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Research Article

Diversity and seasonal patterns of algal flora in select eco-sensitive floodplain wetlands of Eastern Himalayan foothills

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ABSTRACT

The present study investigated the diversity and seasonal dynamics of algae in five important wetlands of the Eastern Himalayas viz., Kapla Beel, Sorbhog Beel, Kukarjan Beel, Gandhi Beel and Kaplimara Beel which were designated as B1, B2, B3, B4 and B5 respectively. The study was conducted from December, 2019 to November, 2021 for a period of two years. A total of 265 algal species belonging to 104 genera, 30 orders and 57 families were recorded under 11 taxonomic classes. Maximum algal species richness was recorded in Kapla beel (B1) with 137 species, while, minimum species richness was observed in Kukarjan beel (B3) with 91 species. The algal community in the present study displayed distinct seasonal changes. As per Palmer's pollution index, the study sites could be arranged as: B4 (30)> B3 (29)> B1 (28)> B5 (26)> B2(23). PCA graph displayed significant correlation between algal classes and four seasons during the study period.

Key words: Algal diversity; Wetland ecology; Seasonal dynamics; Pollution assessment

INTRODUCTION

Eastern Himalaya, one of the Earth's biodiversity hotspots (Myers *et al*., 2000) outspreads across Bhutan, Northeast India, Darjeeling hills of West Bengal, southeast Tibet in China and north of Myanmar (Chettri *et al*., 2010). Yarlung Tsangpo, which originates in the Tibet, flows downward from Arunachal Pradesh as Siang in to Assam in the form of Brahmaputra (Qinye & Du, 2004). The mighty Brahmaputra and its tributaries create a large floodplain system which encompasses most parts of Assam (Singh, 2001).

The foothills of Eastern Himalaya provide water for all species, in the form of major rivers and several wetlands, which are predominantly dominated by beels, swamps and lakes (Singh, 2001). With high water load, the Brahmaputra River and its tributaries create about 11,261 number of small and large wetlands along its floodplains (Baruah & Baruah, 2022). Due to high productivity, floodplain wetlands serve as an important habitat for fishes and fisheries (Baruah & Baruah, 2024). These freshwater bodies are extraordinarily rich in biodiversity (Baruah *et al*., 2022) and their species richness is much higher than that of terrestrial and marine ecosystems (Baruah & Baruah, 2003; Nath & Baruah, 2020). Algae including phytoplankton and macrophytes belong to the autotrophic community, while, zooplanktons, insect larvae, small fishes, large fishes, birds belong to the heterotrophic community in a beel ecosystem, a typical shallow waterbody formed due to river meanders (Baruah & Baruah, 2023), where algal diversity is always outnumbered than the other aquatic species. It is also seen that with concomitant seasonal changes in physical, chemical, and biological components of water bodies, there are changes in the algal population too which results in variation of composition and relative abundance of algal communities (Srivastava *et al*., 1987).

Barpeta district of Lower Brahmaputra Valley in Assam lies at an aerial distance of 40 km from Manas Biosphere Reserve; 140 km from Raimona National Park; 100 km from Deepor Beel Ramsar site and 280 km from Kaziranga National Park bordering Bhutan Himalaya. The district houses as many as 32 numbers of floodplain wetlands, locally known as 'Beel' which are seen to be important hub for flora, fauna and migratory birds. But these ecosensitive water bodies are now under serious threat due to growing anthropogenic activities in and around the areas. Although there are reports on the study of physicochemical parameters of water and soil, avian, rotifer, ichthyofaunal and macrophyte diversity (Barman & Baruah, 2013; Das *et al*., 2014; Dutta *et al*., 2014; Talukdar & Bhattacharyya, 2016; Talukdar & Rajbongshi, 2018; Choudhury, 2020) in the ecosensitive beels of Barpeta district, but there is a gap on the study of algal diversity with scanty reports (Deka *et al*., 2009). However, in recent times, there is ample research on algal flora in ponds and rivers of Assam (Borah, 2024; Kalita et al., 2024; Rongpipi et al., 2025; Sinha et al., 2025). As algae are an important biological tool for determining the water quality and degree of organic pollution in water bodies (Baruah & Baruah, 2024), to conserve the ecological significance of these dwindling ecosystems, the present study was designed with the following objectives: 1. To study the diversity and distribution pattern of fresh water algae in selected beels of Barpeta district, 2. To study the seasonal dynamics of algal community in the beels.

MATERIALS AND METHODS

Study site

The study area is the erstwhile Barpeta district prior to the formation of Bajali district which is situated at the Lower Brahmaputra Valley of Assam and lies between geographical coordinates of 26°5′N and 26°51′N latitudes and 90°38′E and 91°20′E longitudes. The district

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is surrounded by the Bhutan hills and Baksa district in the North, Nalbari district in the East, Kamrup and Goalpara district in the South, Bongaigaon and Chirang district in the West. Barpeta district occupies around 4.21% of the total geographical area of the state and 16.05% of the Lower Brahmaputra Valley zone. The climate of Barpeta district can be divided into four seasons, i.e., Premonsoon (March, April, May); Monsoon (June, July, August), Postmonsoon (September, October, November) and Winter comprising of December, January, February months of a year.

In the present study, five Beels of Barpeta district were selected viz., Kapla Beel, Sorbhog Beel, Kukarjan Beel, Gandhi Beel and Kaplimara Beel which were desginated as B1, B2, B3, B4 and B5 respectively. The map (Fig. 1) includes a scale bar showing distances from 0 to 20 km. The selected study sites are the resting and breeding grounds for several migratory birds such as Asian woollyneck, Brahminy duck, Bar headed goose, Grey-headed lapwing, Common crane, Black ibis, Whistling teal, White Wagtail etc.

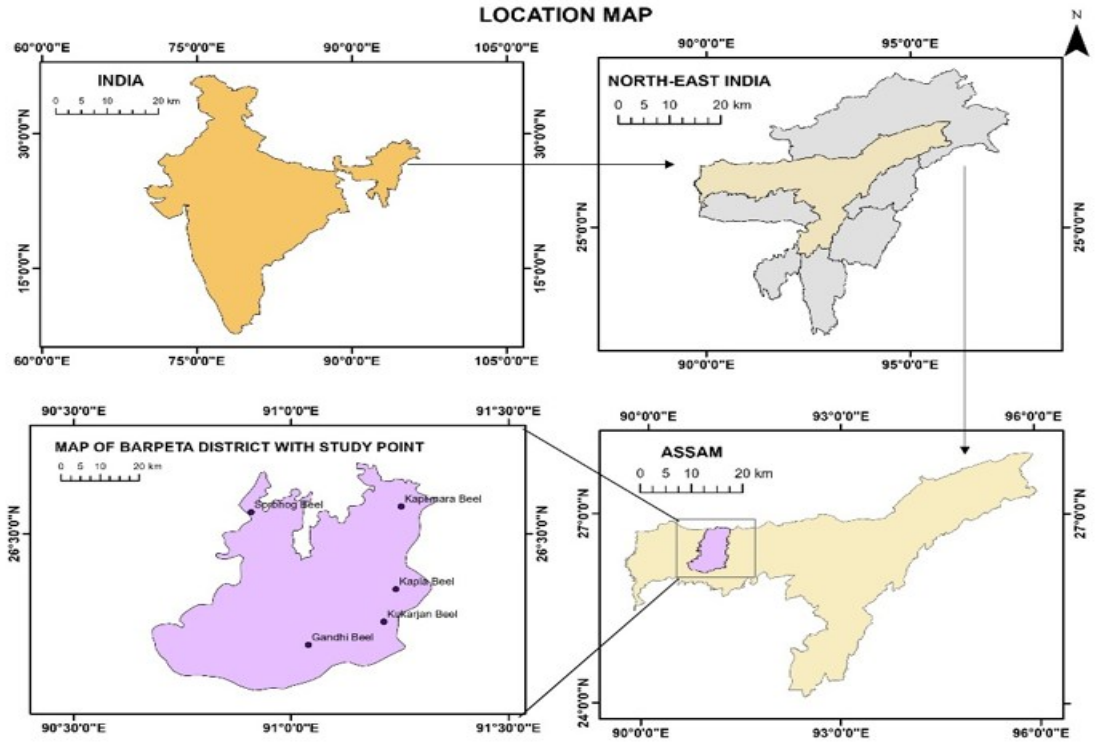

Figure 1. Map of study sites

SAMPLING

Collection of algal samples

Algal samples were collected randomly from each study site every month from December 2019 to November 2021 for a period of two years by filtering technique (Roy & Pal, 2015) using net of mesh size 20 µm. After passing 20 litres of water through the mesh, the residual cellular materials were collected in clean specimen bottles. On the other hand, visible algal samples were collected by using forceps from leaves and stems of aquatic plants, sides of the water bodies, floating logs and bamboos, surface of boats etc. Specimen bottles were properly labelled and brought to Plant Ecology Laboratory of Department of Botany, Gauhati University for microscopic observation.

Samples were preferably examined at fresh condition. The remaining portions were preserved in 4% formaldehyde and Lugol's iodine solution.

Microscopic observation and Identification

The collected algal samples were observed under compound microscope (Euromex Delphi-X Observer Series) in low and high magnifications. Photomicrographs were clicked with the help of a Euromex (20 MP) digital camera. Identification of algal samples were done using standard literature and monographs (Desikachary, 1959; Randhawa, 1959; Gandhi, 1960; Komarek & Fott, 1983; Prasad & Srivastava, 1992; Prasad & Mishra, 1992; Kant & Gupta, 1998; Komarek & Anagnostidis, 1998, 2005; Gandhi, 1998; John *et al*., 2005; Perumal & Anand, 2009; Yamagishi, 2010; Das & Adhikary, 2014; Das & Keshri, 2016). The recorded algal species were systematically arranged following Algaebase (Guiry & Guiry, 2020).

Species diversity index (Shannon-Weiner, 1949)

Species diversity in a community can be measured mathematically by species diversity index. It provides information regarding rarity and commonness of species in a community. Diversity index helps in water quality assessment, where lower values indicate higher level of pollution (Trivedy, 1980). Species diversity was measured using Shannon and Weiner Diversity Index which is calculated as follows:

$$H = -\Sigma [Pi \square \log (Pi)]$$

Where:
H = Shannon and Weiner Diversity Index
Pi = ni/N (where, ni = number of individuals in species,
N = total number of individuals in sample)
Trivedy (1980 and 1981) demonstrated a scale for the degree of pollution and diversity index which is represented in Table 1.

