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RESEARCH ARTICLE

SPECIES COMPOSITION AND DIVERSITY INDICES OF PHYTOPLANKTON IN BHAKRA-YAMUNA LINK CANALS IN NARWANA REGION OF HARYANA

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ABSTRACT

Phytoplankton forms an important trophic level in an aquatic ecosystem and contributes significantly to their primary productivity. The present investigation was carried out on Bhakra-Yamuna link canals at three selected sites (Site S_1, S_2 and S_3) for the qualitative and quantitative analysis of phytoplankton. The constituents monitored were abundance, distribution, total population, group percentage and species diversity of phytoplankton for one year (January-December, 2013).Shannon diversity index (2.47 to 3.29) and species evenness (0.71 to 0.93) were higher at site S_2 indicating high diversity and lower (1.58 to 2.42) at site S_1. Phytoplankton density showed maximum values at site S_2 and S_3 as compare to site S_1.Species richness, population density and mean values of Shannon diversity index of phytoplankton show decrease in their values at site S_3 after linking with site S_1. Jaccard's similarity coefficient calculated on the basis of phytoplankton revealed that site S_2 and S_3 was more similar as compare to site S_3& S_1 and site S_1& S_2 throughout the study period. *Oscillatoria* sp., *Scenedesmus* sp. and *Spirulina* sp. were dominant at site S_1 while at site S_2 green algal flora like *Spirogyra* sp. and *Zygnema*sp. showed abundance.

Key words: Phytoplankton, Bhakra-Yamuna link canals, Shannon diversity index.

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INTRODUCTION

Canal irrigation system is very old in Haryana and has remained the primary source of water supply for potable and non potable uses. Out of a total geographical area of 4.421 million hectare (Mha), 3.819 Mha is cultivable, of which 3.048 Mha is irrigated by canal system. It is believed that the first irrigation canal, Western Yamuna Canal was constructed during the Mughal era (Rao *et al*., 2010). Over the years, an extensive irrigation canal network evolved and according to Irrigation Department, Haryana there are 59 main canals having a length of 1500 km, 1326 distributaries and minor having a length of 12328 km. The canal network in Haryana is divided into four parts: Bhakra canal system, Western Yamuna canal system, Jui canal and Gurgaon canal system. Besides irrigation, the canal systems have been playing a significant role in interlinking of the river system. Each water source has its unique properties and biodiversity. Interlinking will surely bring about sever change in the overall ecology of two feeding systems and the new environment may or may not support the inhabiting biota. Hence, present study of phytoplankton diversity of Bhakra-Yamuna link canal is of utmost importance to evaluate the effect of linking on phytoplankton diversity of selected canal system.

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MATERIALS AND METHODS

Study sites: For the present study, three sampling sites (S_1, S_2, and S_3) were selected on Bhakra-Yamuna link canal system (Figure 1). Site S_1 is located 1 Km upstream from Dhakal head on Sirsa branch of Western Yamuna Canal. SiteS_2 is located 1 Km upstream from Dhakal head on Barwala link canal and site S_3 is located 2.5 km downstream on Sirsa branch after junction with Barwala link canal in the Narwana region of Haryana. Dimensions of selected canals at their study sites were shown in Table 1.

Phytoplankton Analysis: To study plankton species diversity and population density, 50 litres of water was filtered through plank tonic net of mesh size 50 µm with demarcated tube fitted at the bottom, the concentrated sample preserved in 4% formalin. Planktons were identified, using standard references (Ward and Whipple, 1959; Needham and Needham, 1962; Gupta, 1972; APHA, 1998 and Garg *et al*., 2002). Population density was calculated from the concentrated sample following drop count method. Species diversity for phytoplankton was calculated using Shannon Weaver diversity Index (Shannon and weaver, 1963), Simpson Diversity Index (Simpson, 1949).

Table 1. Dimensions of Canals at study sites

Parameters	Site S_1	Site S_2	Site S_3
Geographical position	29º63'N & 76 º17'E	29º61'N & 76 º15'E	29º59'N & 76 º14'E
Top Width(m)	22.33	25	28.76
Bottom width(m)	13.11	0	17.68
Depth(ft)	9.5	20.97	11.90
Slope of boundary wall	1.25:1	1.50:1	1.25:1
Shape of canal	Trapezium	Parabolic	Trapezium

