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Research Article

Seasonal Variation of Diatom Community in Some Freshwater Ponds of Kolkata

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Abstract

The water quality of different natural water bodies is now monitored in many countries by the diatom population. Thus a study on the diatom population in water bodies of a city is important and a study on the seasonal variation of such species in small water bodies like ponds may help us to find out which diatom species are related to polluted water. In this study, we selected six ponds located in the city of Kolkata, three ponds located in the slum area, and three ponds located in the non-slum area. Monthly five observations of diatom species in each pond were done from January 2018 to December 2019. After obtaining the raw data Shannon diversity index was calculated and compared. Most diatom species were found in the rainy and autumn season; however, in other months particularly when rainfall is very low only one or two species were found indicating their activities in polluted water. The isolates were *Navicula radiosa*, *Synendra ulna*, *Cyclotella meneghiniana*, *Nitzschia stagnorum*, *Navicula gracilis, Navicula viridula*, Others (occasionally found) [*Navicula protracta*, *Cymbella tumida*, *Gomphonema vibrio*, *Grammatophora undulata*, *Aulacoseira granulata*; Navicula reinhardtii, *Achnanthes subsessilis*, *Cocconeis pediculus*]. *Synendra ulna*, *Cyclotella meneghiniana* were particularly found in polluted water.

Keywords: Diatom; Water Bodies; Seasonal Variation; Shannon Diversity Index

Introduction

The unicellular algae diatoms are distributed in the aquatic environment throughout the globe. Their cell wall (frustules) are sculptured by silicon biomineralization. At present, there are more than 260 genera with over 100000 diatom species. The chloroplasts in diatoms are usually golden-brown. They are mainly habitats of shallow aquatic ecosystems [1] and some diatoms like *Synendra, Cyclotella*, *Gomphonema*, *and Melosira* can tolerate pollution well [2]. Diatoms show a promising role in the purification of water bodies in the urban area. Only a few researchers studied diatom flora in the West Bengal state of India. Important contributions were made by Biswas [3], Das and Santra [4], Pal., *et al.* [5], Pal and Santra [6], Banerjee and Santra [7], Halder and Sinha [8] and Jena., *et al.* [9] in this line. In this study, seasonal variations of the diatom community were studied in freshwater ponds of Kolkata from January 2018 to December 2019.

Materials and Methods

Three ponds were selected in the slum area and three ponds were selected in slum free area of the Southern zone of Kolkata. Among three ponds in both slum and no-slum areas, one pond was selected which is commonly used by residents, one pond is occasionally used by the residents and is located near the roadside, and the remaining pond was selected which is not used by the residents and is away from the roadside. The locations of all these

ponds for slum and no-slum populations are indicated in table 1.

In each month five water samples were collected and studied. After two years of study, the average figures for each month were generated and used for further analysis. Hygrophytes were targeted for collection. For collection from hygrophytes (similar types), the surface of leaves and stems was gently scrapped, and then the water was collected. In each sample, similar types of plants were scrapped before collection and a uniform pattern was maintained in all cases. As the hygrophytes provided a vertical surface free from mud clean water samples were obtained.

The identification of the diatom species and the average number of diatom species per low-power microscopic field (x100) was noted first after examination of 20 different microscopic fields; after that acid digestion method was followed for confirmation of identifications at higher magnification (x400) of the microscope. For acid digestion collected water sample was treated with concentrate nitric acid in a ratio of 10:1. In this study after proper mixing of the water samples, 5 ml of each water sample was mixed with 500 µL of Conc. HNO3 in a test tube and the opening end of the tubes were covered with aluminium foils. After that, they were kept overnight for acid digestion. After digestion, the water was taken in centrifuge tubes and centrifuged at a lower speed of 1200 rpm for 5 minutes. Lower speed was used to keep all the diatoms intact without any breaks. This step was repeated 2 times with distilled water after removing supernatants. After that centrifuged deposits were taken on glass slides, covered with coverslips, and examined under the high power of the microscope. Identification was done following standard identification manuals [10-13] and some others and also from diatom identification sites on the net. In our study, we also prepared smears on the glass slides and then stained them with Gram's and methylene blue which also gave excellent results for easy identification.

In this study, we used the Shannon diversity index which is a well-known metric used in ecology. It is based on Claude Shannon's formula for the estimation of species diversity. Shannon diversity index formula: $H = -\sum[(pi) * \log(pi)]$, H - Shannon diversity index; pi - Proportion of individuals of i-th species in a whole community: $pi = n/N$, where: n - individuals of a given type/species; and N - total number of individuals in a community, $\sum$ - Sum symbol; and log - Usually the natural logarithm. Thus the Shannon diversity index formula becomes- $H = -\sum[(pi) \times \ln(pi)]$. The proportion (pi) of each species was calculated by dividing the number of each species by the total number of individuals. Then it was multiplied by the logarithm of the proportion. The Sum of all numbers obtained was multiplied by -1. Different values were obtained from software known as Omnicalculator using raw data (https://www.omnicalculator.com/ecology/shannon-index).

