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Phytoplankton studies in relation to physico-chemical environment of Bihar River district Rewa (M.P.) India

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Abstract
The primary focus of this research is to examine the biodiversity of phytoplankton as well as the physical and chemical attributes of the Beehar River during the post-monsoon period. Water samples and phytoplankton were collected in the morning using a plankton net with a mesh size of 20 µm. Within the study area, a total of forty-three distinct genera of phytoplankton were identified, categorized into Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae. The investigation also encompassed an analysis of various physico-chemical factors such as temperature, pH levels, dissolved oxygen, carbon dioxide, alkalinity, calcium content, water hardness, nitrate and silicate concentrations, and productivity. The findings demonstrated noticeable disparities in phytoplankton diversity and physico-chemical parameters among different sampling locations.

Keywords: Phytoplankton, physico-chemical parameters, Beehar River

Introduction
The world of phytoplankton, microscopic single-celled organisms thriving in both marine and freshwater environments, is incredibly diverse and fascinating. These organisms serve as the fundamental components of aquatic ecosystems, displaying a wide range of shapes and sizes. Not only do they play a crucial role in food webs beneath the water's surface, but they also serve as primary producers. Through the process of photosynthesis, phytoplankton absorb large quantities of carbon dioxide, rivaling even the most majestic forests and terrestrial plants. Their importance extends further as they act as a critical link between the atmosphere and the ocean, facilitating the exchange of carbon dioxide and producing a significant amount of atmospheric oxygen, comparable to their terrestrial counterparts. Additionally, these remarkable organisms form the foundation of nearly every aquatic food web, playing an essential role in global ecology and ecosystem function. As primary producers, they contribute an impressive fifty percent of the planet's primary production and are crucial in sustaining life through global nutrient cycles, establishing themselves as a unparalleled force within any body of water they inhabit (Biddanda and Benner, 1997) [1].
Phytoplankton populations' composition and abundance are mainly controlled by inorganic nutrients like nitrogen, phosphorus, and silica, especially in the form of nitrate, nitrite, ammonia, and soluble orthophosphate (USEPA, 2000) [2]. The distribution and fluctuations of phytoplankton in freshwater environments are dependent on their physical and chemical characteristics (Cetin and Sen, 2004) [3]. Phytoplankton is commonly used as an indicator of ecological health and the impact of chemical pollutants on aquatic ecosystems (Yu *et al.*, 2014) [4]. Changes in water quality can be observed through alterations in the structure of the biotic community, including phytoplankton, with more delicate species acting as indicators of pollution. To maintain a suitable habitat for aquatic organisms, regular monitoring of physical and chemical factors is necessary. The activity of living organisms is influenced by seasonal and daily variations in these parameters (Akinyeye, 2011) [5]. This study focuses on examining the diversity of phytoplankton populations and the physico-chemical parameters of the Beehar River during the post-monsoon season.

Materials and Methods
It is one of the most important river of Rewa district. Beehar river is North westernly flowing river of Rewa district and is about 97 kilometers long. The river originates in the Kaimore hills of Kharamkheda village (Satna district) at the elevation of 600 meters above sea level in the Satna district (M.P.). After its origin in Kharamkheda, it flows through the hilly tract of Amarpatan, courses through plateau of Huzur and Sirmour tehsil, reaches the edges of plateau of Chachai village, where with its other tributries, it forms a water fall, known as “Chachai fall”.

