



SEASONAL PHYTOPLANKTONIC DIVERSITY OF PADMALA POND IN RANTHAMBHORE FORT, DISTRICT SAWAI MADHOPUR, RAJASTHAN, INDIA

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ABSTRACT

The assessment of the quality of water involves the analysis of physicochemical, biological and microbiological parameters that reflect the biotic and abiotic status of an ecosystem. The water samples were collected for two years (2014 to 2016) from Padmala pond of Ranthambhore Fort located in the district of Sawai Madhopur (Rajasthan). The analyzed physicochemical parameters fluctuated according to seasons except D.O. The value of all parameters is higher in summer except the D.O. content. Total 17 algal genera and 30 species belonging to 4 classes have been accounted from the two sites of the pond. Few species were recorded throughout the year while others were found fluctuating in different seasons, mainly in summer and winter. During the summer season, the algal species that were recorded belong to Chlorophyceae (10 species) and Cyanophyceae (9 species) as the most dominant group. While Bacillariophyceae (2 species) were most dominant during winter. The most common algal species reported from the ponds were *Microcystis aeruginosa*, *Anabaena azollae*, *Nostoc muscorum*, *Microcystis flos-aquae*, *Scenedesmus quadricauda* and *Spirogyra* sp. throughout the investigation.

KEY WORDS: *Padmala Pond, Phytoplanktonic diversity, Water pollution*



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INTRODUCTION

Water is a vital concern of mankind since it is directly linked with human welfare. The maintenance of a healthy aquatic ecosystem depends on the physicochemical characters of water and also biological diversity^{1,2}. A special attention is required worldwide for investigation of biodiversity of an aquatic ecosystem which is an important characteristic of the Nation's resources and it is also a major indication of the trends of its evolution¹. The pollution of the aquatic environment is concerned as one of the most serious problems faced by human². Water pollution occurs due to domestic waste, other polluted material, organic matter, sewage effluent, cattle dung and these pollutants are poured indirectly/directly into the water bodies. As such the physicochemical and biochemical properties of the water are changed and it becomes non potable³. Phytoplankton are essential component of any aquatic habitat and good source of water quality⁴. These are primary producers and provide oxygen for the flora and fauna as well as for the degradation of organic matter. Phytoplankton show seasonal fluctuation depending on nutrients present in water. The Nutrient enrichment in water bodies is affected by sewage and agriculture waste. Discharge is the main cause of water pollution which is known as eutrophication³. These nutrients encourage the growth of algal bloom which make water unfit for human health^{5, 6}. Algae serve as indicators of water quality and their distribution in time and space is used for detecting the characteristic of water⁷. Several authors have studied the range and density of phytoplankton and their association as biological indicators⁸⁻¹⁵. Sawai Madhopur is world famous for Ranthambhore National Park, a wildlife reserve and a place of historical importance famous for conservation of tiger. The major attraction of the fort is Trinetra-Ganesh (Lord Ganesh) temple. Some important man-made ancient ponds in the fort are Padmala pond (Figure 1a, 1b), Rani Hode, Jangali pond and Sukhsagar. Padmala pond is the main source of water for the majority of human population of the fort like local public, pilgrims including the shopkeepers for drinking, washing and bathing. An annual fair is held on Bhadrpada Sudi Chaturthi, fourth day in the month of Bhadra (August-September). Thousands of people come from every corner of the country to visit the fort and seek the blessings of the Lord for happiness and prosperity. Since last two decades, the water of pond has become polluted due to high pressure of human activities, recreational and religious activities at the site. For the last few years, the pond has also been invaded by the phytoplankton. The estimation of physicochemical parameters on par with WHO guideline may compel the civic authorities to modify the sustainable techniques to enhance the water quality¹⁶. In addition, there is an urgent need to continuously bio-monitor the various aquatic ecosystems for water quality assessment. The present study reveals the investigation on seasonal variation of phytoplankton and the relevance of physicochemical characteristics of water in the Padmala pond of Ranthambhore fort in the district of Sawai Madhopur (Rajasthan).

