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RESEARCH ARTICLE

Phytoplankton study in the Ranikere and Dodderikere lakes of Challakere Taluk of Chitradurga District, Karnataka, India

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Abstract

Freshwater algae play a vital role in aquatic ecosystems due to their primary productivity and contribution to the food chain. Among them, phytoplankton are key biological indicators of water quality, reflecting ecological status and nutrient availability. The present study aimed to analyze the phytoplankton diversity in two freshwater lakes Ranikere and Dodderikere over a one-year period from May 2019 to April 2020. Water samples were collected monthly and phytoplankton were identified based on morphological characteristics such as thallus organization, cell shape, pigmentation and cellular arrangement. A total of 54 algal taxa were recorded across both sites. These included 6 species of Chlorophyceae, 5 species of Cyanophyceae, 22 species of Bacillariophyceae, 15 species of Zygnemophyceae, 5 species of Euglenophyceae and 1 species of Charophyceae. The class Bacillariophyceae showed the highest diversity, followed by Zygnemophyceae. The comparative analysis between the two lakes revealed that Ranikere Lake exhibited a higher abundance and diversity of phytoplankton than Dodderikere Lake, possibly is due to the differences in nutrient input, light penetration and ecological conditions. This study highlights the ecological significance of phytoplankton in freshwater systems and underscores their role as indicators of water quality. The findings can contribute to future ecological assessments and conservation strategies in freshwater habitats.

Keywords: Dodderikere; morphological characters; physicochemical factors; phytoplankton diversity; Ranikere lake

Introduction

Freshwater algae, especially phytoplankton, are indispensable primary producers in aquatic ecosystems, serving as the base of the food chain and driving energy flow through higher trophic levels (1). They play a critical role in nutrient cycling, oxygen balance and carbon sequestration, while also influencing the trophic dynamics of aquatic food webs (2). The diversity and abundance of phytoplankton communities are widely recognized as bioindicators of water quality and ecological health (3). Their distribution and seasonal fluctuations are regulated by physicochemical parameters such as temperature, pH, dissolved oxygen, nutrient concentrations (nitrates, phosphates), light penetration and hydrological regimes (4, 5).

Extensive studies across South India particularly Karnataka, Tamil Nadu and Andhra Pradesh have documented phytoplankton diversity in lakes, reservoirs, ponds and streams, revealing strong links between algal community structure and environmental variables. In Karnataka, investigations in Kunigal Tank (Tumkur district) reported 62 phytoplankton species across five classes (Chlorophyceae, Bacillariophyceae, Cyanophyceae, Desmidiaceae and Euglenophyceae), with seasonal variation strongly correlated to water quality parameters (6). Similarly, in Shetter Lake, Navalgund (Dharwad district), 64 species were recorded and Cyanophyceae were found dominant during the rainy season, while shifts in other algal groups were observed across summer and winter (7). A study on two freshwater lakes in Udupi district demonstrated clear seasonal variations in phytoplankton composition, with Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae responding differently to changes in dissolved oxygen, biological oxygen demand and nutrient levels (8).

In Tamil Nadu, the Thachan Pond (Cuddalore district) supported 35 species from four classes, with Cyanophyceae (≈41 %) being dominant, indicating moderate eutrophication and toxin-producing cyanobacterial blooms (*Microcystis aeruginosa, Anabaena* spp.) (9). Similarly, in Valankulam Lake (Coimbatore district), 43 species from 30 genera were identified, where Cyanophyceae were predominant (35.07 %), followed by Chlorophyceae and Bacillariophyceae, with seasonal variation attributed to changes in temperature and nutrient inflow (10). A year-long study at Perumal Lake (Cuddalore district) identified 15 phytoplankton species influenced by parameters such as turbidity, pH, hardness, chlorides, nitrates and phosphates, showing significant correlations between hydrochemistry and species composition (11).

In Andhra Pradesh, studies provide further evidence of seasonal community shifts. In Lakshmipuram Lake (Anakapalli district), 29 genera belonging to Chlorophyceae (52 %), Cyanophyceae (28 %) and Bacillariophyceae (21 %) were recorded, with peak abundances in pre-monsoon and lowest counts during monsoon dilution (12). Similarly, the Kasipatnam Temple Stream

(Visakhapatnam district) revealed 58 species across four classes, with Chlorophyceae contributing the largest share and seasonal peaks occurring outside the monsoon (13). In aquaculture ponds of West Godavari district, Chlorophyceae dominated the phytoplankton community, with maximum abundance in summer and minimum in winter, influenced by seasonal variation in temperature, dissolved oxygen and hardness (14).

Taken together, these studies highlight that phytoplankton diversity in South Indian freshwater ecosystems is shaped by (i) seasonal hydrological cycles, (ii) nutrient inputs and organic loading, (iii) light penetration and (iv) physicochemical fluctuations. Dominance of Cyanophyceae in many water bodies signals nutrient enrichment and possible eutrophication, whereas higher diversity across Chlorophyceae and Bacillariophyceae indicates relatively balanced ecological conditions. Thus, phytoplankton monitoring offers a cost-effective and sensitive tool for assessing water quality and ecological balance across South Indian aquatic ecosystems (15).

The current study focuses on two significant lakes, Ranikere and Dodderikere, in the Challakere Taluk of Chitradurga District, Karnataka. These water bodies not only support biodiversity but also serve as vital resources for irrigation and fisheries. The objectives are to examine phytoplankton diversity and assess the influence of physicochemical factors on their abundance, thereby contributing to the understanding of aquatic ecosystem dynamics in this region.

Materials and Methods

Study area

Ranikere Lake

Ranikere, constructed in 1907, is in Challakere Taluk, Chitradurga District, Karnataka, India (Fig. 1). Geographically, it lies at 14°18'57.6" N latitude and 76°43'24.2" E longitude. The lake spans an area of 942.85 sq km, with a depth of 10.20 m and a maximum height of 12.00 m. The surrounding villages, including Merasabhihally, Karikere, Rangavanahally and Vishveshwarayyapura, depend on this water body for irrigation and fisheries.

Dodderikere Lake

Dodderikere, constructed in 1881, is another vital lake in the region. It is situated at 14°16'38.3" N latitude and 76°41'13.1" E longitude, covering an area of 812.97 acres (approximately 2.79 sq km). The lake has a depth of 4.50 m and a maximum height of 6.00 m. It supports several villages, including Baramasagara, Ullarti and Sanikere, for irrigation and ecological purposes.

Sample collection and analysis

Samples were collected monthly from May 2019 to April 2020 at various locations in both lakes for 6.30 am to 9.30 am by random method. The water was collected at 3 different places on the lakes at random locations all the time of the study duration. The GPS coordinates of the sampling sites mentioned in the materials and methods section. The samples were collected every month, randomly at 3 different locations for 2 years.

Phytoplankton samples were identified based on morphological characteristics such as thallus organization, shape, cell number and pigmentation (16). The data obtained was analyzed using JMP free student version.

Magnus company light microscope was used to see algal samples. Morphological observations were made for diatoms, considering the presence of raphe, Straie, centriole, presence and absence of silica and the presence and absence of sheath, heterocyst's and cell shape and size for Cyanophyceae. For green algae, these observations focused on the presence of chloroplast, filament shape and cell size. By using the standard taxonomic manuals (16 -18) and the taxa were identified.

Results

The study highlights and relative dominance of phytoplankton in Ranikere and Dodderikere lakes. The abundance and distribution of phytoplankton are indicative of the ecological health and water quality of these aquatic ecosystems. The study of phytoplankton across different classes, including Chlorophyceae, Cyanophyceae, Bacillariophyceae, Zygnematophyceae, Euglenophyceae and Charophyceae is discussed below.

