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Research Article

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Seasonal Variation and Biodiversity of Phytoplankton in Parambikulam Reservoir, Western Ghats, Kerala

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ABSTRACT

Lakes, Rivers and Reservoirs are most important water resources with multiple human utilization and ecological relevance. Parambikulam Dam is an embankment dam on the Parambikulam River flowing through Western Ghats and located in the Palghat district of Kerala with a reservoir area of 21.22 km^2 and 69,165×1000 cu.mt. capacity. The present study focuses on the seasonal variation, hydrobiology and biodiversity of phytoplankton of the Parambikulam reservoir during 2009-11. A total of 89 taxa of phytoplankton were recorded during the study. They belong to five different classes, viz Chlorophyceae, Desmidiaceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. Bacillariophyceae was the dominant group with 42 taxa followed by Desmidiaceae with 26 taxa. Members of Euglenophyceae were not recorded during monsoon seasons. The dominant genera were Pinnularia and Navicula from Bacillariophyceae and Closterium and Cosmarium from Desmidiaceae. Shannon diversity index and Margalef's Species richness was found to be highest during post-monsoon season (H'=6.09; d=11.41) and lowest during monsoon seasons (H'=3.8; d=3.4), while average taxonomic distinctness was slightly higher in pre-monsoon (Δ^+=69.30) than post-monsoon (Δ^+=69.10) and lowest during monsoon (Δ^+=65.00). Variation in taxonomic distinctness was highest during post monsoon (Λ^+=417) and lowest during pre monsoon (Λ^+ =347). Fluctuations of the hydrological variables such as pH, DO, nitrate, phosphate, silicate, calcium and chloride were also recorded. The result provides a primary documentation of the microalgae and basic understanding of the trophic status of the reservoir.

Keywords- *Phytoplankton, Western Ghats, Hydrobiology, Biodiversity, Parambikulam Dam.*

INTRODUCTION

Phytoplankton is regarded as an important component of Lakes and reservoirs as they make important contribution to the biological diversity in lakes and reservoirs. Its community structure is important to higher trophic levels because it influences the efficiency of carbon and energy transfer between trophic levels in any given system[14]. Distribution of phytoplankton and their variation at different zones of water body is known to be influenced by physico-chemical parameters of water. Phytoplankton study provides a relevant and convenient point of focus for research on the mechanism of eutrophication and its adverse impact on aquatic ecosystem[22]. Although factors that affect the seasonal variation and composition of phytoplankton have been subjected to several detailed investigation, there is little information on the phytoplankton in the water bodies of Western Ghats.

Hulyal and Kaliwal[8] reported the dynamics of phytoplankton in relation to physico-chemical factors of Almatti reservoir of Bijapur. Jayabhaye[9] studied the phytoplankton diversity in Sawana Dam

Maharashtra. Laskar and Gupta[13] studied seasonal variation of phytoplankton diversity of Chatla flood plain lake, Assam. Shinde *et al.*[22] investigated seasonal variation and biodiversity of phytoplankton in Harsool Dam, Aurangabad. Pramila *et al*[18], Sankaran[20], Krishnan[12], Singh and Balsingh[23] have reported the phytoplanktons of Yercaud, Aliyar, Mullapperiyar and Kodaikanal lakes respectively. The present investigation is focused to assess the water quality of Parambikulam reservoir with special reference to the phytoplankton diversity.

MATERIALS AND METHODS

Study area

Parambikulam reservoir is located between 10°22.40’ N latitudes and 76°45.51’E longitude in the Palghat district of Kerala. The dam built across the Parambikulam River that originates in the Kerala state. This dam is the source of canal irrigation for large tracts of agricultural lands lying nearby in Tamil Nadu and within the Kerala state. The reservoir has a surface area of 21.22 km^2 with an annual mean water capacity of 69, 165 ×1000 cubic meter.

