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Studies on Diversity and Abundance of Fresh Water Diatoms as Indicators of Water Quality in Glacial fed Goriganga River, India

Ashok Kumar
Department of Zoology, Kumaun University, Soban Singh Jeena Campus Almora, Uttarakhand, 263601, INDIA

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Abstract

Diatoms are a major group of algae and are among the most common types of phytoplankton. The diatoms are not only the source of food for fry, fingerlings, young and adult fish, but also influences the abiotic features in the river. Diatoms are important not only for fishery management point of view but also because they are the biological indicators of pollution. Samples for monitoring diversity and abundance of diatoms as indicators of water quality were collected monthly from July-2006 to June-2008 at three selected spots (Spot-1, Jauljibi; Spot-2, Baram and Spot-3, Madkot) for a period of two years. A total of 27 genera of Diatoms (Achnanthes, Amphipleura, Amphora, Bacillaria, Biddulphia, Brebissonia, Caloneis, Cocconeis, Cymatopleura, Cymbella, Denticula, Diatoma, Diatomella, Epithelmia, Eunotia, Fragilaria, Frustulia, Gomphoneis, Melosira, Meridion, Navicula, Nedium, Nitzchia, Pinnularia, Rhicosphenia, Synedra and Tabellaria) were recorded during the course of study which belongs to 11 families of class bacillariophyceae (Cosconodisceae, Biddulphiniaceae, Fragilariaceae, Achnanthaceae, Eunotiaceae, Naviculaceae, Gomphonemaceae, Cymbellaceae, Epithelmiaceae, Nitzschiaceae and Surirellaceae). Most of the Diatoms were present round the year while some ten genera of Bacllariophyceae (Achnanthes, Amphora, Bacillaria, Denticula Diatoma, Navicula, Nitzchia, Pinnularia, , Synedra and Tabellaria) were fairly common at all the selected spots. It was also observed that six genera of Diatoms (Navicula, Nitzschia, Fragilaria, Synedra, and Tabellaria) were recorded as pollution indicator in the present study but their population was very low. Diversity of Diatoms increased from upstream to downstream. A sharp distinction in numerical population of Diatoms were clearly observed at different selected spots in Gorioganga river. Monthly, Seasonal, yearly and spot-wise variations in diversity and abundance of fresh water diatoms of Goriganga river at different selected spots have also been discussed in detail.

Keywords: Diversity, abundance, diatoms, water quality, Goriganga River.

Introduction

Diatoms are considered to be one of the most important tool for the assessment of environmental condition, commonly used as an indicators of water quality. In many countries, diatoms have been used as indicator of river pollution[1-3]. The Diatoms are most diverse and important group of eukaryotic microorganisms on earth and are probably well in excess of 100,000 species[4]. Diatoms are found in both fresh water and marine environments as well as in moist soil. Diatoms are the essential components of primary productivity in aquatic environment. Due to difficulties in the survey and sampling of fast flowing rivers, the investigations on diatoms in river are scanty. However, fresh water diatoms in India have been studied extensively[5-14]. Diatoms constitute an important link in the nutrient cycle of an aquatic ecosystem as the present study was conducted to obtain overall picture of diversity and abundance of diatoms as indicators of water quality. The Goriganga river originates from a dual source in a glacier near south of Untadhura ridge feeding the eastern branch and another glacier near Milam (3600 msl) just north east of Nanda Devi, feeding the western branch[15]. Historically Uttarakhand is believed to be the land where the Vedas and Shastras were composed and the great epic, the Mahabharata was written. The geographical location of the selected river and sampling sites for the present study are shown in fig-1. In Goriganga valley the diatom flora has not been examined from origin to mouth. In view of the above fact, the present study was initiated to generate baseline data on taxonomic richness.

Material and Methods

The samples of Diatoms were collected monthly and seasonally in the Goriganga river at three selected spots, (Spot-1, Jauljibi-600 msl; Spot-2, Baram-900 msl and Spot-3, Madkot- 1300msl*)* by filtering 50 ltr. of the sub-surface water sample through planktonic net made up of bolting silk cloth no. 20 (mesh size 0.06 mm). The filtrate thus obtained were brought to the laboratories of Zoology Department, Almora and centrifuged at a moderately high speed, preserved in 5 % formalin and logule's solution separately for further study i,e for qualitative and quantitative analysis. Identification was done following Ward and Whipple[16] Kant and Gupta[17], APHA[18] and Dass[19]. Counting was done by drop count method using Haemocytometer/Sedgwick rafter counting cell and quantity was estimated in terms of units/l by the standard formula as suggested by Adoni[20].

$$\text{Organisms/l} = A \times \frac{1 \times n}{L \times V}$$

Where: A = No. of organisms per drop. L = Volume of original sample. N = Total volume of concentrated sample. V = Volume of one drop in ml.