Chlorophyceae

Chlorophyceae were a significant component, particularly in Ranikere lake with species like *Pediastrum duplex* var *genuinum* and *Pediastrum duplex* var *clathratum* being particularly abundant. The dominance of these green algae reflects favorable physicochemical properties such as adequate sunlight penetration and nutrient availability (19). Rare species such as *Oedogonium pluriosporum* indicate specific ecological niches within the lakes.

Cyanophyceae

Cyanophyceae, represented by species such as *Chroococcus pallidus* (dominant in Dodderikere Lake), suggest eutrophic conditions in parts of the lake. These blue-green algae are typically indicators of nitrogen and phosphorus enrichment (20). Some of the species like *Anabaena anomala* were recorded, possibly reflecting the localized presence of specific nutrients.

Bacillariophyceae

Diatoms dominated the phytoplankton diversity in both lakes were a significant component, particularly in Dodderikere Lake and Ranikere Lake with dominant species like *Rhopalodia gibba, Gomphonema lanceolatum, Pinnularia viridis* and *Pinnularia macilenta.* Their abundance is an indicator of good water quality and a balanced ecosystem (21). Species like *Mastogloia smithii* were rare, possibly due to competition or specific habitat requirements.

Zygnematophyceae

The class Zygnematophyceae was represented by species like *Cosmarium blyttii* and *Cosmarium connatum*, which were dominant in Ranikere lake. These filamentous algae are common in freshwater ecosystems with high organic content (22). Rare species such as *Spirogyra submaxima* highlight the biodiversity present in unique microhabitats.

Euglenophyceae & Charophyceae

Euglenophyceae are more dominant in Dodderikere lake & its species like *Euglena pisciformis*, which thrive in organically enriched waters (23). The rarity of Charophyceae (*Nitella tenuissima)* reflects the sensitivity of this group to environmental changes, serving as an indicator of minimal anthropogenic disturbances in polluted waters.

Phytoplankton composition and taxonomic richness

Across both lakes, 54 algal taxa were identified, spanning 6 major classes: Bacillariophyceae (diatoms), Zygnematophyceae (desmids), Chlorophyceae (green algae), Cyanophyceae (blue-green algae), Euglenophyceae and Charophyceae. The dominance of Bacillariophyceae (22 species) and Zygnematophyceae (15 species) reflects a well-oxygenated, nutrient-moderate aquatic environment, consistent with mesotrophic conditions.

- Ranikere Lake exhibited higher species richness and diversity, particularly of Chlorophyceae and Zygnematophyceae, suggesting better light penetration and lower organic pollution.
- Dodderikere Lake showed a higher relative abundance of Euglenophyceae and Cyanophyceae, indicative of organic enrichment and possible eutrophication.

The presence of *Nitella tenuissima* (Charophyceae) exclusively in Ranikere suggests minimal anthropogenic disturbance, as Charophytes are highly sensitive to pollution and habitat degradation.

The comparative analysis reveals distinct ecological trajectories:

Ranikere Lake

- Higher depth (10.2 m) and surface area (942.85 sq km) support thermal stratification and diverse niches.
- Dominance of filamentous green algae and desmids suggests oligotrophic to mesotrophic status.
- Presence of rare taxa like *Mastogloia smithii* and *Spirogyra submaxima* indicates ecological stability and niche specialization.

Dodderikere Lake

- Shallower depth (4.5 m) and smaller area (2.79 sq km) limit stratification and increase susceptibility to nutrient loading.
- Dominance of Euglenoids and Cyanobacteria points to organic enrichment and possible anthropogenic stress.
- Lower species richness and fewer rare taxa suggest reduced habitat heterogeneity and resilience.

These findings are consistent with the Intermediate Disturbance Hypothesis, where moderate disturbance (Ranikere) promotes diversity, while high disturbance (Dodderikere) reduces it.

Comparative analysis of Ranikere and Dodderikere Lakes

Phytoplankton diversity was significantly higher in Ranikere Lake compared to Dodderikere Lake, likely due to its larger size, depth and nutrient availability. The dominance of species like *Cosmarium* species & Bacillariophyceae species in Ranikere and Dodderikere lakes indicates its relatively stable ecological conditions. Conversely, Dodderikere lake exhibited fewer species and lower diversity, suggesting greater environmental stress or limited resources.

Ecological implications

The abundance of phytoplankton across the lakes is reflective of their primary productivity and ecological health. The presence of dominant species indicates favorable conditions for phytoplankton growth, while rare species highlight the need for conservation efforts to protect biodiversity.

Table 1 represents the relative dominance and distribution of phytoplankton in Ranikere & Dodderikere. The dataset represents the diversity and abundance of algal species in two freshwater bodies: Ranikere and Dodderikere. The algae are categorized based on their relative abundance as dominant (+++), common (++) and rare (+). A dash (-) indicates absence.

The dominant species in Ranikere were 9, commonly found are 17 and the rare species are 18 in Ranikere lake while in Dodderikere, the dominant species are 7, the commonly found species are 13 and the rare species are 10. The table clearly indicates the occurrence of the species in different population density, such that they are common in one lake, while it is abundant or rare in other lakes.

A wide variety of algal taxa are recorded, including members from Chlorophyta (green algae), Cyanophyta (blue-green algae), Bacillariophyta (diatoms), Euglenophyta and Charophyta.

Ranikere: *Pediastrum duplex* var *genuinum*, *P. clathratum*, *Gomphonema gracile, Pinnularia viridis, P. macilenta, Cymbella cistula*, *Rhopalodia gibba*, *Cosmarium blyttii*, *C. connatum*, were dominant, indicating a high prevalence of Chlorophyceae, Bacillariophyceae, Zygnematophyceae. Many species appeared as common, especially *P. echinulatum, Oedogonium welwitschii, Nostoc spongiiforme, Navicula capitatoradiata, Gyrosigma bhusavalensis, Cymbella tumida, Nitzschia sigmoidea, N. linearis, Cosmarium maculatum. C. hammeri, C. miscellium, C. trilobulatum, C. angulosum, Spondylosium nitens, Mesotaenium chlamydosporum, Spirogyra hymerae*. A significant number of rare species like Oedogonium *pluriosporum*, *Anabaena anomala*, *Chroococcus limneticus, Gloeocapsa gelatinosa, Fragilariforma virescens*, *Placoneis placentula, Nitzschia linearis, Hantzschia amphioxys, Mastogloia danseyi, M. smithii, Cosmarium reniforme, C. nitidulum, Euastrum spinulosum, Staurastrum recurvatum, Spirogyra submaxima, Euglena pisciformis*, *E. proxima* and *Nitella tenuissima* also contribute to the biodiversity.

On comparison the Ranikere is rich in Chlorophyceae and Zynemophyceae suggesting better light penetration and potentially higher nutrient availability for Chlorophyta. Dodderikere, with a high abundance of diatoms and Euglenoids, may have fluctuating environmental conditions and possibly higher organic content. The presence of blue-green algae (Cyanophyta) like *Anabaena* and *Gloeocapsa* on both lakes (though rarely) suggest moderate nutrient levels, but not to a eutrophic extent.

- The presence of multiple indicator species, such as *Euglena* and *Nitzschia*, points to moderate pollution or organic enrichment in Dodderikere.
- The dominance of filamentous green algae and desmids in Ranikere indicates a relatively cleaner, stable freshwater environment.

Further discussion on their diversity factors needs to be studied and will be reported in the further communications.

