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Phytoplankton communities of two floodplain lakes of the Dibru Saikhowa biosphere reserve, Tinsukia, Assam (Northeast India): Ecology, richness, and abundance

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ABSTRACT

Phytoplankton communities of Dibru Saikhowa Biosphere Reserve (DSBR) beels were studied from October 2013 to September 2015 in two floodplain lakes (beels), namely Maghuri beel and No.11 beel in Tinsukia district, upper Assam, Northeast India. Phytoplankton reveal a richness of (61 species) belonging to five groups: Chlorophyta (35 species) > Bacillariophyta (13 species) > Euglenophyta (7 species) > Cyanophyta (5 species) > Dinophyta (1). The monthly phytoplankton richness indicated 13–32 (25 ±6) species) and 21–39 (30 ±5) and with distinct species importance of Chlorophyta (5-17) 12 ±4 and (10-24) 15 ±3 species in Maghuri beel and No.11 beel respectively. Phytoplankton abundance ranged between 162 ±157 n/L and 138 ±39 n/L and comprised a sub-dominant component of net plankton, i.e., between 39.7 ±15.8% and 41.0 ±9.9% in Maghuri beel and No.11 beel respectively. Seventeen abiotic factors recorded relatively limited influence on the phytoplankton richness and abundance of the sampled bells. The canonical correspondence analysis asserted higher cumulative influence along the first two axes of 17 abiotic factors on phytoplankton assemblages of Maghuri beel (76.46%) than in No.11 beel (61.73%) beels.

Keywords: Beels, Conservation area, Composition, Distribution, Phytoplankton, Chlorophyta

Introduction

The floodplain lakes are unique ecosystems supporting aquatic life forms of diverse plants and animals and are considered the most critical and productive ecosystem. The floodplain is ideal for limnological considerations vis-à-vis aquatic biodiversity, water quality, ecology, and biological productivity. Little is known about phytoplankton richness, abundance ecology and their role in biological productivity in these environs of India (Jana, 1998). The earlier studies from northeastern India are confined to preliminary reports by Sharma (2004), who initiated a detailed analysis of phytoplankton of a floodplain lake of upper Assam. Sharma (2009) studied phytoplankton's composition, abundance, and ecology in Loktak Lake (a Ramsar site), Manipur. This study is based on the detailed analysis of phytoplankton assemblages of the selected floodplain lakes (beels) in upper Assam. The investigations merit ecosystem diversity, biogeography and ecological importance for Indian limnology and phytoplankton biodiversity in wetlands of conservation areas of India in particular.

Materials and Methods

Limnological studies were undertaken for two years monthly from October 2013 – September 2015, in two floodplain lakes (beels) named Maghuri (27° 34' 19.2" - 27° 34' 25.2" N; 95° 22' 04.5"-95° 22' 35.2" E; altitude: 96.1 m ASL; area: 1197 ha) and No. 11 (27° 34' 04.8"-27° 34' 11.5"N; 95° 20' 21.8"-95° 20' 25.8" E; 94.7 m ASL; area: 12 ha) beels located in the 'buffer zone' of the Dibru-Saikhowa Biosphere Reserve (DSBR), Tinsukia district, upper Assam. The sampled beels are invariably referred to as 'DSBR beels' in this article.

Aquatic vegetation of these beels included *Eichhornia crassipes, Pistia stratiotes*, *Lemna* sp., *Azolla* sp., *Ludwigia* sp., *Rumex* sp. *Cabomba caroliniana*, *Hygroryza aristata*, *Trapa natans*, *Eleocharis* sp., and *Nymphaea* sp.

Water temperature, pH and specific conductivity were recorded with the help of field probes and dissolved oxygen was estimated by the modified Winkler's method. The other abiotic parameters, such as free carbon dioxide, total alkalinity, total hardness, calcium, magnesium, chloride, dissolved organic matter, total dissolved solids, phosphate, nitrate, sulphate, and silica, were analysed following APHA (1992). The rainfall data was obtained from the Citrus Research Station, Government of Assam, Tinsukia, Assam.

The qualitative plankton samples were collected by towing nylobolt plankton net (No. #50 µm), and the quantitative samples were by filtering 25 litres of water from the selected sites at regular monthly intervals and were preserved in 5% formalin. Various phytoplankton taxa were screened with a Wild Stereoscopic Binocular Microscope for isolation and were observed with a Leica (DM 1000) stereoscopic phase contrast microscope fitted with an image analyser. The phytoplankton taxa were identified following the works of Tiffany and Britton (1952), Needham and Needham (1962), Islam and Haroon (1980), Adoni et al. (1985), Fitter and Manuel (1986) and Perumal and Anand (2008), and several research papers.

The percentage similarities (Sorenson's index), Species diversity (Shannon's index), Dominance (Berger-Parker's index), and Evenness (Pielou's index) were calculated following Ludwig and Reynolds (1988) and Magurran (1988). Ecological relationships between the abiotic and biotic parameters were determined by Pearson correlation coefficients (r_1 and r_2, respectively, for Maghuri beel and No.11 beel). The canonical correspondence analysis (XLSTAT 2014) was done to observe the cumulative influence of stated abiotic factors on phytoplankton assemblages.

