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SPECIES COMPOSITION OF PERIPHYTON COMMUNITY IN PONDS OF CHAPRA DISTRICT, BIHAR, INDIA

KUMAR P.[1], MISHRA R.[2]* AND SINGH D.K.[3]

[1]District Health Society, Patna- 800 004, Bihar, India.
[2]State Health Society, Patna- 800 014, Bihar, India.
[3]Jai Prakash Vishwavidyalaya, Chapra- 841 301, Bihar, India.
*Corresponding Author: Email- ragini330@gmail.com

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Abstract- Periphyton is a group of organisms attached to benthic sediment, rock at the bottom and edges of water-bodies. In many areas around the world, they are considered appropriate indicators of ecological condition and pollution. Little is known of the shallow small lakes and ponds of tropical regions, especially those located at lower altitudes. Based on these considerations it was decided to look at the species composition of the periphyton community of two small ponds located in Chapra, Bihar. Monthly collections of periphytons were done for two years from both the water bodies. Species diversity index was calculated using Shannon-Weiner Index. Various parameters of species diversity such as species richness, abundance, evenness etc. were assessed for the two ponds. Dissimilarity index as well as Beta diversity for the two habitats was also calculated for better analysis of results. The species composition was found to agree with other studies of tropical ponds & lakes, with a dominance of Myxophyceae and Bacillariophyceae and a general paucity of Euglenophyceae and Chlorophyceae in both pond water bodies. Species richness varied considerably among the ponds. A low evenness in the species abundances was found in Pond A when compared to Pond B. The density and diversity of phytoplanktons in increasing order is as follows: Myxophyceae> Bacillariophyceae>Chlorophyceae>Euglenophyceae. The density of and diversity of zooplanktons in increasing order is as follows: Rotifera>Copepoda>Protozoa>Cladocera. The Dissimilarity index between the two species was found to be 0.07 in 2 habitats viz: Pond A & B. The Beta diversity in the two pond water bodies was found to be 2.

Keywords- species composition, periphyton, shannon weiner index, beta diversity

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Introduction

Periphyton is a group of organism consisting of the plants or animals attached to benthic sediment, rock, and each other at the bottom and edges of water-bodies. In many areas around the world they are considered appropriate indicators of ecological condition and pollution. Phytoplankton fluctuation and diversity are widely used as biological determinates of water quality in lakes and reservoirs. From phytoplankton density and species composition in tropical lakes, the annual cycle and biological distinctiveness can be established. Diversity, distribution, and variation in the biotic parameters provide a good indication of energy turnover in aquatic environments. A high diversity count suggests a healthy ecosystem; the reverse of this indicates a degraded environment. Our present investigation focuses on a comprehensive study of periphyton diversity, their species composition, population density, and community characterization. All these factors are important bio-indicators for determining the nutrient content of the pond as a feeding ground for migratory water birds population [1-5].

Periphyton community structure, species composition, and succession respond to environmental conditions and thus can be used to classify waterways [6,7]. In addition, these algal communities can and have been used as biotic indicators of ecological condition and change in condition in response to human and natural disturbance [8-13]

The diversity gradients existing from the temperate regions towards the tropical regions has long been acknowledged [14]. In general, species diversity (measured as species richness or as the inverse of the dominance of the most common species) increases towards the Equator [15-17]. The freshwater phytoplankton and zooplankton, however, appear to follow a reversed pattern [18-20] being more diverse in the temperate zones. This phenomenon has been observed by other people as well [21]. Despite the several papers that make the comment about the lower diversity of tropical freshwater phytoplankton, Lewis [19] appears to be the only instance where data is provided, and a formal comparison is made Round [22] In recent years some controversy about the validity of these observations has been raised Hecky and Kling [23]. The lack of data, however, is a major problem, and as Tundisi, et al. [24] claimed, our present knowledge about tropical lakes comes mainly from relatively big lakes. Little is known of the shallow small lakes

and ponds of tropical regions, especially those located at lower altitudes cf. also Reynolds [25]. Based on these considerations it was decided to look at the species composition of the periphyton community of two small ponds located in Chapra, Bihar. The ponds for study were chosen to include representatives from the main climatic zones of the state. Monthly collections of periphytons were done for two years from both the water bodies. Species diversity index was calculated using Shannon-Weiner Index. Various parameters of species diversity such as species richness, abundance, evenness etc. were assessed for the two ponds. Dissimilarity index as well as Beta diversity for the two habitats was also calculated for better analysis of results.