Results

For the slum Population	
Type of pond	**Location**
Pond which is commonly used by residents.	Benibag, Sarat Ghosh Garden Road. Kolkata-31. Latitude: 22.5114025. Longitude: 88.3761629
Pond which is occasionally used by residents and it is located near roadside.	A.T.Chatterjee Road. Kolkata-31. Latitude and longitude coordinates are: 22.572645, 88.363892
Pond which is not used by residents and it is located away from roadside	A.T.Chatterjee Road. Kolkata-31. Latitude and longitude coordinates are: 22.572645, 88.363892
For no slum Population	
Type of pond	**Location**
Pond which is commonly used by residents.	Sarat Ghosh Garden Road. Kolkata-31 Latitude:22.5118250681. Longitude: 88.3741240203
Pond which is occasionally used by residents and is located near roadside.	R.N.Das Road. Dhakuria, Kolkata-31. longitude — 88°22′16.39′′E (88.371217), latitude — 22°30′32.29′′N (22.508967).
Pond which is not used by residents and is located away from roadside	Near Sarat Ghosh Garden Road. Kolkata-31. (Unknown Pond) Latitude:22.5118250681. Longitude: 88.3741240203

Table 1: Details of the location of the ponds are given.

Maximum diatoms were obtained in Monsoon; while the minimum number of diatoms was found in Summer and Autumn. Following groups of diatoms were identified in the samples tested: *Navicula radiosa*, *Synendra ulna*, *Cyclotella meneghiniana*, *Nitzschia stagnorum*, *Navicula gracilis, Navicula*

viridula, Others (occasionally found) [*Navicula protracta*, *Cymbella tumida*, *Gomphonema vibrio*, *Grammatophora undulata*, *Aulacoseira granulata*; Navicula reinhardtii, *Achnanthes subsessilis*, *Cocconeis pediculus*]. The details of Shannon diversity index parameters of diatoms in different seasons are given in table 2 and figures 1 and 2.

Ponds	Shannon diversity index	Evenness	Richness (number of species)	Total number of individuals (average field)	Average population size	Predominant diatom/s
January						
1	1.74	0.968	6	9	1.5	NR/SU/CM
2	1.73	0.967	6	8	1.33	NR/SU
3	1.79	1	6	6	1	-
4	1.73	0.967	6	8	1.33	NR/SU
5	1.73	0.967	6	8	1.33	NR/SU
6	1.75	0.976	6	7	1.17	NR
February						
1	1.55	0.963	5	7	1.4	NR/SU
2	1.33	0.961	4	5	1.25	NR
3	1.33	0.961	4	5	1.25	NR
4	1.33	0.961	4	5	1.25	NR
5	1.33	0.961	4	5	1.25	NR
6	1.33	0.961	4	5	1.25	NR
March						
1	1.1	1	3	3	1	-
2	1.1	1	3	3	1	-
3	0.693	1	2	2	1	-
4	1.1	1	3	3	1	-
5	0.693	1	2	2	1	-
6	0.693	1	2	2	1	-
April						
1	0.693	1	2	2	1	-
2	0	0	1	1	1	-
3	0	0	0	0	0	-
4	0	0	1	1	1	-
5	0	0	1	1	1	-
6	0	0	0	0	0	-
May						
1	0.693	1	2	2	1	-
2	0.693	1	2	2	1	-
3	0.693	1	2	2	1	-
4	0.693	1	2	2	1	-
5	0.693	1	2	2	1	-
6	0.693	1	2	2	1	-

June						
1	1.74	0.971	6	18	3	SU
2	1.56	0.972	5	13	2.6	SU
3	1.52	0.946	5	9	1.8	SU
4	1.56	0.972	5	13	2.6	SU
5	1.47	0.912	5	11	2.2	SU
6	1.52	0.946	5	9	1.8	SU
July						
1	1.75	0.978	6	20	3.33	NR
2	1.71	0.955	6	17	2.83	NR/SU
3	1.75	0.976	6	12	2	CM
4	1.69	0.944	6	18	3	SU
5	1.71	0.955	6	17	2.83	NR/SU
6	2.15	0.98	9	21	2.33	NR/SU/CM
August						
1	1.71	0.955	6	17	2.83	SU
2	1.73	0.968	6	14	2.33	NR/SU/CM
3	1.7	0.951	6	12	2	NR/SU
4	1.74	0.969	6	15	2.5	NR/SU/CM
5	1.7	0.951	6	12	2	NR/SU
6	1.7	0.951	6	12	2	NR/SU
September						
1	1.73	0.968	6	14	2.33	NR/SU
2	1.74	0.97	6	13	2.17	NR/SU
3	1.75	0.976	6	10	1.67	NR/SU/CM/ NG
4	1.73	0.968	6	14	2.33	NR/SU
5	1.75	0.976	6	10	1.67	NR/SU/CM/ NG
6	1.75	0.976	6	10	1.67	NR/SU/CM/ NG
October						
1	1.56	0.967	5	10	2	CM
2	1.28	0.921	4	7	1.75	CM
3	1.33	0.959	4	6	1.5	CM/NG
4	1.28	0.921	4	7	1.75	CM
5	1.05	0.96	3	5	1.67	CM/NG
6	1.05	0.96	3	5	1.67	CM/NG
November						
1	1.56	0.97	5	6	1.2	SU
2	1.56	0.97	5	6	1.2	SU
3	1.39	1	4	4	1	-