Table 1. Diversity index value (Trivedy, 1980 and 1981)

Diversity index value	Water condition
>4.0	Clean water
3.0-4.0	Very light pollution
2.0-3.0	Moderate pollution
<2.0	Heavy pollution

Palmer's pollution index (Palmer, 1969)

Based on the algal data, Palmer (1969) developed Palmer's pollution index for evaluation of organic pollution in water bodies. This index table included 20 algal genera which were most tolerant to organic pollution and their respective score or number depending on their relative tolerance. The numbers scored by each genus present in a sample are added to get the Palmer's pollution index of the water body. The Palmer pollution index is represented in the Table 2.Based on the above table, Palmer (1969) formulated the pollution index scale for assessment of organic pollution of water body (Table 3).

Table 2. Palmer's (1969) pollution index

Sl No.	Genera	Pollution index	Sl No.	Genera	Pollution index
1	*Anacystis* (*Microcystis*)	1	11	*Micractinium*	1
2	*Ankistrodesmus*	2	12	*Navicula*	3
3	*Chlamydomonas*	4	13	*Nitzschia*	3
4	*Chlorella*	3	14	*Oscillatoria*	4
5	*Closterium*	1	15	*Phormidium*	1
6	*Cyclotella*	1	16	*Pandorina*	1
7	*Euglena*	5	17	*Phacus*	2
8	*Gomphonema*	1	18	*Scenedesmus*	4
9	*Lepocinclis*	1	19	*Stigeoclonium*	2
10	*Melosira*	1	20	*Synedra*	2

Table 3. Palmer's (1969) pollution status scale

Pollution index	Pollution status
<15	Very light organic pollution
15-20	Organic pollution
>20	High organic pollution

Canonical Correspondence Analysis (CCA)

Canonical Correspondence Analysis (CCA) between different seasons and algal groups were done using PAST version 4.04.

Principal component analysis (PCA)

Principal Component Analysis (PCA) is a statistical technique used to simplify the dimensionality of large datasets by converting correlated variables into a smaller set of uncorrelated principal components, with minimal loss of important information (Baruah and Baruah, 2024). In this study, a two-dimensional PCA graph was used to analyze the relationship between algal classes and the four seasons throughout the study period.

RESULTS

Algal diversity

In the present study, a total of 265 algal taxa were recorded under 6 algal phyla. With 78 taxa, Bacillariophyta was outnumbered followed by Chlorophyta (61), Charophyta (58), Cyanobacteria (43), Euglenozoa (24) and Ochrophyta (1) respectively. The algal taxa belonged to 30 orders; 57 families and 11 classes. The diversity and distribution pattern of algal species reported from the study sites is represented in Table 4.

Kapla beel (B1) was represented by highest species richness with 137 species under 74 genera and 8 taxonomic classes. Sorbhog beel (B2) was listed second in terms of species richness with 128 species under 72

genera and 9 classes. The beel with third highest species richness was denoted by Kaplimara beel (B5) having 118 species under 66 genera and 9 classes. This was followed by Gandhi beel (B4) with 100 species, 57 genera, 8 classes; and Kukarjan beel (B3) with 91 species, 58 genera and 9 classes. The class Bacillariophyceae dominated all the selected beels with a percentage coverage of 29.68 % in B2 (Sorbhog beel), followed by 29.19 % in B1 (Kapla beel), 27.47 % in B3 (Kukarjan beel), 27.11 % in B5 (Kaplimara beel) and 27 % in B4 (Gandhi beel).

Table 4. Diversity and distribution pattern of algae in the study sites B1 to B5

Sl No.	Species	B1	B2	B3	B4	B5
	Phylum: Bacillariophyta; Class: Bacillariophyceae; Order: Achnanthales; Family: Achnanthidiaceae					
1.	*Planothidium rostratoholarcticum* Lange-Bertalot & Bak	*		*		
	Family: Achnanthaceae					
2.	*Achnanthes adnata* Bory		*		*	
3.	*Achnanthes coarctata* (Brébisson ex W. Smith) Grunow	*				*
	Family: Cocconeidaceae					
4.	*Cocconeis placentula* var. *euglypta* (Ehrenberg) Cleve	*	*			*
	Order: Bacillariales; Family: Bacillariaceae					
5.	*Nitzschia acicularis* (Kützing) W. Smith	*		*		*
6.	*Nitzschia acicularis* var. *closterioides* Grunow	*	*		*	
7.	*Nitzschia alpina* Hustedt					*
8.	*Nitzschia pusilla* Grunow		*	*	*	
9.	*Nitzschia thermalis* (Ehrenberg) Auerswald	*				
10.	*Nitzschia umbonata* (Ehrenberg) Lange-Bertalot	*	*			
	Order: Cymbellales; Family: Cymbellaceae					
11.	*Cymbella affinis* Kützing	*		*		
12.	*Cymbopleura amphicephala* (Nägeli ex Kützing) Krammer					*
13.	*Cymbella cistula* (Ehrenberg) O. Kirchner		*		*	
14.	*Cymbopleura inaequalis* (Ehrenberg) Krammer				*	*
15.	*Cymbella stuxbergii* (Cleve) Cleve	*				*
16.	*Cymbella tumida* (Brébisson) Van Heurck	*	*	*		
17.	*Cymbella turgidula* Grunow		*		*	*
18.	*Encyonopsis oliffii* (Cholnoky) Krammer	*	*		*	
	Family: Gomphonemataceae					
19.	*Gomphoneis elegans* (Grunow) Cleve				*	
20.	*Gomphonema augur* Ehrenberg	*		*		
21.	*Gomphonema dichotomum* Kützing				*	*
22.	*Gomphonema gracile* Ehrenberg	*	*			*
23.	*Gomphonema hebridense* W. Gregory	*	*			
24.	*Gomphonema insigne* W. Gregory			*	*	
25.	*Gomphonema intricatum* Kützing					*
26.	*Gomphonema sphaerophorum* Ehrenberg	*	*			
27.	*Gomphonema vibrio* Ehrenberg		*	*	*	*
	Order: Eunotiales; Family: Eunotiaceae					
28.	*Eunotia glacialis* F. Meister	*	*			
29.	*Eunotia naegelii* Migula	*		*		*

Sl No.	Species	B1	B2	B3	B4	B5
	Order: Fragilariales; Family: Fragilariaceae					
30.	*Fragilaria crotonensis* Kitton	*	*			*
31.	*Fragilaria incisa* (C.S. Boyer) Lange-Bertalot				*	*
32.	*Fragilaria intermedia* (Grunow) Grunow	*		*		
33.	*Synedra familiaris* Kützing				*	*
34.	*Synedra gracilis* Kützing		*		*	
	Order: Licmophorales; Family: Ulnariaceae					
35.	*Ctenophora pulchella* (Ralfs ex Kützing) D.M. Williams & Round		*		*	
36.	*Tabularia tabulate* (C.Agardh) Snoeij	*	*			
37.	*Ulnaria amphirhynchus* (Ehrenberg) Compère & Bukhtiyarova		*	*		*
38.	*Ulnaria biceps* (Kützing) Compère				*	*
39.	*Ulnaria delicatissima* (W. Smith) Aboal & P.C. Silva	*				
40.	*Ulnaria ulna* (Nitzsch) Compère	*	*	*		
	Order: Mastogloiales; Family: Mastogloiaceae					
41.	*Mastogloia lacustris* (Grunow) Grunow		*		*	
	Order: Melosirales; Family: Melosiraceae					
42.	*Melosira aequalis* C. Agardh	*	*			*
43.	*Melosira varians* C. Agardh	*		*		
	Order: Naviculales; Family: Amphipleuraceae					
44.	*Frustulia rhomboides (*Ehrenberg) De Toni			*	*	
45.	*Halamphora veneta* (Kützing) Levkov	*	*			
	Family: Brachysiraceae					
46.	*Brachysira vitrea* (Grunow) R. Ross			*	*	
47.	*Brachysira aponina* Kützing		*			*
	Family: Diadesmidaceae					
48.	*Diadesmis confervacea* Kützing	*	*	*		
	Family: Naviculaceae					
49.	*Caloneis beccariana* (Grunow) Grunow ex Cleve		*			*
50.	*Gyrosigma eximium* (Thwaites) Boyer		*		*	
51.	*Gyrosigma scalprum* (Gaillon) Sterrenburg	*		*		
52.	*Navicula cryptocephaloides* Hustedt		*			*
53.	*Navicula dicephala* var. *sphaerophora* A. Cleve	*	*		*	
54.	*Navicula lanceolata* Ehrenberg	*		*		
55.	*Navicula microspora* Kant & P. Gupta	*	*			
56.	*Navicula radiosa* Kützing			*		*
57.	*Navicula spicula* var. *pulneyensis* Krishnamurthy				*	
58.	*Navicula striolata* (Grunow) Lange-Bertalot	*				*
59.	*Navicula viridula* (Kützing) Ehrenberg		*		*	
	Family: Neidiaceae					
60.	*Neidium affine* var. *amphirhynchus* (Ehrenberg) Cleve	*		*	*	*