Sampling and identification

Water samples, in quadruplicate, were collected seasonally for a period of two years from fixed stations in the reservoir. pH and dissolved oxygen (DO) were measured in the field. Nitrate, sulphate, phosphate, silicate, chloride, fluoride, calcium, magnesium and iron were determined in the laboratory following APHA[1]. For the qualitative analysis of phytoplankton 1 litre of the water sample was collected seasonally. Two ml of Lugol’s iodine solution was added to the sample and it was allowed to stand for 2 days and was centrifuged to make it concentrate. The supernatant was poured out phase wise until the solution was concentrated to 10ml. the concentrated samples were preserved in 4% formalin. General phytoplanktons were studied for qualitative and quantitative details. Counting was made using a stereomicroscope with 40X magnification using Lacky’s drop method[24], Phytoplanktons were identified using standard keys. Statistical analysis like mean and S.D were calculated. Diversity indices like Shannon index, Margalef’s species richness, Average taxonomic distinctness and Variation in taxonomic distinctness was calculated using Primer 6[3].

RESULTS

The results on the seasonal variation of pH, DO, nitrate, phosphate, silicate, calcium and chloride are presented in the table1. Since means of phytoplankton diversity and environmental variables showed no significant ($P>0.05$) difference between two years, data collected during the present study is pooled and used for the analysis. A total of 89 species of phytoplanktons were recorded from the study area. They belong to 5 different classes namely Chlorophyceae, Desmidiaceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. Bacillariophyceae form the major group with 42 species followed by Desmidiaceae with 23 and Chlorophyceae, Cyanophyceae and Euglenophyceae with 13, 6 and 5 species respectively. The percentages of different groups are presented in the figure1. Diversity was more during Post-monsoon period and was lowest during monsoon season. During pre-monsoon season comparatively higher percentage of Cyanophyceae and Euglenophyceae were recorded while during monsoon season the Euglenoids were totally absent. During the monsoon season filamentous Chlorophyceae were occurred abundantly than other seasons. The dominant taxa recorded during the period of study were *Pinnularia* and *Navicula* belong to the Bacillariophyceae and *Cosmarium* and *Closterium* belong to Desmidiaceae. List of the total phytoplanktons recorded are presented in the table 2.

Shannon diversity index showed higher value during post monsoon season (H’=6.09) followed by pre-monsoon (H’=5.15) and in monsoon the lowest value was recorded (H’= 3.88). Margalef’s Species richness also showed similar result (Fig 3). The average taxonomic distinctness ($\Delta+$) showed higher value in pre-monsoon ($\Delta+= 69.30$) than in post monsoon and in monsoon the value was $\Delta+ =69.10$. While variation in taxonomic distinctness was highest in post monsoon season ($\Lambda+= 414.30$) and lowest during pre-monsoon seasons ($\Lambda+= 347.50$).

Fig.1: Percentage of phytoplanktons in Parambikulam reservoir during 2009-11

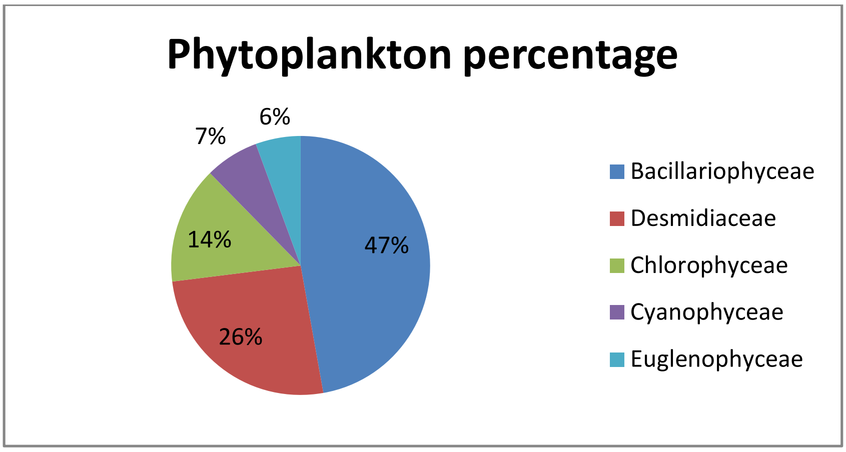


Fig.2: Seasonal variation in diversity indices of phytoplankton in the Parambikulam Reservoir during 2009-2011

