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 S1, S2, and S3) 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 S2 indicating high diversity and lower (1.58 to 2.42) at site S1. Phytoplankton density showed maximum values at site S2 and S3 as compare to site S1. Species richness, population density and mean values of Shannon diversity index of phytoplankton show decrease in their values at site S1 after linking with site S2. Jaccard’s similarity coefficient calculated on the basis of phytoplankton revealed that site S2 and S3 was more similar as compare to site S1 & S2 and site S1 & S2 throughout the study period. Oscillatoria sp., Scenedesmus sp. and Spirulina sp. were dominant at site S1 while at site S2 green algal flora like Spirogyra sp. and Zygnemasp. 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 canals. 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.

MATERIALS AND METHODS
Study sites: For the present study, three sampling sites (S1, S2, and S3) were selected on Bhakra-Yamuna link canal system (Figure 1). Site S1 is located 1 Km upstream from Dhakal head on Sirsa branch of Western Yamuna Canal. Site S2 is located 1 Km upstream from Dhakal head on Barwala link canal and site S3 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).
Evenness was calculated by Pielou’s evenness index (Pielou, 1966).

**Drop count method**

\[
\text{Individual/L} = \frac{\text{no. of organism per drop} \times \text{vol. of concentrated sample (ml)}}{\text{vol. of original sample in liters} \times \text{vol. of one drop (ml)}}
\]

**Shannon and weaver diversity Index**

\[
H = -\sum (n_i/N) \log_2 (n_i/N)
\]

Where, \( H \) = Species Diversity

\( n_i \) = No. of individuals of \( i \)th Species

\( N \) = Total Number of Individual in the Sample

**Simpson Diversity Index:**

\[
D = \frac{\Sigma n(n-1)}{N(N-1)}
\]

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.

\[
C_j = \frac{j}{(a+b-j)}
\]

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 S1 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 S1 which were all together absent at site S2. Green algal flora like Spirogyra sp. and Zygnema sp. showed abundance at site S2 which was unpolluted (Table 1.2).

Table 1.2. Phytoplankton recorded at study sites (S1, S2 and S3) during study period

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Scientific name</th>
<th>Site S1</th>
<th>Site S2</th>
<th>Site S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Family Chlorophyceae</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>Cyclotella sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>Diatoma sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>Fragilaria sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>Gomphonema sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Melosira sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>Navicula sp.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>Nitzschia sp.</td>
<td>++</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Pinnularia sp.</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Synedra sp.</td>
<td>++</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>II</td>
<td>Family Cyanophyceae</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>Closterium sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td>Chlorella sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>12</td>
<td>Coelastrum sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>13</td>
<td>Cosmarium sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>14</td>
<td>Neidium sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>15</td>
<td>Pediastrum sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>16</td>
<td>Scenedesmus sp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>17</td>
<td>Selenastrum sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>18</td>
<td>Spirogyra sp.</td>
<td>-</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>19</td>
<td>Stauroastrum sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>20</td>
<td>Ulothrix sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>21</td>
<td>Zygnema sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>III</td>
<td>Family Chlorophyceae</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>22</td>
<td>Oscillatoria sp.</td>
<td>++</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>23</td>
<td>Rivularia sp.</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>24</td>
<td>Chlorophyceae</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>25</td>
<td>Spirulina sp.</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

+ 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

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 S2. Site S1 was also characterised by dominance of Chlorophyceae but their percentage decreased from site S2 due to the influence of water from site S1 (Fig. 2). Only five taxa were observed as common at three different study sites viz. Chlorella sp., Diatoma sp., Fragilarea 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 S2, species richness and Shannon-Weaver diversity index was found low throughout study period as compare to site S1 and S3 (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 May which decreased in rainy months and then further increased during post monsoon season (September-November) at site S2 and S3. 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 S₁ 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 S₂ 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 S₁ and S₃, population density of phytoplankton showed maximum values during March-May months however, at site S₂, phytoplankton density was maximum in month of January and February because it becomes dry during summer months (Figure 7). Their abundance during March-May months was 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 S₂ and S₁ was more similar as compare to site S₃ and site S₁ & S₂ throughout the study period. This may be due to the fact that site S₂ carried higher volume of water throughout the year while canal at site S₁ 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 S₂ as compared to site S₁ and S₃ during the whole study period. At site S₂, species diversity as well as population density of phytoplankton show decrease in their values on comparison with S₁ after linking with site S₁. 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).

REFERENCES


