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A study on Phytoplanktonic diversity of Pothara river, near Khambada, Maharashtra

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Abstract

The Pothara river is one of the lotic ecosystem in the Chandrapur district. The river was studied for a period of two year from Feb. 2022 to Jan 2024 for phytoplankton community structure. Collections were taken on monthly basis to investigate the abundance and diversity of phytoplankton. In the present investigation, the phytoplankton was represented by 34 algal genera. Some of these recordings were captured only during specific times of the year, whereas others were distributed across various seasons, with a focus on winter and summer.During winter season, Chlorophyceae was the enormously dominating group afterwards Basillariophyceae. On the other hand, during the summer season, Cyanophyceae and Euglenophyceae emerged as the most dominant groups. Certain species like *Pediastrum* sp., *Chlorella* sp., *Oedogonium* sp., *Oscillatoria* sp., and *Euglena* sp. were reported during the year *Anacystis, Oscillatoria, Chlorella*, and *Nitschia* were identified as reliable indicators of water pollution.

Key words : Pothara river, Phytoplanktonic diversity, Physico-chemical parameters, Khambada.

Water is an essential component for the survival of all living organisms but water pollution is a serious problem they face.Various physico-chemical parameters influence the growth and diversity of aquatic microflora in river systems.Phytoplankton serve as the primary producers and occupy the first level in the aquatic food chain, playing a pivotal role in water quality and quantity for all aquatic animals.Bio-monitoring involves assessing the species composition of plankton, which acts as an important indicator reflecting the water quality and pollution level in a given ecosystem[8]. Planktons are commonly found across various regions due to their cosmopolitan distribution, which is predominantly influenced by physico-chemical and climatic factors[3]. Phytoplankton, as microscopic organisms, function as autotrophic primary producers, holding a crucial position in fisheries as the first level in the food chain for all aquatic animals in both lotic and lentic water ecosystems[9].

Small rivers play a significant role in forming the water resources within a river basin. In India, there is a predominant focus on studying the water quality and biodiversity of large rivers. Unfortunately, there has been limited research on the hydrobiology and limnology of small rivers in recent years. Therefore, it is crucial to give more attention to the study of small rivers, particularly in terms of their qualitative, quantitative, and biotic aspects of water quality[17]. The Pothara river, situated near Khambada, Maharashtra, holds significant importance for various purposes, including being a source of drinking water, irrigation, wildlife support, and laundry. To date, no efforts have been observed to study the limnological aspects of this river. Therefore, the current investigation aims to assess the phytoplankton diversity in the Pothara river concerning its physico-chemical properties.

Study area : The research area includes sections of Chandrapur and Wardha districts, where the Pothara river flows. The Pothara river water quality gets deteriorated due to heavy traffic on bridge near Khambada, sewage water and anthropogenic activity. Geographically study area is situated at latitude $20^0$44'18" N and longitude $78^0$9'90"E.

Sampling : River water samples were collected for physico – chemical and biological analysis from select location during Feb. 2022 to Jan. 2024 for two years as per the standard method[1]. The water samples for phytoplankton were collected using a planktonic net with a mesh size of 25µm. Sterilized 100 mL borosilicate bottles were used to preserve the samples, and Lugol's iodine solution was added immediately for preservation. Onsite measurements of pH, dissolved oxygen, conductivity, TDS (Total Dissolved Solids), and turbidity were conducted. The analysis of other physico-chemical parameters was performed as per standard methods[1]. The identification and enumeration of phytoplankton were conducted using freshwater plankton keys[13,1,14,15].

The two year data on the physico – chemical characteristics of Pothara river are presented in Tables-1 and 2 and phytoplankton composition of Pothara river in Table 3 and 4 respectively. Physico-chemical observation reveled that average range of temperature recorded in summer season was 30.01 ± 1.18, in monsoon 27.35 ± 0.91 and winter season showed 22.30 ± 0.68 respectively during Feb. 2022 to Jan. 2023. During Feb. 2023 to Jan. 2024 showed 30.45± 1.10 in summer, 27.72± 0.80 in monsoon, and 22.77± 0.67 in winter. Increased temperature has enhanced the rate of decomposition by which water enriched the nutrient as well as temperature considered as the most important factor for determining the composition and fluctuations of planktonic growth[16]. Similarly, Mittal and Senger (1989) were concluded that the turbidity, low temperature and total solid enrich the growth of green algae[10]. Kaur *et al.*,[5] have demonstrated that temperature is the primary factor influencing species richness and diversity[5]. The EC values varied between 305.25 ± 4.86 to 404.48± 9.68 µS. The TDS values varied from 198.55± 14.88 to 314.13±