Sl No.	Species	B1	B2	B3	B4	B5
	Family: Pinnulariaceae					
61.	*Pinnularia acrosphaeria* W. Smith	*	*			
62.	*Pinnularia borealis* Ehrenberg			*	*	
63.	*Pinnularia gibbiformis* Krammer		*			*
64.	*Pinnularia interruptiformis* Krammer	*	*			
65.	*Pinnularia microstauron* (Ehrenberg) Cleve	*				*
66.	*Pinnularia nodosa* (Ehrenberg) W. Smith			*		*
67.	*Pinnularia stauroptera* (Grunow) Rabenhorst	*	*			
68.	*Pinnularia viridis* (Nitzsch) Ehrenberg			*	*	*
	Family: Sellaphoraceae					
69.	*Sellaphora pupula* (Kützing) Mereschkovsky		*			*
	Family: Stauroneidaceae					
70.	*Prestauroneis protracta* (Grunow) Kulikovskiy & Glushchenko	*				*
	Order: Rhopalodiales; Family: Rhopalodiaceae					
71.	*Rhopalodia gibba* (Ehrenberg) O. Müller	*	*		*	
72.	*Rhopalodia gibba* var. *ventricosa* (Kützing) H. Peragallo & M. Peragallo	*		*		
	Order: Surirellales; Family: Surirellaceae					
73.	*Iconella capronii* (Brébisson & Kitton) Ruck & Nakov	*				*
	Class: Coscinodiscophyceae; Order: Aulacoseirales; Family: Aulacoseiraceae					
74.	*Aulacoseira granulata* (Ehrenberg) Simonsen		*		*	
75.	*Aulacoseira islandica* subsp. *helvetica* (O. Müller) Simonsen			*		*
	Class: Mediophyceae; Order: Stephanodiscales; Family: Stephanodiscaceae					
76.	*Discostella pseudostelligera* (Hustedt) Houk & Klee	*	*	*		
	Order: Thalassiophysales; Family: Catenulaceae					
77.	*Amphora ovalis* (Kützing) Kützing	*			*	*
	Family: Thalassiosiraceae					
78.	*Thalassiosira tumida* (Janisch) Hasle	*				*
	Phylum: Charophyta; Class: Zygnematophyceae; Order: Desmidiales; Family: Closteriaceae					
79.	*Closterium aciculare* T. West	*		*		
80.	*Closterium acutum* Brébisson				*	*
81.	*Closterium calosporum* Wittrock	*	*	*		
82.	*Closterium closterioides* (Ralfs) A. Louis & Peeters			*		*
83.	*Closterium dianae* Ehrenberg ex Ralfs	*	*			
84.	*Closterium dianae* var. *brevius* (S.P. Petkoff) Willi Krieger	*			*	
85.	*Closterium dianae* var. *pseudodianae* (J. Roy) Willi Krieger		*			*
86.	*Closterium ehrenbergii* Meneghini ex Ralfs		*			*
87.	*Closterium gracile* Brébisson ex Ralfs	*	*		*	
88.	*Closterium incurvum* Brébisson			*	*	
89.	*Closterium lunula* Ehrenberg & Hemprich ex Ralfs	*	*			
90.	*Closterium parvulum* Nägeli		*			*
91.	*Closterium parvulum* var. *obtusum* Croasdale					*
92.	*Closterium tumidulum* F. Gay			*	*	

Sl No.	Species	B1	B2	B3	B4	B5
	Family: Desmidiaceae					
93.	*Actinotaenium cucurbita* (Brébisson ex Ralfs) Teiling	*		*		
94.	*Cosmarium angulatum* f. *majus* (Grunow) W.B. Turner	*	*			
95.	*Cosmarium awadhense* B.N. Prasad & R.K. Mehrotra				*	*
96.	*Cosmarium circulare* var. *messikommeri* Krieger & Gerloff			*		*
97.	*Cosmarium contractum* O. Kirchner		*		*	
98.	*Cosmarium contractum* var. *ellipsoideum* (Elfving) West & G.S. West	*		*		
99.	*Cosmarium contractum* var. *incrassatum* A.M. Scott & Prescott 1958				*	*
100.	*Cosmarium crenulatum* Nägeli		*	*		
101.	*Cosmarium cyclicum* var. *crassum* R.M. Whelden		*			*
102.	*Cosmarium galeritum* var. *subtumidum* O. Borge	*				*
103.	*Cosmarium granatum* Brébisson ex Ralfs	*	*			
104.	*Cosmarium humile* Nordstedt ex De Toni	*	*			
105.	*Cosmarium moniliforme* Ralfs	*			*	
106.	*Cosmarium nitidulum* De Notaris	*			*	
107.	*Cosmarium ordinatum* (BØrgesen) West & G.S. West		*			
108.	*Cosmarium pakistanicum* A.K. Islam				*	*
109.	*Cosmarium porteanum* W. Archer				*	*
110.	*Cosmarium pyramidatum* var. *indicum* J.P. Keshri & D. Das			*	*	*
111.	*Cosmarium quadrum* P. Lundell	*			*	
112.	*Cosmarium quadrum* var. *minus* Nordstedt	*		*		*
113.	*Cosmarium quadratulum* (F. Gay) De Toni	*	*			
114.	*Cosmarium rosae* Ruzicka		*		*	
115.	*Cosmarium tetraophthalmum* Brébisson ex Ralfs	*	*			
116.	*Cosmarium trilobulatum* var. *abscissum* (Schmidle) Willi Krieger & Gerloff				*	*
117.	*Cosmarium tyrolicum* (Nordstedt) Krieger & Gerloff	*		*		
118.	*Cosmarium undulatum* var. *minutum* Wittrock	*		*		
119.	*Cosmarium yoksumum* J.P. Keshri & D. Das			*	*	
120.	*Desmidium aptogonum* Brébisson ex Kützing	*	*			
121.	*Desmidium coarctatum* Nordstedt		*			*
122.	*Euastrum binale* Ehrenberg ex Ralfs	*		*	*	
123.	*Euastrum luetkemuelleri* F. Ducellier			*		*
124.	*Hyalotheca dissiliens* Brébisson ex Ralfs	*				*
125.	*Micrasterias pinnatifida* Ralfs	*			*	

Sl No.	Species	B1	B2	B3	B4	B5
126.	*Pleurotaenium eugeneum* var. *scoticum* (West & G.S. West) Azevedo & C.E.M. Bicudo			*	*	
127.	*Pleurotaenium rectum* Delponte		*			*
128.	*Staurastrum bifidum* Brébisson ex Ralfs	*		*		*
129.	*Staurastrum brebissonii* W. Archer	*	*			
130.	*Spondylosium nitens* f. *majus* W.B. Turner	*	*			
131.	*Staurastrum thangaicum* Brühl & Biswas			*	*	*
132.	*Staurastrum zelleri* W.B. Turner		*		*	
133.	*Xanthidium antilopaeum* Kützing	*			*	
	Order: Spirogyrales; Family: Spirogyraceae					
134.	*Spirogyra kundaensis* R.N. Singh		*		*	
135.	*Spirogyra maravillosa* Transeau		*			*
136.	*Spirogyra parvula* (Transeau) Czurda	*		*		
	Phylum: Chlorophyta; Class: Chlorophyceae; Order: Chlamydomonadales; Family: Palmellopsidaceae					
137.	*Sphaerellocystis ampla* (Kützing) Nováková	*			*	*
138.	*Tetrasporidium javanicum* Möbius				*	*
139.	*Tetrasporidium sarawakense* Yamagishi	*		*		
	Family: Volvocaceae					
140.	*Pandorina morum* (O.F. Müller) Bory			*	*	
141.	*Pleodorina californica* (Iyengar) H. Nozaki		*			*
142.	*Volvulina steinii* Playfair	*	*			*
	Order: Sphaeropleales; Family: Dictyochloridaceae					
143.	*Dictyochloris fragrans* Vischer	*				*
	Family: Hydrodictyaceae					
144.	*Hydrodictyon reticulatum* (Linnaeus) Bory	*	*			
145.	*Lacunastrum gracillimum* (West & G.S. West) H.A. McManus		*		*	
146.	*Monactinus simplex* (Meyen) Corda			*		*
147.	*Parapediastrum biradiatum* var. *longecornutum* (Gutwinski) P.M. Tsarenko	*			*	
148.	*Pediastrum tetras* var. *tetras*	*				
149.	*Pseudopediastrum cornutum* (Raciborski) Lenarczyk			*		*
150.	*Stauridium tetras* (Ehrenberg) E. Hegewald		*	*		
151.	*Stauridium tetras* var. *tetraodon* (Corda) J.D. Hall & Karol				*	*
	Family: Radiococcaceae					
152.	*Radiococcus nimbatus* (De Wildeman) Schmidle	*		*		*
	Family: Scenedesmaceae					
153.	*Coelastrum microporum* Nägeli		*		*	
154.	*Coelastrum pseudomicroporum* Korshikov		*			*
155.	*Coelastrum sphaericum* Nägeli	*		*	*	
156.	*Dimorphococcus cordatus* Wolle	*	*			

Sl No.	Species	B1	B2	B3	B4	B5
157.	*Dimorphococcus lunatus* A. Braun			*		*
158.	*Desmodesmus abundans* (Kirchner) E.H.Hegewald	*		*		
159.	*Desmodesmus armatus* (Chodat) E.H. Hegewald		*			*
160.	*Desmodesmus armatus* var. *bicaudatus* (Guglielmetti) E.H. Hegewald	*	*			
161.	*Desmodesmus armatus* var. *longispina* (Chodat) E. Hegewald	*	*	*		
162.	*Desmodesmus bicellularis* (Chodat) S.S. An, T. Friedl & E. Hegewald			*	*	
163.	*Desmodesmus brasiliensis* (Bohlin) E.Hegewald	*			*	
164.	*Desmodesmus communis* (E. Hegewald) E. Hegewald	*		*	*	
165.	*Desmodesmus intermedius* (Chodat) E. Hegewald	*			*	*
166.	*Desmodesmus opoliensis* var. *carinatus* (Lemmermann) E. Hegewald	*			*	
167.	*Desmodesmus protuberans* (F.E. Fritsch & M.F. Rich) E. Hegewald		*			*
168.	*Pectinodesmus pectinatus* (Meyen) E. Hegewald, M. Wolf, Al. Keller, Friedl & Krienitz	*	*			
169.	*Scenedesmus acuminatus* (Lagerheim) Chodat		*			*
170.	*Scenedesmus acunae* Comas Gonzáles	*		*		
171.	*Scenedesmus dimorphus* (Turpin) Kützing		*		*	
172.	*Scenedesmus obtusus* f. *disciformis* (Chodat) Compère	*			*	
173.	*Scenedesmus opoliensis* var. *bicaudatus* Hortobagyi	*	*			*
174.	*Scenedesmus quadricauda* (Turpin) Brébisson			*		*
175.	*Tetradesmus obliquus* (Turpin) M.J. Wynne		*			*
	Family: Selenastraceae					
176.	*Ankistrodesmus bernardii* Komárek	*		*		
177.	*Ankistrodesmus falcatus* (Corda) Ralfs	*				*
178.	*Ankistrodesmus fusiformis* Corda	*			*	
179.	*Kirchneriella lunaris* (Kirchner) Möbius	*				
180.	*Messastrum gracile* (Reinsch) T.S. Garcia		*			*
181.	*Monoraphidium arcuatum* (Korshikov) Hindák		*		*	
182.	*Monoraphidium contortum* (Thuret) Komárková-Legnerová		*		*	*
183.	*Monoraphidium indicum* Hindák	*				*
184.	*Monoraphidium irregulare* (G.M. Smith) Komárková-Legnerová	*		*		*
185.	*Monoraphidium litorale* Hindák		*		*	
186.	*Monoraphidium mirabile* (West & G.S. West) Pankow	*		*		
187.	*Selenastrum bibraianum* Reinsch		*	*		