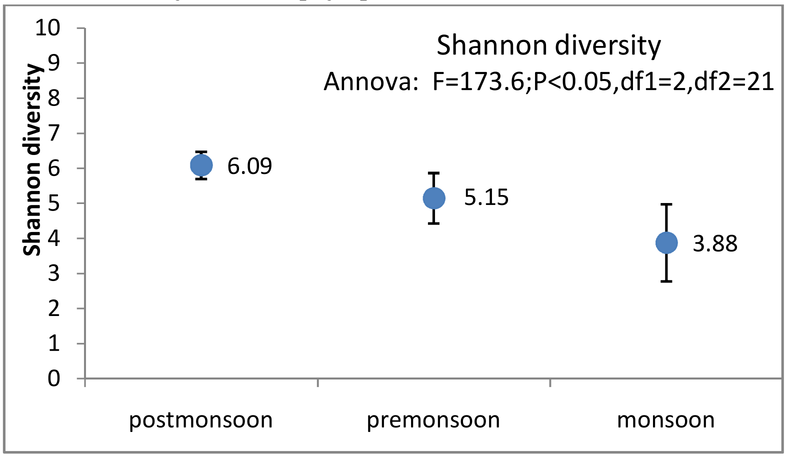


Fig.3: Seasonal variation in diversity indices of phytoplankton in the Parambikulam Reservoir during 2009-2011

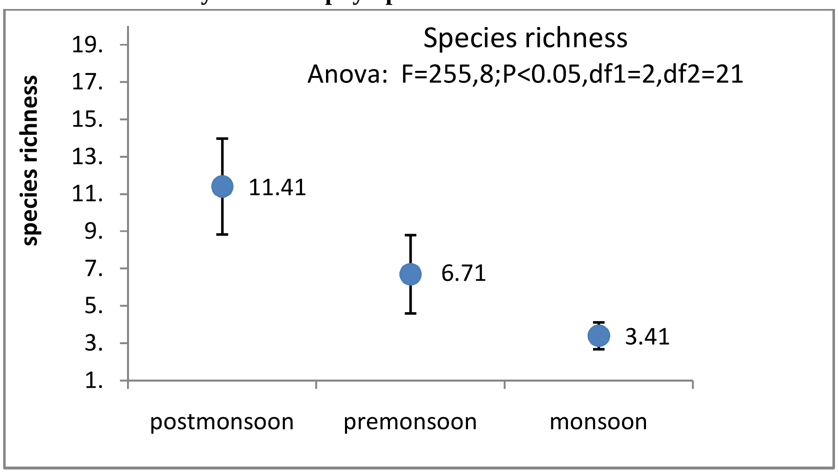


Fig.4: Seasonal variation in diversity indices of phytoplankton in the Parambikulam Reservoir during 2009-2011

