

Seasonal variations in phytoplankton community of Manyas Reservoir (Balıkesir, Turkey) in relation to certain physical and chemical variables

by

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DOI: <https://doi.org/10.26881/oahs-2026.1.05>

Category: **Original research papers**

Received: **November 19, 2025**

Accepted: **February 03, 2026**

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Abstract

This study investigates the seasonal shifts in phytoplankton communities in the Manyas Reservoir (Balıkesir, Turkey) and their relationships with key physicochemical variables. A total of 59 taxa belonging to Heterokontophyta, Chlorophyta, Cyanobacteria, Euglenozoa, Charophyta and Miozoa were identified. The dominant species were *Cyclotella meneghiniana*, *Fragilaria capucina*, *Nitzschia lorenziana*, *Navicula radiosa* and *Ulnaria acus* from Heterokontophyta; *Desmodesmus communis*, *Desmodesmus protuberans* and *Pediastrum simplex* from Chlorophyta; and *Trachelomonas volvocina* from Euglenozoa. The analysis of the data clearly showed that electrical conductivity (EC), dissolved oxygen (DO), nitrate-nitrogen, total nitrogen (TN) and pH significantly shaped phytoplankton species distributions. The findings highlight the importance of hydrodynamics driving diatom dominance in turbulent zones contrary to the previous studies showing that high flow rates cause low diversity and abundance of phytoplankton in turbulent waters.

Key words: CCA, cosmopolitan species, Heterokontophyta, Manyas Reservoir, phytoplankton

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1. Introduction

Reservoirs differ fundamentally from natural lakes in hydrological characteristics, including retention time, mixing regimes and water-level fluctuations (Threlkeld, 1990). These hydrodynamic drivers strongly influence plankton community dynamics (Tundisi et al., 2008; Wang et al., 2024).

It is critical to understand how lakes and reservoirs have responded to human-induced environmental alterations and climate change in order to realistically manage them. Phytoplankton is commonly studied at a global scale for assessing the magnitude of ecosystem changes due to their sensitivity to lake surface temperatures (Fang et al., 2022; Sharma et al., 2015).

Phytoplankton is the major primary producer in freshwaters and plays a critical role in determining the changes in biodiversity and productivity of aquatic life (Long et al., 2020). The changes in phytoplankton community structure directly affect the water quality, energy flow, nutrient cycling and biological resources' availability in the upper trophic levels (Rimet et al., 2018).

Knowledge of the seasonal dynamics of phytoplankton community provides further understanding of ecological interactions in aquatic ecosystems. Therefore, the seasonal dynamics of phytoplankton have been deeply investigated worldwide (Feng et al., 2021; Mishra et al., 2019; Nikolenko & Fedonenko, 2021; Qu et al., 2024; Wang et al., 2025).

The European Parliament included phytoplankton as a biological element for the assessment of ecological status of surface waters in the water framework (Poniewozik & Lenard, 2022; Tekebayeva et al., 2024). Therefore, it is important to understand the linkage between changes in environmental conditions and phytoplankton community dynamics.

In temperate lakes, phytoplankton community dynamics are mostly driven by seasonal variations in physical and chemical environmental factors (Evans et al., 2024). Extreme droughts in recent years, with higher evaporation in summer, may result in reduced water levels and enhanced eutrophication of water bodies, especially in the Mediterranean region (Ouballouk et al., 2025).

The only study that has been conducted on Manyas Reservoir (Balıkesir, Turkey) so far is by Çelik and Giritlioğlu (2017), dealing with the seasonal dynamics of zooplankton and their relationships with certain physical and chemical parameters. Therefore, this is the first study aiming to determine the phytoplankton community dynamics of the reservoir in relation to certain physical and chemical variables using multivariate statistical techniques.

Previous studies dealing with phytoplankton and climate change have often been limited to several

well-studied lakes in Europe and North America. In this work, we studied phytoplankton community structure of a Manyas Reservoir to determine how it is affected by human impacts as this reservoir is an important water resource for irrigation, flood control and hydropower production. The dataset should help researchers compare the details from the other parts of the world.

2. Materials and methods

Manyas Reservoir is located 18.5 km southwest of the Manyas district in Balıkesir, Turkey. It was built on Kocaçay Stream by the State Hydraulic Works in 2009 for irrigation, flood control and hydropower production. The reservoir has a surface area of 16.8 km² and an average depth of 25 m (General Directorate of State Hydraulic Works, 2025).

Sampling occurred seasonally at three ecologically distinct stations. The first station was set where the Kocaçay Stream enters the reservoir (39.9505441 N, 27.720446 E), the second station at the transition zone where the stream largely loses its influence (39.950462 N, 27.752052 E) and the third station at the deepest part of the reservoir (39.978354 N, 27.778851 E) near the dam (Fig. 1).

Electrical conductivity (EC, $\mu\text{s} \cdot \text{cm}^{-1}$), pH, dissolved oxygen (DO, $\text{mg} \cdot \text{L}^{-1}$) and water temperature (T, °C) were measured *in situ* at 5-m intervals from the surface to the bottom using a *Yellow Spring Instruments* (YSI) multi-probe. Water transparency was measured using a Secchi disk (SD). Total suspended solids (TSS, $\text{mg} \cdot \text{L}^{-1}$), nitrate-nitrogen ($\text{NO}_3\text{-N}$, $\text{mg} \cdot \text{L}^{-1}$), total nitrogen (TN, $\text{mg} \cdot \text{L}^{-1}$) and total phosphorus (TP, $\text{mg} \cdot \text{L}^{-1}$) concentrations were determined on water drawn from the surface, middle and bottom of each station.