Results and Discussion

The results presented in the paper are based on the qualitative and quantitative studies of diatoms (class-Bacillariophyceae) conducted on glacial fed mountainous Goriganga river from July 2006 to June 2008.

Qualitative composition of Diatoms in Goriganga river during 2006-07 and 2007-08 at three spots has been depicted in table-1. Qualitative estimation of diatoms revealed that some 27 genera of diatoms(*Achnanthes, Amphipleura, Amphora, Bacillaria, Biddulphia, Brebissonia, Caloneis, Cocconeis, Cymatopleura, Cymbella, Denticula, Diatoma, Diatomella, Epithelmia, Eunotia, Fragilaria, Frustulia, Gomphoneis, Melosira, Meridion, Navicula, Nedium, Nitzchia, Pinnularia, Rhicosphenia, Synedra and Tabellaria*) were recorded during the course of present study table-1, which belongs to 11 families of class *bacillariophyceae* (*Cosconodisceae, Biddulphiniaceae, Fragilariaceae, Achnanthaceae, Eunotiaceae, Naviculaceae, Gomphonemaceae, Cymbellaceae, Epithelmiaceae, Nitzschiaceae and Surirellaceae*). During first year (2006-07), total 24 genera were recorded from all the selected spots which belongs to 10 families of class *bacillariophyceae* (*Coscinodisceae, Biddulphiniaceae, Fragilariaceae, Achnanthaceae, Naviculaceae, Gomphonemaceae, Cymbellaceae, Epithelmiaceae, Nitzchiaceae and Surirellaceae*). Maximum 22 genera were recorded at spot-1, 19 genera at spot-2 and minimum 18 genera were recorded at spot-3 table-1. Maximum 8 genera were recorded in family *Naviculaceae* followed by 4 genera in *Fragilariaceae,* 2 genera in *Achnanthaceae, Cymbellaceae, Epithelmiaceae* and *Nitzchiaceae* each while minimum one genus was recorded in *Coscinodisceae, Biddulphiniaceae, Gomphonemaceae* and *Surirellaceae* families each.

During second year (2007-08), total 27 genera were recorded from all the selected spots which belongs to 11 families of class *bacillariophyceae (Cosconodisceae, Biddulphiniaceae, Fragilariaceae, Achnanthaceae, Eunotiaceae, Naviculaceae, Gomphonemaceae, Cymbellaceae, Epithelmiaceae, Nitzschiaceae and Surirellaceae).* Maximum 24 genera were recorded at spot-1, 22 genera at spot-2 and minimum 18 genera were again recorded at spot-3 Table 1. Maximum 8 genera were again represented by family *Naviculaceae* followed by 5 genera by *Fragilariaceae*, 3 genera by *Achnanthaceae*, 2 genera by *Cymbellaceae, Epithelmiaceae* and *Nitzchiaceae* each whereas minimum one genus was represented by *Coscinodisceae, Biddulphiniaceae, Eunotiaceae, Gomphonemaceae* and *Surirellaceae* each. The diversity of diatoms increased from upstream to downstream. It was also observed that diversity of diatoms varied spot-wise, yearly, altitudinally and seasonally.