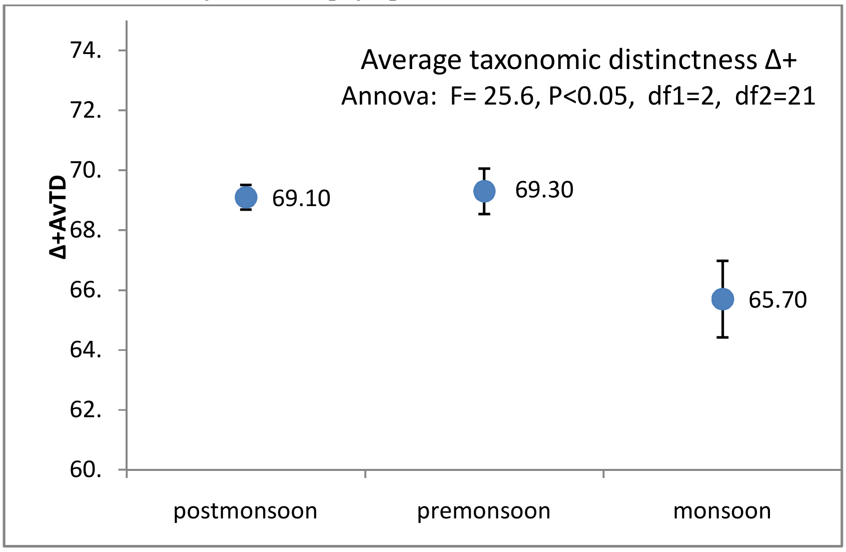
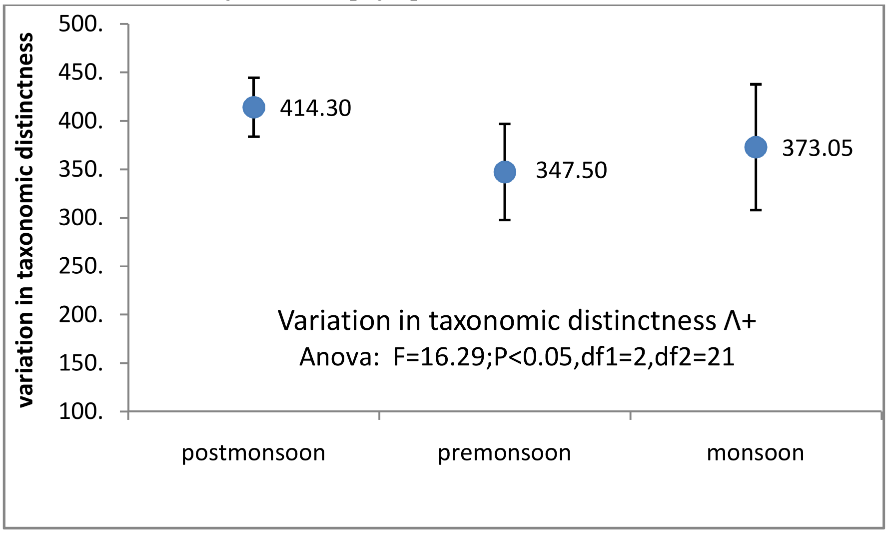


Fig.5: Seasonal variation in diversity indices of phytoplankton in the Parambikulam Reservoir during 2009-2011



DISCUSSION

The ability of phytoplankton to grow and prosper in an aquatic system is the outcome of a complex series of interactions between hydrological, water quality and biotic factors. The abundance and occurrence of phytoplanktons is primarily depending on the pH and nutrient load of the region[2]. Lasker and Gupta[13] recorded 34 taxa of phytoplanktons from Chatla lake Assam, Jayabhai[9] identified 48 phytoplankton species from Sawana Dam Maharashtra, Krishnan[12] observed 59 taxa of phytoplankton from Mullaperiyar Lake. A recent study by Shinde *et al*.[22] recorded 35 genera from Harsool- Savangi dam, Aurangabad. In the present study 89 species of phytoplanktons were identified from Parambikulam reservoir of Western Ghats pointing to a chance of higher phytoplankton diversity than Northern Indian water bodies.

A distinct seasonal variation in the diversity of microalgae was observed during the present study with a higher algal productivity during post monsoon period and lower in monsoon season. A low algal productivity was recorded in treatment ponds during the monsoon season compared to pre monsoon and post monsoon seasons[10]. The decrease in the diversity of algae may be due to the dilution of the nutrients during monsoon months[17] and during dry seasons the water become concentrated due to the decrease in the water level, with rich amounts of nutrients especially nitrate and phosphate[12]. During post-monsoon seasons there will be a chance for the sedimentation of nutrients from the adjacent forest through the monsoon currents and subsequent release of nutrients. This can be attributed to the higher diversity and productivity of algae during post-monsoon period. The variation in productivity and diversity can further be attributed to the higher solar illumination during post-monsoon and pre-monsoon when compared to the monsoon season.