4	1.33	0.961	4	5	1.25	SU
5	1.39	1	4	4	1	-
6	1.39	1	4	4	1	-
December						
1	1.79	1	6	6	1	-
2	1.61	1	5	5	1	-
3	1.61	1	5	5	1	-
4	1.61	1	5	5	1	-
5	1.61	1	5	5	1	-
6	1.61	1	5	5	1	-

Table 2: Seasonal variation of Shannon diversity index, Evenness, Richness (number of species), Total number of individuals (average field), Average population size, and Predominant diatom/s in different ponds (1-6). NR- *Navicula radiosa*, SU- *Synendra ulna*, CM- *Cyclotella meneghiniana*, NS- *Nitzschia stagnorum*, NG- *Navicula gracilis*, NV- *Navicula viridula*.

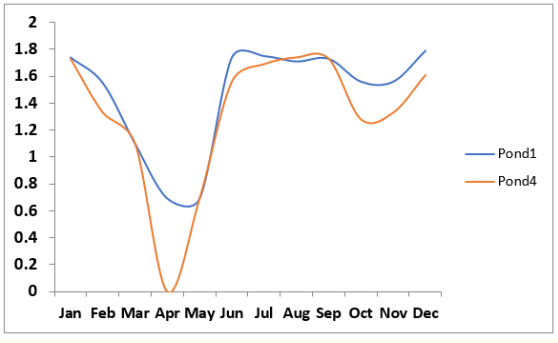

Figure 1: Seasonal variation of Shannon diversity index of diatoms in two ponds (Pond 1: located in a slum area used by residents; Pond 2: located in a non-slum area used by residents; in slum area Pond 1 and non-slum area Pond 4 showed the maximum number of diatoms).

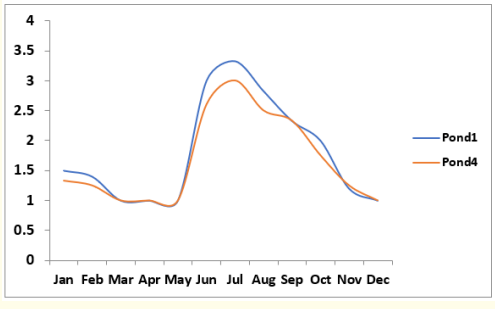

Figure 2: Seasonal variation of average population size of diatoms in two ponds (Pond 1: located in a slum area used by residents; Pond 2: located in a non-slum area used by residents; in slum area Pond 1 and non-slum area Pond 4 showed the maximum number of diatoms).

Discussion and Conclusion

Navicula radiosa, *Synendra ulna*, *Cyclotella meneghiniana*, *Nitzschia stagnorum*, *Navicula gracilis, Navicula viridula* were the predominant diatom species in the ponds of Kolkata in 2018-19. Other species obtained from the ponds were *Navicula protracta*, *Cymbella tumida*, *Gomphonema vibrio*, *Grammatophora undulata*, *Aulacoseira granulata*; *Navicula reinhardtii*, *Achnanthes subsessilis*, *Cocconeis pediculus*. Seasonal variation of the Shannon diversity index of diatoms showed increased index value between June to January with a sharp fall between February to May. Again species variations were prominent in different seasons. Thus in June, the predominant species was *Synendra ulna*, but between July to September various species particularly *Navicula radiosa*, *Synendra ulna*, *Cyclotella meneghiniana*, *and Navicula gracilis* were present in combinations. In October the predominant species was *Cyclotella meneghiniana* and in November it was mainly *Synendra ulna*. These findings indicate that *Cyclotella meneghiniana* and *Synendra ulna* are probably related to polluted water while others were related to fresh rainwater.

Studies on the relationship of diatoms with environmental changes began in the 1970s [14]. Later diatom species composition and community structure were studied by many workers [15,16]. Water quality was also monitored by observing diatom populations by many scientists [17]. Inhibition of bacterial population by diatoms was also well documented [18]. At present diatoms are used as environmental indicators. This study will be helpful for rational use of diatoms in water bodies of Kolkata.

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