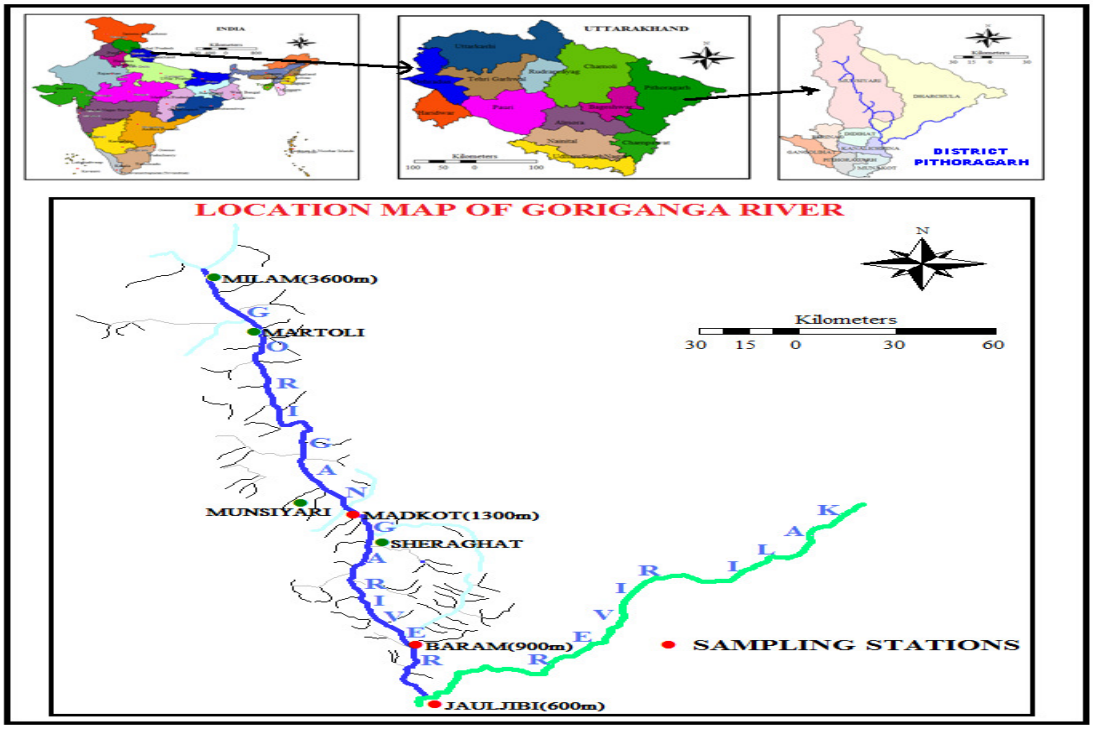

Figure-1

Location map showing geographical location of the Goriganga river and sampling sites Jauljibi-1 (600 MSL), Baram-2 (900 MSL) and Madkot-3 (1300 MSL) for the present study

In the present study table-1, it was also observed that six genera of Diatoms (*Navicula, Nitzschia, Fragilaria, Synedra, and Tabellaria*) were recorded as pollution indicator in the present study but their population was very low.

Quantitative estimation in diatoms showed sharp distinction in numerical population observed at different sampling stations in Goriganga river table-2. During first year (2006-07) the diatom population at sot-1 was observed to be rising from summer season (35.84%) and reached the maximum during winter season (56.84%) and at spot-2, the maximum diatom population was recorded in winter season (50.83%) and same trend of diatom population (53.49%) was observed at spot-3 during winter season in the present study table-3, figure-4. While the minimum diatom population density (7.30%, 8.90% and 9.42%) was recorded at spot-1, spot-2 and spot-3 respectively during monsoon season in the present study during first year (2006-07) table-3, figure-4. The study of second year (2007-08), showed the same seasonal rhythm of diatom population density Table-3. During second year (2007-08) diatom population increased from summer season (36.57%, 31.96% and 36.86%) and reached the maximum during winter season (54.82%, 60.32% and 54.50%) at spot-1, spot-2 and spot-3 respectively in the present study table-3, figure-5. Whereas the lowest diatom population density during second year (2007-08) was observed similar to the first year (2006-07) in monsoon season (8.59%, 7.70% and 8.62%) at spot-1, spot-2 and spot-3 respectively in the present study table-3, figure-5. It showed that maximum diatom population density in winter season may be due to low temperature and low velocity of water, moderate in summer season and minimum in monsoon season due to high temperature and velocity of water. It was also observed that January samples during both the years revealed a maximum diatom population (640 units/l at spot-1and 512 units/l at spot-2) except at spot-3 during 2006-06 where maximum diatom population (504 units/l) was recorded in December table-2, figure-2. During second year (2007-08) maximum diatom population density (596 units/l, 512 units/l and 548 units/l) was recorded at spot-1, spot-2 and spot-3 respectively in the month of January table-2, figure- 3.

Table-1
Qualitative composition of Diatoms in Goriganga river during 2006-07 and 2007-08