MATERIALS AND METHODS

Investigation area

Sawai Madhopur is the gateway to the world renowned Ranthambhore National Park. The Ranthambhore fort is located 14 kms away from Sawai Madhopur situated about 180 km North East of Jaipur among the rolling hills of Vindhyan and Aravalli. It is situated on 76°28' East longitude to 26°2' North latitude and covering an area of 4 Sq.k.m. with Vindhyan and Aravalli hills having 481 meter highest point. Every part of the fort reflects the ancient characteristics of the Indian culture and philosophy. The 8th Century "Ganesh temple" is a major attraction of the fort. Padmala pond is a major source of water for majority of human population of the fort which is located in the front of the Ganesh temple. It is also known as Padma pond or Padam Talab. The pond was named so in honour of Rani Padmawati. There are various places of historical interest inside the fort namely Toran Dwar, Mahadeo Chhatra, Samanton Ki Haveli, 32 Pillared Chhatra, Mosque, Ganesh temple, Kali Mata Temple, Gupt Ganga and three other artificial water ponds namely Rani hod, Jangali pond and Sukhsagar. The seasons in the study area are extending from November to February (winter season), March to June (summer season) and July to October (rainy season). The area of sanctuary is surrounded with subsidiary edaphic type of dry tropical forest having key plant species namely *Anogeissus pendula*, *Butea monosperma*, *Ziziphus mansitiana*, *Prosopis cineraris*, *Acacia catechu*, *A. nilotica* as dominant flora. The major fauna are Tiger, Chital, Sambhar deer, blue bull and Hanuman langurs.

Sampling sites and sample collection

The seasonal collection of water was made for a period of two years (November 2014 to October 2016) to record the physicochemical and phytoplankton characteristics of Padmala pond. The water samples (1 litre) were collected between 9-10 AM in sterile plastic bottles in the second week of each month from two different sites of the ponds. Site 1 and Site 2 are located almost 100-150 meter distance from the Ganesh temple. There are houses, shops, drinking water spots situated on the front side and behind the Ganesh temple in the fort. The major activities on the site include the use of water for drinking, cooking, bathing and washing of clothes. Algal samples were collected in plastic or glass vials using planktonic net of various size and preserved in 4% formalin and brought to the laboratory for microscopic examination.

Laboratory analysis

The collected samples were brought to the laboratory as early as possible for physicochemical and phytoplankton analysis. Water temperature by digital thermometer and pH by pH strip was recorded regularly at the site. Various physicochemical parameters of the water were analyzed using standard methods (APHA)¹⁷. Phytoplankton samples were centrifuged or cultured for their taxonomic enumeration. The samples were preserved in 4% formalin for further investigation. These were regularly examined microscopically and measurements with photomicrographs were taken for the majority of species. Counting of the plankton was

done by Sedgewick-Rafter cell count method. The identification was done by standard method keys¹⁸⁻²².

for two years. The data were presented as mean and standard deviation (Mean \pm S.D.). Statistical analysis of data was carried out using Excel analysis ToolPak (MS Office).

STATISTICAL ANALYSIS

Physicochemical experiments of water were performed



Figure 1a
Actual view of the Padmala pond in winter season.



Figure 1b
Actual view of the Padmala pond in summer season.