Materials and Methods

Description of the Research Site

Chapra is located at 25.773460° N, 84.727470°E. The district of Saran (Chapra) is situated between 25°36' and 26°13' N latitude and 84°24' and 85°15' E longitude.

The present ponds under investigation are located about 2 km north from the district headquarter Chapra near the Bazar Samiti Chapra (Pond A). The other pond selected for the study lies adjacent to the first pond. Since it was close to Jagdam College, it was named Jagdam College pond (Pond B). The present ponds are said to be the result of slow urbanization of the Chapra town. According to the locals, the ponds were formed about 25 years ago as a by-product due to the formation of Bazar Samiti and Jagdam College, Chapra. The soil of the area was uplifted for the formation of the Bazar Samiti leading to the formation of this pond. Thus these ponds are not natural rather an artificial one. The shape of both the ponds is irregular. The ponds receive water from the nearby catchment area of chaurs as well as rain water. The ponds are perennial in nature and the water spread area is about of nine bigha. The depth of the water is variable from seven fit to fifteen fit at the middle of the pond.

The study of periphyton diversity and its seasonal variation was carried out by sampling water taken from the Pond A and Pond B, of Chapra district on monthly basis between 2010 & 2011. As periphyton constitutes many organisms, only zoo-periphytons and phyto- periphytons have been selected for the present study.

Species Diversity Calculation

The concept of diversity has been aptly described by Legendre, et al [26]. They discussed that the variation in species composition among sites within a region of interest should be called as beta diversity. The species richness and species abundance together of a place constitute the species diversity. Species Diversity is further divided into following categories

Alpha (α) Diversity

The alpha diversity for the Periphyton species is calculated as per the species composition and species abundance within two ponds in the one focused district.

The Shannon-Wiener index has been found as the most important technique for calculation of the alpha diversity in the present set of research. The species diversity has been calculated by using formula provided by Shannon and Wiener which has been plotted as follows

$$H = -\sum(pi)\,(\log pi)$$

Where,

H = information content of sample (bits/individual) = index of species diversity.

Pi = n1/N i.e. the probability of an individual to belong to a species or proportion of total sample belonging to the one species.

n1 = number of individuals of one species in the sample.

N = total number of individuals in the whole sample.

à The evenness of any two species in a population has been calculated by the following formula as under

$$E = H/H^{max}$$

Where,

E = Evenness

H = diversity index derived by Shannon-Wiener equation.

H^{max} = number of species.

à The Dissimilarity index between the two species has been calculated as Jaccard Co-efficient as the following formula—

Jaccard Co-efficient

$$(Qj) = j/(a + b - j)$$

Where,

a = number of species found in habitat (A)

b = number of species found in habitat (B)

j = number of species found in both habitats.

Dissimilarity index 'Dj' = (1- Jaccard's Co-efficient).

Beta (β) Diversity

As per Legendre, et al [26] any marked variation in species composition among sites within a region of interest should be called as beta diversity. So for the species composition in the present research, the calculation of beta diversity has been taken into main account.

$$\beta \text{ diversity} = (S1-c)+(S2-c)$$

Where

S1=total species in 1st environment

S2= total species in 2nd environment

c= No of species that the 2 environments have in common

Various Parameters for Species Diversity

Various parameters have been taken in account for the proper knowledge of the species diversity. These have been represented as following parameters

Species Richness: This parameter has been taken into the account for the knowledge about the presence of population of individuals of various species of one genera or the related genera in a particular place as per the reference of any particular time. This has been measured mainly by the calculation of density of periphytons in a particular time in a particular place under natural conditions.

Species Dominance: This parameter has been taken into the account for the best knowledge about the dominance of any particular species coming under the focused genus or related genera in any species in a particular time. This parameter has been measured by the help of Shannon-Wiener index.

Species Evenness: Sometimes more than one species coming under the same or related genera have been found dominant in a particular place at the particular time. So in these circumstances, the species evenness has been calculated with help of Jacquard Co -efficient.