Genera	**July 2006-June 2007**			**July 2007-June 2008**		
Bacillariophyceae	**Jauljibi (Spot-1)**	**Baram (Spot-2)**	**Madkot (Spot-3)**	**Jauljibi (Spot-1)**	**Baram (Spot-2)**	**Madkot (Spot-3)**
Achnanthes	+	+	+	+	+	+
Amphipleura	-	+	+	+	+	+
Amphora	+	+	+	+	+	+
Bacillaria	+	+	+	+	+	+
Biddulphia	+	-	-	+	-	-
Brebissonia	+	+	-	+	+	-
Caloneis	+	-	-	+	+	-
Cocconeis	-	-	-	+	+	+
Cymatoplerua	+	+	+	-	-	+
Cymbella	+	+	+	+	+	-
Denticula	+	+	+	+	+	+
Diatoma	+	+	+	+	+	+
Diatomella	-	+	+	+	+	+
Epithelmia	+	-	+	+	+	+
Eunotia	-	-	-	-	+	+
Fragilaria	+	+	+	+	+	-
Frustulia	+	+	-	-	+	+
Gomphoneis	+	-	+	+	+	-
Melosira	+	+	-	+	-	-
Meridion	-	-	-	+	+	+
Navicula	+	+	+	+	+	+
Nedium	+	+	+	+	-	-
Nitzschia	+	+	+	+	+	+
Pinnularia	+	+	+	+	+	+
Rhicosphenia	+	-	-	+	-	-
Synedra	+	+	+	+	+	+
Tabellaria	+	+	+	+	+	+
Total	22	19	18	24	22	18

Highest annual percentage of diatom population was recorded at spot-1 (35.67% and 36.85) during 2006-07 and 2007-08 respectively, whereas the lowest annual percentage of diatom population was recorded at spot-2 (32.07% and 28.01%) during 2006-07 and 2007-08 respectively in the present study table 2. Monthly the lowest population density of diatoms was recorded in the month of August (16 units/l, 12 units/l and 18 units/l) at spot-1, spot-2 and spot-3 respectively during 2006-07, while it was in the month of July (16 unis/l, 8 units/land 12 units/l) at spot-1, spot-2 and spot-3 respectively during 2007-08 table-2, figure-2 and 3. Some genera like, *Achnanthes, Amphora, Bacillaria, Denticula, Diatoma, Navicula, Nitzschia, Pinnularia, Synedra and Tabellaria* were commonly present at all the spots table-1.

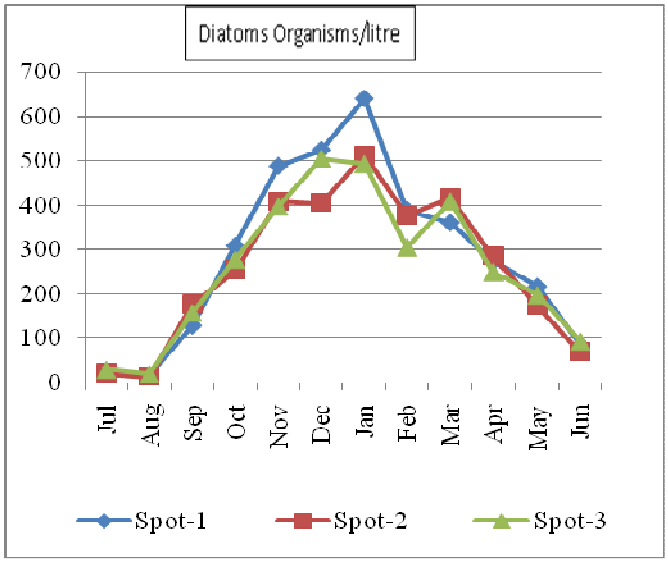

Figure-2
Monthly variations in Diatom population at three spots in Goriganga River during 2006-07

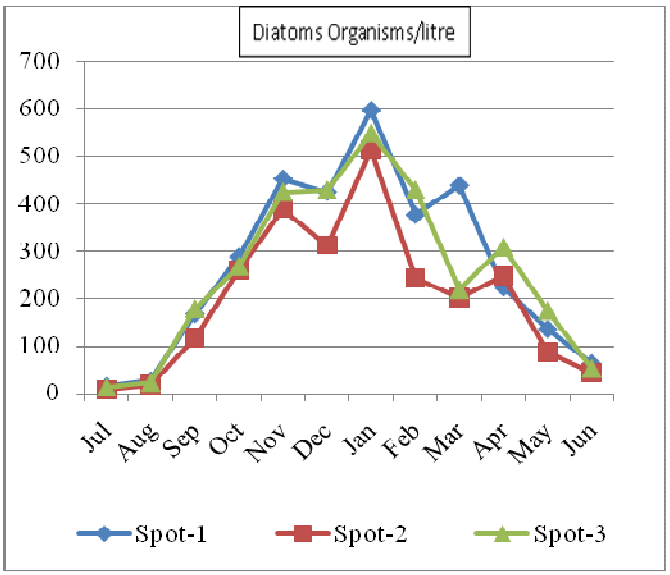

Figure-3
Monthly variations in Diatom population at three spots in Goriganga River during 2007-08

Conclusion

From the results, it can be concluded that Goriganga river harbours 27 genera of diatoms which belongs to 11 families of class *bacillariophyceae*. Six genera of diatoms were recorded as pollution indicator but their population was very low. Diversity of diatoms increased from upstream to downstream. Seasonally highest population density was recorded in winter season because of low temperature and low velocity of water and minimum population density of diatoms was recorded in monsoon season. Highest annual percentage of diatom population was recorded at spot-1 and the lowest annual percentage of diatom population was recorded at spot-2 during the entire course of study.

