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Phytoplankton as an Indicator of the River Water Quality: A case Study in the Tail race of River Dikhow, Assam, India

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ABSTRACT: The present study was carried out for three consecutive years (2011-2014). Investigations were carried out on the diversity and percentage composition of phytoplankton species in the tail race of Dikhow river. Dikhow is a southern tributary of the mighty river Brahmaputra originating from Naga Hills. Phytoplankton diversity was used as an indicator to assess the water quality of the river. The aim of this study was to understand the pollution status of the river and analyze the diversity and distribution pattern of phuytoplankton which was influenced by the rainfall. During the study, four groups of phytoplankton were recorded which belong to group Chlorophyceae, Euglanophyceae, Bacillariophyceae and Myxophyceae. *Bacillariophyceae* and *Chlorophyceae* were more abundant both qualitatively and quantitatively. The percentage distribution of *Bacillariophyceae and* c*hlorophyceae* was found to be 50% and 32.37 % respectively. Abundance of Bacillariophyceae with 50% relative occurrence could be recognized as a good indication of the pollution of the river.

Keywords: Phytoplankton, Brahmaputra, Bacillariophyceae, Chlorophyceae, Euglanophyceae

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INTRODUCTION

Phytoplanktons can be considered as the base of an aquatic ecosystem and plays an important role in the ecosystem functioning and services (Buric *et al*, 2007). Climate can change the environmental factors and also has an impact on the phytoplankton diversity, composition, distribution and also the taxonomy. Phytoplankton study may be fruitful and useful for the study of biotic potential ad diversity of an aquatic ecosystem (Badsi *et al*, 2012; Nassar and Ghanib, 2014). Diversity, distribution and growth of phytoplankton is influenced by availability of nutrients and ecological factors (Dutta *et al*, 2009; Bhivgade *et al*, 2010; Ahmed and Wanganeo, 2015).

River Dikhow is one of the major tributaries of the mighty river Brahmaputra. It originates from Naga Hills and confluences to Brahmaputra at Dikhowmukh. The composition of plankton may be used as a reliable tool for biomonitoring study and assessment of the ecological study of the water body. As a river is a running water ecosystem, they are perhaps the most impacted ecosystem on the planet as they have been the focus for human settlement and are heavily exploited for water supplies, irrigation, electricity generation, and waste disposal (Malmquvist and Rundle, 2002).

The quality of the water is impacted by the dominating geology of its drainage as well as the surrounding land use. It may be said that whatever goes on within a river's or stream's drainage may ultimately affect the ecology of that stream (Hutchinson, 1993) Organisms, populations and communities composed of different species make up the biological diversity of aquatic ecosystems. Aquatic organisms, often considered 'engineers' of aquatic ecosystems, not only react to physical and chemical changes in their environment, but also they can drive such changes and have important roles in cleansing and detoxifying their environment (Ostroumov, 2005). The physical and chemical parameters exert their influence both, individually and collectively and their interaction creates a biotic environment, which ultimately conditions the origin, development and finally succession of the biotic communities. The cumulative effect of physical, chemical, biological and environmental influences the ecological status of a water body. Qualitative and quantitative studies of the biological groups in a water body establish a system to assess the health and ecological status of the water body (Ansari and Singh, 2017).

Planktons are the starting point of energy transfer and source of utmost importance for the ecological development of an aquatic ecosystem. The present study was conducted to analyze the diversity and distribution of phytoplankton in the tail race of Dikhow river and to study the influence on the river ecology.

MATERIAL AND METHODS

A. Study Area

The study area is the tailrace of Dikhow River, a 65 km. stretch from Nazira to the river confluents to the Brahmaputra at Dikhowmukh. The stretch was demarcated into five stations longitudinally. Samples were collected and studied for consecutive three years (from 2011-2014) on a seasonal basis viz., pre-monsoon (Mar.-May), monsoon (Jun.-Aug.), post-monsoon (Sept.-Nov.) and winter (Dec.-Feb.).

B. Sampling sites

The study was conducted at five sampling stations viz. station I, station II, station III, station IV and station V (Fig. 1) over a period of three years. The selected study area is the tailrace of Dikhow River, covering a stretch of 65 km. The study area has been demarcated into five stations as shown in Fig.1.