Results and Discussion

The observed variations in abiotic factors (mean ± SD) of two regularly sampled beels, namely the Maghuri beel and No.11 beel, are indicated in Table 1. Water temperature corroborated with the geographical location of the wetlands. Specific Conductivity showed low ionic concentrations and, thus, warranted the inclusion of DSBR beels under the 'Class 1' category of trophic classification vide Talling and Talling (1965). Slightly acidic to alkaline nature of waters and soft to moderate waters of these beels depict moderate dissolved oxygen and free carbon dioxide, low concentration of micro-nutrients and other abiotic factors. The Chloride concentrations in the beels registered low and thus indicated a lack of influence of organic pollution caused by human impact.

Richness

Sixty-one species of phytoplankton belonging to five groups: Chlorophyta (35 species) > Bacillariophyta (13 species) > Euglenophyta (7 species) > Cyanophyta (5 species) > Dinophyta (1) were documented from DSBR beels. The temporal variation of phytoplankton between the sites is indicated in Table 2. Maghuri beel and No.11 beel recorded species richness of 61 species each. The phytoplankton richness concurred with the 62, 61 and 59 species recorded from Utra and Waithou pats (Sharma, 2010) of Manipur and Deepor beel (Sharma, 2015) of Assam while it showed a more diverse nature than the earlier reports from 49 and 55 species from Rawalsar and Prashar lakes of Himachal Pradesh (Thakur et al., 2013); 52

species from Samuajan beel (Sharma, 2004) and Ghorajan beel (Sharma, 2012) from Assam, respectively. However, the phytoplankton richness of DSBR beels is lower than 75 species reported from Loktak Lake (Sharma, 2009), Manipur. Chlorophyta (35 species) depicted qualitative importance of phytoplankton are characterised by the rich desmid genera, namely *Cosmarium* (6 species) = *Micrasterias* (6 species) > *Staurastrum* (4 species) > *Closterium* (3 species) = *Euastrum* (3 species) > *Pediastrum* (2 species) which collectively comprised ~51.0 % of the Chlorophyta richness in the sampled beels. Desmid diversity is an essential indicator of waters with low ionic concentrations and Calcium content (Payne, 1986; Sharma, 1995; Sharma and Pachuau, 2016). This important characteristic is attributed to the salient features of the water quality of DSBR beels.

Bacillariophyta (13 species) recorded importance but showed lower richness than the reports of Sharma (2004, 2009, 2010, 2012, 2015) and Khan (2017). The monthly phytoplankton richness ranged between 13–32 (25 ±6) species) and 21–39 (30 ±5) species in the Maghuri beel and No.11 beel during the study period. It did not show any significant correlation with abiotic factors during the study period, thus indicating a lack of the role of abiotic factors vis-à-vis phytoplankton diversity. The present study showed no definite periodicity of the richness of phytoplankton in the sampled beels concurrent with the remarks of Sharma (2004, 2010, 2012, 2015) in certain floodplain lakes of NEI and from other water bodies of Meghalaya (Sharma and Lyngskor, 2003; Sharma and Lyngdoh, 2003) and Mizoram (Pachuau, 2009).

The phytoplankton community similarities ranged between 14.6–77.2 % in the Maghuri beel and 36.0–74.7 % in the No.11 beel, respectively. The recorded ranges suggested heterogeneity in phytoplankton composition in DSBR beels during the study period. The heterogeneity remarks are endorsed by the facts that the similarity matrices indicated lower similarity, i.e., 31-40%, 41-50% and 51-60% in 49, 75 and 92 instances (~78% of total instances), respectively in Maghuri beel; and 41-50% and 51-60% in 79 and 124 instances (~74% of total instances) in No.11 beel. The hierarchical cluster analysis endorsed heterogeneity in phytoplankton assembles of two beels during the study.

Abundance

Phytoplankton is characterised by low abundance, i.e., between 162 ±157 n/L in Maghuri beel and 138 ±39 n/L in No. 11 beel (Noroh, 2019); it comprised a sub-dominant component of net plankton, i.e., between 39.7 ±15.8% and 41.0±9.9% in Maghuri beel and No.11 beel respectively during the study period. Phytoplankton recorded relatively more comprehensive density variations in Maghuri beel and contributed significantly to quantitative variations of net plankton in Maghuri (r_1= 0.974, p< 0.0001). The abundance broadly concurred with the reports from Nigeen Lake, Kashmir Himalayas (Shafi *et al*., 2013) and certain beels of lower Assam (Khan, 2017) while it is lower than the results from floodplain lakes (Sharma, 2010) of Manipur; Deepor Beel (Sharma, 2015), Samuajan beel (Sharma, 2004) and Ghorajan beel (Sharma, 2012) of Assam; and the Majuli floodplains lakes (Hatimuria, 2015).