Sl No.	Species	B1	B2	B3	B4	B5
	Class: Chlamydomonadaceae; Order: Oedogoniales; Family: Oedogoniaceae					
188.	*Oedogonium globosum* Nordstedt ex Hirn	*		*	*	
	Class: Trebouxiophyceae; Order: Chlorellales; Family: Eremosphaeraceae					
189.	*Neglectella solitaria* (Wittrock) Stenclová & Kastovsky	*	*			*
	Family: Nephrocytiaceae					
190.	*Nephrocytium lunatum* West	*	*			
	Family: Oocystaceae					
191.	*Oocystis borgei* J.W. Snow			*	*	
192.	*Oocystis marssonii* Lemmermann				*	*
193.	*Oocystis naegelii* A. Braun	*	*			
	Order: Trebouxiophyceae ordo incertae sedis; Family: Trebouxiophyceae incertae sedis					
194.	*Crucigenia lauterbornii* (Schmidle) Schmidle	*				*
195.	*Crucigenia rectangularis* (Nägeli) Gay			*		*
	Class: Ulvophyceae; Order: Cladophorales; Family: Pithophoraceae					
196.	*Pithophora roettleri* (Roth) Wittrock		*	*		
	Order: Ulotrichales; Family: Ulotrichaceae					
197.	*Ulothrix tenerrima* (Kützing) Kützing		*			*
	Phylum: Cyanobacteria; Class: Cyanophyceae; Order: Oscillatoriales; Family: Aerosakkonemataceae					
198.	*Microseira wollei* (Farlow ex Gomont) G.B. McGregor & Sendall ex Kenins	*	*	*	*	
	Family: Microcoleaceae					
199.	*Limnoraphis hieronymusii* (Lemmermann) J. Komárek, E. Zapomelová, J. Smarda, J. Kopecký, E. Rejmánková, J. Woodhouse, B.A. Neilan & J. Komárková	*	*			
200.	*Lyngbya martensiana* Meneghini ex Gomont			*	*	
201.	*Planktothrix planctonica* (Elenkin) Anagnostidis & Komárek	*	*	*		
202.	*Tenebriella curviceps* (C. Agardh ex Gomont) Hauerová, Hauer & Kaštovský	*				*

Sl No.	Species	B1	B2	B3	B4	B5
	Family: Oscillatoriaceae					
203.	*Oscillatoria leonardii* Compère	*	*			
204.	*Oscillatoria anguina* Bory ex Gomont		*			
205.	*Oscillatoria limosa* C. Agardh ex Gomont				*	*
206.	*Oscillatoria princeps* Vaucher ex Gomont			*		*
207.	*Oscillatoria simplicissima* Gomont		*			
208.	*Oscillatoria tenuis* C. Agardh ex Gomont		*		*	*
209.	*Oscillatoria vizagapatensis* C.B. Rao		*			*
210.	*Phormidium crassior* (Behre) Anagnostidis		*	*		
211.	*Phormidium lucidum* Kützing ex Gomont			*		*
212.	*Phormidium puteale* (Montagne ex Gomont) Anagnostidis & Komárek		*		*	
213.	*Phormidium retzii* Kützing ex Gomont				*	*
	Order: Chroococcales; Family: Chroococcaceae					
214.	*Chroococcus dispersus* (Keissler) Lemmermann		*			*
215.	*Chroococcus minor* (Kützing) Nägeli			*		*
	Family: Cyanothrichaceae					
216.	*Limnococcus limneticus* (Lemmermann) Komárková, Jezberová, O. Komárek & Zapomelová	*	*			
	Family: Microcystaceae					
217.	*Aphanothece saxicola* Nägeli	*			*	
218.	*Merismopedia elegans* A.Braun ex Kützing	*				*
219.	*Merismopedia trolleri* H. Bachmann		*		*	
220.	*Microcystis novacekii* (Komárek) Compère				*	*
221.	*Synechocystis pevalekii* Ercegović	*	*	*		
	Order: Coleofasciculales; Family: Wilmottiaceae					
222.	*Anagnostidinema amphibium* (C. Agardh ex Gomont) Strunecký, Bohunická, J.R. Johansen & J. Komárek		*			*
223.	*Anagnostidinema lemmermannii* (Wołoszyńska) Strunecky, Bohunická, J.R. Johansen, Capková, Raabová, P. Dvořák & Komárek			*	*	*
	Order: Leptolynbyales; Family: Leptolyngbyaceae					
224.	*Limnolyngbya circumcreta* (G.S. West) X.Li & R.Li.		*			*
225.	*Planktolyngbya brevicellularis* G. Cronberg & Komárek		*			
226.	*Planktolyngbya contorta* (Lemmermann) Anagnostidis & Komárek	*			*	*
	Order: Nostocales; Family: Aphanizomenonaceae					
227.	*Anabaena augstumalis* var. *marchica* Lemmermann		*			*
228.	*Anabaena bornetiana* Collins	*		*		
229.	*Anabaena catenula* Kützing ex Bornet & Flahault	*		*	*	
230.	*Anabaena inaequalis* Bornet & Flahault				*	*

Sl No.	Species	B1	B2	B3	B4	B5
231.	*Anabaena oscillarioides* Bory ex Bornet & Flahault	*				*
232.	*Anabaena torulosa* Lagerheim ex Bornet & Flahault	*				*
233.	*Anabaena volzii* var. *crassa* (C.B. Rao) F.E. Fritsch	*	*			
234.	*Pseudoanabaena biceps* Böcher	*	*			
235.	*Pseudoanabaena galeata* Böcher		*		*	
236.	*Wollea ambigua* (C.B. Rao) R.Y. Singh			*		*
	Family: Nodulariaceae					
237.	*Anabaenopsis arnoldii* Aptekar		*			
	Family: Nostocaceae					
238.	*Nostoc aureum* Kützing ex Bornet & Falhault	*		*		*
239.	*Nostoc commune* Vaucher ex Bornet & Flahault			*	*	
240.	*Nostoc ellipsosporum* var. *violaceum* C.B. Rao	*	*			
	Phylum: Euglenozoa; Class: Euglenophyceae; Order: Euglenales; Family: Euglenaceae					
241.	*Euglena sanguinea* Ehrenberg		*		*	
242.	*Euglena texta* (Dujardin) Hübner	*		*		
243.	*Trachelomonas abrupta* Svirenko		*	*	*	
244.	*Trachelomonas cylindracea* (Playfair) T.G. Popova				*	*
245.	*Trachelomonas dubia* Svirenko	*		*		
246.	*Trachelomonas guttata* Middelhoek	*				*
247.	*Trachelomonas hispida* (Perty) F. Stein	*	*			*
248.	*Trachelomonas pavlovskoensis* (Poljanskij) Popova		*		*	
249.	*Trachelomonas planctonica* Svirenko				*	*
250.	*Trachelomonas playfairii* Deflandre	*		*		
251.	*Trachelomonas raciborskii* Wołoszyńska	*		*		*
252.	*Trachelomonas sculpta* Balech		*			
253.	*Trachelomonas volvocina* (Ehrenberg) Ehrenberg		*			*
254.	*Trachelomonas volzii* var. *acidophila* Bourrelly	*	*		*	
255.	*Trachelomonas volzii* var. *pellucida* Playfair	*		*		
	Family: Phacaceae					
256.	*Lepocinclis fusiformis* (H.J. Carter) Lemmermann	*		*		*
257.	*Lepocinclis ovum* (Ehrenberg) Lemmermann	*	*			
258.	*Phacus alatus* G.A. Klebs				*	*
259.	*Phacus curvicauda* Svirenko		*		*	
260.	*Phacus lefevrei* Bourrelly	*		*		*
261.	*Phacus onyx* Pochmann		*		*	*
262.	*Phacus orbicularis* Hübner	*	*			*
263.	*Phacus raciborskii* Drežepolski	*	*			
264.	*Phacus stokesii* Lemmermann		*		*	
	Phylum: Ochrophyta; Class: Xanthophyceae; Order: Mischococcales; Family: Sciadiaceae					
265.	*Ophiocytium capitatum* Wolle	*	*	*		

(an Asterik * represents presence of the species)

Diversity index

The Shannon and Weaver Diversity index ranged from 1.21 in Gandhi beel (B4) during premonsoon season to 1.74 in Kapla beel (B1) during winter season, indicating presence of diverse algal groups across different seasons of the study period (Table 5). Moreover, as proposed by Trivedy & Goel (1980 and 1981), diversity index value lesser than 2 indicated heavy pollution in the study sites.

Palmer's pollution index

The Palmer's pollution index of the five study sites were also calculated and was depicted in Table 6. In the present study, Palmer's pollution index was calculated to be highest in B4 (30), followed by B3 (29), B1 (28), B5 (26) and B2 (23). Since values in all the study sites were more than 20, it indicated high level organic pollution in all the study sites.