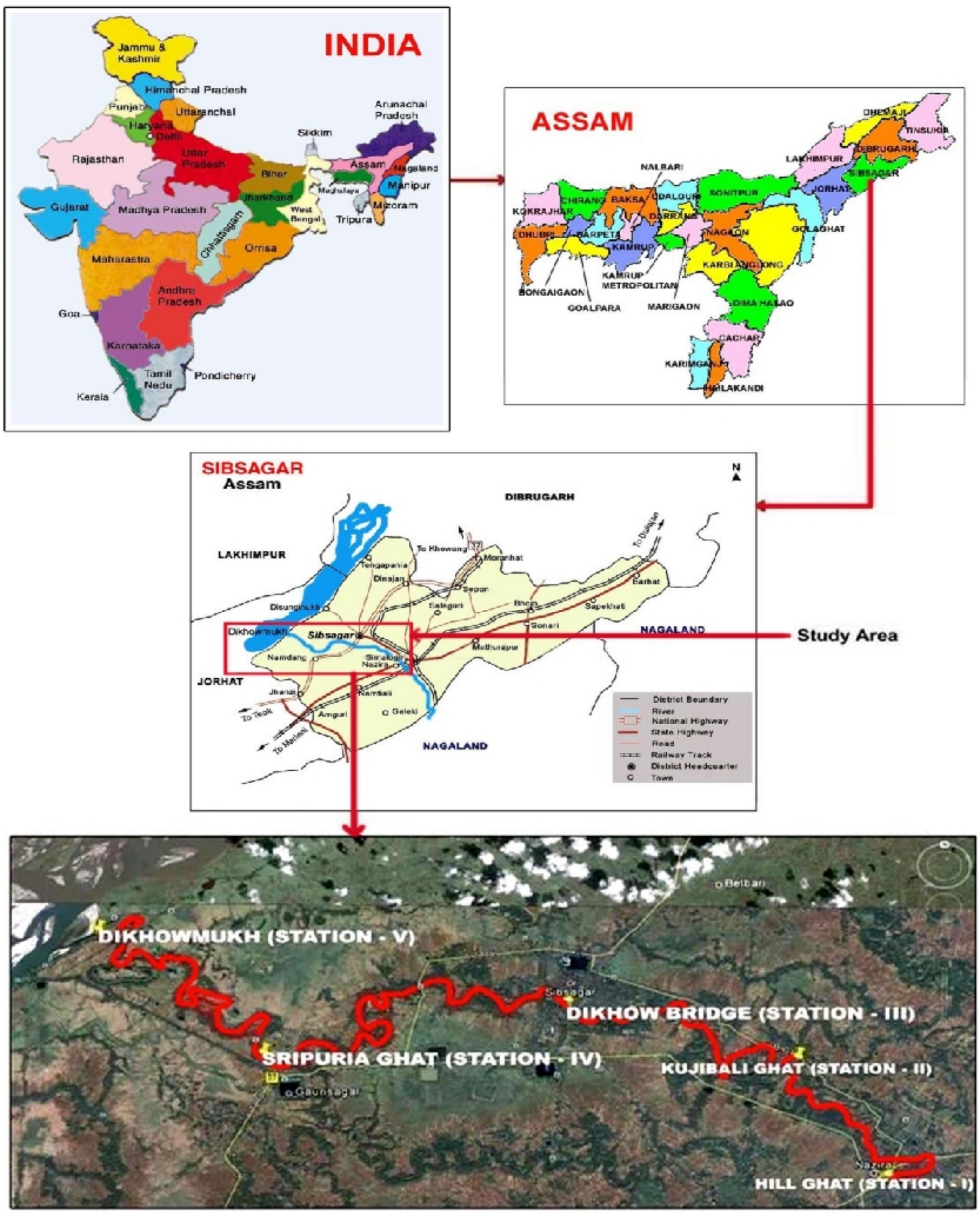

Fig. 1. Location map of the study area.