Phytoplankton abundance did not follow any definite fluctuation pattern during the study period. The former generalisation concurred with the reports of Sharma (2010, 2012). Still, it differed from the trimodal pattern observed in Loktak Lake (Sharma, 2009) and Deepor beel (Sharma, 2015) and also from bimodal variations reported by Yadava *et al.* (1987), Sanjer and Sharma (1995) and Jindal et al., (2014). Chlorophyta > Bacillariophyta recorded phytoplankton dominance in No.11 beels during the study period but showed Bacillariophyta > Chlorophyta during the first year in Maghuri beel thus indicating a little deviation in quantitative importance. Cyanophyta and Euglenophyta exerted limited importance in the selected beels. The stated variations are attributed to ecological heterogeneity amongst DSBR beels. The significance of Chlorophyta concurred with the reports from specific aquatic ecosystems of northeast India (Goswami and Goswami, 2001; Sharma, 2009, 2010, 2012, 2015; Hatimuria, 2015), while Bacillariophyta importance in Maghuri beel concurred with the reports of Baruah *et al.* (1993). Chlorophyta comprised an important component (45.6 ±15.6% and 47.8 ±7.6%) and contributed notably (r_1= 0.711, p= 0.0001) and (r_2= 0.894, p< 0.0001) to quantitative variations of phytoplankton of Maghuri beel and No.11 beel, respectively during the study period. Peak density of Chlorophyta was recorded during February 2014 in the Maghuri beel and March 2014 in the No.11 beel. Chlorophyta indicated relatively lower abundance with the reports of Sharma (2004, 2009, 2010, 2015) from the floodplain lakes of northeast India as well as from certain reservoirs of Meghalaya (Sharma, 1995; Sharma and Lyngdoh, 2003; Sharma and Lyngskor, 2003).

Chlorophyta is characterised by the quantitative importance of certain desmid taxa, namely *Cosmarium* spp. (9 ±9 n/L, 11 ±7 n/L) and *Closterium* spp. (15 ±11 n/L, 13 ±7 n/L) and limited importance of *Micrasterias* spp. (5 ±4 n/L, 11 ±9 n/L) during the study period in Maghuri beel and No.11 beel, respectively. The present result of the quantitative role agreed with the importance of certain species of green algae indicated by Sharma (2004). Bacillariophyta, the second most diverse group after Chlorophyta, showed abundance ranged between 16.7-80.4% (41.3±20.1)% and 18.0-44.8% (32.2±6.9)

% in Maghuri beel, and No.11 beel respectively during the study period. Bacillariophyta abundance did not follow any definite pattern of variation throughout the study period, which, in turn, contrasts the results of Sharma (2012) and differs from a trimodal pattern reported by Deepor beel (Sharma, 2015). Annual maxima were observed in March 2014 and May 2015 in both Maghuri beel and No.11 beel, respectively. The Diatom abundance lacked the distinct role of any individual species, as reported by Sharma (2015).

Species Diversity, Evenness and Dominance

The species diversity of phytoplankton is influenced by richness and equitability, or relative abundance of species, and it is recorded in the following stated order of species diversity (*vide* Shannon's index) of phytoplankton of No. 11 beel (2.812-3.401, 3.133 ±0.165) > Maghuri (1.161-3.012, 2.570 ±0.446) beel. The characteristic differences are further endorsed by higher diversity (> 3.0) during 19 months in No.11 beels, while such a condition is noticed during eight and one months in the Maghuri beel. The results thus endorsed phytoplankton heterogeneity on account of habitat diversity and ecological differences amongst the beels. Chlorophyta richness contributed significantly to phytoplankton richness (r_1= 0.830, p< 0.0001 and r_2= 0.845, p <0.0001) in Maghuri beel and No.11 beel, respectively. It is influenced by richness and equitability or relative abundance of species. The phytoplankton diversity did not show any definite pattern of variation during the study period. The most diverse and species-rich Chlorophyta > Bacillariophyta contributed to the phytoplankton diversity in the sampled beels.

Phytoplankton dominance is characterised by consistently low values in the No.11 beel (0.0690.180, 0.116 ±0.031) but indicated certain variations in the Maghuri beel (0.104-0.776, 0.255 ±0.161). In general, low phytoplankton dominance in the sampled beels is attributed to low abundance and equitable distribution of different species (Osborne *et al.,*1976), while selected instances of high dominance resulted from the quantitative importance of fewer phytoplankton species (Whittaker, 1965). The latter conclusion is particularly valid for Maghuri beel during February and March (2014) with the density importance of *Volvox aureus* and *Closterium* spp. (*C. moniliferum*) in particular. The variations of dominance between the beels concurred with the earlier reports from various aquatic ecosystems of NEI (Sharma and Lyngdoh, 2003; Sharma, 2004, 2010, 2012, 2015). Dominance positively correlated with phytoplankton abundance (r_1= 0.835, p= 0.0001), Bacillariophyta abundance (r_1= 0.862, p= 0.0001) and inversely correlated with species diversity (r_1= -0.916, p< 0.0001) in Maghuri beel.