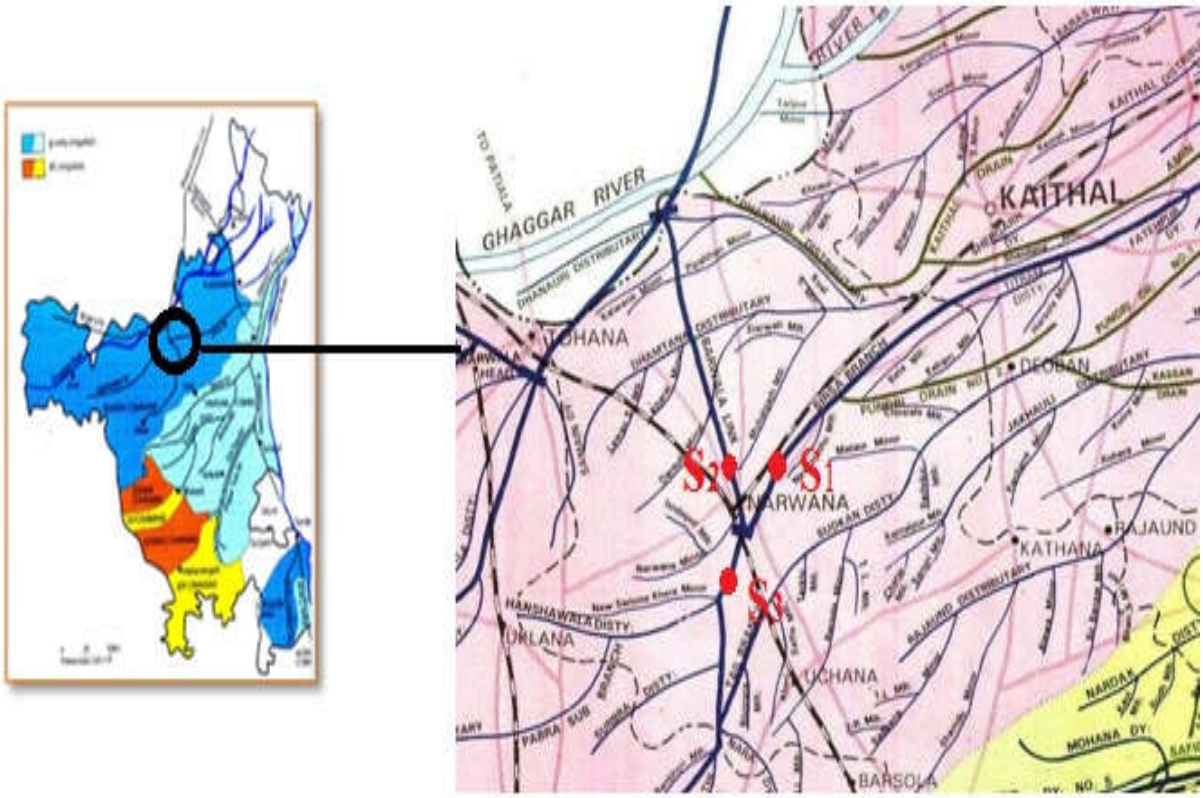

Fig. 1. Map of Haryana showing study sites on selected canals.

Evenness was calculated by Pielou's evenness index (Pielou, 1966).

Drop count method

$$\text{Individual/L} = \frac{\text{no. of organism per drop x vol. of concentrated sample (ml)}}{\text{Vol. of original sample in litters x vol. of one drop (ml)}}$$

Shannon and weaver diversity Index

$$H = -\Sigma(ni/N)\log 2\ ni/N$$

Where, H = Species Diversity
n_i= No. of individuals of i^{th} Species
N = Total Number of Individual in the Sample

Simpson Diversity Index: $D = \Sigma n(n-1)/N(N-1)$

Where, n = the total number of organisms of a particular species.
N = the total number of organisms of all species.

Pielou's Evenness index: J'=H'/ Log S

Where, H' is the number derived from the Shannon diversity index
S is the total number of species

J' is constrained between 0 and 1. The less variation in communities between the species, the higher J' is.

Similarity Coefficient (Jaccard, 1912): Similarity coefficient was calculated by using Jaccard similarity coefficient (Jaccard, 1912) to compare the three zones selected for sample collection on the basis of biodiversity/richness of biota.

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

Where,j= No. of species common at both sites
a=No. of species at site 1
b=No. of species at Site 2
C_j range between 0 and 1. The habitat are completely similar of C_j=1 and completely dissimilar if C_j=0.

RESULTS AND DISCUSSION

A total of twenty five taxa of phytoplankton belonging to three main groups, viz., Chlorophyceae, Bacillariophyceae and Cyanophyceae were encountered (Table 4.2). Out of total 25 taxa, maximum 13 taxa (52 per cent) were contributed by Chlorophyceae followed by Bacillariophyceae (36 per cent) and cyanophyceae (12 per cent) which were represented by 9 and 3 species respectively (Figure 2).