Station I: Silghat- Nazira (N-26º54'51.6" and E-94º44'14.6")
Station II: Kujibali- Hanhsora (N-26º57'2.3" and E-94º42'30.2")
Station III: Dikhow bridge- Sivasagar (N-26º58'35.1" and E-94º37'49.2")
Station IV: Baliaghat-Gourisagar (N-26º58'48.9" and E-94º30'49.4")
Station V: Dikhowmukh (N- 26º59'58.5" and E-94º28' 03.9")

Sampling. Phytoplankton samples were collected from the selected stations seasonally (pre-monsoon, monsoon, post-monsoon and winter) over a period of three years. For convenience, pre-monsoon and monsoon were considered as wet seasons and post-monsoon and winter were considered as dry seasons.

Sampling and laboratory analysis were conducted in accordance with the standard methods of de Vlaming *et al*., (2006), Sharma (1999), Battish (1992), Needham and Needham (1966), (1988), Edmonson (1978, 1959). For laboratory analysis, the phytoplankton samples brought from the field were allowed to settle at least overnight. The laboratory method followed a modification of de Vlaming *et al.*, (2006).

The quantitative analysis of phytoplanktons was done by using Sedgwick-Rafter counting chamber following the method given in APHA (2000).

Plankton abundance and density was calculated counts/ml of the original sample using the equation: (Boyd, 1981; APHA, 1992).

$$D = T\,(1000) \times V_c \,/\, AN \times V_s$$

Where
D = Density of plankton (ind/mil)
T = Total number of planktons counted
A = Area of grid in mm^2,
N = Number of grids employed
1000 = Area of counting chamber (mm^2),
V_c and V_s = Volumes of concentrate and sample respectively

RESULT

A total of 29 phytoplankton species belonging to four classes (Bacillariophyceae, Chlorophyceae, Euglenophyceae and Myxophyceae) were quantified through the analysis of samples collected from 05 stations in 04 seasons. Bacillariophyceae made up the highest number (11 genera, 11 species) followed by Chlorophyceae (6 genera, 8 species). Bacillariophyceae and Chlorophyceae were more abundant both qualitatively and quantitatively (50%) and (32.37 %) respectively than the other taxonomic groups (Table 1). Annual mean density of phytoplankton was highest in station II (17.5 ± 7.35) followed by the same in station V where the value was 17.25 ± 7.93 (Table 1). The diversity of the phytoplankton community of overall sites in the tail race of the Dikhow was dominated by diatoms (Table 2). Distribution pattern of Phytoplankton diversity in the tail race of Dikhow river is presented in Table 2. Chlorophyceae was highest in station II followed by Bacillariophyceae Euglenophyceae and Myxophyceae were found to be equally abundant. Percentage composition of phytoplankton in the tail race of Dikhow river was dominated by Bacillariophyceae followed by that of Chlorophyceae as shown in Fig. 2.

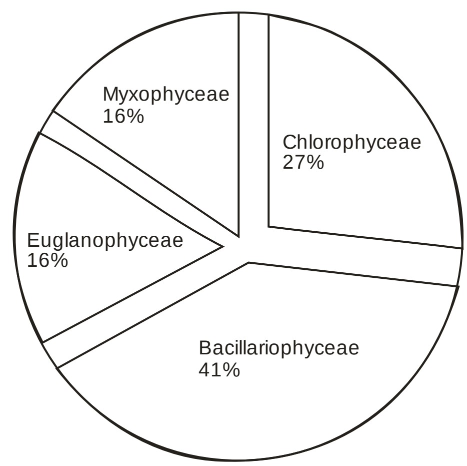

Fig. 2. Percentage composition of phytoplankton in the tail race of River Dikhow.

Increased flow velocities and turbulent flow may also lead to increased turbidity in waterholes and reduce the production of phytoplankton (Bunn *et al.,* 2003).

Thus suppression of algal production for one to two weeks is predicted to have significant effects on short-term food availability for aquatic biota (Bunn *et al.*, 2006, a, b). Algal production in the tail race has been found to be a significant contributor to the biomass carbon of aquatic biota, including fish and turtles (Bunn *et al*., 2003).

Table 1: Annual mean density and percentage composition of phytoplankton in River Dikhow.

	Stations(org/ml)					%
Phytoplankton class	**I**	**II**	**III**	**IV**	**V**	**Composition**
Chlorophyceae	13	19	13	16	18	32.37%
Bacillariophyceae	23	29	20	23	30	50.00%
Euglenophyceae	9	11	9	9	11	20.08%
Myxophyceae	9	11	9	10	10	20.08%
Mean ±S.D.	13.5±5.72	17.50±7.39	12.74±4.9	14.50±5.59	17.25± 7.98	

Table 2: Distribution of phytoplankton in River Dikhow.