Shannon index (H') combines species richness components as an overall index of diversity. The higher values of Shannon index and richness indicates greater species diversity and Shinde *et al.*[22] recorded higher index during winter seasons from Harsool Savangi dam. In the present investigation higher values of this index and higher diversity occurred during post monsoon seasons. Average taxonomic distinctness show higher value in pre-monsoon than post-monsoon seasons. Vaheeda[25] reported higher AvTD Value of phytoplanktons of Kodungallur brackish water during pre-monsoon and opined that this was due to low environmental stress during the season. The above observations hold true in the present investigation also. While variation in taxonomic distinctness was higher during post monsoon followed by monsoon and was lowest during pre-monsoon season. Higher VarTD means dominance of a particular group in the area and during post-monsoon the diatoms recorded dominance in the area.

pH is one of the most important single factor which influences the aquatic production. Hujare[7] mentioned that diatoms are usually abundant in alkaline water. Water in the Parambikulam reservoir is recorded to be alkaline and consequent occurrence of higher percentage of diatoms and diatoms have also been considered as indicators of water quality. Mohammed and Nabila (2005) reported the dominance of Bacillariophyceae in the Mediterranean Sea and attributed higher correlation of diatoms to high silicate concentrations. High count of diatoms during the present study may be attributed to the high silicate concentration, as silicate is the main components of diatom frustules[4,5]. Silicate is the major nutrient available in the study area and coincides with the observations of Karikal[11]. The DO concentration of the reservoir ranged between 7.2 to 8 mg/l during the study and support oligotrophic character of the water body. Desmidiaceae are the second major groups of microalgae encountered throughout the period of study. The study of Venkateswarlu[26] opined that the dominance of desmids indicates the oligotrophic nature of the water body. They are considered to be very sensitive group of microalgae as they are unable to withstand even slight changes in the quality of aquatic habitats[8].

Among the nutrients nitrates and phosphate concentration found very low in the study area. In Almatti Reservoir, Hulyal and Kaliwal[8] recorded maximum value for nitrate and low pH and consequent increase of Cyanophycea. Nitrate is an important environmental variable for the proliferation of Cyanophyceae and Euglenophyceae[21]. Corroborates with the above results, present investigation also recorded low percentages of pollution indicative groups like Cyanophyceae and Euglenophyceae during monsoon season. Complete absence of Euglenoids during monsoon season indicates oligotrophic nature of the system. The members of Chlorophyceae have revealed its adaptability to different conditions. According to Happy-wood[6] Chlorophycean members have been found in poor nutrient oligotrophic water bodies. But Saify *et al.*[19] reported that with eutrophication of water body, the number of Chlorophyceae increased both qualitatively and quantitatively. Munawar[16] reported that low pH favours the growth of Chlorophyceae. In the present investigation Chlorophyceae represent only 14%. This clearly indicates that the Parambikulam was almost free from pollution.

From the above observations it is concluded that the condition of water in Parambikulam reservoir is oligotrophic which favours the growth of microalgae. However, the occurrence of pollution indicator groups such as Euglenophyceae and Cyanophyceae points towards the possibility of Eutrophication. There is an immediate need for the continuous monitoring of the water quality as far as the conservation of habitat is concerned. The information generated from this investigation may be used by the decision makers for conservation and effective utilization of the water body. Immediate measures for the control anthropogenic intervention to the reservoir may be regulated for the conversion of the lake to eutrophic condition.