The river descends about 115 meters below its normal level and flow through a plain, to join the tons rivers, which is one of the important tributaries of Ganga river. Its catchment covers an area of about 1685 sq.km. out of which 636 sq.km. is in Satna and rest 1049 sq.km. in Rewa district. The upstream region consist of Beehar river at Rewa district, Rajghat (Upstream), Jayanti kunj (midstream) and Ajigarha (Downstream) comprises top and down regions. Water samples were collected during the post monsoon season *i.e*., October 2021 to January 2022. Samples were collected during the early morning time before the outbreak of sunlight. Phytoplankton was collected by plankton net Number-20 silk bolting cloth having a mesh of 20µm in size. The samples were collected and stored in a plastic containers and preserved using 4% formalin and Lugol's iodine for better settlement. Microscopic observations were conducted by Magnus (MX 2li clinical) light compound microscope and phytoplankton identified with the help of Fresh water algal identification key established by Desikachary (1959) [6], Prescott (1982) [7] and Philipose (1967) [8]. Physico-chemical characteristics such as temperature, pH, dissolved oxygen, carbon dioxide, alkalinity, amount of calcium, hardness of water, content of nitrate and silicate and productivity were analyzed according to standard procedures (APHA, 2001) [9].

Results and Discussion

Following the conclusion of the monsoon season, a wide range of phytoplankton diversity was recorded in the study's findings. A total of forty-three genera were identified, with four major families being highlighted. The most abundant was Chlorophyceae, which had the highest number of representatives, closely followed by Bacillariophyceae, Cyanophyceae, and Euglenophyceae, the latter having the fewest amount. It is worth noting that the river displayed a dominance of eighteen Chlorophyceae species, while Euglenophyceae had a smaller count of three. (Table 1).

The complex relationships between a wide variety of phytoplankton species and the physical and chemical properties of aquatic ecosystems are unquestionably deep. The growth and abundance of phytoplankton are deeply connected to the current physicochemical conditions, whether influenced directly or indirectly. The presence of *Navicula, Cymbella, Nitzchia* and *Oscillatoria* serves as a telltale sign of water contamination, acting as steadfast indicators thereof. Overall, the broader phytoplankton communities can be judiciously employed as invaluable barometers of pollution, facilitating an accurate assessment of water quality (Usman, 2016) [10]. The occurrence of *Ocillatoria* in the present study also indicates pollutants of biological origin (Altaf and Saltanat, 2014) [11]. It is evident from the results that the river is progressing from the oligotrophic to the mesotrophic state (Sharma *et al.* 2017) [12]. In the downstream, the water temperature reached its peak at a balmy 27 °C. The concentration of hydrogen ions, a crucial factor, plays a vital role in the biological functions of all aquatic creatures (Wetzel, 1975) [13]. In the current analysis, the pH levels spanned from 6.99 to 7.89, signifying a delicate balance in the aquatic ecosystem. The presence of dissolved oxygen emerges as a pivotal element crucial for the survival of underwater organisms, a notion well-expounded upon by Namdeo and Singh (2021b) [14]. The upstream area was found to have the most elevated level of dissolved oxygen. Significant variations in nutrient levels, including nitrate, phosphate, and silicate, were observed in different regions. A detailed summary of the results pertaining to the physico-chemical elements can be accessed in Table 2.

Table 1: Phytoplankton diversity in Beehar River at Rewa during post monsoon season

S. No.	Class	S. No.	Phytoplankton	Upstream	Midstream	Downstream
1.	Bacillariophyceae	1.	*Amphora*	+	-	-
		2.	*Aulacoseira*	+	-	+
		3.	*Cocconeis*	+	+	-
		4.	*Cyclotella*	+	-	+
		5.	*Cymbella*	+	+	+
		6.	*Diadesmis*	-	-	+
		7.	*Fragilaria*	+	-	+
		8.	*Gomphonema*	+	+	+
		9.	*Gyrosigma*	+	-	+
		10.	*Melosira*	-	+	+
		11.	*Navicula*	+	+	+
		12.	*Nitzschia*	+	+	+
		13.	*Pinnularia*	+	+	+
		14.	*Stephanodiscus*	+	-	-
		15.	*Surirella*	+	+	+
		16.	*Synedra*	+	+	+
		17.	*Tabellaria*	+	+	+
2.	Chlorophyceae	18.	*Chlorella*	+	+	+
		19.	*Closterium*	+	-	+
		20.	*Cloteriopsis*	+	+	+
		21.	*Coelastrum*	-	+	+
		22.	*Cosmarium*	+	+	+
		23.	*Euastrum*	+	-	+
		24.	*Kirchneriella*	-	+	+
		25.	*Micrasterias*	+	-	+
		26.	*Microspora*	+	-	-
		27.	*Oedogonium*	-	+	-
		28.	*Onychonema*	-	-	+
		29.	*Pediastrum*	+	+	+
		30.	*Scenedesmus*	+	+	+