In the present investigation, the dominance of Bacillariophyceae like *Navicula* sp, *Nitzschia* sp., *Synedra* sp.,and *Diatoma* sp.was observed at Site S_1 which was also supported by Jindal and Rumana (2000) and Malhotra *et al.*(2014). Pollution tolerant taxa such as *Oscillatoria* sp., *Scenedesmus* sp. and *Spirulina* sp. were reported at site S_1 which were all together absent at site S_2. Green algal flora like *Spirogyra* sp. and *Zygnema* sp. showed abundance at site S_2 which was unpolluted (Table 1.2).

Table 1.2. Phytoplankton recorded at study sites (S_1, S_2 andS_3) during study period

Sr.No.	Scientific name	Site S_1	Site S_2	Site S_3
I	**Family Bacillariophyceae**			
1	*Cyclotella* sp.	+	-	+
2	*Diatoma* sp.	+	+	+
3	*Fragillaria* sp.	-	+	+
4	*Gomphonema* sp.	-	+	-
5	*Melosira* sp.	-	+	-
6	*Navicula* sp.	++	-	+
7	*Nitzschia* sp.	++	-	-
8	*Pinnularia* sp.	-	+	-
9	*Synedra* sp.	++	-	+
II	**Family Chlorophyceae**			
10	*Cladophora* sp.	-	+	+
11	*Chlorella* sp.	-	-	-
12	*Closterium*. Sp	+	-	+
13	*Coelastrum* sp.	-	+	-
14	*Cosmarium* sp.	-	+	-
15	*Netrium* sp.	+	-	-
16	*Pediastrum* sp.	-	+	+
17	*Scenedesmus* sp.	++	-	+
18	*Selenastrum* sp.	-	+	-
19	*Spirogyra* sp.	-	++	++
20	*Staurastrum* sp.	-	+	-
21	*Ulothrix* sp.	-	+	-
22	*Zygnema* sp.	-	++	-
III	**Family Cyanophyceae**			
23	*Oscillatoria* sp.	++	-	+
24	*Rivularia* sp.	+	-	-
25	*Spirulina* sp.	+	-	+

+ Present, - Absent, ++ Abundance

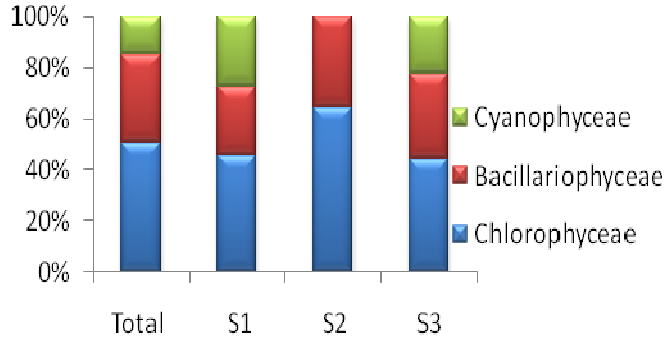

Fig. 2. Per cent contribution of different groups of phytoplankton during study period