Table 1. Mean and S.D of physic-chemical parameters in Parambikulam reservoir during 2009-11

No.	Parameters	Postmonsoon		Premonsoon		Monsoon	
		mean	S.D	mean	S.D	mean	S.D
1	pH	7.5	0.129	6.94	0.117	7.5	0.120
2	DO	7.2	0.630	7.2	0.721	8.0	0.560
3	Nitrate mg/L	0.66	0.193	0.0	0.0	0.90	0.152
4	Phosphate mg/l	0.003	0.001	0.038	0.0011	0.03	0.002
5	Silicate mg/l	9.59	0.475	4.90	0.481	4.20	0.630
6	Calcium mg/l	5.60	0.685	4.80	0.385	4.80	0.935
7	Chloride mg/l	18	2.25	22	1.35	14	2.28

Table.2. List of phytoplanktons recorded from the Parambikulam reservoir during 2010-2012

Bacillariophyceae	Post-monsoon	Pre-monsoon	Monsoon
Melosira sp.	**	*	*
M. varians	*	*	__
Achnanthes lanceolata	*	__	__
A. brevipes	*	__	__
A. inflata	*	__	__
Cocconeis placentula	**	*	*
Eunotia monodon	*	*	__
Fragilaria brevistriata	*	*	__
Tabellaria flocculosa	*	__	__
Amphora ovalis	*	*	__
A. coffeaeformis	*	__	__
Cymbella tumida	__	*	*
C. turgida	*	*	__
Gomphonema intricatum	*	__	__
Anomoeneis sp.	*	__	__
Frustulia sp.	*	__	__
Gyrosigma distortum	__	*	__
Mastogloia smithii	*	__	__
Navicula cincta	**	*	*
N. cuspidata	*	*	__
N. decussis	**	*	__
N. halophila	__	__	*
N. peregrina	*	__	__
N. pupula	*	__	__
N. viridula	*	*	__
Neidium indicum	*	__	__
Pinnularia acrosphaeria	**	*	__
P. borealis	*	__	__
P. brevicostata	**	*	*
P. conica	__	*	__
P. interrupta	*	__	*
P. termis	*	__	*
P. viridis	**	__	__
P. major	*	__	__
Pleurosigma angulatum	*	*	__
Stauroneis agrestis	*	__	__

S. anceps	*	__	__
Hantzschia amphioxys	*	*	__
Nitzschia amphibia	__	__	*
N. closterium	*	*	*
N. palea	*	__	__
Surirella elegans	*	*	__
Desmidiaceae			
Closterium acutum	__	*	*
C. dianae	*	__	*
C. kuetzingii	**	*	*
Closterium macilentum	*	__	__
Closterium parvulum	**	__	__
C. acerosum	*	__	__
C. contractum	__	*	*
C. blyttii	*	*	__
C. auriculatum	**	__	*
C. curtum	*	__	*
C. decoratum	*	__	__
C. moniliforme	**	*	__
Euastrum inermius	*	__	*
E. insulare	*	__	__
E. spinulosum	__	*	*
Micrasterias pinnatifida	*	__	__
Penium cylindrus	*	__	__
Pleurotaenium ehrenbergii	*	*	__
P. keyei	*	__	*
Staurastrum chaetoceros	*	__	__
S. coroniferum	*	__	*
Staurastrum erasum	*	__	*
S. gracile	__	*	__
Chlorophyceae			
Pediastrum duplex	__	*	*
P. tetras	*	__	__
Tetraedron minimum	*	__	__
Scenedesmus quadricauda	*	__	__
S. acuminates	__	*	__
S. bijugatus	*	__	__
S. opoliensis	*	*	__
Ankistrodesmus falcatus	*	__	__
A. sigmoides	*	__	__
Pandorina cylindricum	__	__	*
P. morum	*	__	__
Spirogyra Sp. *1*	*	*	**
Spirogyra sp. 2	__	__	*
Cyanophyceae			

Chroococcus turgidus	*	**	__
Gloeocapsa sp.	__	*	__
Merismopedia minima	*	**	__
Microcystis sp.	__	*	__
Oscillatoria acuta	*	**	*
O. boryana	__	*	__
Euglenophyceae			
Astasia fustis	*	*	__
Euglena limnophila	*	*	__
E. proxima	*	*	__
Phacus corculum	__	*	__
P. obolus	__	*	__

*Present, **abundant, -- absent

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