Phytoplankton communities of DSBR beels exhibited moderate to high evenness during the study period, i.e., between 0.335-0.950 (0.813 ±0.142) and 0.884-0.962 (0.930 ±0.018) in Maghuri beel and No.11 beel, respectively. High evenness observed during several months is attributed to the equitable abundance of the majority of phytoplankton taxa (Washington, 1984). Evenness variations concurred with the report from the Majuli floodplains, Assam (Hatimuria, 2015). Phytoplankton evenness is negatively correlated to phytoplankton abundance (r_1= -0.910, p= 0.0001), Bacillariophyta abundance (r_1= -0.907, p= 0.0001), *Volvox aureus* (r_1= -0.695, p= 0.0002) and dominance (r_1= -0.951, p= 0.0001); it is correlated positively with species diversity (r_1= 0.886, p < 0.0001) in Maghuri beel. Phytoplankton evenness was inverse correlated with dominance (r_2 = -0.816, p< 0.0001) in No.11 beel.

Canonical Correspondence Analysis (CCA)

The canonical correspondence analysis asserted higher cumulative influence along the first two axes of 17 abiotic factors on phytoplankton assemblages of Maghuri beel (76.46%) than in No.11 beel (61.73%) beel. CCA coordination biplots indicated the influence of rainfall and dissolved oxygen on net plankton abundance, Chlorophyta richness, and sulphate on phytoplankton density and *Cosmarium* spp. the abundance of dissolved organic matter in Maghuri beel. Net plankton abundance was influenced by chloride, dissolved organic matter and silicate; Chlorophyta abundance and richness were influenced by total alkalinity and plankton richness by total hardness in No.11 beel. The present study recorded limited influence of individual abiotic factors, and CCA results suggested the cumulative importance of seventeen abiotic factors vis-à-vis variations of phytoplankton assemblages DSBR beels.

Ecological Relationships

The present study did not register any significant influence of individual abiotic factors on phytoplankton richness and its constituent group. The results thus depicted a limited role of individual abiotic factors vis-à-vis phytoplankton richness. This conclusion marked a little deviation from the much-limited influence of individual abiotic parameters recorded in certain beels of Assam (Sharma, 2012, 2015) and the importance of certain abiotic factors noted in two floodplain lakes of Manipur (Sharma, 2010).

The phytoplankton abundance (r_1= 0.681, p= 0.0002), Bacillariophyta abundance (r_1= 0.704, p= 0.0001) and *Volvox aureus* abundance (0.632, p= 0.0009) indicated positive correlation with nitrate in Maghuri beel. Cyanophyta abundance (r_2= 0.623, p= 0.0011) positively correlates with rainfall and

Cosmarium spp. abundance is positively correlated with nitrate ($r_2 = 0.662$, $p = 0.0004$) in No.11 beel. The stated remarks depicted the role of abiotic factors vis-à-vis phytoplankton concurred with the reports of Sharma and Lyngskor (2003) and Sharma (2004, 2010, 2012). The limited role of abiotic parameters concurred with the results of Sharma (2004, 2012), while it deviated from the influence of some factors indicated by Sharma (2009) or even lack of importance of any individual abiotic parameters as reported by Sharma (2015).