Table 5. Shannon and Weiner diversity index of the study sites during the study period

Study site	Season			
	Winter	Premonsoon	Monsoon	Postmonsoon
Kapla beel (B1)	1.74	1.57	1.51	1.66
	0.84	0.75	0.72	0.79
Sorbhog beel (B2)	1.72	1.62	1.55	1.68
	0.83	0.74	0.78	0.81
Kukarjan beel (B3)	1.63	1.59	1.52	1.69
	0.78	0.76	0.73	0.82
Gandhi beel (B4)	1.67	1.21	1.33	1.44
	0.69	0.58	0.61	0.63
Kaplimara beel (B5)	1.58	1.34	1.42	1.53
	0.76	0.64	0.68	0.73

Table 6. Palmer's pollution index of the study sites

Sl No.	Genera	Pollution index	Study sites				
			B1	B2	B3	B4	B5
1	*Microcystis*	1	-	-	-	1	1
2	*Ankistrodesmus*	2	2	-	2	2	2
3	*Chlamydomonas*	4	-	-	-	-	-
4	*Chlorella*	3	-	-	-	-	-
5	*Closterium*	1	1	1	1	1	1
6	*Cyclotella*	1	-	-	-	-	-
7	*Euglena*	5	5	-	5	5	-
8	*Gomphonema*	1	1	1	1	1	1
9	*Lepocinclis*	1	1	1	1	-	1
10	*Melosira*	1	1	1	1	-	1
11	*Micractinium*	1	-	-	-	-	-
12	*Navicula*	3	3	3	3	3	3
13	*Nitzschia*	3	3	3	3	3	3
14	*Oscillatoria*	4	4	4	4	4	4
15	*Phormidium*	1	1	1	1	1	1
16	*Pandorina*	1	-	-	1	1	-
17	*Phacus*	2	2	2	2	2	2
18	*Scenedesmus*	4	4	4	4	4	4
19	*Stigeoclonium*	2	-	-	-	-	-
20	*Synedra*	2	-	2	-	2	2
Total Palmer's Pollution index			**28**	**23**	**29**	**30**	**26**

Algal seasonality

During the present investigation, the algal flora displayed distinct seasonal variations in the study sites (Figure 2.1, 2.2, 2.3, 2.4 and 2.5).

In the study site B1, during winter Chlorophyceae (24%) was the dominant group followed by Bacillariophyceae (21%), Cyanophyceae (19%) and Zygnematophyceae (19%). During premonsoon season also, Chlorophyceae (28%) dominated the study site followed by Bacillariophyceae (21%) and Zygnematophyceae (20%). But during monsoon the algal community was dominated by Bacillariophyceae (29%) followed by Zygnematophyceae (19%) and Cyanophyceae (17%). Bacilariophyceae (32%) again dominated during postmonsoon, followed by Cyanophyceae (23%) and Chlorophyceae (20%) (Figure 2.1).

In study site B2, Bacillariophyceae dominated during winter, premonsoon and monsoon season. While, during postmonsoon season, Cyanophyceae (25%) dominated the study site followed by Bacillariophyceae (22%) and Chlorophyceae (21%) (Figure 2.2).

In study site B3, Chlorophycean members (29%) dominated winter season, followed by Cyanophyceae (19%), Zygnematophyceae (19%) and Bacillariophyceae (15%). During premonsoon season, Chlorophyceae (29%), followed by Bacillariophyceae (27%) and Cyanophyceae (20%). In monsoon season also Chlorophyceae (31%) outnumbered Cyanophyceae (26%) and Bacillariophyceae (24%). Whereas, during postmonsoon season, the study site was dominated by Cyanophyceae (28%), followed by Chlorophyceae (24%) and Bacillariophyceae (22%) (Figure 2.3).

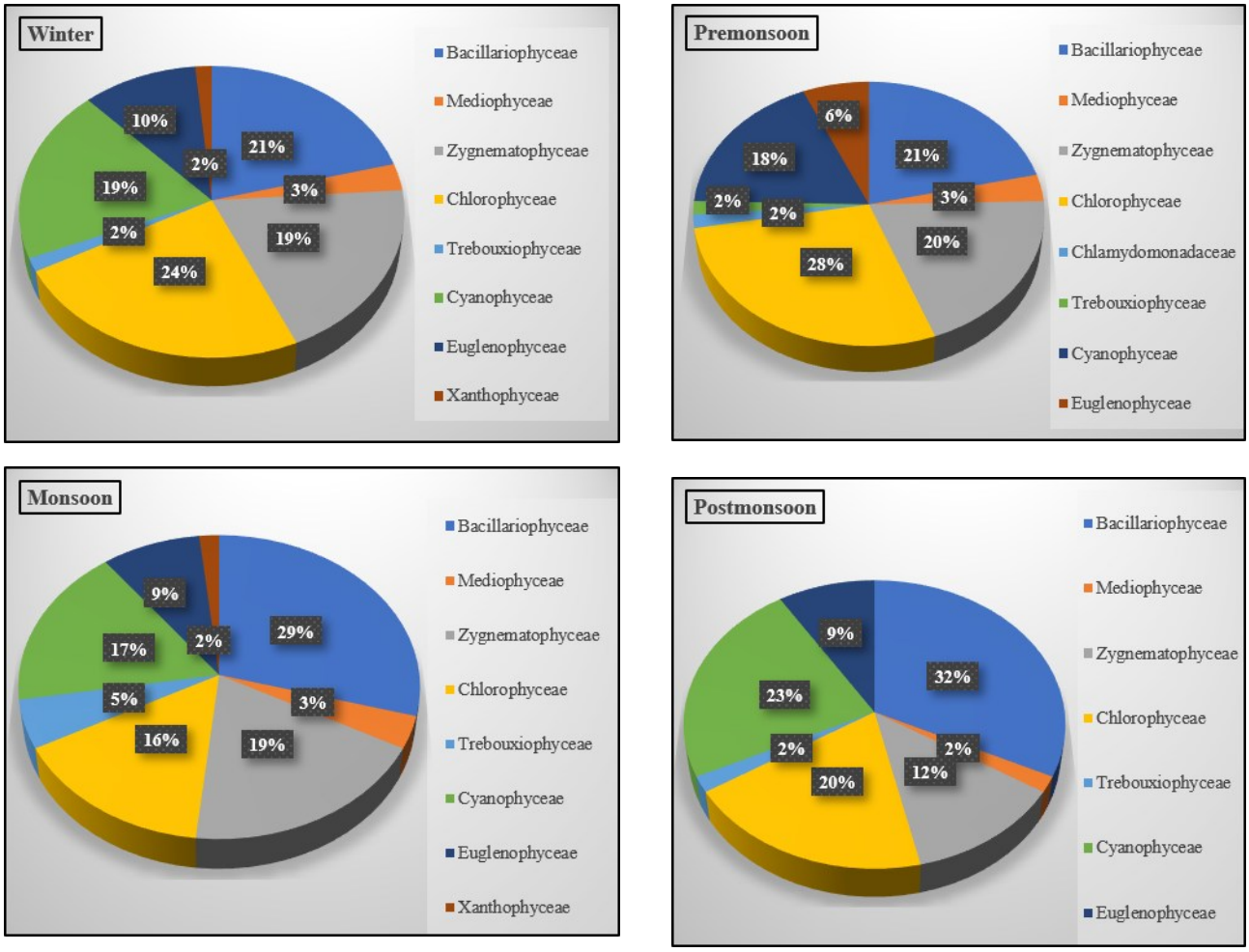

Figure 2.1. Seasonality of algae in Kapla beel (B1)

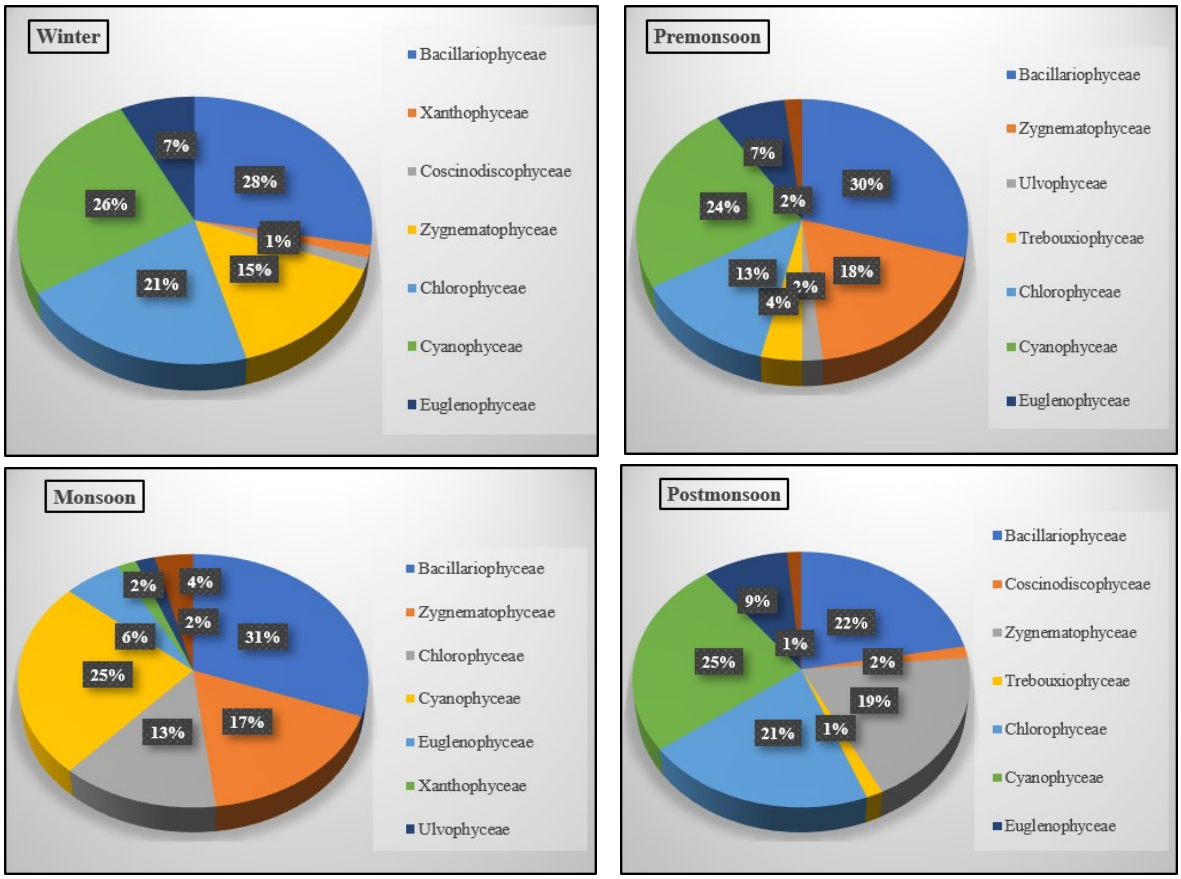

Figure 2.2. Seasonality of algae in Sorbhog beel (B2)

