IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 10, Issue 11 Ver. II (Nov. 2016), PP 55-58
www.iosrjournals.org

Seasonal Variation in Periphyton Community in Ponds of Chapra district, Bihar

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Abstract: *The periphyton community constitutes a major component of aquatic biological systems as they affect the water quality.Very little is known about the periphyton community structure in pond water bodies of Chapra district, Bihar and on the seasonal variation of periphyton. Bazar Samiti (Pond A) and Jagdam College Pond (Pond B) are important water bodies of Chapra, Bihar. It is an important source of pisciculture in addition to irrigation. But this water body is under constant threat due to tourist disposal, domestic sewage and increased human activities. The aim of the present study was to know the diversity of periphyton community and their seasonal variation in the two ponds of Chapra district. The study of periphyton diversity and its seasonal variation was carried out by sampling water taken from the Pond A and Pond B on monthly basis between 2010 & 2011. The monthly collections were summed into three major seasons viz: Summer, Monsoon & Winter. Season wise diversity of Periphyton was co-related with pollution level of the two water bodies. Among the phyto- periphyton, Myxophyceae were the dominant group in Pond A (39% each) in 2010 & 2011 respectively followed by Bacillariophyceae (38% & 34%).In Pond B Bacillariophyceae was the dominant group (44% in 2010) followed by Myxophyceae (39%). Inverse was found in 2011 where Myxophyceae composition was more (46%) followed by Bacillariophyceae (35%) in Pond B. Among the zoo-periphyton, in Pond A, Rotifers were the dominant group (33% & 34%) in pond A in 2010 & 2011 respectively. Composition of Protozoans (29%) was more in 2011 followed by Copepoda (29%) in pond A. The vice-versa situation was found in 2010 in pond A for these two groups. Cladocerans constituted (8% & 7%) in 2010 & 2011 respectively. In pond B, Rotifers were the dominant group (38 & 45%) followed by Copepoda (33 & 32%), Protozoa (20&13%) and Cladocera (9 & 10%) in 2010 & 2011 respectively The distribution of both the zooplanktons and phytoplanktons was more during summer months. Seasonality of both these groups was as follows: Summer>Winter>Monsoon. The co-relation with pollution level showed that the pond A showed moderate level of pollution in the monsoon season Pond A showed slightest pollution in summer season. However, in Pond B moderate to slight pollution in winter and summer season respectively.*

Keywords: *Seasonal variation, Periphyton, pond in Chapra, Shanon Weiner Index*

I. Introduction

The periphyton community constitutes a major component of aquatic biological systems (Biggs, 1987). Periphyton includes both the phyto-periphyton and zoo-periphyton and sometime aquatic insects (Wetzel, 1983; Biggs, 1987). They also play a major role in recycling nutrients as well as cycling energy within their respective environments and affects water quality [1]. Periphyton are useful in assessing the effect of pollutants on lakes, streams, and estuaries (APHA, 1998) [2]. Phytoplankton and zooplankton communities in lake systems undergo seasonal succession in relation to nutrient availability, predation, and competition [3]. Sommer *et al.* described these patterns as part of the Plankton Ecology Group (PEG) model, with 24 statements constructed from the analysis of numerous systems. Both phyto and Zooplanktons live in different environments where many factors such as light availability, temperature and nutrient uptake influence distribution [4]. Their composition and abundance are related to many factors, such as water hydrochemistry, season, lake morphology, presence of macrophytes, predators etc. and particularly to the productivity of the lake that is lake trophic condition [5]. A very few research works on percentage composition, seasonal variation and abundance in phytoplanktons and zooplankton are available for Bazar Samiti and Jagdam College Ponds pond, Chapra, Bihar. A number of workers such as Das (1956), Dhanapathi (2000), Gopal (1984), Nair (2009), Sugunan (2000) and zafar (1964) have reported on different aspect of zooplankton inhabiting Indian fresh waters. Bihar in spite of being recognized as a state of flood conditions is characterized by large number of water bodies both natural and manmade. Bazar Samiti and Jagdam College pond (pokhra) is an important water body of Chapra, Bihar. It is an important source of pisciculture in addition to irrigation. But this water body is under constant threat due to tourist disposal, domestic sewage and increased human activities. It is therefore, urgent need to manage scientifically this water body to tap it maximum potentiality. The aim of the present study was to know the

diversity of periphyton community and their seasonal variation in the two ponds of Chapra district and to co-relate their presence to pollution level.

II. Methodology used

The study of phytoplankton diversity and its seasonal variation was carried out by sampling water taken from the Pond A and Pond B, of Chapra on monthly basis between 2010 & 2011. The monthly collections were summed into three major seasons viz: Summer, Monsoon & Winter. Various physico-chemical variables were recorded and the correlation of this with phytoplankton density was established *using simple graphical* Analysis.