Table 2 represents the identified algae from Dodderikere and Ranikere lakes and their taxonomic description. Ranikere dominated with the species richness compared to Dodderikere.

Table 1. Relative dominance and distribution of phytoplankton in Ranikere and Dodderikere

Sl. No	Name of the algae	Abundance					
		RANIKERE			DODDERIKERE		
		Dominant	Common	Rare	Dominant	Common	Rare
1.	*Verrucodesmus verrucosus*	-	++	-	-	-	+
2.	*Pediastrum duplex* (Meyen) var *genuinum*	+++	-	-	-	-	-
3.	*Pediastrum simplex* var *echinulatum*	-	++	-	-	-	-
4.	*Pediastum duplex* var *clathratum*	+++	-	-	-	-	-
5.	*Oedogonium pluriosporum*	-	-	+	-	-	-
6.	*Oedogonium welwitschii*	-	++	-	-	-	-
7.	*Nostoc spongiiforme*	-	++	-	-	-	+
8.	*Anabena anomala*	-	-	+			
9.	*Chroococcus pallidus*				+++	-	-
10.	*Chroococcus limneticus*	-	-	+	-	++	-
11.	*Gloeocapsa gelatinosa.*	-	-	+	-	-	+
12.	*Gomphonema gracile*	-	-	+	-	++	-
13.	*Gomphonema parvulum*	-	-	-	-	++	-
14.	*Gomphonema truncatum*	-	-	-	-	++	-
15.	*Gomphonema lanceolatum*	-	-	-	+++	-	-
16.	*Fragilariforma virescens*	-	-	+	-	++	-
17.	*Caloneis permagna*	-	-	-	-	-	+
18.	*Craticula ambigua*	-	-	-	-	++	-
19.	*Placoneis placentula*	-	-	+	-	++	-
20.	*Pinnularia viridis*	+++	-	-			
21.	*Pinnularia macilenta*	+++	-	-	-	-	+
22.	*Navicula capitatoradiata*	-	++	-	-	-	+
23.	*Gyrosigma bhusavalensis*	--	++	-	-	-	+
24.	*Cymbella cistula*	+++	-	-	-	++	-
25.	*Cymbella tumida*	-	++	-			
26.	*Cymbella cymbiformis*				-	++	-
27.	*Nitzschia sigmoidea*	-	++	-	-	-	+
28.	*Nitzschia linearis*	-	++	+			
29.	*Hantzschia amphioxys*	-	-	+	-	++	-
30.	*Mastogloia danseyi*	-	-	+	-	-	-
31.	*Mastogloia smithii*	-	-	+			
32.	*Eunotia epithemioides*	-	-	-	-	++	-
33.	*Rhopalodia gibba*	+++	-	-			
34.	*Cosmarium reniforme*	-	-	+	-	-	-
35.	*Cosmarium maculatum.*	-	++	-	-	-	-
36.	*Cosmarium hammeri*	-	++	-	-	-	-
37.	*Cosmarium miscellium*	+++	-	-	-	-	-
38.	*Cosmarium blyttii*	+++	-	-	-	-	-
39.	*Cosmarium connatum*	+++	-	-	-	-	-
40.	*Cosmarium nitidulum*	-	-	+	-	-	-
41.	*Cosmarium trilobulatum*	-	++	-	-	-	-
42.	*Cosmarium angulosum*	-	++	-	-	-	-
43.	*Euastrum spinulosum*	-	-	+	-	-	-
44.	*Staurastrum recurvatum*	-	-	+	-	++	-
45.	*Spondylosium nitens*	-	++	-	-	-	-
46.	*Mesotaenium chlamydosporum*	+++	-	-	-	-	-
47.	*Spirogyra submaxima*	+++	-	-	-	-	-
48.	*Spirogyra hymerae*	-	++	-	-	-	-
49.	*Euglena sociabilis*	-	-	-	-	++	-
50.	*Euglena pisciformis*	-	-	+	+++	-	-
51.	*Euglenaformis proxima*	-	-	+	-	++	-
52.	*Euglena caudata*	-	-	-	-	-	+
53.	*Trachelomonas spectabilis*	-	-	-	-	-	+
+*54.	*Nitella tenuissima*	-	-	+	-	-	-

(+++: dominant); (++: common); (+: rare)

Table 2. Enumeration of detected algae in a systematic manner and their taxonomic description