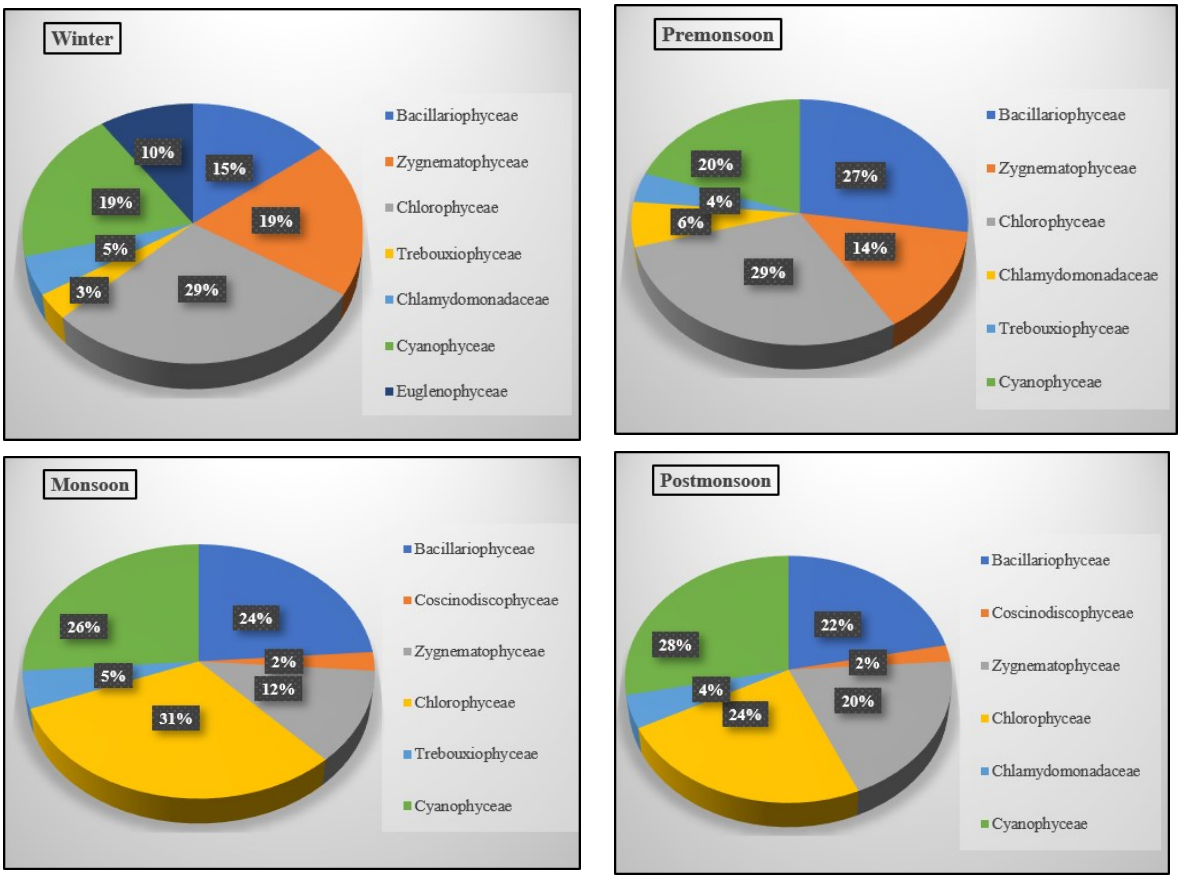

Figure 2.3. Seasonality of algae in Kukarjan beel (B3

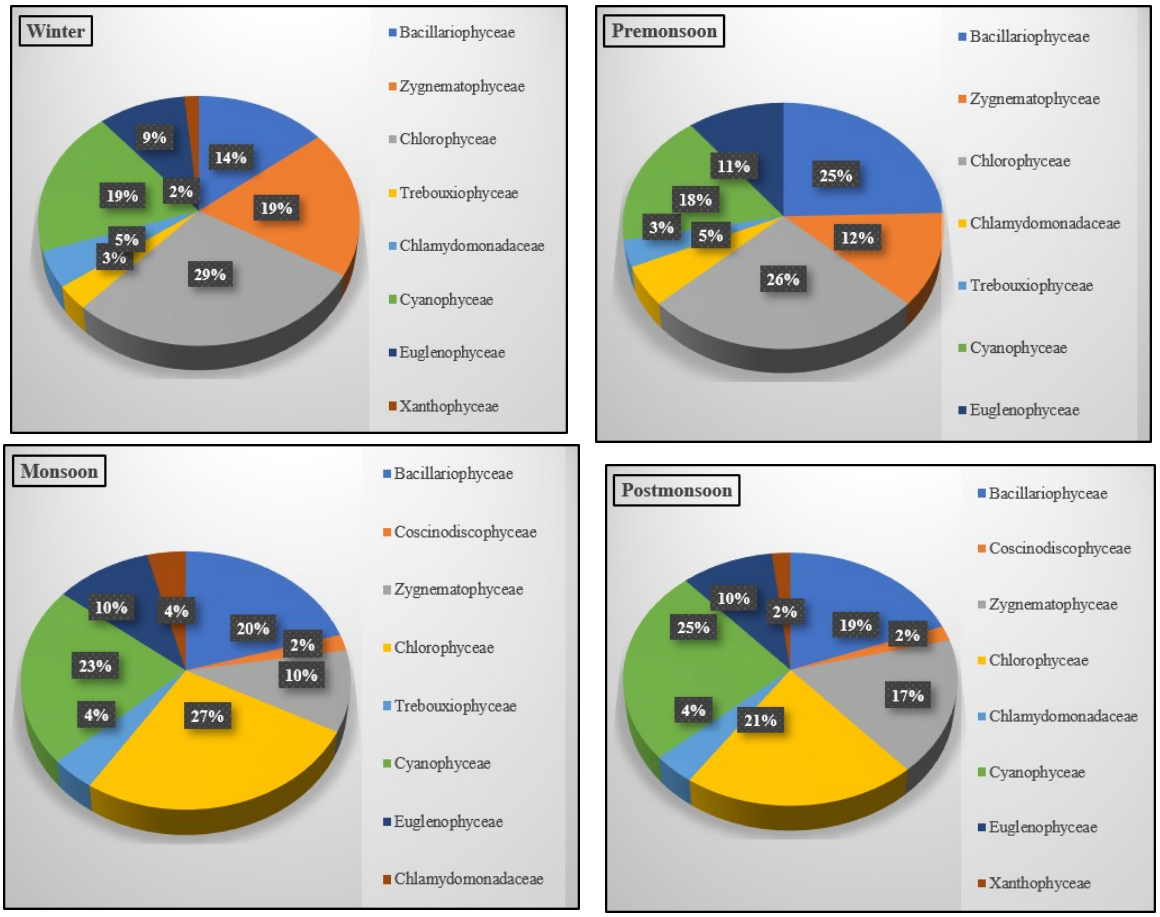

Figure 2.4. Seasonality of algae in Gandhi beel (B4)

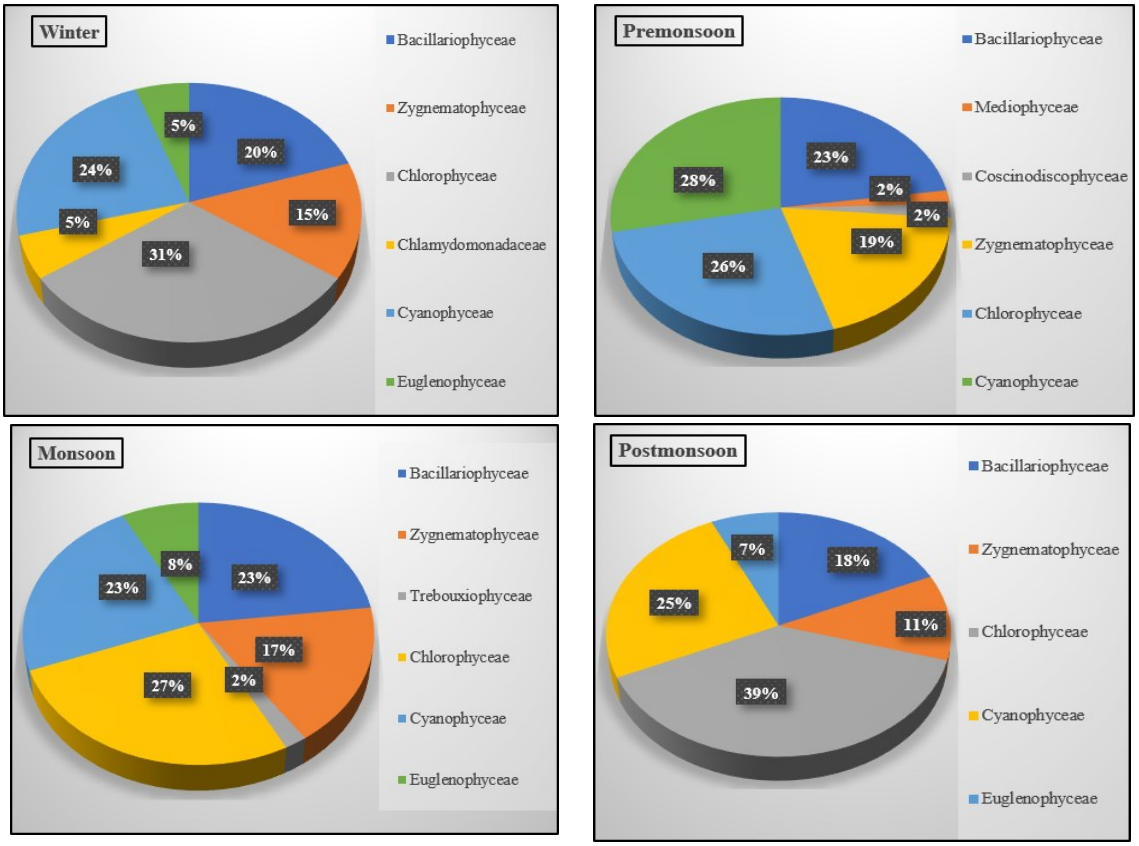

Figure 2.5. Seasonality of algae in Kaplimara beel (B5)

In the study site B4, Chlorophyceae (29%) showed dominance over Cyanophyceae (19%), Zygnematophyceae (19%) and Bacillariophyceae (14%) in winter season. Chlorophyceae (26%) also outnumbered Bacillariophyceae (25%) and Cyanophyceae (18%) during premonsoon season. In monsoon season too, Chlorophyceaen members (27%) dominated, followed by members of Cyanophyceae (23%) and Bacillariophyceae (20%). During postmonsoon season, on the other hand, the study site was dominated by Cyanophyceae (25%), followed by Chlorophyceae (21%) and Bacillariophyceae (19%) (Figure 2.4).