14.60 mg/L. Turbidity of river water was ranged from 03.34±0.64 to 09.92± 1.4 NTU. The pH values of water bodies were alkaline throughout all the seasons. The pH range was found in between studied 7.38 ± 0.03 to 8.41 ± 0.19 and became suitable for the growth of plankton. Variations in D.O. content due to one or more factors, as the temperature, light intensity, turbidity, photosynthetic and respiratory activity. Higher alkalinity reflected pollution of water bodies in which during summer season alkalinity was increased. The alkalinity of water samples was ranged from 108.25 ± 4.96 to 189.30 ± 6.55 mg/L. Biological oxygen demand (BOD) of water was recorded between 04.55 ± 0.28 and 08.88 ± 0.13 mg/L. Free CO_2 concentration was recorded between 01.23 ± 0.09 to 2.82 ± 0.23 mg/L. The concentration of phosphate, nitrate, and chloride increased during both summer and winter seasons, leading to an increase in the plankton population. The presence of nitrate and phosphate content in water bodies has a direct relationship with the growth of phytoplankton, signifying their importance.Two year (Feb. 2022 to Jan. 2024) numerical data of water bodies were documented in table 1 and 2 and was supported by graphical presentation (Fig. 1 and 2).

The algal population in the river comprised 34 genera, of which 17 belongs to Chlorophyceae, 8 to Cyanophyceae, 7 to Bacillariophyceae and 2 to Euglenophyceae (Table 3 and Table 4). Seasonal changes hasinfluenced phytoplanktonic population, most of the species was absent in the period June – September (monsoon season). Throughout the study period, the highest population of Chlorophyceae was observed during the winter season. Some species of Chlorophyceae was present throughout the year viz. *Spirogyra* spp., *Zygnema* spp. and *Closterium* spp. Member of Bacllariophyceae was dominated in winter season followed by Chlorophyceae viz. *Pinnularia* spp., *Diatoma* spp., Mastogloia spp. and *Fragilaria* spp. Diatom species thrive abundantly under conditions of high pH, nitrate levels, organic matter, and low phosphate quantities, as well as in low-temperature environments.The size and morphology of phytoplankton play a crucial role in determining the variability of ecosystems under different environmental conditions[2]. According to Nautiyal *et al.*,[11] and Tarar and Bodkhe[18] diatoms experienced more favorable conditions for multiplication during the winter months. Water temperature and nutrient levels are vital factors that contribute to the increase in both the abundance and diversity of phyto-plankton[12]. Cyanophyceae and Euglenophyceae were most dominant during summer season. Cyanophyceae reached their peak population between the months of April to June and showed a decline in numbers thereafter. *Oscillatoria* spp., *Microcystis* spp., Nostoc spp., *Anabaena* spp., *Scytonema* spp., *Anacystis* spp. were most dominant species during high temperature (Table 1 and 2). This is only because of high value of free CO_2, pH and high turbidity (Table 1 and 2) which favours cyanobacterial growth[19]. In comparison to other classes of algae, the members of Euglenophyceae were found to be the least numerous. The highest number of species belonging to *Phacus* and *Euglena* were observed during the summer season. Kiran *et al.*[6] reported that a higher range of carbon dioxide (15 - 24 mg/L) facilitated the moderate growth of Euglenophyceae[6].

Table-1. Seasonal variation of physico– chemical parameters

Sr. No.	Months → Parameters ↓	February 2022 to January 2023					
		Summer		Monsoon		Winter	
		Mean	SE	Mean	SE	Mean	SE
1	Water Temperature	30.01	± 1.18	27.35	± 0.91	22.30	± 0.68
2	Conductivity	305.25	± 4.86	379.00	± 12.97	287.2	± 15.93
3	T.D.S.	212.98	± 6.58	295.23	± 13.22	198.55	± 14.88
4	Turbidity	09.60	± 1.46	06.39	± 0.52	03.34	± 0.64
5	pH	08.08	± 0.12	07.76	± 0.12	07.38	± 0.03
6	D.O.	06.06	± 0.09	06.71	± 0.11	08.09	± 0.21
7	Total Alkalinity	167.70	± 6.32	130.25	± 4.41	108.25	± 4.96
8	B.O.D.	08.80	± 0.21	07.45	± 0.52	04.55	± 0.28
9	**Free CO_2**	02.70	± 0.22	01.96	± 0.15	01.23	± 0.09
10	Chloride	43.25	± 3.96	32.93	± 2.074	24.21	± 1.19
11	Phosphate	00.51	± 0.06	00.46	± 0.05	0.205	± 0.01
12	Nitrate	00.56	± 0.06	00.92	± 0.04	0.525	± 0.01