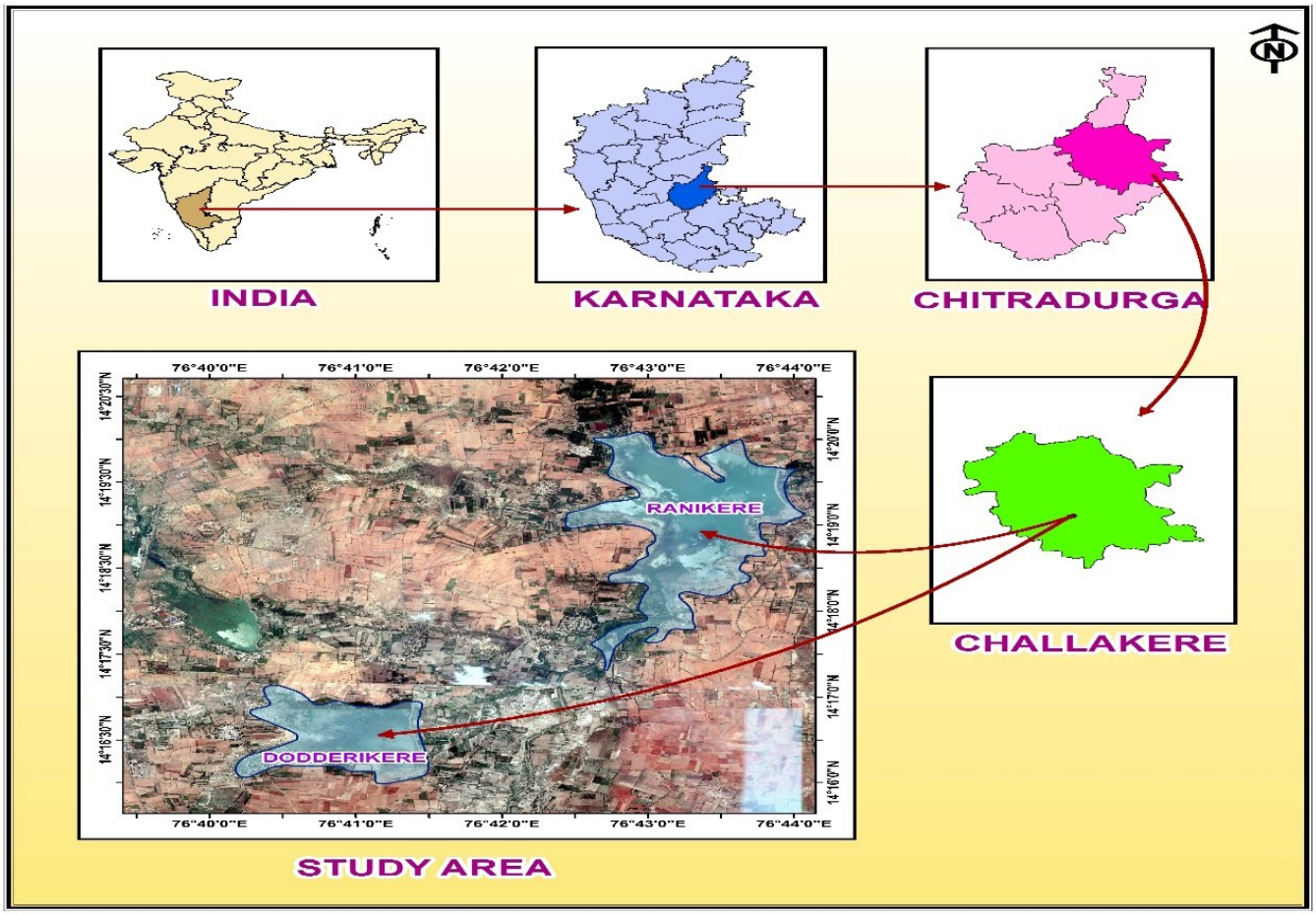
Chlorophyta	Chlorophyceae	Chlorococcales	Scenedesmaceae	*Verrucodesmus verrucosus* (Smith) Hegewald Synonym: *Scenedesmus bifugates*.	Cell small, 8 celled coenobia in alternating series, oblong ovoid, Cells 6-7 µm length & 2-4 µm broad (24, 25), Fig. 1, Pl: 1	Ranikere 13.2405° N, 74.7728° E
				Pediastrum duplex (Meyen) *var genuinum*	Colonies 4-8-16-32 celled with large intercellular spaces. Marginal cells are U shaped horn like curved. Cells 5-19 µm length & 32-66 µm in diameter (24), Fig. 2, Pl: 1	Ranikere. 13.2405° N, 74.7728° E.
				Pediastrum simplex var *echinulatum*	Colonies 4-8-16-32 cells with intercellular space is absent, cell wall densely covered with small spines, cells 20-32 µm length & 5-15 µm diameter (26), Fig. 3, Pl:1	Ranikere 13.2405° N, 74.7728° E.
				Pediastum duplex var *clathratum* (A. Braun).	Colonies 4-8-16-32 cells with small perforation, marginal, cell little bit horn like truncate, cells 10-20 µm length & 5-14 µm diameter (27), Fig. 4, Pl:1	Ranikere. 13.2405° N, 74.7728° E.
		Oedogoniales	Oedogoniaceae	*Oedogonium pluriosporum* Wittrock.	Vegetative cells are cylindrical, homothallic macrandrous, 1or more ring like scars & cell division, globous oospores, cell 74- 103µm long & 39-64 µm broad, antheridial cells 95 µm long and 12-14 µm broad (16), Fig. 5, Pl: 1	Ranikere. 13.2405° N, 74.7728° E.
				Oedogonium welwitschii. West &West.	Vegetative cells not cylindrical, heterothallic macrandrous, slightly larger at anterior end. globose ooaspore, cells 90-112 µm long & 39-50 µm broad, antheridial cells 64 µm long & broad (16), Fig. 6, Pl:1	Ranikere. 13.2405° N, 74.7728° E.
Cyanophyta	Cyanophyceae	Nostacales	Nostocaceae	*Nostoc spongiiforme.* Agardh.ex. Born et Flab.	Thallus gelatinous, globules, brownish in colour, trichome is 6-7 µm long & 3-4 µm broad, each cell sub spherical & oblong, heterocyst 6-7 µm long & 3-5 µm broad, spores oval or round, cells with sheath 8-10 µm long & 6-7 µm broad smooth epispore (17), Fig. 7, Pl: 2	Ranikere 13.2405° N, 74.7728° E.
				Anabena anomala Fritsch	Thallus thin, blue green in colour, gelatinous trichome, trichomes are irregular aggregated and densely, moniliform, apex obtuse, generally cells 2-3 µ long as broad, rare in heterocyst. Intercalary cells are spherical 3-6 µ broad (17), Fig. 8, Pl: 2	Ranikere. 13.2405° N, 74.7728° E.
		Chroococccales	Chroococcaceae	*Chroococcus pallidus* Nag: in Kutzing	Thallus gelatinous, colourless or yellow, cell are spherical, single cells or colonies of 8-20 cells, slimy cells are spherical or ellipsoidal, each cell without sheath 6-8 µm & with sheath 6-11.5 µm broad & long (17), Fig. 9, Pl: 2	Dodderikere 14.3167° N, 76.6499° E
				Chroococcus limneticus var *distans*. Lemm.	Thallus tubular gelatinous layer, cells are spherical or sub spherical after division, colony with 4-30 cells, without sheath 5-12 µm diameter, with sheath 7-14 µm diameter, cells colorless or yellowish (17), Fig. 10, Pl: 2	Dodderikere 14.3167° N, 76.6499° E
				Gloeocapsa gelatinosa. kutz.	Thallus gelatinous cells are oval/ spherical, cells without sheath 2.4 µm & with sheath 6.1-10 µm diameter, bluegreen in colour, colonies are 24-25 µm diameter, seemingly thin, when old lamellated (17), Fig. 11, Pl: 2	Dodderikere. 14.3167° N, 76.6499° E