Algal members in B5 followed similar trend during winter, monsoon and postmonsoon season where Chlorophyceae dominated the site, followed by Cyanophyceae, Bacillariophyceae and Zygnematophyceae. Whereas in premonsoon, the study site was outnumbered by Cyanophyceae (28%), followed by Chlorophyceae (26%) and Bacillariophyceae (23%) (Figure 2.5).

The findings were similar to Sedamker & Angadi (2003), Sharma & Lyngdon (2003), Deka *et al*. (2009), Hulyal & Kaliwal (2009), Bordoloi & Baruah (2015).

Principal component analysis (PCA)

The percentage of variance and eigen values for PC 1 (Axis 1) and PC 2 (Axis 2) is depicted in Table 7. Since axes 1 and 2 have cumulative 91.14 %, a two-dimensional PCA graph (Figure 3) was prepared to study the correlation between algal classes and four seasons during the study period. Algal classes Zygnematophyceae, Mediophyceae, Chlamydomonadaceae positively correlated with winter; while, Chlorophyceae and Cyanophyceae showed positive correlation during premonsoon season; on the other hand, classes Xanthophyceae and Euglenophyceae displayed positive correlation with monsoon season; during postmonsoon season, Bacillariophyceae and Euglenophyceae correlated positively (Figure 3).

Table 7. Eigenvalues and percentage variance of Principal component 1 and 2

Axis	Eigenvalue	% variance
1	24.24	73.09
2	5.98	18.05
3	2.93	8.84

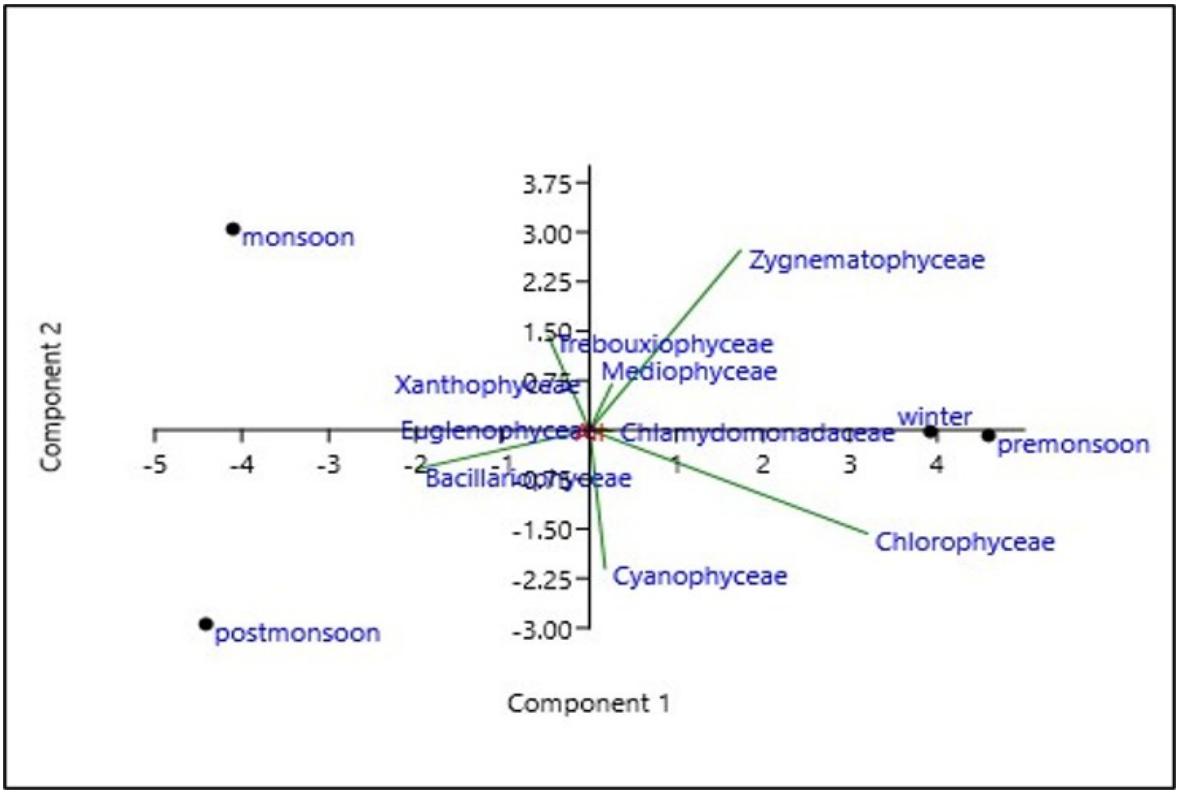

Figure 3. PCA graph between algal classes and seasons

In PC 1 (Figure 4.1), the algal classes Mediophyceae, Zygnematophyceae, Chlorophyceae and Chlamydomonadaceae displayed positive correlation. Whereas, Bacillariophyceae, Trebouxiophyceae and Xanthophyceae showed negative correlation among each other.

In PC 2 (Figure 4.2), the algal classes Mediophyceae, Zygnematophyceae, Trebouxiophyceae and Xanthophyceae displayed positive correlation among them. Whereas, Bacillariophyceae, Chlorophyceae, Chlamydomonadaceae and Cyanophyceae showed negative correlation between each other.

In PC 3 (Figure 4.3), Bacillariophyceae, Mediophyceae, Zygnematophyceae, Cyanophyceae, Euglenophyceae and Xanthophyceae reflected positive correlation while Chlorophyceae, Chlamydomonadaceae and Trebouxiophyceae displayed negative correlation.

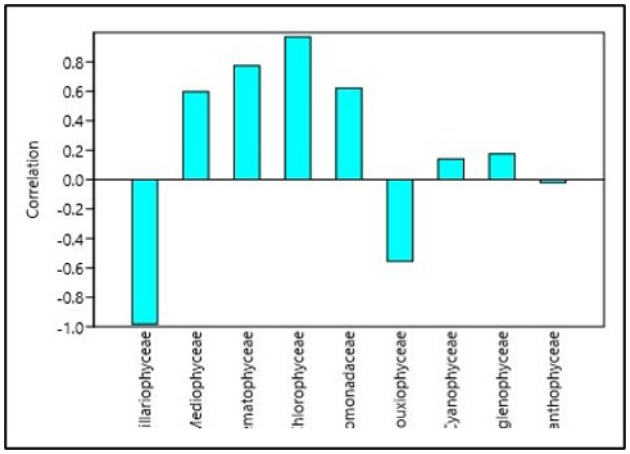

Figure 4.1. Correlation among algal classes in PC 1

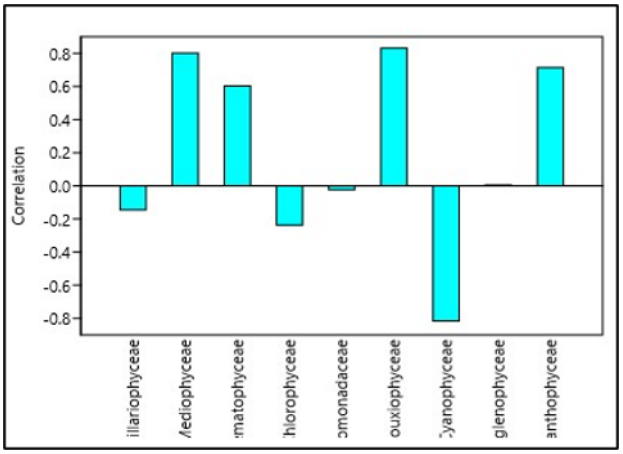

Figure 4.2. Correlation among algal classes in PC 2

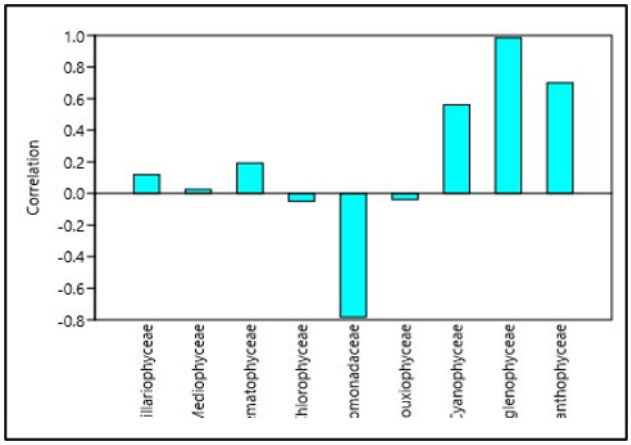

Figure 4.3. Correlation among algal classes in PC 3

CONCLUSION

A total of 265 algal taxa were recorded under 6 algal phyla in the present study. Phylum Bacillariophyta with 78 taxa outnumbered the other five phyla viz., Chlorophyta (61), Charophyta (58), Cyanobacteria (43), Euglenozoa (24) and Ochrophyta (1) respectively. The algal taxa documented throughout the study belonged to 30 orders, 57 families and 11 classes. The dominant class Bacillariophyceae (73 species) was followed by Zygnematophyceae (58 species), Chlorophyceae (51 species), Cyanophyceae (43 species), Euglenophyceae (24 species), Trebouxiophyceae (7 species), Mediophyceae (3 species), Coscinodiscophyceae and Ulvophyceae (2 species each), and Chlamydomonadaceae and Xanthophyceae (1 species each).

Species richness was highest in Kapla beel (B1) with 137 species under 74 genera and 8 taxonomic classes. With 128 species under 72 genera and 9 classes, Sorbhog beel (B2) was recorded second in terms of species richness. Kaplimara beel (B5) demonstrated third highest species richness with 118 species under 66 genera and 9 classes. This was followed by Gandhi beel (B4) with 100 species, 57 genera, 8 classes; and Kukarjan beel (B3) with 91 species, 58 genera and 9 classes. Bacillariophyceae was the dominant class in all the study sites, covering 29.68 % in B2 (Sorbhog beel), followed by 29.19 % in B1 (Kapla beel), 27.47 % in B3 (Kukarjan beel), 27.11 % in B5 (Kaplimara beel) and 27 % in B4 (Gandhi beel).