Table-2. Seasonal variation of physico – chemical parameters

Sr. No.	Months → Parameters ↓	February 2023 to January 2024					
		Summer		Monsoon		Winter	
		Mean	SE	Mean	SE	Mean	SE
1	Water Temperature	30.45	± 1.10	27.72	± 0.80	22.77	± 0.67
2	Conductivity	331.60	± 5.13	404.48	± 9.68	319.2	± 18.09
3	T.D.S.	231.90	± 5.56	314.13	±14.60	226.2	± 15.11
4	Turbidity	09.92	± 1.47	6.87	± 0.49	03.70	± 0.62
5	pH	08.41	± 0.19	8.068	± 0.20	07.57	± 0.044
6	D.O.	05.90	± 0.12	6.54	± 0.11	07.84	± 0.251
7	Total Alkalinity	189.30	± 6.55	153.05	± 5.02	125.50	± 5.37
8	B.O.D.	08.88	± 0.13	07.46	± 0.49	05.36	± 0.28
9	**Free CO_2**	2.815	± 0.23	02.13	± 0.14	1.51	± 0.06
10	Chloride	44.87	± 3.91	35.23	± 2.29	26.52	± 1.47
11	Phosphate	0.78	± 0.17	0.63	± 0.14	0.27	± 0.03
12	Nitrate	0.58	± 0.07	0.98	± 0.04	0.61	± 0.11

Table-3. Phytoplankton diversty on seasonal variation

Season → Phytoplankton ↓	February 2022 to January 2023		
	Summer	Monsoon	Winter
Cyanophyceae			
Nostoc spp.	++	++	++
Microcystis spp.	+++	ND	++
Rivularia spp.	+++	ND	+++
Scytonema spp.	++	++	++
Anabaena spp.	+++	++	++
Spirulina spp.	+++	++	++
Anacystis spp.	+++	++	++
Oscillatoria	+++	++	++
Bacillariophyceae			
Nitzchia spp.	++	ND	++
Navicula spp.	++	++	++++
Pinnularia spp.	+++	++	+++
Diatoma spp.	+++	++	+++
Mastogloia spp.	+++	++	+++
Fragilaria spp.	+++	++	+++
Gyrisigma spp.	++	++	+++
Chlorophyceae			
Volvox spp.	++	++	++
Pediastrum spp.	++	++	+++
Chlorella spp.	++	++	+++
Ulothrix spp.	++	ND	++
Cladophora spp.	++	++	+++
Oedogonium spp.	++	++	++
Spirogyra spp.	+++	++	++++
Zygnema spp.	++	+++	++++
Closterium spp.	+++	++	++++
Cosmarium spp.	ND	++	+++
Gloeocystis spp	++	++	++
Micrasterias spp.	ND	ND	++
Vaucheria spp.	++	++	+++
Microspora spp.	ND	ND	++
Scenedesmus spp.	ND	ND	ND

Chlorocloster spp.	+ +	+ +	+ + +
Coelastrum spp.	ND	+ +	+ +
Euglenophyceae			
Euglena spp.	+ +	+ +	+ +
Phacus spp.	+ +	ND	+ +