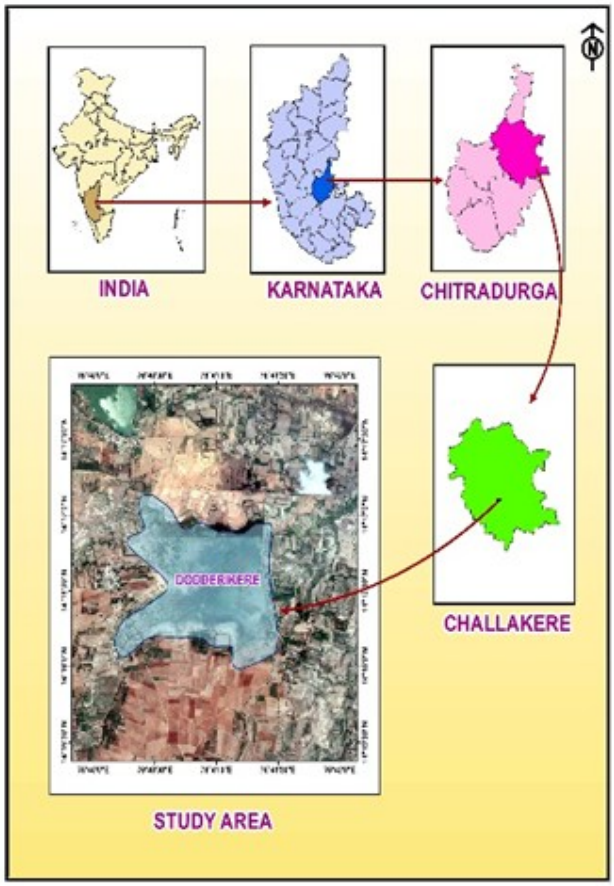
Bacillariophyta	Bacillariophyceae	Cymbellales	Gomphonemataceae	*Gomphonema gracile* Ehernberg sensu strict	Valves in girdle view narrow, valves weakly heteropolar, clavate, lanceolate, axial area linear narrowing slightly towards the apices. Central area rounded & commonly asymmetrical, shortening of central striae, 20-31 µm valve length, 3-5 µm valve width, 8-11 µm striae density (18), Fig. 12, Pl:3	Dodderikere 14.3167° N, 76.6499° E
				Gomphonema parvulum Kutzing sensu strict	Valves are weak. Heteropolar, club shaped, oval or lanceolate in shape, axial area is narrow, linear stigmata closely to central striae, striae parallel to weak and radial, Raphe laterally weak. 11-37 µm valve length, 3-9 µm valve width, 6-10 µm striae density (18), Fig. 13, Pl: 3	Dodderikere. 14.3167° N, 76.6499° E
				Gomphonema truncatum Ehrenberg pro parte Syn. *Gomphonema lanceolatum* Reichart	Valves only slightly constricted below the head pole more elongate broad at one side and central (18), Fig. 14, Pl:3	Dodderikere. 14.3167° N, 76.6499° E
				Gomphonema lanceolatum var Brebissonia lanceolate (Agardh)	Valves are lanceolate to elliptic with slightly protracted, broad and round end, parallel striae, The central nodule is elongate and large gap between proximal raphe ends. 56-145 µm length, 16-25 µm width, 10-14 µm striae density (28), Fig. 15, Pl:3.	Dodderikere. 14.3167° N, 76.6499° E
		Fragilariales	Fragilariaceae	*Fragilariforma virescens* (Rafls)	Broad frustules, lateral surfaces turgid with lanceolate constricted near the end. Valves linear to rostrate, striae are distinct. 14-50 µm valve length, 5- 7 µm valve width, striae density 20-23 µm (29), Fig. 16. Pl:3	Dodderikere. 14.3167° N, 76.6499° E
		Naviculales	Naviculaceae	*Calonies permagna* (Bailey) Cleve	Valves lanceolate, apices are rounded & protracted, Proximal raphe, Central area is widely width reaching both the margins. 14-50 µm length, 4-8 µm valve width, 28-30 µm striae density (30), Fig:17, Pl:3	Dodderikere. 14.3167° N, 76.6499° E
				Craticula ambigua (Ehrenberg) DG Mann Syn *Navicular ambigua* Ehrenberg	Valves are lanceolate, elliptic with protracted & crostrate, weak sub-capitate apices. Central area absent or very slightly widened. 40-95 µm valve length, 12-24 valve width, 14-18 µm striae density (18), Fig. 18, Pl:3	Dodderikere 14.3167° N, 76.6499° E and Ranikere. 13.2405° N, 74.7728° E.
				Placoneis placentula var *Navicula plancenta* (Ehrenberg) Kutzing.	Valves are elliptical & lanceolate with rostrate, protracted apices, central small area & individual puncta. 30-70 µm valve length, 12-29 µm valve width, 6-10 µm striae density (18), Fig. 19, Pl:3	Dodderikere 14.3167° N, 76.6499° E and Ranikere. 13.2405° N, 74.7728° E.
			Pinnulariaceae	*Pinnularia viridis* (Nitzsch) Ehrenberg.	Linear valves, parallel margins, rounded apices, lateral raphe, 3 longitudional visible lines is present, axial valve breadth area is large & linear, lanceolate towards the poles, central area are rounded & irregular (18), Fig. 20, Pl:3	Ranikere 13.2405° N, 74.7728° E.
				Pinnularia macilenta Ehrenberg-1843.	Valves are linear & lanceolate, broad, rounded apices & in large specimens. Broad axial area. Central area is wide & irregular. Lateral broadly raphe. Straie are radiate in the centre.70-125 µm valve length, 14-17 µm valve breadth, striae: 6.8 - 10 µm (31), Fig. 21, Pl:3	Ranikere 13.2405° N, 74.7728° E. and Dodderikere. 14.3167° N, 76.6499° E
				Navicula capitatoradiata. Germain	Valves are lanceolate to elliptical, apices are lanceolate with rostate, filiform raphe, narrow axial area, central area broad, radiate striae, poles are convergent. 23-41 µm valve length, 9-11 µm valve width, 5-6 µm striae density (18), Fig. 22, Pl:3	Ranikere 13.2405° N, 74.7728° E and Dodderikere. 14.3167° N, 76.6499° E

		Pleurosigmataceae.	*Gyrosigma bhusavalensis,* Sarode & Kamat.	Valves are linear & sigmodies, apices are rotundatis, raphe central at sigmoides, elipsiformis, striae transverses. 115-130 µm valve length, 20-23 µm valve width, 28-41 µm striae density (32), Fig. 23, Pl:3	Ranikere. 13.2405° N, 74.7728° E.
	Cymbellales	Cymbellaceae	*Cymbella cistula* var *neocistula* (Ehrenberg)	Valves dorsiventral strong ventral margin straight in smaller slightly convex margin, central swelling large specimens, small central area and rounded. Raphes are lateral. Three or more Stigmata. 32-110 µm valve length, 12-20 µm width. 7-10 striae density. 3-6 stigmata (18), Fig. 24, Pl:3	Ranikere 13.2405° N, 74.7728° E & Dodderikere 14.3167°N, 76.6499°E
			Cymbella tumida (Brebisson) var Haurck	Valves strongly dorsiventral, convex type of dorsal margin, convex ventral margin, tumid mid region, rostrate & slightly protracted apices. Linear, narrow axial area. Central area distinct, rounded in shape, raphe slightly lateral, 35-96 µm valve length, 16-25 µm valve width, 8-12 straiae density, 1 stigmata (18), Fig. 25, Pl:3	Ranikere 13.2405° N, 74.7728° E & Dodderikere. 14.3167° N, 76.6499° E
			Cymbella cymbiformis Agardh	Valves are dorsiventrally moderate, apices blunty & rounded. Dorsal margin arched, ventral margin small straight and mid region is tumid, linear axial area, laterally strong raphe, proximal end are rounded and distinct, striae strongly radiate towards the apices and slightly radiate in midrib region. 40-106 µm valve length, 13-17 µm valve width, 7-10 µm striae density (18), Fig. 26, Pl:3	Ranikere 13.2405° N, 74.7728° E & Dodderikere. 14.3167°N, 76.6499°E
	Bacillariales	Bacillariaceae	*Nitzschia sigmoidea* (Nitzch) W.Smith.	Linear frustules, sigmoid with rounded end, thin raphe, striae not destines, 120-130 µm length, 10-14 µm breadth, 10-15 µm striae density (33), Fig. 27, Pl:3	Ranikere 13.2405° N, 74.7728° E.
			Nitzschia linearis (gardh) W.Smith.	Linear lanceolate, cuneate poles. Capitates to rostrate apices, raphe marginal, central area distinct, striae indistinct to weakly visible. 34-230 µm length, 2-6 µm valve breath, 28-41 µm striae density, 8-20 µm fibulae density (18), Fig. 28, Pl:3	Ranikere. 13.2405° N, 74.7728° E.
			Hantzschia amphioxys. (Ehrenberg) Grunow	Dorsiventral valves, linear margins, middle is concave, roasted, protracted apices, striae straightly, radial, irregular short fibulae, 20-250 µm valve length, 5-25 µm valve breadth, 11-30 µm striae density, 4-12 fibulae density (18), Fig. 29, Pl:3	Dodderikere 14.3167° N, 76.6499° E
	Mastogloiales	Mastogloiaceae	*Mastogloia danseyi.* (Thwaites) Thwaites	Linear valves with parallel margins, apices are slightly protracted, raphe is slit, marked by sinuous, central elliptical & transapically enlarged. 20-82 µm valve length, 9-20 µm valve breadth, 14-18 striae density (18), Fig. 30, Pl:3	Ranikere. 13.2405° N, 74.7728° E.
			Mastogloia smithii. Thwaites	Elliptical lanceolate to linear lanceolate valves, protracted, broaded or narrow capitate apices, central area transapically enlarged and rectangular. 20-55 valve length, 8-14 valve breadth, 18-22 striae density (18), Fig. 31, Pl:3	Ranikere. 13.2405° N, 74.7728° E.
	Eunotiales	Eunotiaceae	*Eunotia epithemioides*.Hustedt in Schmidt. 1913.	Frustule's lateral view is rectangular, strongly lateral undulate sides, dorsiventral valves isopolar, convex dorsal margin, concave ventral margin, rounded ends, radiate striae, diagonally opposed frustules, 35-85 µm valve length, 7-10 µm valve breadth,16-19 µm striae density in 10 µm, 26-30 areolae in 10 µm (34), Fig. 32, Pl:3	Ranikere 13.2405° N, 74.7728° E. & Dodderikere 14.3167° N, 76.6499° E