Shanon Weiner Index has been taken as the sample estimation because its value is less dependent on sample size.

Plankton Collection

Plankton samples were collected regularly once in a month for the complete two years by hauling about 100 litres of subsurface water through a plankton net made up of bolting silk (no. 25) having mesh size of 0.03 to 0.04 mm.

Preservation

The concentrated plankton samples were preserved in 4% formalin formation for further qualitative and quantitative analysis.

Enumeration of Plankton

The quantitative determination of phytoplankton and zooplankton were made with the help of Lackey Drop Microtransect Counting Method of Lackey [27] subsequently modified by Edmondson [28].

The plankton concentration was thoroughly mixed and one drop of it was put in a clean slide by the dropper and covered with a 22 x 22 mm glass cover slip. Counting of organisms was made in 5 strips along the width of the slide. Five such drops were examined under low and high power.

The width of the low and high power fields were measured with the help of an ocular and stage micrometer. Each transect will represent a definite fraction of area under the coverslip, hence a definite volume of the sample. The number of plankton per drop was calculated as follows

$$\text{Number of plankton / drop} = \frac{\text{Area of coverslip}}{\text{Area of Transect}} \times \text{Individual count recorded per transect}$$

The number of drops of water in one ml volume was calculated. This value was multiplied by the number of plankton / drop, which thus gives the value of number of plankton / ml. Knowing the value of water filtered through the plankton net, volume of concentrate and number of plankton per ml, the values for phytoplankton, zooplankton and individual plankters were calculated per litre. The value was then expressed into percentage.

The identification of plankton are based on Smith [29], Edmondson [28], Desikachary [30], Philipose [31], Needham & Needham [32], Fritsch [33] and Tonapi [34].

Results

The species composition was found to agree with other studies of tropical ponds & lakes, with a dominance of Myxophyceae and Bacillariophyceae and a general paucity of Euglenophyceae and Chlorophyceae in both pond water bodies. Among the zooplanktons, Rotifers were the dominant groups followed by Copepoda and Protozoans. There was general paucity of Cladocerans among the zooperiphytons [Table-1].

Table 1- Diversity Status of Phyto and Zoo-periphytons in Pond A and B in Chapra district, Bihar In 2010 & 2011

	Yearly average count of individuals		Total species/Species richness		% Composition of groups		Yearly Average value of Shannon Weiner Index (SWI)		Species evenness		Species Abundance	
					Phyto-periphyton							
Name of the Pond	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B
Year	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011
Bacillariophyceae	120/113	63/82	7/7	7/7	38/34	44/35	2/2.1	1.09/1.3	0.28/0.30	0.15/0.18	40/37.6	21/27.3
Chlorophyceae	44/56	20/27	4/4	3/3	14/17	9/11	0.87/1.3	0.5/0.5	0.21/0.32	0.17/0.18	14.6/18.6	6.6/9
Myxo/Cyanophyceae	122/133	83/110	7/7	6/6	39/39	39/46	1.9/3.4	0.9/1.08	0.27/0.49	0.16/0.18	40.6/44.3	27.6/36.6
Euglenophyceae	29/35	16/18	1/1	1/1	9/10	8/8	0/10	0/0	0/0	0/0	9.6/11.6	5.3/6
					Zoo-periphyton							
Name of the Pond	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B	Pond A	Pond B
Year	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011	2010/2011
Protozoa	44/62	24/17	3/3	3/3	29/30	20/13	0.4/0.8	0.4/0.4	0.14/0.29	0.14/0.14	14.6/20.6	8/5.6
Rotifera	59/71	47/59	3/3	3/3	33/34	38/45	0.7/1.2	0.7/0.7	0.24/0.41	0.24/0.24	19.6/23.6	15.6/19.6
Copepoda	54/59	41/43	2/2	2/2	30/29	33/32	0.5/0.6	0.5/0.5	0.27/0.31	0.28/0.27	18/19.6	13.6/14.3
Cladocera	14/14	11/13	1/1	1/1	8/7	9/10	0/0	0/0	0/0	0/0	4.6/4.6	3.6/4.3