1. Plankton Collection

Plankton samples were collected regularly once in a month for the complete summer season 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.

2. Preservation

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

3. Enumeration of plankton

The quantitative determination of phytoplankton and zooplankton were made with the help of Lackey Drop Microtransect Counting Method of Lackey (1938) subsequently modified by Edmondson (1974).

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 (1955), Edmondson (1959), Desikachary (1959), Philipose (1967), Needham and Needham (1972), Fritsch (1977) and Tonapi (1980).

Shanon Weiner Index was taken for calculation of species diversity as the sample estimation because its value is less dependent on sample size. Seasonal variation in periphyton community (phyto & Zoo-periphytons) diversity was also analyzed. Season wise diversity of periphyton was co-related with pollution level of the two water bodies.

The species diversity has been calculated by using formula provided by Shannon and Wiener[8] 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

III. Results & Discussion

Table: 1

Season wise density of Periphytons in Pond A in 2010/2011			
PHYTOPLANKTON	**Summer**	**Winter**	**Monsoon**
	DENSITY (UL^{-1})	**DENSITY (UL^{-1})**	**DENSITY (UL^{-1})**
Myxophyceae	270 – 425/ 275 - 430	175-235/ 180-240	45-50/50-55
Chlorophyceae	50 – 60/55 - 60	30-50/35-55	6-10/7-15
Euglenophyceae	5-25/6-30	2-17/3-20	1-9/1-12
Bacillariophyceae	200 – 980/210 – 985	110-576/ 120-585	25-30/30-35
TOTAL	**525 – 1490/546-1505**	**317-878/338-900**	**77-99/88-117**
ZOOPLANKTON	**Summer**	**Winter**	**Monsoon**
	DENSITY (UL^{-1})	**DENSITY (UL^{-1})**	**DENSITY (UL^{-1})**

Protozoa	10 – 20/15 – 25	4-16/5-20	2-8/2-10
Rotifera	15 – 80/20 – 90	5-27/7-30	2-10/2-10
Copepoda	10 – 50/15 – 55	5-25/5-30	1-5/1-6
Cladocera	5 – 10/8 – 15	2-5/2-8	1-3/1-4
TOTAL	**40 – 160/58-185**	**16-73/19-88**	**6-26/6-30**

Table: 2

Season wise density of Periphytons in Pond B in 2010/2011			
PHYTOPLANKTON	**Summer**	**Winter**	**Monsoon**
	DENSITY (UL^{-1})	**DENSITY (UL^{-1})**	**DENSITY (UL^{-1})**
Myxophyceae	220 – 375/225 - 385	135-200/140-220	25-30/30-35
Chlorophyceae	35 – 45/40 - 50	10-30/12-35	2-8/2-10
Euglenophyceae	5-20/5-25	2-10/2-15	1-5/1-8
Bacillariophyceae	182 – 962/190 – 975	62-428/65-435	12-20/10-25
TOTAL	**442 – 1402/460-1435**	**209-668/219-705**	**40-63/43-78**
ZOOPLANKTON	**Summer**	**Winter**	**Monsoon**
	DENSITY (UL^{-1})	**DENSITY (UL^{-1})**	**DENSITY (UL^{-1})**
Protozoa	5 – 10/6 – 11	2-10/2-12	1-5/1-6
Rotifera	10 – 50/12 – 55	2-15/2-16	1-6/1-6
Copepoda	5 – 15/5 – 15	2-12/2-12	1-4/1-5
Cladocera	2 – 8/2 – 10	2-3/2-4	1-2/1-2
TOTAL	**22-83/22-83**	**8-40/8-44**	**4-17/4-19**

Table 3:

Average seasonal value of Shannon Weiner Index (H) for Periphyton community (phyto & Zoo-periphytons) as a whole in Pond A & Pond B							**Shannon's index and pollution levels**	
	Pond A			**Pond B**			**Species Diversity**	**Pollution level**
	Winter	**Summer**	**Monsoon**	**Winter**	**Summer**	**Monsoon**	**3.0-4.5**	Slight
2010	2.2	3.41	1.04	1.6	2.76	0.3	**2.0-3.0**	Light
2011	2.73	3.42	2.23	2.04	2.79	0	**1.0-2.0**	Moderate
Average	**2.4**	**3.4**	**1.6**	**1.8**	**2.7**	**0.3**	**0.0-1.0**	Heavy