Sr. No.	Name of species	Org/l	Sr. No	Name of species	Org/l
	Chlorophyceae				
1.	*Chlorella vulgaris*	20,000	**16.**	*Gyrosigmaspencerii*	5000
2.	*Cladophoraglomerata sp.*	2000	**17.**	*Raphidonema sp.*	6000
3.	*Closteriumturgidium*	3000	**18.**	*Stauroneisacuta*	4000
4.	*Clolestrumreticulatum*	1000	**19.**	*Surirellaovalis*	2000
5.	*Microsporaquadrata*	2000	**20.**	*Synedrapulchella*	4000
6.	*Nostoc sp.*	10,000		**Myxophyceae**	
7.	*Oedogoniumgracilis*	5000	**21.**	*Anabaena fertilissima*	500
8.	*Spirogyra pratensis*	15,00	**22.**	*Lyngbyalimnetica*	400
9.	*Spirogyra singulariasis*	14,00	**23.**	*Nostocvaginicola*	1000
	Bacillariophyceae		**24.**	*Oscillatorialimnetica*	1200
10.	*Asterionellagracillima*	17,000	**25.**	*Oscillatoriahomogeneae*	100
11.	*Calonesia sp.*	20,000		**Euglenophyceae**	
12.	*Cocconeis sp.*	10,000	**26.**	*Euglena acus*	1800
13.	*Cyclotellaocellata*	10,000	**27.**	*Euglena viridis*	1500
14.	*Denticulaelegens*	3,000	**28.**	*Phacuscaudatus*	500
15.	*Diatomaelongatum*	5,000	**29.**	*Phacusviridis*	700

Formation of these productive benthic algal zones is clearly facilitated by stable water levels associated with periods of low flow. Algae are able to track the narrow photic zone as the water recedes due to evaporation and appear to be reasonably tolerant of short-term desiccation (Arthington *et al*., 2006). During the present study, Phytoplankton abundance and species composition showed both spatial and seasonal variation. The species recorded at different sampling stations belonged to the genera *Chlorella, Cladophora, Closterium, Microspora, Oedogonium, Spirogyra, Asterionella, Calonesia, Cocconeis, Cyclotella, Denticula, Diatoma, Gomphonema, Gyrosygma, Raphidonema, Stauroneis, Surirella, Syndera, Anabaena, Lyngoloya, Nostoc, Oscilatoria, Euglena,* and *Phacus*. Most of these are tolerant to organic pollution. (Sakset and Chankaew, 2013; Rott *et al*., 2008; Palmer, 1969). Thus their presence may indicate organic pollution of the river. Phytoplanktons are very susceptible to changes in the environment, and large variations in phytoplankton species composition are often a reflection of significant alteration in ambient conditions within an ecosystem. (Rajagopal *et al.*, 2010; Madhu *et al.*, 2007). Plankton communities in the river can be served as an indicator for the change in ecosystems under the pollution stress. Many workers have reported many algal species belonging to Bacillariophyceae and hlorophyceae as indicator of water pollution (Naik *et al*, 2005, Zargar and Ghosh, 2006). The tail race of Dikhow river was found to be subjected to acute pollution due to addition of industrial effluents, fertilizers from agricultural lands and domestic sewage. Progressive enrichment of the river water with certain nutrients may result in the mass production of algae which may increase the productivity and undesirable biotic changes (Ahmed, 1996).

CONCLUSION

It is summarized from the present study that the down stream of Dikhow river is polluted. In the present study phytoplankton diversity was dominated by diatoms. Diatoms respond to a certain number of environmental and biological variables. Because of their sensitivity, they may act as reliable bioindicators. They act as pollution indicator in the present study. On the other hand the diversity indices also indicate the pollution level of the river. Bacillariophyceae and Chlorophyceae dominance indicate organic pollution in the river. The effect of anthropogenic stress was also identified through the phytoplankton structure and diversity study. Exposure of organic pollution was identified during the study, Hence certain anthropogenic activities near the river should be regulated to ensure its protection and conservation. Which may contribute to national development and improvement of water resources.

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DATA AVAILABILITY STATEMENT

The data will be available only on request: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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