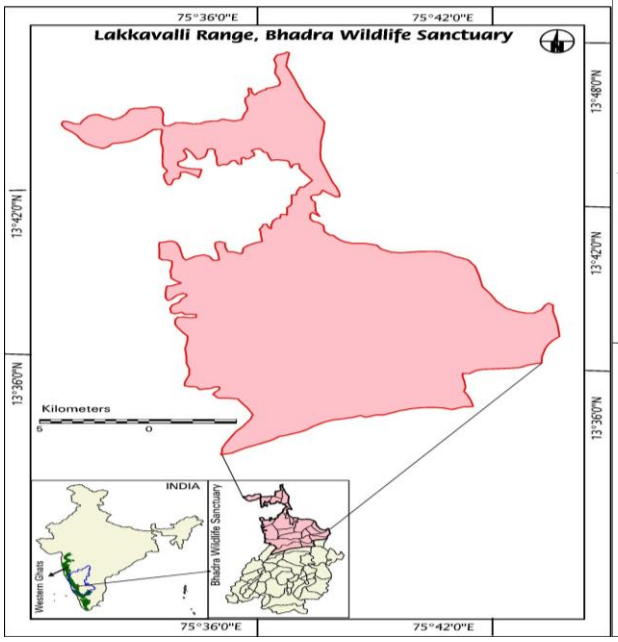

Fig 1. Location of the study area

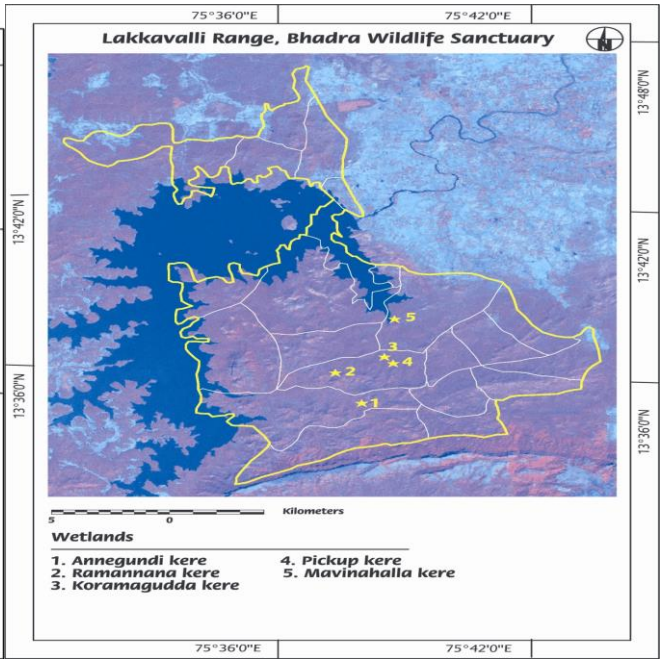

Fig 2. Satellite imagery of the selected wetlands in the study area

Results and Discussion

Phytoplankton belongs to highly diverse group of photoautotrophic organisms and forms the base of most of the wetland food webs. They are ecologically significant as they form the basic link in the food-chain of all aquatic animals (Misra et al., 2001). The plankton study is very important tool for the assessment of biotic potential and contributes to overall estimation of basic nature and general economic potential of a water body (Pawar et al., 2006). Like other communities in water, the phytoplankton are sensitive to environmental changes and their spatial and temporal distribution is governed by a number of environmental factors. The salinity and ionic composition of water are the most striking key factors regulating the community including the phytoplankton. Researchers like Ashutosh Mishra et al. (2003), Dilip Rathore et al. (2006) have studied the phytoplankton in different water bodies and reported that, it is easier to evaluate the periodicity and distribution of individual groups together. Therefore, in the present study individual phytoplankton groups have been considered independently. During the present investigation, phytoplankton population in Koramagudda kere of Lakkavalli range of BWS composed of 4 major groups viz., Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. A total of 26 genera and 40 species of phytoplankton were recorded (Table .1 to 4).

Chlorophyceae:

The Chlorophyceae, occur in fresh cold water where they seem to have their majority evolution. They either form greenish scum on the surface of stagnant or quiet water or grow firmly attached to the submerged rock, pieces of wood and other objects in water. Francis (2001) have recorded chlorophyceae, in the water bodies that they have studied and attributed the same to the temperature of water. They were of the opinion that, low range of temperature does not support the Chlorophyceae. In the present observation, water temperature ranged between 20 to 34ºC. High atmospheric or water temperature along with the bright sunshine to be an important factor in the periodicity of Chlorophyceae, which have been supported by Gupta et al. (2003). A total of 10 genera and 21 species of Chlorophyceae, have been recorded in this wetland. The diversity of Chlorophyceae, include, Cosmarium, Cloestrium, Desmidum Euastrum, Micrasterias, Pediastrum, Spirogyra, Staurastrum, Ulothrix and Zygnema. Seasonally, maximum density recorded during pre-monsoon season and minimum density recorded during post-monsoon season (Table .1).

Bacillariophyceae:-

Bacillariophyceae constitute an important part of fresh water or marine plankton, which forms the basic food of the aquatic animals and possesses chlorophyll a and c. The pattern of distribution of Bacillariophyceae is a very useful indication to the type of water in which they grow. Their occurrence controls the silica concentration in water. The ecologists have also used these to access the degree of pollution in water and other variations. The ecology of Bacillariophyceae has been studied by Pawar et al. (2006) . pH as a factor has a definite influences on the Bacillariophyceae population. Several workers like Gupta et al. (2003) have discussed the importance of water temperature in the regulation of Bacillariophyceae. They have observed an inverse relationship between temperature and Bacillariophceae population.It supported 6 genera and 9 species. The genus Navicula represented by 3 species Amphora represented by 2 species Cymbella, Diatoma, Melosira, Pinnularia and Synedra with single species each. Seasonally, maximum density recorded during pre-monsoon season and minimum density recorded during monsoon season (Table .1).