		31.	*Spirogyra*	+	+	-
		32.	*Spondylosium*	-	-	+
		33.	*Staurodesmus*	+	+	+
		34.	*Volvox*	-	-	+
		35.	*Xanthidium*	+	-	+
3.	Cyanophyceae	36.	*Anabaena*	-	+	+
		37.	*Lyngbya*	+	+	-
		38.	*Merismopedia*	+	-	-
		39.	*Oscillatoria*	-	+	+
		40.	*Spirulina*	+	+	-
4.	Euglenophyceae	41.	*Euglena*	+	+	+
		42.	*Phacus*	-	+	+
		43.	*Trachelomonas*	-	-	+

Table 2: Physico-chemical qualities of the water samples

S. No.	Parameters	Upstream	Midstream	Downstream
1.	Temperature (°C)	27	28	30
2.	PH	6.6	7.89	6.99
3.	Dissolved oxygen (mg/l)	5.9	4.6	3.9
4.	CO_2 (mg/l)	5	7	10
5.	Alkalinity (mg/l)	11.4	18.3	26.7
6.	Calcium (mg/l)	5.18	3.98	4.35
7.	Hardness of water (mg/l)	15.9	19.3	20.1
8.	Nitrate (mg/l)	0.123	0.095	0.166
9.	Phosphate (mg/l)	0.137	0.087	0.037
10.	Silicate (mg/l)	0.187	0.203	0.264
11.	Productivity of the water (mg/C/l/hr)	0.535	0.464	0.236

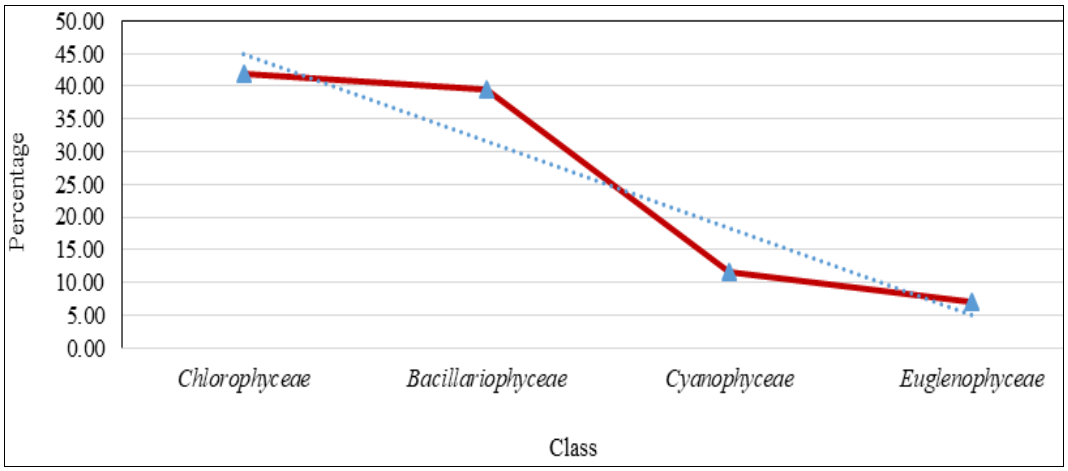

Fig 1: Graph analysis of class % age presentation of phytoplaktonic diversity

Conclusion

During the post-monsoon season, an interesting relationship is observed in Rewa's Beehar river between the variety of phytoplankton present and various physico-chemical factors. Chlorophyceae are notably more abundant than other types, making them useful for assessing water quality. Furthermore, there are differences in the physico-chemical parameters at various points along the river.

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