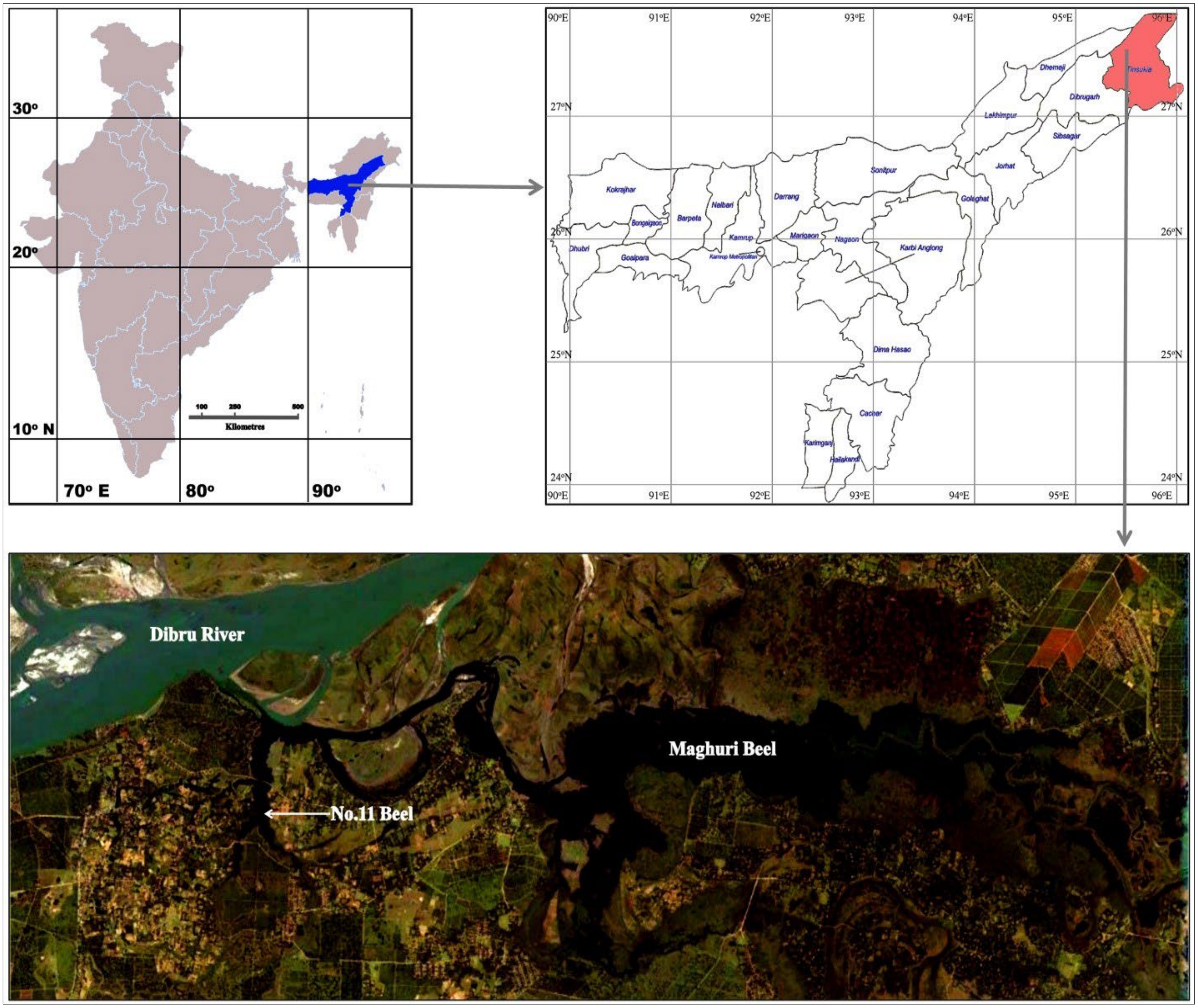


Figure 1. Map of India showing Assam state indicating location of Tinsukia district and satellite map showing the sampled beels

Table 1. Abiotic parameters (Mean ± SD) of the samples

Beel→	**MAGHURI BEEL**		**NO.11 BEEL**	
Parameters↓	**Range**	**Mean ±SD**	**Range**	**Mean ±SD**
Rainfall (mm)	0.0 - 615.0	188.4 ±193.6	0.0 - 615.0	188.4 ±193.6
Water temperature (ºC)	15.0 -30.8	24.7 ±4.6	15.5 - 30.7	25.4 ±4.6
pH	6.51 - 8.26	7.38 ±0.50	6.39 - 8.72	7.42 ±0.54
Specific conductivity (µS/cm)	69.0 - 140.0	100.0 ±19.4	46.0 - 139.0	84.7 ±22.3
Dissolved Oxygen (mg/L)	4.0 - 8.0	6.0 ±1.4	4.0 - 8.0	5.6 ±1.2
Free Carbon-dioxide (mg/L)	10.0 - 28.0	15.8 ±5.0	10.0 - 24.0	16.1 ±3.8
Total alkalinity m(g/l)	40.0 - 80.0	58.9 ±12.9	38.0 - 80.0	52.4 ±10.0
Total hardness (mg/L)	54.0 - 96.0	72.6 ±10.5	50.0 - 100.0	69.2 ±10.7
Calcium hardness(mg/L)	14.7 - 25.2	20.1 ±2.8	12.6 - 25.2	18.8 ±3.7
Magnesium hardness(mg/L)	7.00 - 17.71	12.75 ±2.60	8.07 - 18.69	12.24 ±2.44
Chloride hardness (mg/L)	7.99 -20.97	13.23 ±3.43	10.98 - 24.98	16.52 ±3.67
DOM (mg/L)	0.041 -0.131	0.101 ±0.027	0.045 - 0.131	0.097 ±0.022
TDS (mg/L)	0.080 -0.320	0.160 ±0.075	0.040 - 0.320	0.155 ±0.077
Phosphate (mg/L)	0.134 - 0.322	0.189 ±0.054	0.136 - 0.371	0.194 ±0.062
Nitrate (mg/L)	0.352 - 1.881	0.733 ±0.352	0.369 - 1.550	0.720 ±0.293
Sulphate (mg/L)	6.143 - 25.047	11.020 ±5.584	5.767 - 22.907	11.482 ±5.213
Silica (mg/L)	0.657 - 1.089	0.877 ±0.188	0.661 - 1.167	0.900 ±0.192