RESULTS AND DISCUSSION

The data on the physicochemical characteristics and phytoplankton population in water samples of Padmala pond for two years (November 2014 to October 2016) are presented in Table 1 and 2, respectively. The results of water analysis show fluctuation in the value of various physicochemical parameters of the pond in different seasons throughout the study period (Table 1). However, the values of almost all parameters (D.O., B.O.D., C.O.D., Cl, Ca, T.D.S., Nitrates, Alkalinity, Total Hardness, Phosphate etc.) were found higher in summer (except the D.O.) due to the high rate of

organic decomposition, rise in temperature, decrease in the water level and huge growth of macrophytes during the summer. The algal population of the pond consisted of 17 genera with 30 species out of which 13 species belong to Chlorophyceae, 11 species belong to Cyanophyceae, 2 species Euglenophyceae and 4 species Bacillariophyceae. Microscopic photographs of some of the algal species are given in Plates 1, 2. The highest population of Chlorophyceae, Cyanophyceae and Euglenophyceae was recorded in summer season (March-June) while Bacillariophyceae has highest growth in winter season (November-February) (Table 2).

Table 1
Seasonal variation of physicochemical parameters of water at Padmala pond from November 2014 to October 2016

Parameters	Summer	Rainy	Winter
Colour	Green	Brown	Light green
Temperature (°C)	45.25 \pm 2.9	31.5 \pm 3.38	25.05 \pm 1.84
pH	7.92 \pm 0.32	7.62 \pm 0.15	7.55 \pm 0.26

C.O.D. (mg/l)	46.25±9.24	31.25±15.30	42.5±13.46
B.O.D. (mg/l)	6.12±1.43	3.12±2.2	5.25±0.73
D.O. (mg/l)	3.45±1.39	4.25±0.90	5.05±1.50
Chloride (mg/l)	77.5±6.40	33.75±9.54	48.75±3.58
Calcium (mg/l)	28.25±3.0	21±4.54	29.5±2.96
Phosphate (mg/l)	0.05±0.02	0.07±0.06	0.12±0.04
Hardness (as CaCO ₃ mg/l)	182±19.54	128.75±30.99	119.5±25.50
TDS (mg/l)	464±55.35	410±41.83	347.5±6.51
Nitrate (mg/l)	25.5±6.18	9.0±3.59	11.25±9.10
Alkalinity	211.25±7.14	177.5±7.63	181.25±7.11

Summer: March-June, Rainy: July-October, Winter: November-February
Values are mean ± SD (n = 4)

In Chlorophyceae population, there is no much difference observed in summer, rainy and winter season. The maximum population was recorded in summer season (Table 2). It may be due to higher concentration of Nitrate, low phosphate enriched with N, P compounds, low D.O., high temperature and pH value. The other reasons include faecal contamination and slow water current. The phytoplankton species like *Ankistrodesmus falcatus*, *Coelastrum microsporum*, *C. dinae*, *Chlorella vulgaris*, *Chara brachypus*, *Cosmarium botrytis*, *Cosmarium quadrifolium*, *Pediastrum tetras*, *P. simplex*, *Scenedesmus quadricauda*, *S. abudans*, *Spirogyra jungalis*, *S. punctulata* formed the maximum population during summer season. *Chlorella vulgaris*, *Spirogyra jungalis*, *Scenedesmus quadricauda* are considered as indicators of organic pollution because they were observed during the whole year in polluted water. The maximum number of Cyanophyceae was isolated during the summer and least in the winter season. *Anabaena azollae*, *Anabaenopsis arnoldii*, *Merismopedia minima*, *Nostoc muscorum*, *N. punctiforme*, *Oscillatoria proteus*, *O. limosa*, *Microcystis flos-aquae*, *M. aeruginosa*, *M. robusta*, *Spirulina major* were the most frequent during summer season due to favourable temperature, pH, abundant mineral nutrients (Table 1) that support the Cyanobacterial growth. The direct relationship between various physicochemical factors and variation in phytoplankton diversity has been