		Rhopalodiales	Rhopalodiaceae	*Rhopalodia gibba* (Ehrenberg) O Muller.	Valves are dorsiventrally strong, claw like shapes, dorsal margin are stongly convex, ventral margin are more or less straight, apices are rounded, raphe branches & supported by fibulae. 20-300 µm valve length, 18-30 µm v/alve breadth, 28-30 µm striae density, 4-8 µm fibulae density (18), Fig. 33, Pl:3	Ranikere 13.2405° N, 74.7728° E. & Dodderikere 14.3167° N, 76.6499° E
Charophyta	Zygnematophyceae	Desmidiales	Desmidiaceae	*Cosmarium reniforme*(Rafls) W. Archer1874.	Cell body medium in size, each cell is spherical & pyramidal with strong constriction at the centre. Apical view is elliptical, semicells reniform, side view circular, 47-57 µm cell length, 36-40 µm cell width, 15-21 µm isthumus (34), Fig. 34. Pl-4.	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium maculatum. WB Turner	Cells are elongated, each cell little bit cylindrical wide & flattened, with little constriction, cell body is large in size, 134-168 µm cell length, 67-90 µm width, 46-47 µm isthamus (35), Fig. 35. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium hammeri. Reinsch.	Cells are medium, long & broad, deep constriction, cell wall smooth, all angled rounded, 20-32 µm cell length, 16-22 µm width, 3-5 µm isthmus (18, 36), Fig. 36. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium miscellium. Skuja.	Cells are longer with wide, deep constriction, closed, broad sinus, semi cells have broad base, apex narrow, cellwall with fine granulation, cells are 40-45 µm length, 35-38 µm width, 15-17 µm isthmus (25), Fig. 37. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium blyttii. Wille.	Cells 1to 2 times longer& broad, not deep constriction, sub-rectangular semi cells, granular cell wall, 10-16 µm cell length, 8-15 µm width, 3-5 µm isthmus (36), Fig. 38. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium connatum. Brebisson ex Rafls.	Cells are large, broad, flat surfaces united, cell wall punctuate, not deep constriction, 45-50 µm cell length, 25- 35 µm width, 12-19 µm isthmus (36), Fig. 39. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium nitidulum. De Notaris 1867.	Cells are small, broad & little longer, deep constriction, linear narrow sinus, apex is slightly dilated & rounded, semi cells are truncate, chloroplast is axial with one pyrenoid, cellwall punctuate 24-28 µm cell length, 24-25 µm cell width, 8-9 µm isthmus (37), Fig. 40. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium trilobulatum. Reinsch	Cells are small, sinus closed, not deep constriction, semi cells is 3 lobed, pyrenoid clear visible and spherical in shape, 17-18 µm cell length, 14-15 µm width, 7-8 µm isthmus (38), Fig. 41. Pl:4	Ranikere 13.2405° N, 74.7728° E.
				Cosmarium angulosum varconicinum.West& West	Cells are small, longer than broad, deep constriction, linear sinus, closed, circular semi cells & rectangular, 12-16 µm cell length, 11-15 µm width, 2-4 µm isthumus (36), Fig. 42. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Euastrum spinulosum. Deplonte 1876.	Cells are small, deep constriction, sinus narrow widely rounded lobes, semi cells are 5 lobes rounded angles, big granules & acute indentations between then, cell wall with short spines. 47-56 µm cell length, 30-35 µm width, 18-19 µm wide isthmus (37), Fig. 43. Pl-4	Ranikere 13.2405° N, 74.7728° E.

				Staurastrum recurvatum Turner.	Cells are small, long & slightly broad, deep constriction with open sinus, fusiform semi cells, dorsal convex margin with undulate & ventral slightly swollen, each tip 3-4 spines & with 5-6 denticulations concentric rings, top view triangular cell contains chloroplasts & one pyrenoid, 20-21 µm cell length, 17-18 µm width without arm (39), Fig. 44. Pl:4	Dodderikere 14.3167°N, 76.6499°E
				Spondylosium nitens f. minor. W B Turner	Cells long & wider, deeply constricted, compressed, semi cells ellipitical & oblong, broadly rounded apex, cell wall is smooth, 10-12 µm cell length, 8-9 µm broad (40), Fig. 45. Pl-4.	Ranikere 13.2405° N, 74.7728° E.
		Zygnematales	Mesotaniaceae	*Mesotaenium chlamydosporum* de. var. *Chlamydosporum*	Cell body oblong & ellipsoidal or short cylindrical, chloroplast plate like, mucilaginous is present, 28-29 µm cell length, 12-13 µm width (Fig. 46) (34), Fig. 45. Pl:4	Ranikere 13.2405° N, 74.7728° E.
			Zygnemataceae.	*Spirogyra submaxima*. Transeau	Filamentous brownish gold to olive green, unbranched, conjugation is scalariform & brown globose zygospores, free floating, vegetative cell is 100-105 µm long, 40-45 µm wide, cell wall is thick & 8 chloroplast is present (41), Fig. 47. Pl-4	Ranikere 13.2405° N, 74.7728° E.
				Spirogyra hymerae. Transeau M E Britton & B H Smith.	Filamentous green, branched, scalariform, 2-4 chromatophores 0.5-2 turns in cell, ellipse zygospores, both cells are slightly enlarge & cylindric tube formed gametogonia, vegetative cells 83-92 µm long, 43-50 µm wide (42), Fig. 48. Pl:4	Ranikere 13.2405° N, 74.7728° E.
Euglenoophyta	Euglenoidea	Eugenales	Euglenaceae	*Euglena sociabilis.* P A Danderd, 1901	Cells are cylindrical or fusiform, short posterior & rounded anterior, 6 -12 in numerous chloroplasts, elongate, each cell contain large pyrenoids with discoid paramylon bodies. Flagellum 1- 1.5 in length. Vegetative cell 46-50 µm long, 19-20 µm wide (25), Fig. 49. Pl:5	Dodderikere 14.3167° N, 76.6499° E
				Euglena pisciformis Klebs.1883	Cells are short & fusiform, posterior is slightly rounded, numerous chloroplasts to 5-10 in number with large, elongated chloroplasts. Vegetative cell 21-29 µm long & 7-12 µm wide (43), Fig. 50. Pl:5.	Dodderikere 14.3167° N, 76.6499° E
				Euglenaformis proxima (Dangeard) M S Bennett & Triemer. 2014	Cells are fusiform & elongated, anterior end is broad, tapering posterior end, small discoid chloroplast. Vegetative cells 48-54 µm long & 10-15 µm wide (43), Fig. 51. Pl:5	Dodderikere 14.3167° N, 76.6499° E
				Euglena caudata Hubner	Cells are green, spindle shape, ovoid & elongated, anterior end bluntened, dorsal end pointed, numerous chloroplasts, 2 paramylon bodies, basal nucles, flagella equal to body length, vegetative cell 60-100 µm long, 15-40 µm wide (44), Fig. 52. Pl:5	Dodderikere 14.3167° N, 76.6499° E
				Trachelomonas spectabilis Deflandre	Lorica ellipsoid and surface of lorica densely covered very fine short rod like spines or spinules, anterior side pore with or without annular thickening & without flagellum, numerous chromatophores, flagellum is absent, lorica is 40-45 µm long, 30-38 µm breadth (16), Fig. 53, Pl:5	Dodderikere 14.3167° N, 76.6499° E
Charophyta	Charophyceae	Charales	Characeae	*Nitella tenuissima.* (Desvaux) Kutzing.	Monoecious type, plant length 5-12 cm tall, axes 150-580 mm diameter, internode 0.7-3.8mm long, branchlets is present, whorled reduced, vegetative cell 250-1960 mm long, 100-250 mm diameter, basal node absent, corona 40-62 µm long, 39-76 µm diameter, oospore reddish brown is 200-400 µm long, 200-390 µm diameter, striae 6-8 ridges, antheridia 150-270 µm diameter with triangular shields (16), Fig. 54, Pl:5	Ranikere 13.2405° N, 74.7728° E.