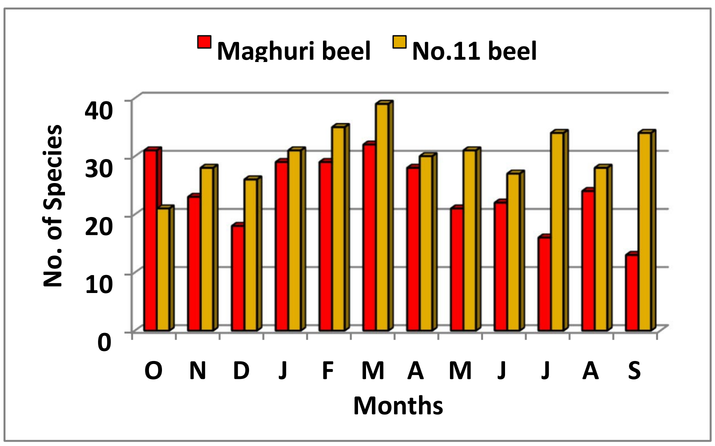


Figure 2. Monthly variation of richness of phytoplankton of DSBR beels (2013-2014)

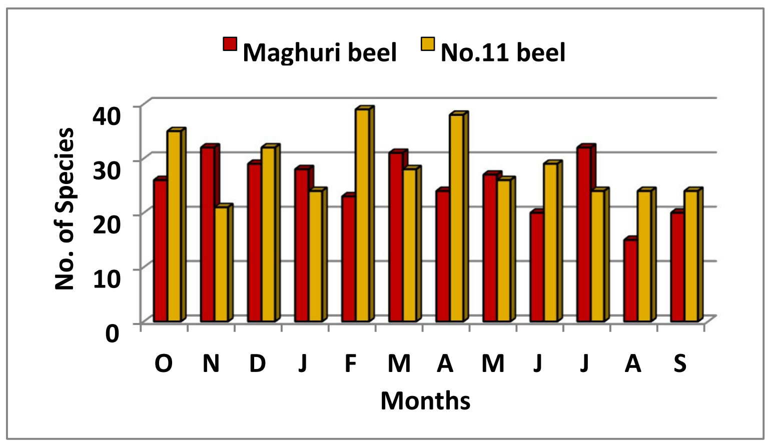
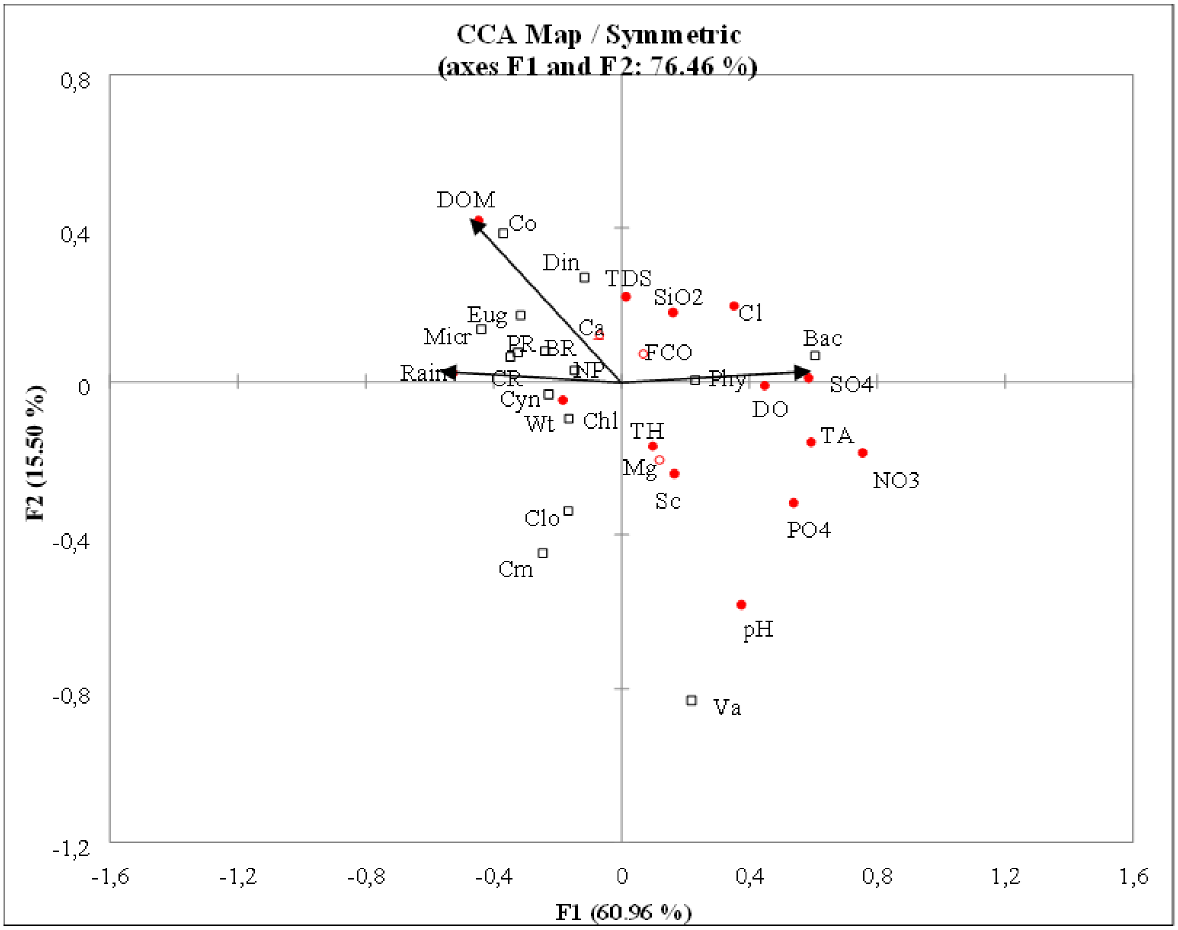