FUTURE PERSPECTIVES

The identified algal species (265 species) in the selected beel ecosystems will serve as an important database for the future in the field of phycological research in Eastern Himalayan region. The algal indicator species will be helpful in estimating the extent of pollution in the water bodies as well as in monitoring the impact of environment upon the living organisms who are directly or indirectly dependent on the beel ecosystems. With gradual anthropogenic influences in agriculture and pisciculture in the vicinity, there is an increase in toxicity in the physical, chemical, and biological properties of water in each beel. This in turn, negatively impacts not only the lives of fishes, local and migratory birds residing in the water bodies, but it is also likely to impart detrimental health effects to human beings who rely on these water resources. Moreover, such physico-chemical variation in water properties cause direct alternation in the seasonal pattern of algal flora inhabiting aquatic environments. Changes in algal seasonality, on the other hand, dismantles algal diversity, which is indispensable for sustaining nutrient cycles and maintaining water quality in aquatic ecosystems.

STATEMENTS AND DECLARATION

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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REFERENCES

Barman, A. and Baruah, B.K. 2013. Aquatic insects of Kapla Beel, a flood plain wetland of Barpeta District of Assam, India. *The Clarion- International Multidisciplinary Journal*, 2, 27-31.

Baruah, D. and Baruah, P.P. 2022. Water quality monitoring of Kapla Beel: an ecologically sensitive floodplain wetland of Eastern Himalaya Biodiversity Hotspot. *International Journal of Energy and Water Resources*. DOI: 10.1007/s42108 -022-00196-y.

Baruah, D. and Baruah, P.P. 2023. Physico-chemical parameters and phytoplankton heterogeneity in different seasons of Sorbhog Beel, a pivotal floodplain wetland in the Himalayan Foothill. *Vegetos*, 8, 341-360. DOI:10.1007/s42535-023-00573-w.

Baruah, D. and Baruah, P.P. 2024. Evaluation of Water Quality Through Water Quality Index at Sorbhog Beel, a Critical Ecotone Along Indo-Bhutan Boundary. *Water Air and Soil Pollution*, 235, 525. https://doi.org/10.1007/s11270-024-07335-7

Baruah, P.P. and Baruah, C.K. 2003. Distribution and Diversity of Aquatic Macrophytes of Kaziranga National Park. *Environment and Ecology*, 21 (2), 367-371.

Baruah, P.P., Kalita, H. and Nath, S. 2022. An annotated checklist of cyanobacterial flora in Rudrasagar Ramsar site, Tripura, India. *Asian Journal of Conservation Biology*, 11(2), 228–239.

Borah, M. 2024. Identification and Ecological Study of Algal Species in the Polluted Stretchof Bharalu River, Guwahati, Assam, India. *International Journal of Ecology and Environmental Sciences*, 50, 941-948.

Bordoloi, D. and Baruah, P.P. 2015. Phytoplankton diversity in digboi oil refinery effluent receiving stream of Assam, India. *Bangladesh Journal of Botany*, 44(2), 163-175.

Chettri, N. et al. 2010. Biodiversity in the Eastern Himalayas: Status, trends and vulnerability to climate change: climate change impact and vulnerability in the eastern himalayas - technical report 2. Available at: http://lib.icimod.org/record/26847 .

Choudhury, B. 2020. Present status of plants found in the wetlands of Barpeta district of Assam, North East India. *Paripex- Indian Journal of Research*, 9 (5), 64-67.

Das, D. and Keshri, J.P. 2016. Desmids of Eastern Himalaya. Bibliotheca Phycologica, 119. J. Cramer, Germany, p 260.

Das, J. et al. 2014. Present status of aquatic avifaunal diversity in Kapla wetland of Barpeta district, Assam. *Journal of Research in Biology*, 4(6), 1451-1457.

Das, S. K. and Adhikary, S.P., 2014. Freshwater algae of eastern India. Daya publication, New Delhi, p 453.

Deka, R.M. et al. 2009. Study on plankton population of Kapla Beel, a freshwater wetland in Barpeta District, Assam. *Pollution Research*, 28, 535-542.

Desikachary, T. V. 1959. Cyanophyta. I.C.A.R. monograph on Algae. New Delhi, p 686.

Dutta, T., Deka, U. and Rabha, P.K. 2014. Diversity of aquatic macrophytes of Kapla beel (wetland) of Barpeta district, Assam, India. *Annals of Biological Research*, 5 (12), 41-45.

Gandhi, H. P. 1960. On the diatom flora of some ponds around Vasna village near Ahmedabad. *Journal of Indian Botanical Society*, 39, 558–567.

Gandhi, H. P. 1998. Freshwater diatoms of Central Gujarat. Bishen Sing. Mahendra Pal Singh, Shiva Offset Press, p 168.

Guiry, M. D. and G. M. Guiry. 2020. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. Available at: http://www.algaebase.org.

Hulyal, S. B. and Kaliwal, B. B. 2009. Dynamics of Phytoplankton in relation to physico-chemical factors of Almatti reservoir. Environmental Monitoring and Assessment, 153, 45-59.

John, D. M., Whitton B.A. and Brook, A. J. 2005. The freshwater algal flora of the British Isles: An identification guide to freshwater and terrestrial algae, Cambridge University Press, Cambridge, p 702.

Kalita, H., Boruah, S.K. and Baruah, P.P. 2024. Aquatic macrophytes and associated periphytonic algae in Pobitora Wildlife Sanctuary, Assam (India) *Pleione*, 18(3), 313 - 319.

Kant, S. and Gupta, P. 1998. Algal flora of Ladakh. Scientific Publication, Jodhpur, India, p 341.

Komarek, J. and Anagnostidis, K. 1998. Cyanoprokaryota I. Teil: Chroococcales. Herausgegeben von H. Ettl, G. Gartner, H. Heynig, D. Mollenhauer (eds.), SusWasserflora. Von Mitteleuropa, Gaustav Fischer, 19. p 548.

Komarek, J. and Fott, B. 1983. Das phytoplankton des Suβwassers, 7. Teil: - E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. p 1001.

Komarek, J. and Anagnostidis, K. 2005. Cyanoprokaryota II. Teil: Oscillatoriales. B. Budel, G. Gartner, L. Krienitz and M. Schagerl (eds.), SusWasserflora. Von Mitteleuropa, Elsevier, 19. p 759.

Myers, N. et al. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403, 853-858.

Nath, S. an Baruah, P.P., 2020. Algal diversity in Chandubi Beel, a tectonic water body of North East India. *Nelumbo*, 62 (1), 68-69.

Perumal, G. M. and Anand, N. 2009. Manual of Freshwater Algae of Tamil Nadu. Bishen Singh Mahendra Pal Singh. Dehra Dun, India, p 133.

Prasad, B. N. and Misra, P.K. 1992. Fresh Water Algal Flora of Andaman & Nicobar Islands. Vol. II. Bishen Singh Mahendra Pal Singh. Dehra Dun, p 238.

Prasad, B. N. and Srivastava, M.N.1992. Fresh water algal flora of Andaman & Nicobar Islands. Vol. 1. Bishen Singh Mahendra Pal Singh. Dehra Dun, p 369.

Qinye, Y. and Du, Z. 2004. Tibetan Geography. China: China Intercontinental Press.

Randhawa, M. S.1959. Zygnemataceae. ICAR, New Delhi. pp. 478.

Rongpipi, K., Nongbet, A. and Hajong, P. 2025. Seasonal Dynamics of Algal Communities under Environmental and Anthropogenic Stressors in the Kopili River, Northeast India. *Asian Journal of Environment & Ecology*, 24 (12), 170-184.

Roy, A.S. and Pal, R. 2015. An investigation on Morphotaxonomy and Diversity of Planktonic Chlorophytes from fresh water Eutrophic Wetland of Indian Ramsar Site. *Phykos*, 45 (2), 29-42.

Sedamker, E. and Angadi, S.B. 2003. Physicochemical parameters of two fresh water bodies of Gulbarga, India, with special reference to phytoplankton. *Pollution Research*, 22, 411-422.

Shannon, C.E. and Weiner, W. 1949. The mathematical theory of communication. University of Illinois, Illinois, p125.

Sharma, B. K. and Lyngdon, R.,2003. Abundance and ecology of net and phytoplankton of subtropical reservoir of Meghalaya (N.E. India). Ecology Environment and Conservation, 9,325-333.

Sinha, T., Borah, D. and Rout, J. 2025. Algal communities in urban freshwater ponds: prospects for biodiesel production. *Vegetos* 38, 202–212. https://doi.org/10.1007/s42535-023-00804-0.

Singh, B.P. 2001. The Eastern Himalaya: Wetlands, Forests and Beliefs. Economic and Political Weekly, 36 (31), 2968-2975.

Srivastava, U.K., Dholakia, B.H. and Vathsala, S. 1987. Brackish water Aquaculture Department in India. Concept publishing Co. New Delhi.

Talukdar, J.K. and Rajbongshi, M.K. 2018. Ichthyofaunal Diversity and Conservation Status of Puthimari Beel of Barpeta, Assam, India. International Journal of Applied and Advanced Scientific Research, 3(1), 233-237.

Talukdar, R. and Bhattacharyya, K.G. 2016. Distribution of A Few Heavy Metals in The Water of a Freshwater Wetland in Barpeta District, Assam, India. *Paripex-Indian Journal of Research*, 5(4), 489-491.

Trivedy, R.C. 1980. Population studies on Chambal River and surrounding due to Nagda Industrial complex. Ph.D. thesis. Vikram University, Ujjain, M.P.

Trivedy, R.C., 1981. Use of diversity index in evaluation of water quality. In: WHO workshop on Biological Indicator and Indices of Environmental Pollution, held on 21- 23 September, 1981, Central Board for prevention and control of Pollution. Osmania University Hyderabad, India, 175-188.

Yamagishi, T. 2010. Plankton Algae of Southeast Asia. Bishen Singh Mahendra Pal Singh. Dehra Dun, India, p 249.