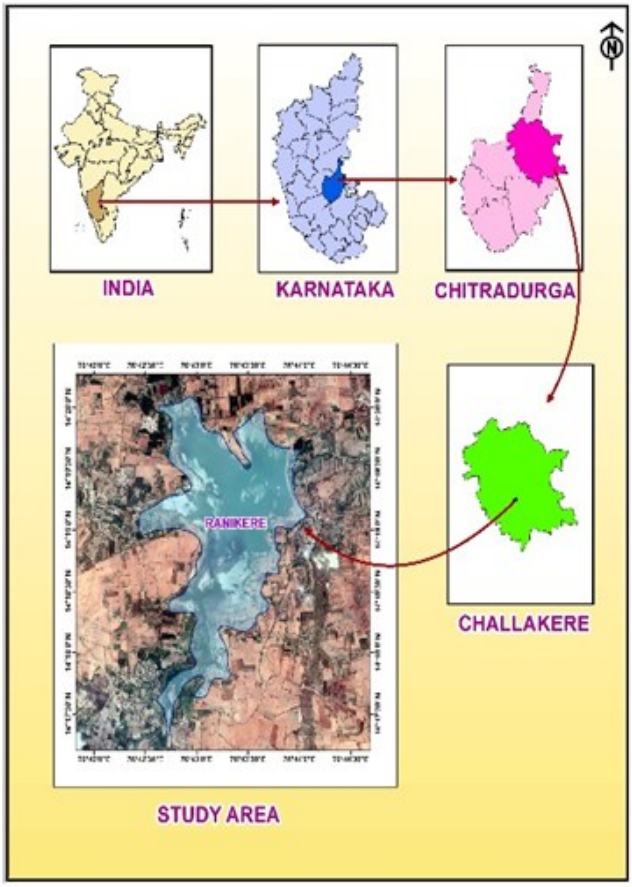


Plate 1. Map showing two lakes of study area.

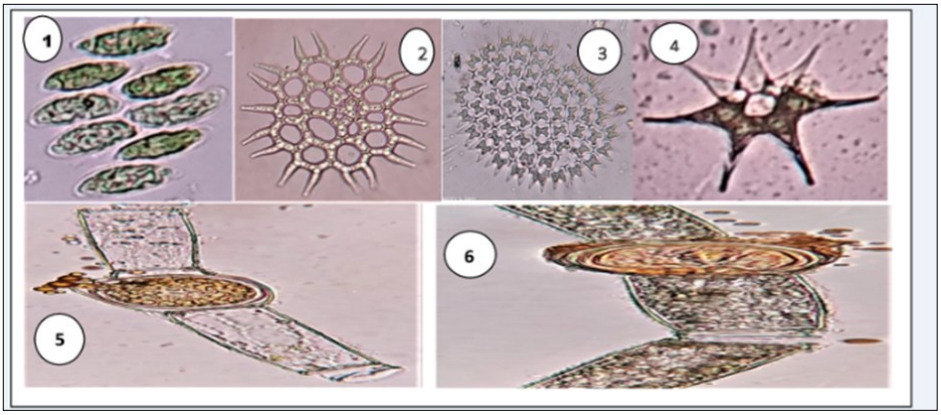


Fig. 1-6, Plate 1. Chlorophyceae members 1. *Verrucodesmus verrucosus,* 2. *Pediastrum duplex* var. *genuinum,* 3. *Pediastrum simplex* var. *echinulatum,* 4. *Pediastrum duplex* var. *clathratum,* 5. *Oedogonium pluriosporum,* 6. *Oedogonium welwitschii.*

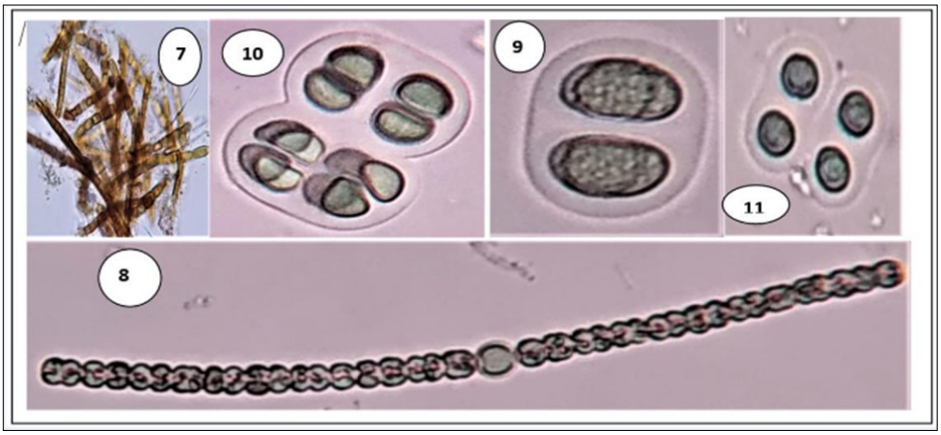


Fig. 7-11; Plate. 2. Cyanophyceae members: 7. *Nostoc spongiaeforme,* 8. *Anabaena anomala,* 9. *Chroococcus pallidus,* 10. *Chroococcus limneticus,* 11. *Gloeocapsa gelatinosa*