Cyanophyceae:-

Cyanophyceae are found in most of all aquatic ecosystems. They are single celled organisms and have the general tendency to organize colony of cell which may be spherical, squarish or filamentous. In the present study, Cyanophyceae were recorded in high number throughout the year but peak proliferation was found during pre-monsoon in the selected waterbodies, it is due to the sunshine which is required for their growth. Similar observation was made by Sulabha and Prakasam (2006). The significance of phosphates and nitrate in regulating the Cyanophyceae members has been discussed by Banakar et al. (2006) who conclude that Cyanophyceae increased in their population when nitrate and phosphate were low. Some researchers have also related their growth with the presence of DO. The Cyanophyceae in this wetland consists of 7 genera and 8 species the diversity of Cyanophyceae is considered, the Aphanocapsa, Anabaena appeared in two species Aphanocapsa, Arthospira, Chrococcus, Microcystis, Oscillatoria and Spirulina and recorded in one species in this wetland. Seasonally, maximum density recorded during pre-monsoon season and minimum density recorded during post-monsoon season (Table .1).

Euglenophyceae:-

This group as a whole facultative heterotrophic and generally abundant in waters rich in organic matter. Pawar et al. (2006) stated that the more concentration of CO2 and low DO favoured the growth of Euglenophyceae. The influence of carbon dioxide and dissolved oxygen on Euglenophyceae is of considerable interest. The Euglenophyceae in this wetland consists of 2 genera and 2 species. If the diversity of Euglenophceae considered, the genus Euglena is represented by 1 species followed by phacus with 1 species. Seasonally, maximum density recorded during pre-monsoon season and minimum density recorded during post-monsoon season (Table .1).

The species diversity calculated among the phytoplankton recorded in Koramagudda kere and the indices were represented in Table.2. The Shannon-Weiner diversity index reveals the highest index value (1.219). The Shannon's equitability index was also followed the similar pattern (4.688). The Simpson's equitability index also follows the same pattern of Simpson diversity index. Correlation coefficient was calculated among the phytoplankton and represented in (Table .3), insignificant correlation was observed. The ANOVA calculated revealed that, the Cladocera, Rotifera and Bacillariophyceae members have represented the

significance to ANOVA test indicating the differences among the density encountered during the study period. All other species do not exhibit the significance to the ANOVA test revealing constant encounter of the species during the study period. (Table .4).

Table 1. Seasonal variation of phytoplankton density in Koramagudda kere (O/L), 2007 to 2009

Phytoplankton	**2007 – 08**			**2008 – 09**		
	Monsoon	**Post-monsoon**	**Pre-monsoon**	**Monsoon**	**Post-monsoon**	**Pre-monsoon**
	Mean ± Sd (Min - Max)	Mean ± Sd (Min -Max)	Mean ± Sd (Min - Max)	Mean ± Sd (Min - Max)	Mean ± Sd (Min - Max)	Mean ± Sd (Min - Max)
Chlorophyceae	3069.75 ± 698.309 (2326 - 4008)	3605 ± 339.264 (3120 - 3900)	3300 ± 796.702 (2181 - 3900)	2709 ± 312.411 (2370 – 3125)	2897.5 ± 1022.949 (1500 - 3720)	3779.67 ± 524.090 (3180 - 4150)
Bacillariophyceae	1745 ± 473.231 (1290 - 2181)	2775 ± 914.567 (1880 - 3820)	3660 ± 1342.659 (2090 - 5150)	2054.25 ± 1281.496 (1151 – 3955)	3355 ± 437.912 (2900 - 3870)	3396.67 ± 471.734 (2950 - 3890)
Cyanophyceae	437.5 ± 77.082 (325 - 490)	425.5 ± 133.951 (225 - 499)	415.25 ± 73.337 (329 - 506)	346.25 ± 33.886 (298 - 376)	355.75 ± 104.749 (260 - 493)	448 ± 108.476 (325 - 530)
Euglenophyceae	145.25 ± 52.354 (98 - 200)	133.75 ± 36.473 (99 - 180)	183.75 ± 43.668 (126 - 231)	130.75 ± 29.568 (101 - 160)	141.75 ± 65.886 (85 - 225)	149.67 ± 43.616 (108 - 195)

Table 2. Species diversity indices calculated among the phytoplankton (O/L) recorded in the study sites

Diversity indices	**Koramagudda kere**
Simpson diversity index	4.688
Simpson equitability index	1.172
Shannon-Weiner diversity index	1.219
Shannon-Weiner equitability index	0.879

Table 3. Correlation coefficient of phytoplankton in Koramagudda kere

Phytoplankton	**Chlorophyceae**	**Bacillariophyceae**	**Cyanophyceae**	**Euglenophyceae**
Chlorophyceae	1	0.317	0.463	0.484
Bacillariophyceae		1	0.142	0.226
Cyanophyceae			1	0.240
Euglenophyceae				1

Table 4. One-way ANOVA calculated in Koramagudda kere

Plankton	**F**	**Sig.**
Chlorophyceae	0.054	0.820
Bacillariophyceae	50.678	**0.000***
Cyanophyceae	0.444	0.515
Euglenophyceae	0.075	0.787

***** *With bold letters indicate the significant values*

Conclusion

As the season changes there is a fluctuation in the Phytoplankton population and it composed of 4 major groups viz., Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. A total of 26 genera and 40 species of phytoplankton were recorded. Similarly insignificant correlation was observed The Various diversity indices have revealed different values for the index calculation.

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