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Evaluation of Phytoplankton Diversity and Environmental Implications of Two Lacustrine Wetlands, Located In Midland and Lowland Critical Zones of Kerala, India

Research Article

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Abstract

Current study was carried out to provide a better understanding on the species richness of phytoplankton community in two Freshwater lakes of Kerala, namely; Sasthamkotta and Vellayani located in the respective midland and lowland critical zones of Kerala, and their relationship with nutrient status. Samplings were conducted seasonally i.e., during pre-monsoon, monsoon and post monsoon seasons. Water samples were collected for nutrients analysis (TN, NO_2^-, NO_3^-, TP and PO_4^{3-}) and phytoplankton counting. The investigations showed a total of forty-two phytoplankton genera, representative of four families were identified. The nutrient concentrations in the two lake ecosystems show higher values throughout the year and the phytoplankton community show species richness. In general, increase in nutrient concentration triggered the increased diversity of phytoplankton community. This was clearly evident from the correlation analysis, there was a significant positive relationship noticed between phytoplankton community with the nutrient concentrations.

Keywords: Phytoplankton diversity; Nutrients; Freshwater lakes; Critical zone; Correlation analysis

Introduction

The sustenance of a healthy aquatic ecosystem depends on the physico-chemical and the biological diversity of the ecosystem [1]. Phytoplankton represents the microscopic algal communities which collectively accounted about half of the earth's primary producers. They act as pioneers of aquatic food chain and the productivity of an aquatic system is directly related to diversity of phytoplankton. Anthropogenic discharges into the water bodies act as an important source of the nutrients that accelerate the growth of aquatic communities and further leads to the qualitative changes of the aquatic systems [2].

The present study has been carried out to estimate the phytoplankton diversity of two fresh water lakes of Kerala, namely, Sasthamkotta and Vellayani with special reference to nutrients levels. This type of study is highly significant in Kerala, since these lakes form the source of water for public distribution systems located in the respective midland and highland critical zones of the state.

Sasthamkotta lake, is the largest fresh water lake in Kerala, which was declared as a Ramsar site of International importance and it serves as the source of drinking water for half a million people at the Kollam corporation and panchayats adjust ant to the lake. Vellayani Lake, the second largest lake of the state, situated at the outskirts of Thiruvananthapuram City. This lake is extensively used for drinking as well as irrigational purposes.

Materials and Methods

Twenty water samples were collected seasonally (pre-monsoon,

monsoon and post-monsoon) from Sasthamkotta and Vellayani lakes and the samples were analysed for various nutrients (TN, NO_2^-, NO_3^-, TP and PO_4^{3-}) following APHA [3].

Phytoplankton samplings were also carried out according to the standard methods prescribed in APHA [3]. Approximately 20lit of water from each site was filtered using plankton net with a mesh size of 60µm. The collected samples were fixed with 4% Lugol's solution. Taxonomic identification of plankton up to genus level was done using standard keys [4-7].

Results and Discussion

The various nutrients estimated in the lakes were depicted in terms of the ranges and averages (Table 1). The annual fluctuations of the percentage composition of the four major groups of phytoplankton community in Sasthamkotta and Vellayani lakes were given in (Table 2). Based on the data obtained through the analysis, correlation

Table 1: Ranges and Averages of nutrient concentrations in Vellayani and Sasthamkotta lakes during Pre-monsoon (PRM), Monsoon (MON) and Post-monsoon (PMO) seasons.

Parameters	Vellayani				Sasthamkotta			
	PRM	MON	PMO	Annual Avg.	PRM	MON	PMO	Annual Avg.
TN	1.91	2.52	2.81	2.43	1.42	1.39	2.25	2.11
NO_2^-	0.27	0.12	0.25	0.19	0.21	0.2	0.48	0.25
NO_3^-	0.48	0.32	0.41	0.42	0.29	0.24	0.35	0.29
TP	0.42	0.41	0.43	0.42	0.26	0.29	0.17	0.25
PO_4^{3-}	0.069	0.045	0.019	0.056	0.04	0.04	0.008	0.02

Table 2: Annual percentage of species diversity in vellayani and sasthamkotta lakes.