The distribution of both the zooplanktons and phytoplanktons increased during summer months. Seasonality of both these groups was as follows: Summer>Winter>Monsoon. The distribution of zooplanktons were more limited in monsoon months when compared to the phytoplanktons. In some cases complete absence of zooplanktons in monsoon months could be seen. This may be attributed to phytoplanktons evolving some mechanism of resisting against the rain waters. The number of phytoplanktons in summer and winter months were more in 2011 for pond A when compared to 2010. The number of protozoans and Rotiferans were slightly more in the summer months of year 2011 when compared to 2010 for pond A. The number of copepods remained the same in summer months of both the years in pond A.The number of Myxopyceae and Chlorophyceae were more in summer and winter months of 2011 in pond B when compared to 2010. The number of Roriferans were more in pond B in summer and winter months of 2011 when compared to 2010 in pond B. The number of copepods were more in summer months in 2011 while it remained constant in winter months of both the years.The number of protozoans were higher in summer month of 2010 while it was more in winter month in pond B in 2011.The number of cladocerans were nearly same in all the seasons in both years in pond B. A peculiar feature in seasonal distribution of zooplanktons in pond B was their complete absence in monsoon months in both the years.

Population densities of zooplankton showed a high degree of seasonality within and between the groups. Some species were present throughout the year while others make sporadic appearance. Among the phyto- periphyton, Myxophyceae were the dominant group in Pond A (39% each) in 2010 & 2011 respectively followed by Bacillariophyceae (38% & 34%). However, both Chlorophyceae (14% (2010) & 17% (2011)) and Euglenophyceae (9% (2010) & 10% (2011) was found to be more in 2011 in the pond A. In Pond B Bacillariophyceae was the dominant group (44% in 2010) followed by Myxophyceae (39%). Inverse was found in 2011 where Myxophyceae composition was more (46%) followed by Bacillariophyceae (35%) in Pond B. These two groups were followed by Chlorophyceae (9% & 11%) in 2010 & 2011 respectively. The composition of Euglenophyceae was found to remain constant constituting (8% each) in 2010 & 2011.

Among the zoo-periphyton, in Pond A, Rotifers were the dominant group (33% & 34%) in pond A in 2010 & 2011 respectively. Composition of Protozoans (29%) was more in 2011 followed by Copepoda (29%) in pond A. The vice-versa situation was found in 2010 in pond A for these two groups. Cladocerans constituted (8% & 7%) in 2010 & 2011 respectively. In pond B, Rotifers were the dominant group (38 & 45%) followed by Copepoda (33 & 32%), Protozoa (20&13%) and Cladocera (9 & 10%) in 2010 & 2011 respectively. The above mentioned periphyton seasonal variation and density has been summarised in [Table 1 & 2].

The co-relation with pollution level showed that the pond A showed moderate level of pollution in the monsoon season which may be due to mixing of the water bodies as a result of rain washing many effluents and debris in the pond water. Pond A showed slightest pollution in summer season. However, in Pond B moderate to slight pollution in winter and summer season respectively. A peculiar feature was noticed in the monsoon season in pond B when average species diversity value in two years was the lowest (0.3) indicating heavy pollution which may be due to excess rain that year in the monsoon season mixing of the effluents in the pond water and other physico-chemical parameters also affecting the pollutant entry into the pond water [Table 3].

IV. Conclusion

Average diversity of periphyton was maximum in the summer season (3.4) followed by winter (2.4) & Monsoon (1.6) season in Pond A. The co-relation with pollution level showed that the pond A showed moderate level of pollution in the monsoon season which may be due to mixing of the water bodies as a result of rain washing many effluents and debris in the pond water. Pond A showed slightest pollution in summer season. However, in Pond B moderate to slight pollution in winter and summer season respectively. A peculiar feature was noticed in the monsoon season in pond B when average species diversity value in two years was the lowest (0.3) indicating heavy pollution which may be due to excess rain that year in the monsoon season mixing of the effluents in the pond water and other physico-chemical parameters also affecting the pollutant entry into the pond water. Overall analysis of both the ponds showed that the two ponds may be attributed to oligotrophic category. Pond A (Bazar Samiti pond)/(pokhra) as well as Pond B (Jagdam College Pond) are important water bodies of Chapra, Bihar. They are an important source of pisciculture in addition to irrigation. But this water body is under constant threat due to tourist disposal, domestic sewage and increased human activities. It is therefore, urgent need to manage scientifically this water body to tap it maximum potentiality. Knowledge of seasonal variation in periphyton population can play a vital role in harnessing the available resources in the water bodies.

Acknowledgements

The Authors are thankful to JP University Chapra for providing valuable support. Thanks are also due to the community members residing near the Pond area in Chapra for their cooperation during field collections

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