Discussion

Species richness varied considerably among the ponds. A low evenness in the species abundances was found in Pond A when compared to Pond B. Species diversity of Euglenophyceae among the phytoplanktons & Cladocera among the zooplanktons was the least. Single species of Euglenophyceae represented by *Euglena* among the phyto-periphytons and single species of Cladocera represented by Diaphnosoma among the zoo-periphytons was found in both the ponds in the present study. Individual species abundance and species composition was found to vary with time in both the ponds. Diversity indices sensitive to changes in the abundance of rare species tend to be higher in both the ponds. Diversity indices sensitive to changes in the numbers of abundant species tend to be similar between the two ponds examined. Bacilliariophyceae (Diatoms) were represented by 7 sps viz: *Fragilaria, Synedra, Diatoma*, *Navicula, Cyclotella, Cymbella and Pinnularia; Myxophyceae/ Cyanophyceae* (Blue-Green algae) was again represented by 7 species viz: *Oscillatoria, Rivularia, Phormidium, Nostoc*, *Anabaena, Lyngbya & Nodularia; Chlorophyceae represented by 4 species viz: Spirogyra, Scenedesmus, Cosmarium, Pediastrum*; Euglenophyceae represented by single species Euglena. Among zooplanktons, Protozoans were represented by 3 species viz: *Centrophyxis, Arcella & Nothoica*; Rotifera was represented by 3 species viz: *Brachionus angularis, Filinia & Monoslala*; Copepoda was represented by 2 species *Cyclops* & *Mesocyclop*s and Cladocera was represented by single species *Diaphnosoma*. The density and diversity of phytoplanktons in increasing order is as follows: Myxophyceae> Bacillariophyceae>Chlorophyceae>Euglenophyceae. The density and diversity of zooplanktons in increasing order is as follows: Rotifera>Copepoda>Protozoa>Cladocera. The Dissimilarity index be-

tween the two species was found to be 0.07 in 2 habitats viz: Pond A & B. The dissimilarity index of Myxophyceae & Chlorophyceae was 0.85 & 0.75 in the two pond habitats. In case of zooplanktons no dissimilarity in the two habitats was seen. The Beta diversity in the two pond water bodies was 2 that can be interpreted as there were 2 species which were either only in environment (Pond A) one or only in environment 2 (Pond B). In pond B complete absence of *Rivularia* and *Scendesmus* was found. Shannon Weiner index derived was used to interpret the pollution status of the pond water bodies. The average yearly value of Shannon Weiner Index in Pond A and B was 4.3 and 4.4 respectively that indicates only slight pollution of water bodies [Table-2] and [Table-3].

Table 2- Similarity & Dissimilarity Index of periphytons in Pond A & B in Chapra district, Bihar

Species	No of species in Pond A		No of species in Pond B		Jaccard Co-efficient (Qj) = j/ (a + b –j) a = number of species found in habitat (A) b = number of species found in habitat (B) j = number of species found in both habitats	Dissimilarity index 'Dj' = (1- Jaccard's Co-efficient)
	2010	2011	2010	2011		
Phyto-periphyton						
Bacilliariophyceae (Diatoms)	7	7	7	7	1	0
Myxophyceae/ Cyanophyceae (Blue-Green algae)	7	7	6	6	0.857143	0.142857
Chlorophyceae	4	4	3	3	0.75	0.25
Euglenophyceae	1	1	1	1	1	0
Zoo-periphytons						
Protozoa	3	3	3	3	1	0
Rotifera	3	3	3	3	1	0
Copepoda	2	2	2	2	1	0
Cladocera	1	1	1	1	1	0
Total sps. (phyto+zooplanktons)	28	28	26	26	0.928571	0.071429

Table 3- Beta diversity of Periphyton in two ponds in Chapra district, Bihar, India

No of species in pond A	No of species in pond B	c	β diversity
28	26	26	2

Conclusion

The literature on species diversity of periphytons of pond waters is scarce, and only few studies are available on the subject leaving a gap in the information about small shallow tropical ponds. So, the present work on periphyton species composition and diversity in two shallow ponds in Chapra district (Bihar) may help attaining knowledge about the ecological boundaries affecting the population of various communities including the periphyton communities in the aquatic system.

Conflict of Interest: None Declared.

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