Table-2
Quantitative abundance of Diatoms at three spots in the Goriganga river during 2006-07 and 2007-08

Month	Diatoms units/l 2006-07			Diatoms units/l 2007-08		
	Spot-1 (Jauljibi)	Spot-2 (Baram)	Spot-3 (Madkot)	Spot-1 (Jauljibi)	Spot-2 (Baram)	Spot-3 (Madkot)
Jul	24	20	28	16	8	12
Aug	16	12	18	28	18	22
Sept	128	176	156	168	118	178
Oct	308	252	276	288	260	268
Nov	488	408	396	452	388	424
Dec	524	404	504	424	312	428
Jan	640	512	492	596	512	548
Fer	388	376	304	376	242	428
Mar	360	416	408	438	202	218
Apr	272	284	248	224	248	308
May	216	172	196	136	88	174
Jun	84	68	92	64	44	52
Total	3448	3100	3118	3210	2440	3060
Annual %	35.67%	32.07%	32.25%	36.85%	28.01%	35.13%

Table-3
Seasonal percentage of Diatoms at three spots in the Goriganga river during 2006-07 and 2007-08

Season	% Population					
	Diatoms 2006-07			Diatoms 2007-08		
	Spot-1	Spot-2	Spot-3	Spot-1	Spot-2	Spot-3
Monsoon	7.30	8.90	9.42	8.59	7.70	8.62
Winter	56.84	50.83	53.49	54.82	60.32	54.50
Summer	35.84	40.25	37.07	36.57	31.96	36.86

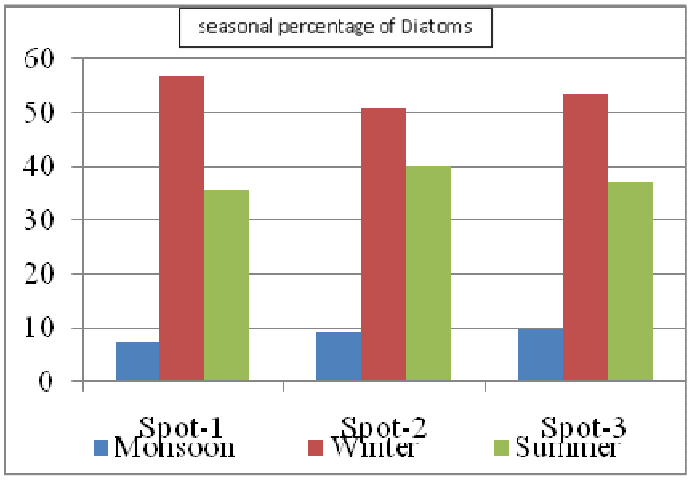

Figure-4
Seasonal percentage of Diatoms at three spots in the Goriganga river during 2006-07

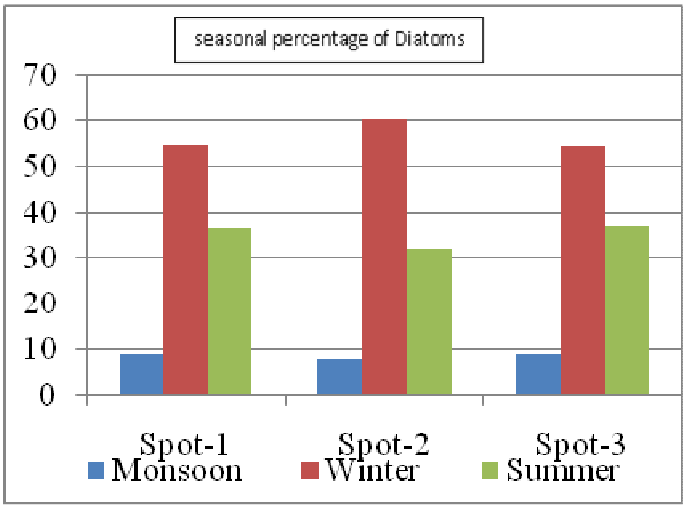

Figure-5
Seasonal percentage of Diatoms at three spots in the Goriganga river during 2007-08

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