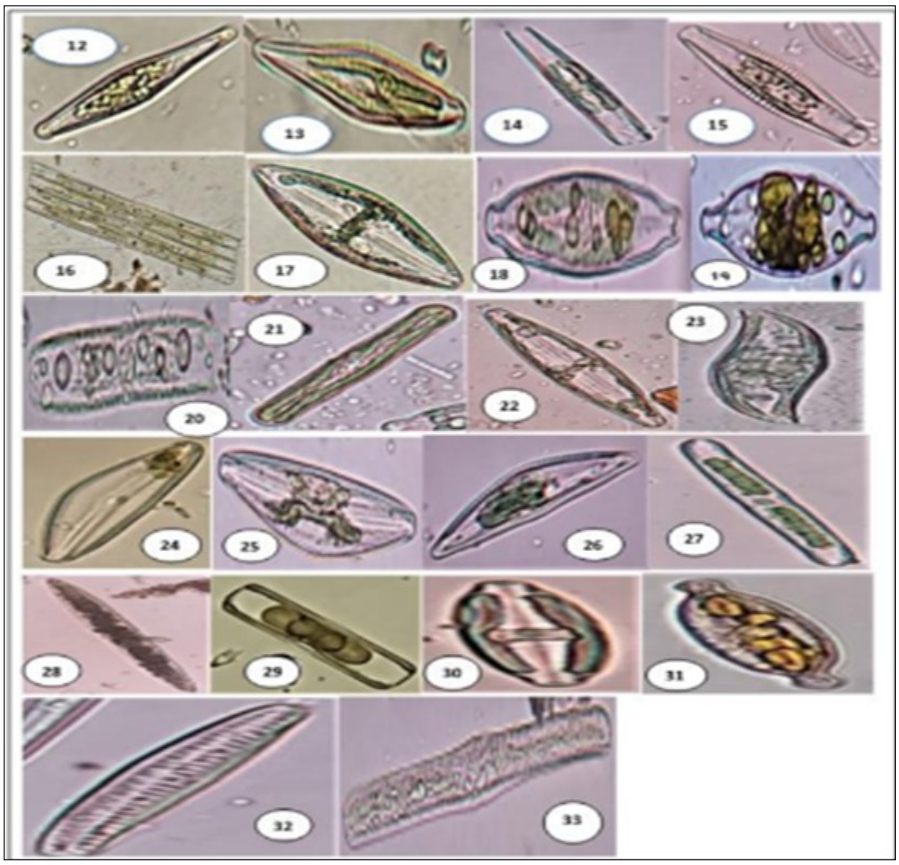


Fig. 12 - 33. Plate 3. Bacillariophyceae members 12. *Gomphonema gracile,* 13. *Gomphonema parvulum,* 14. *Gomphonema truncatum,* 15. *Gomphonema lanceolatum*, 16. *Fragilariforma virescens,* 17. *Caloneis permagna,* 18. *Craticula ambiqua,* 19. *Placoneis placentula,* 20. *Pinnularia viridis,* 21. *Pinnularia macilenta,* 22. *Navicula capitatoradiata,* 23. *Gyrosigma bhusavalensis,* 24. *Cymbella cistula,* 25. *Cymbella tumida,* 26. *Cymbella cymbiformis,* 27. *Nitzschia sigmoidea,* 28. *Nitzschia linearis,* 29. *Hantzschia amphioxys,* 30. *Mastogloia danseyi,* 31. *Mastogloia smithii,* 32. *Eunotia epithemioides,* 33. *Rhopalodia gibba*.

Fig. 34 - 48. Plate 4. Zygnematophyceae members. 34. *Cosmarium reniforme,* 35. *Cosmarium maculatum,* 36. *Cosmarium hammeri,* 37. *Cosmarium miscellium,* 38. *Cosmarium blyttii,* 39. *Cosmarium connatum,* 40. *Cosmarium nitidulum,* 41. *Cosmarium trilobulatum,* 42. *Cosmarium angulosum* var. *Conicinum,* 43 *Euastrum spinulosum*, 44. *Staurastrum recurvatum,* 45. *Spondylosium nitens,* 46. *Mesotaenium chlamydosporum,* 47. *Spirogyra submaxima,* 48. *Spirogyra hymerae.*

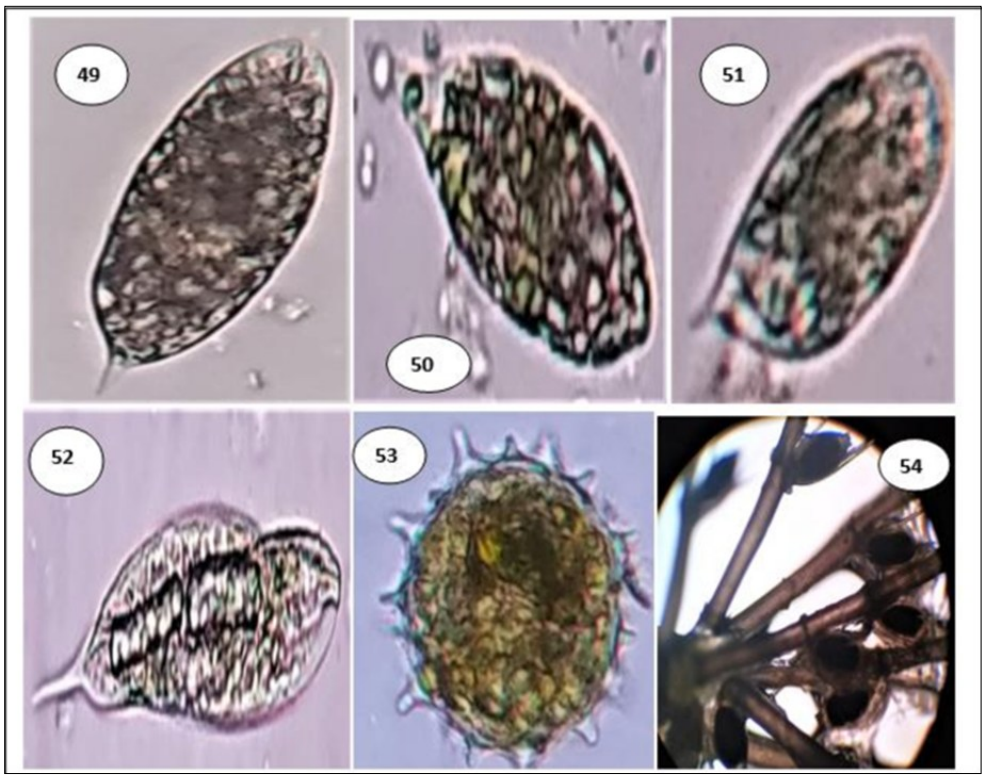


Fig. 49 - 54. Plate 5. Euglenophyceae and Charophyceae members. 49. *Euglena sociabilis,* 50. *Euglena pisciformis,* 51. *Eugleniformis proxima,* 52. *Euglena caudate,* 53. *Trachelomonas spectabilis,* 54. *Nitella tenuissima.*

Discussion

The study provides a comprehensive assessment of phytoplankton diversity in two freshwater lakes Ranikere and Dodderikere by categorizing algae based on relative dominance, frequency and ecological indicators. The observed variations in phytoplankton composition and abundance between the two lakes offer valuable insights into their ecological health, trophic status and environmental quality. The phytoplankton diversity patterns observed in Ranikere and Dodderikere lakes offer a bio-indicative lens into their ecological functioning and water quality. While Ranikere demonstrates healthier and more stable ecological conditions, Dodderikere presents signs of organic enrichment and possible pollution.

Phytoplankton diversity directly influences aquatic food webs, nutrient cycling and oxygen dynamics. The dominance of Bacillariophyceae and Chlorophyceae in Ranikere suggests:

- Efficient primary productivity
- Balanced autotrophic-heterotrophic interactions
- Potential for higher trophic support (zooplankton, fish)

In contrast, Dodderikere's phytoplankton profile implies:

- Elevated biochemical oxygen demand (BOD)
- Risk of algal blooms under nutrient influx
- Reduced resilience to environmental fluctuations

This taxonomic distribution aligns with global limnological patterns where diatoms dominate in stable, oxygen-rich waters, while Euglenoids and Cyanobacteria proliferate under nutrient stress or organic loading". give a reference for the discussion of this statement (45). Further studies involving physicochemical profiling, seasonal variation analysis and long-term monitoring are essential to formulate sustainable management plans.

Conclusion

The current study reveals that 6 major classes *viz*., Bacillariophyceae, Zygnematophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceaeand Charophyceae recorded in both the study areas. Occurrence of Brown algae is relatively high than Green & Blue green algae. The members of Charophyceae are present only in Ranikere. The algal diversity data reflect distinct ecological conditions in the two lakes. Ranikere appears to be more oligotrophic or mesotrophic, supporting a rich flora of green algae and desmids, while Dodderikere seems to lean towards mesotrophic to slightly eutrophic, favouring diatoms and Euglenoids. Both lakes support a broad spectrum of algae, contributing to the overall biodiversity and indicating varied ecological niches within each water body.

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Authors' contributions

JMP prepared the original draft, methodology and software. Supervision, editing and review were done by SGM. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: No conflict of interest

Ethical issues: None

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