examined by many authors in different water bodies^{4,15,23}. During the study, it was observed that high turbidity, alkalinity, pH, bicarbonate, chloride may be responsible for the Cyanophyceae growth and bloom as reported earlier¹³. An inverse relationship between CO₂ and pH have been recorded. It has also been reported that the higher diversity of blue green algae may be attributed high nitrate value during the rainy season²⁴. During this investigation, it was noted that Padmala pond water body was found contaminated due to anthropogenic activities (Bathing and washing). After one month of rain, Padmala pond was found dominated by toxic algal bloom of *Microcystis* covering the entire water surface as well as up to various depths as also reported earlier in other water bodies¹³. In the present study, four species of diatoms (Bacillariophyceae) - *Cymbella aspera*, *C. excise*, *Fragilaria pinnata*, *Navicula abrupta* were recorded during the winter season (Table 2). Results clearly showed the presence of diatoms more in winter season than in summer and rainy season. The diatom species like *Cymbella aspera* and *Navicula abrupta* are good indicator of water pollution. The species of diatoms grow abundantly in high pH, low Nitrate, High TDS, low Phosphate and low temperature and weak light. The winter months were more favourable for the development of diatoms as clearly evident from the reported literature^{14,15,25}.

Table 2
Seasonal variation of the phytoplankton in Padmala pond during the year November 2014 to October 2016

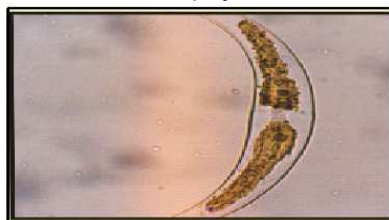
S. No.	Name of Species	Summer	Rainy	Winter
Chlorophyceae				
1.	<i>Ankistrodesmus falcatus</i>	+	+	-
2.	<i>Coelastrum microsporum</i>	+	±	-
3.	<i>Closterium dinae</i>	+	+	-
4.	<i>Chlorella vulgaris</i>	+	+	±
5.	<i>Chara brachypus</i>	-	±	+
6.	<i>Cosmarium botrytis</i>	+	±	-
7.	<i>Cosmarium quadrifolium</i>	+	±	-
8.	<i>Pediastrum tetras</i>	+	+	+
9.	<i>Pediastrum simplex</i>	-	-	+
10.	<i>Scenedesmus quadricauda</i>	+	+	+
11.	<i>Scenedesmus abudans</i>	-	±	-
12.	<i>Spirogyra jungalis</i>	+	+	±
13.	<i>Spirogyra punctulata</i>	+	±	-
Cyanophyceae				
14.	<i>Anabaena azollae</i>	+	±	-
15.	<i>Anabaenopsis arnoldii</i>	+	+	-
16.	<i>Merismopedia minima</i>	±	+	-

17.	<i>Microcystis flos-aquae</i>	+	+	±
18.	<i>M. robusta</i>	+	+	-
19.	<i>M. aeurginosa</i>	+	+	±
20.	<i>Nostoc muscorum</i>	+	+	-
21.	<i>N. punctiforme</i>	+	+	-
22.	<i>Oscillatoria proteus</i>	+	+	-
23.	<i>O.limosa</i>	+	+	-
24.	<i>Spirulina major</i>	+	-	-
Euglenophyceae				
25.	<i>Euglena acus</i>	+	+	+
26.	<i>E. viridis</i>	+	-	±
Bacillariophyceae				
27.	<i>Cymbella aspera</i>	±	-	+
28.	<i>Cymbella excise</i>	+	-	+
29.	<i>Fragilaria pinnata</i>	+	-	-
30.	<i>Navicula abrupt</i>	-	-	+

+ Present, - absent, ± rare

As presented in the earlier reports, the members of Euglenoides were also recorded during the study period. The maximum population of Euglenoides found during summer (Table 2) may be due to high water pollution in the summer. The variation in the physicochemical

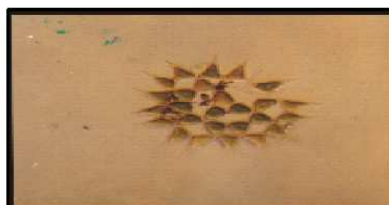
properties of water and the phytoplankton population of different water bodies clearly shows that India has wide variation in climate factor in different months in different region²⁶.