Phytoplankton Species	Vellayani			Sasthamkotta		
	Pre-monsoon	monsoon	Post- monsoon	Pre-monsoon	monsoon	Post- monsoon
Chlorophyceae						
Pediastrum simplex	29.01	30.07	43.11	43.54	56.20	76.09
Pediastrum duplex	54.22	56.20	63.23	28.9	30.07	64.5
Oedogonium sp.	71.01	77.98	81.23	3.65	4.71	19.8
Volvox sp.	23.67	25.67	29.06	1.88	2.48	6.79
Scenedesmus quadricauda	11.98	17.67	19.80	2.57	3.10	4.33
Ulothrix sp.	45.09	54.67	51.21	1.90	2.90	4.12
Staurastrum sp	3.08	3.94	4.56	2.03	3.05	5.45
Clostridium dianai	14.56	15.88	17.09	1.89	2.61	4.52
Cosmarium sp.	-	-	-	2.32	3.67	10.21
Spirogyra sp.	-	-	-	24.51	49.08	67.98
Desmidium sp.				5.87	12.33	19.88
Tetrahedron minimum	-	-	-	-	-	-
Zygnema circum carinatum	-	-	-	-	-	-
Bacillariophyceae						
Aulacoseira granulata	5.67	7.08	8.99	1.95	2.32	2.99
Gomphonema	17.66	25.67	32.44	11.19	17.66	36.09
Pinnularia biceps	43.32	44.09	46.76	53.89	55.0	56.78
Rhizosolenia eriensis	6.88	12.34	15.67	7.18	16.09	18.99
Nitzschia sp.	11.23	15.09	17.89	8.77	9.09	23.41
Cymbella aspera	8.99	13.23	17.98	6.14	12.33	14.56
Amphipleura pellucida	4.33	11.03	12.34	3.51	8.01	11.21
Cyclotella sp.	12.77	16.88	21.33	7.89	12.98	17.88
Navicula radiosa	3.22	4.41	7.97	3.51	7.33	7.88
Navicula rectangularis	2.09	2.11	4.66	8.51	10.09	10.23
Synedra formosa	3.22	4.11	5.09	2.80	4.43	9.33
Synedra acus	-	-	-	9.08	13.2	26.87
Mastogloia exilis	-	-	-	4.56	5.22	
Eunotia formica	-	-	-	2.93	4.86	3.24
Melosira granulata	-	-	-	4.66	6.79	5.23
Surirella sp.	-	-	-	4.79	5.67	5.22
Cocconeis sp.	-	-	-	1.45	6.79	2.31
Cyanophyceae						
Microcystis	5.16	6.12	11.09	3.45	3.90	4.12
Arthrospira platensis	12.01	13.45	15.94	16.99	20.05	29.77
Nostoc azollae	23.14	21.66	29.66	24.66	25.03	46.78
Anabaena	-	-	-	5.66	6.76	7.09
Gloeocapsa magma	-	-	-	-	-	-
Dinophyceae						
Peridinium sp.	13.05	11.13	20.88	13.98	4.65	25.14
Ceratium trichoceros	-	-		11.38	2.50	9.88

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study was made to find out the interrelationship between the phytoplankton density and nutrient levels in both lakes (Table 3 and 4). The annual percentage composition showed that Chlorophyceae was the most dominant group (56.43%) observed in Vellayani Lake as reported earlier by Priya, et al. in the Vellayani Lake [8]. Remarkably, in Sasthamkotta Lake, the dominant group was Bacillariophyceae (41.85%) which was observed previously by Girija, et al. [9].

A comparative evaluation was made in both lakes in terms of species diversity. Of the total 42 genera identified in the two lakes, the highest percentage of composition was observed by Oedogonium *sp*. (81.23%) in Vellayani lake during post-monsoon season and the lowest percentage was by *Cocconeis sp.* (1.45%) in Sasthamkotta lake during pre-monsoon season. According to Dumont, the water body is regarded as rich, if it contains 30-50 species. In this sense, both the lakes can be treated as rich in terms of species diversity [10].

In both lakes, it was observed that phytoplankton was abundant during post-monsoon season and the least was observed during pre-monsoon seasons. The excessive flooding was the main causative factor for the presence of a low population of phytoplanktons during monsoon [11].

Correlation analysis of Chlorophyceae, Bacillariophyceae, Cyanophyceae and Dinophyceae with the nutrients (TN, NO_2^-, NO_3^-, TP and PO_4^{2-}) of water samples from Vellayani Lake and Sasthamkotta Lake revealed that there existed a significant linkage between plankton community with nutrients, both in nitrogenous as well as phosphatic nutrients. It was very much clear from this study that the increased algal growth may be due to the increased level of nutrients. From field observations, it was noticed that artificial fish feeding due to integrated fish farming and the pesticide residues from the surrounding agricultural lands resulted in the accumulation of nutrients in the lake systems. The presence of *Microcystis* sp. in both lakes indicates the signs of nutrient enrichment.

Table 3: Correlation matrix of Phytoplankton density along with nutrient status of Vellayani Lake.

	TN	NO_2	NO_3	TP	PO_4	Chloro.	Bacillario.	Cyano.	Dino.
TN	1.000								
NO_2	0.203								
NO_3	0.080	0.801**	1.000						
TP	0.013	0.185	0.363	1.000					
PO_4	0.170	0.245	0.377	0.894**	1.000				
Chloro.	0.796**	0.512**	0.610**	0.812**	0.467	1.000			
Bacillario.	0.696**	0.417	0.546**	0.404	0.145	0.459	1.000		
Cyano	0.689**	0.364	0.347	0.791**	0.597**	0.295	0.115	1.000	
Dino.	0. 420	-0.303	0.237	0.688**	0.538**	0.147	0.143	0.174	1.000

Table 4: Correlation matrix relating to the Phytoplankton density along with nutrient status of Sasthamkotta Lake.

	TN	NO_2	NO_3	TP	PO_4	Chloro.	Bacillario.	Cyano.	Dino.
TN	1.000								
NO_2	-0.102	1.000							
NO_3	0.235	0.438	1.000						
TP	0.224	0.228	0.321	1.000					
PO_4	0.122	0.211	0.104	0.622	1.000				
Chloro.	0.792**	0.589**	0.507**	0.656**	0.403	1.000			
Bacillario.	0.786**	0.732**	0.462	0.699**	0.478	0.521**	1.000		
Cyano	0.677**	0.479	0.452	0.545**	0.268	0.608	0.743	1.000	
Dino.	0.505**	0.467	0.364	0.580**	0.481	0.068	0.220	0.216	1.000

Conclusion

In the present study efforts have been made to ascertain the seasonal abundance and population dynamics of phytoplankton community and its relationship with nutrients status of two tropical lakes, Vellayani and Sasthamkotta, Southern Kerala. Algal diversity shows that Chlorophyceae show dominance in Vellayani Lake whereas Bacillariophyceae forms their dominance in Sasthamkotta Lake. The study reveals that there is positive relationship between plankton biomass with nutrients and found that planktonic biomass is regulated by nutrients status in freshwater bodies.

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