Figure 3. Monthly variation of richness of phytoplankton of DSBR beels (2014-2015)

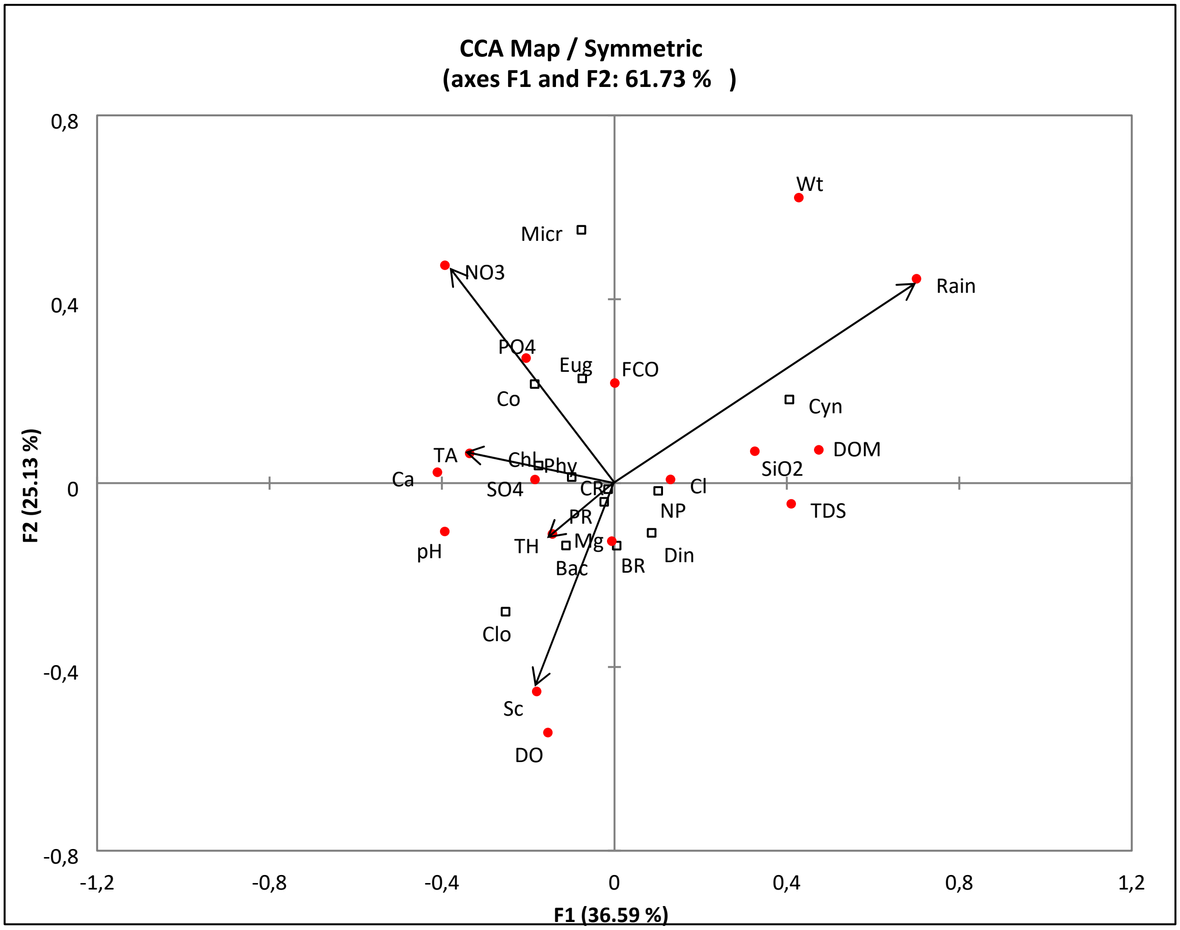
Table 2. Temporal variation of Phytoplankton between sites (October 2013 - September 2015)