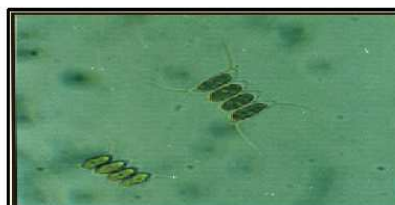
1. *Closterium dinae*



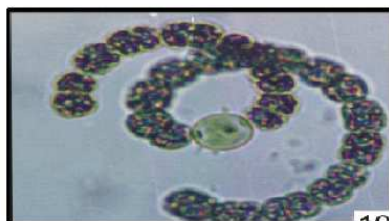
2. *Cosmarium botrytis*



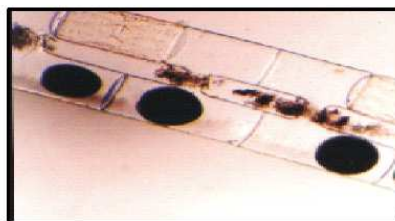
3. *Pediastrum simplex*



4. *Scenedesmus quadricauda*



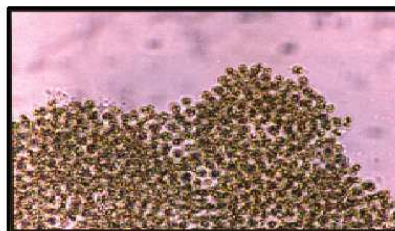
5. *Anabaenopsis arnoldi*



6. *Spirogyra jungalis*



7- *Anabaena azollae*

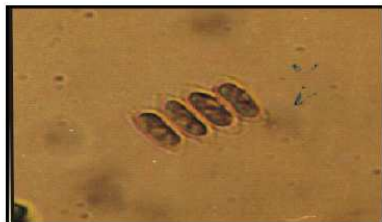


8. *Microcystis flos-aquae*
(Wittr.) Kirchner

Plate 1

Microscopic photographs of algal species

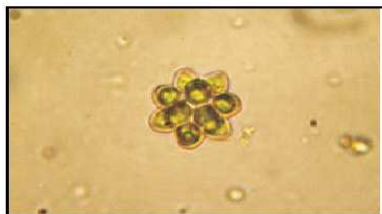
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1. *Scenedesmus abudans*



2. *Microcystis robusta*



3. *Coelastrum microsporium*



4. *Pediatrum tetras*



5. *O. limosa*



6. *Euglena acus*



7. *Fragilaria pinnata*



8. *M. aeurginosa*

Plate 2

Microscopic photographs of algal species

CONCLUSION

The present study shows the seasonal fluctuation of various phytoplankton observed in the months of January, May and September. It is also clear that the summer season is more favourable for the Chlorophyceae, Cyanophyceae and Euglinophyceae. There is abundance of Bacillariophyceae found during the winter season. The algal genera like *Chlorella vulgaris*, *Euglena acus*, *Microcystis flos-aquae*, *M. aeurginosa*, *Pediatrum tetras*, *Spirogyra jungalis*, *Scenedesmus quadrifolium* were recorded throughout the study period. These algal forms are good indicators of water pollution. In the Fort, majority of the public used pond water directly without any treatment. This resulted in the spread of many diseases. Hence, adequate knowledge of phytoplankton must be incorporated for any future plan for utilization of any water source. With this report, we further conclude that if precautions are not taken, the pond will become highly polluted. Further, the research is also needed to predict the effect of phytoplankton on the environment and ecological

characteristic in Padmala pond of Ranthambhore National Park.

AUTHORS CONTRIBUTION STATEMENT

Jyoti Rajawat was done the work, analysed data and wrote the paper with input from Vijendra K. Sharma. Overall directions for planning of the work was given by Vijendra K. Sharma.

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CONFLICT OF INTEREST

Conflict of interest decalred none.

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