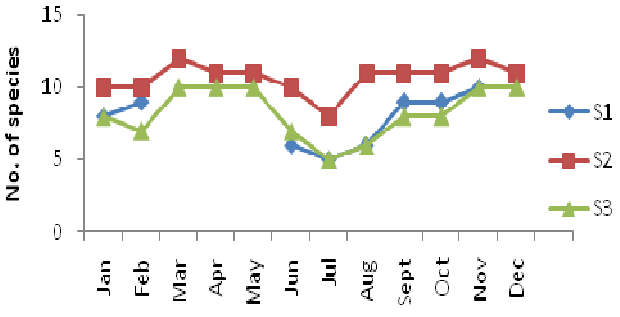

Fig. 3. Species richness of phytoplankton at study sites

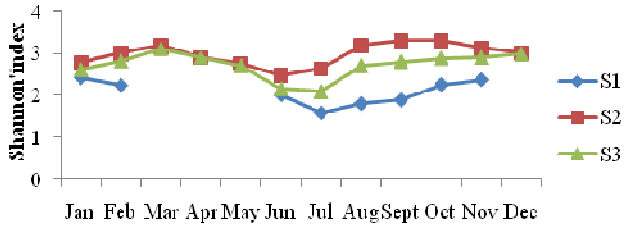

Fig. 4. Shannon-Weaver diversity index of Phytoplankton at study sites

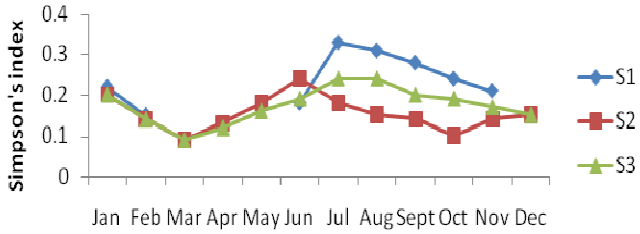

Fig. 5. Simpson' diversity index of phytoplankton at study sites

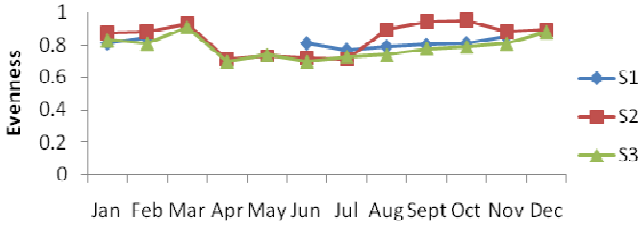

Fig. 6. Evenness index of phytoplankton at study sites

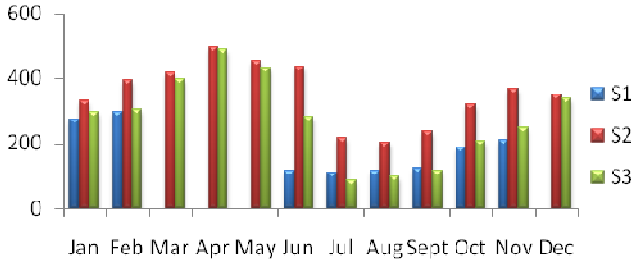

Fig. 7. Population density (Nos. L^{-1}) of Phytoplankton at study sites

Unpolluted Site is characterized by abundance of green algal flora followed by Cyanophyceae and flagellates, as it was supported by earlier workers (More and Nandan, 2000; Nandan and Aher, 2005; Tas and Gonulal, 2007). Cyanophyceae and Euglenophyceae was completely absent at site S_2. Site S_3 was also characterised by dominance of Chlorophyceae but their percentage decreased from site S_2 due to the influence of water from site S_1(Fig. 2). Only five taxa were observed as common at three different study sites viz.*Chlorella* sp., *Diatoma* sp., *Fragillaria* sp., *Closterium* sp.during present investigation (Table 1.2). Biodiversity is fluctuated with different factors like water level, temperature and nutrient level (Matta, 2015). At site S_1, species richness and Shannon-Weaver diversity index was found low throughout study period as compare to site S_2 and S_3(Fig. 3). Malhotra and Kumar, (2014) also reported low phytoplankton biodiversity in Western Yamuna canal as compare to river Yamuna. Relatively higher values of species diversity was observed during the month of March to Maywhich decreased in rainy months and then further increased during post monsoon season (September-November) at site S_2 and S_3. Minimum number of plankton during rainy months (July-

August) could be attributed to cloudy weather, high values of turbidity, fast current of water and dilution in the concentration of some salts (Jindal and Sharma, 2011). Site S_1 was characterized by lowest species diversity and highest species dominance in the month of July which indicate the presence of few dominant species during that period (Figure 4 and 5). Species evenness values were higher at site S_2 during whole study period but follow the same pattern of change i.e. high during December to May and decreased during July and August and further show increase in month of October and November at all three study sites during study period (Figure 6).During present investigation, at site S_2 and S_3, population density of phytoplankton showed maximum values during March-May months however, at site S_1, phytoplankton density was maximum in month of January and February because it becomes dry during summer months (Figure 7). Their abundance during March-May monthswas because of higher values of temperature, hardness and nutrients; moderate values of water current, turbidity and alkaline pH (Saravanakumar *et al*., 2008). Population density of phytoplankton was lowered during the rainy months (July-August) at all sites when the water column was remarkably stratified to a large extent because of heavy rainfall, high turbidity and high total dissolved solids caused by run-off and decreased water temperature. Matta, (2015) also reported increased value of phytoplankton density during summer and post monsoon seasons in Upper Ganga canal. Jaccard similarity coefficient calculated on the basis of phytoplankton diversity revealed that site S_2 and S_3 was more similar as compare to site S_3& S_1 and site S_1& S_2 throughout the study period. This may be due to the fact that site S_2 carried higher volume of water throughout the year while canal at site S_1 become dry during some part of the year. Comparison of mean values of species richness, Shannon-Weaver diversity index, equitability index and population density of phytoplankton at three study sites revealed comparatively high species diversity at site S_2 as compared to site S_1 and S_3 during the whole study period. At site S_3, species diversity as well as population density of phytoplankton show decrease in their values on comparison with S_2 after linking with site S_1. From these results, it can be interpreted that interlinking of canals affect their biodiversity which is also supported by Daniels (2004) and Rajamani *et al*. (2006).

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