Table-4. Phytoplanktonic diversity on seasonal variation

Season → Phytoplankton ↓	February 2022 to January 2023		
	Summer	Monsoon	Winter
Cyanophyceae			
Nostoc spp.	+ +	+ +	+ +
Microcystis spp.	+ + +	+ +	+ +
Rivularia spp.	+ + +	+ +	+ +
Scytonema spp.	+ +	+ +	+ +
Anabaena spp.	+ + +	+ +	+ +
Spirulina spp.	+ + +	+ +	+ +
Anacystis spp.	+ + +	+ +	+ +
Oscillatoria	+ + +	+ +	+ +
Bacillariophyceae			
Nitzchia spp.	+ +	ND	+ +
Navicula spp.	+ +	+ + +	+ + +
Pinnularia spp.	+ + +	+ +	+ + +
Diatoma spp.	+ + +	+ +	+ + +
Mastogloia spp.	+ + +	+ +	+ + +
Fragilaria spp.	+ + +	+ +	+ + + +
Gyrisigma spp.	+ +	+ +	+ + +
Chlorophyceae			
Volvox spp.	+ +	+ +	+ +
Pediastrum spp.	+ +	+ +	+ + +
Chlorella spp.	+ +	+ +	+ + +
Ulothrix spp.	+ +	+ +	+ +
Cladophora spp.	+ +	+ +	+ + +
Oedogonium spp.	+ +	+ +	+ +
Spirogyra spp.	+ + +	+ +	+ + + +
Zygnema spp.	+ +	+ + +	+ + + +

Closterium spp.	+ + +	+ +	+ + + +
Cosmarium spp.	ND	+ +	+ + +
Gloeocystis spp	+ +	+ +	+ +
Micrasterias spp.	ND	+ +	+ +
Vaucheria spp.	+ +	+ +	+ + +
Microspora spp.	ND	ND	+ +
Scenedesmus spp.	+ +	ND	ND
Chlorocloster spp.	+ +	+ +	+ + +
Coelastrum spp.	ND	+ +	+ +
Euglenophyceae			
Euglena spp.	+ +	+ +	+ +
Phacus spp.	+ +	ND	+ +

+ + + + High % population , + + + Moderate % population, + + Average % population, ND: Not detected

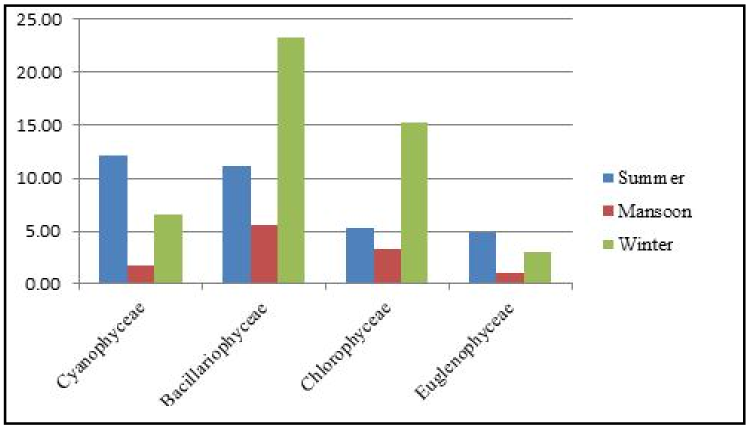

Fig. 1. Seasonal composition of phytoplankton during year February 2022 to January 2023

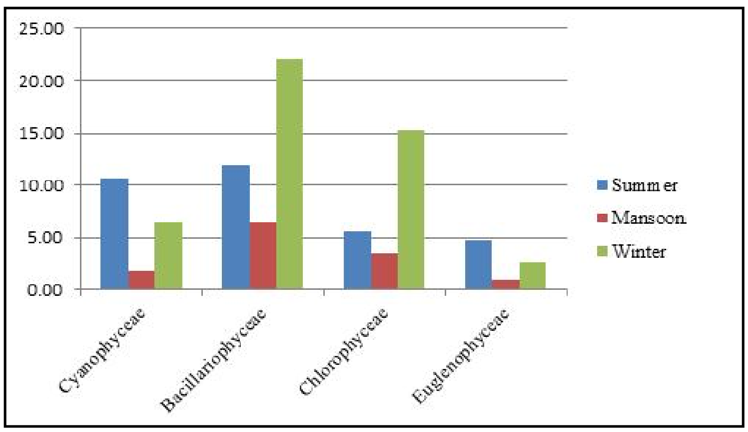

Fig. 2 Seasonal composition of phytoplankton during year February 2023 to January 2024

The study findings indicated that the physico-chemical parameters of Pothara river were within the acceptable limits according to irrigation water quality standards.The investigation revealed that Chlorophyceae and Basillariophyceae thrived more during the winter season, while Cyanophyceae and Euglenophyceae exhibited higher dominance during the summer season.Throughout the year, specific species such as *Pediastrum* sp., *Chlorella* sp., *Oedogonium* sp., *Oscillatoria* sp., and *Euglena* sp. were consistently present. Among these, *Chlorella, Oscillatoria, Anacystis,* and *Nitschia* were identified as reliable indicators of water pollution.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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