QUALITATIVE	Maghuri beel		No.11 beel	
	Study period		Study period	
Net plankton total	**241 species**		**251 species**	
Net plankton	58-122	81±14	65-139	94±20
Phytoplankton Total	61species		61species	
% similarity	14.6-77.2		36-74.7	
Phytoplankton	13-32	25±6	21-39	30 ±5
Chlorophyta	5-17	12 ±4	10-24	15 ±3
Bacillariophyta	4-12	7 ±2	4-10	7 ±2
Cyanophyta	0-4	2 ±1	1-5	3 ±1
Dinophyta	0-1	1 ±1	0-1	1 ±0
Euglenophyta	1-5	3 ±1	1-7	3 ±2
QUANTITATIVE				
Net plankton n/L	214-950	359 ±150	230-438	337 ±52
Phytoplankton	39-811	162 ±157	81-243	138 ±39
% composition	17.0-85.4	39.7 ±15.8	26.7-66.7	41.0 ±9.9
Diversity	1.161-3.012	2.570 ±0.446	2.812-3.401	3.133 ±0.165
Dominance	0.104-0.776	0.255 ±0.161	0.069-0.180	0.116 ±0.031
Evenness	0.335-0.950	0.81 3±0.142	0.884-0.962	0.930 ±0.018
Different Groups				
Chlorophyta	21-128	61 ±32	39-129	66 ±23
% composition	15.4-70.9	45.6 ±15.6	36.0-63.3	47.8 ±7.6
Bacillariophyta	7-652	85 ±132	18-81	45 ±16
% composition	16.7-80.4	41.3 ±20.1	18.0-44.8	32.2 ±6.9
Cyanophyta	0-30	10 ±8	2-29	10 ±8
% composition	0.0-20.0	7.6 ±5.7	1.8-24.8	7.5 ±5.7
Dinophyta	0-3	1 ±1	0-4	1 ±1
% composition	0.0-4.2	0.7 ±1.0	0.0-2.8	0.8 ±0.9
Euglenophyta	1-11	5 ±3	5-44	16 ±9
% composition	0.8-13.1	4.7 ±3.6	4.0-26.3	11.6 ±5.7
Important taxa (n/L)				
***Cosmarium* spp.**	0-36	9 ±9	0-30	11 ±7
***Closterium* spp.**	0-44	15 ±11	3-31	13 ±7
***Micrasterias* spp.**	0-14	5 ±4	0-30	1 1±9



Abbreviations: **Abiotic:** Ca (Calcium), Cl (Chloride), DOM (dissolved organic matter), DO (dissolved oxygen), FCO2 (free carbon dioxide), Rain (rainfall), NO_3 (nitrate), PO_4 (phosphate), SiO_2 (silicate), Sc (specific conductivity), SO_4 (sulphate), TA (total alkalinity), TDS (total dissolved solids), TH (total hardness), pH (hydrogenion concentration), Wt (water temperature). **Biotic:** Bac (Bacillariophyta), BR (Bacillariophyta richness), Chl (Chlorophyta), CR (Chlorophyta richness), Clo (*Closterium*), Cm (*Closterium moniliferum*), Co (*Cosmarium*), Cyn (Cyanophyta), Din (Dinophyta), Eug (Euglenophyta), Micr (*Micrasterias*), NP (Net Plankton), Phy (Phytoplankton), PR (Phytoplankton richness), Va (*Volvox aureus*).

Figure 4. CCA coordination biplot of phytoplankton and abiotic factors of Maghuri beel



Abbreviations: **Abiotic:** Ca (Calcium), Cl (Chloride), DOM (dissolved organic matter), DO (dissolved oxygen), FCO_2 (free carbon dioxide), Rain (rainfall), NO_3 (nitrate), PO_4 (phosphate), SiO_2 (silicate), Sc (specific conductivity), SO_4 (sulphate), TA (total alkalinity), TDS (total dissolved solids), TH (total hardness), pH (hydrogenion concentration), Wt (water temperature). **Biotic:** Bac (Bacillariophyta), BR (Bacillariophyta richness), Chl (Chlorophyta), CR (Chlorophyta richness), Clo (*Closterium*), Co (*Cosmarium*), Cyn (Cyanophyta), Din (Dinophyta), Eug (Euglenophyta), Micr (*Micrasterias*), NP (Net Plankton), Phy (Phytoplankton), PR (Phytoplankton richness).

Figure 5. CCA coordination biplot of Phytoplankton and abiotic factors of No. 11 beel

Conclusion

To sum up, phytoplankton communities of DSBR beels are diverse and speciose and are characterised by Chlorophyta's qualitative and quantitative importance. Bacillariophyta, the second most diverse group after Chlorophyta, also contributed significantly to phytoplankton abundance in the sampled beels. The species diversity of phytoplankton is influenced by richness and equitability or relative abundance of species. Phytoplankton communities depicted higher species diversity, evenness and lower dominance. The present study recorded minimal influence of individual abiotic factors. CCA results suggested the cumulative importance of seventeen abiotic factors vis-à-vis variations of phytoplankton assemblages of the floodplain lakes of DSBR.

Compliance with Ethical Standards

Conflict of interest: The author(s) declares that they have no actual, potential, or perceived conflict of interest for this article.

Ethics committee approval: -

Data availability: Data will be made available on request.

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