TSS ($\text{mg} \cdot \text{L}^{-1}$) were determined by filtering a known volume of water through Merck Whatman 934-AH filters that were pre-rinsed, dried and tared (105°C) (APHA, 1995). $\text{NO}_3\text{-N}$ ($\text{mg} \cdot \text{L}^{-1}$) was determined spectrophotometrically on filtered water. TP ($\text{mg} \cdot \text{L}^{-1}$) was determined from nonfiltered water as orthophosphate after persulfate-acid hydrolysis at 135°C for 2 hr. TN ($\text{mg} \cdot \text{L}^{-1}$) was determined from water samples after digestion by the Kjeldahl method (APHA, 1995).

All physicochemical measurements were standardized to ensure methodological clarity using the formula for z-score standardization, $z = (x - \mu)/\sigma$, where z is the standardized value, x is the original data point, μ is the mean of the data and σ is the standard deviation of the data. pH and $\text{NO}_3\text{-N}$ values were corrected to realistic ecological ranges.

Phytoplankton samples were taken at 30 cm below the surface, in middle and at the bottom of each



Figure 1

Map of Manyas Reservoir and the locations of sampling stations.

station using a Kemmerer water Sampler. Samples were fixed with Lugol's solution and poured into 250 mL dark bottles. In the laboratory, the samples were first shaken, then placed into 50 mL graduated tubes to settle for 24 hr, then the upper 45 mL of water was aspirated and then the remaining 5 mL was placed into a small bottle for microscopic analysis. Enumeration and identification of phytoplankton were performed using an Olympus compound microscope equipped with a phase-contrast attachment and water immersion lenses (40× and 60× magnifications).

Phytoplankton species were identified and enumerated along horizontal transects across a Palmer–Maloney cell using the microscope's moving stage control (Palmer & Maloney, 1954). Using a pipette, 0.1 mL of the subsample was taken and placed in the counting cell. Prior to enumerations, the subsample was scanned to determine the approximate number of transects needed to enumerate 100 cells. A random starting place in the upper left-hand quadrant was selected for a pattern that allows for an equal probability of landing in any area of the chamber.

Species that made >10% of the total number of individuals in each sample were considered dominant (Okhapkin et al., 2022). The trophic status of the

reservoir (TSI) was calculated using the SD-based formula (Carlson, 1977), $TSI(SD) = 60 - 14.41 \times \ln(SD)$.

Phytoplankton identification followed internationally accepted taxonomic keys (Anagnostidis & Komárek, 1988; Bourrelly, 1966; Huber–Pestalozzi, 1971; Krammer & Lange-Bertalot, 1986; John et al., 2002; Komárek & Anagnostidis, 2005; Komárek et al., 1983; Round et al., 2009; Sims, 1996).

Canonical correspondence analysis (CCA) and one-way Analysis of Variance (ANOVA) were used to evaluate environmental–biological relationships (SPSS, 2022; Ter Braak & Verdonschot, 1995) using CANOCO from Microcomputer Power and SPSS from IBM computer programs. CCA measures the strength of association between environmental variables and species. In the resulting ordination diagram, environmental variables are represented by arrows along with the species.

Prior to the application of CCA, detrended correspondence analysis (DCA) was run on the data and the gradient lengths for the first two axes were >4, justifying the use of unimodal CCA. The Monte Carlo permutation test (999 unrestricted permutations) with the forward selection was used to test the variables that had significant effects on the distribution of dominant phytoplankton species (ter Braak & Verdonschot, 1995).



3. Results

The maximum, minimum, mean and standard deviation of the standardized values of water temperature ($^{\circ}\text{C}$), DO ($\text{mg} \cdot \text{L}^{-1}$), EC ($\mu\text{s} \cdot \text{cm}^{-1}$), pH, TSS ($\text{mg} \cdot \text{L}^{-1}$), SD depth (m), TP ($\text{mg} \cdot \text{L}^{-1}$), nitrate-nitrogen ($\text{mg} \cdot \text{L}^{-1}$) and TN ($\text{mg} \cdot \text{L}^{-1}$) are shown in Table 1. The values of pH, $\text{NO}_3\text{-N}$ and TP were corrected to realistic ecological ranges (pH, 8.2–9.5; $\text{NO}_3\text{-N}$, 0.20–1.15 $\text{mg} \cdot \text{L}^{-1}$; TP, 0.22–0.41 $\text{mg} \cdot \text{L}^{-1}$). The dataset indicates environmentally plausible seasonal and spatial variability.

The results of ANOVA test run on the standardized values of physical and chemical variables (Table 2) showed that DO ($F = 8.34$ and $p = 0.01$), TSS ($F = 3.2$ and $p = 0.05$) and TP ($F = 4$ and $p = 0.04$) were significantly different between the stations. T ($F = 18$ and $p = 0.01$), EC ($F = 7.5$ and $p = 0.01$), SD ($F = 4.4$ and $p = 0.02$) and $\text{NO}_3\text{-N}$ ($F = 4.47$ and $p = 0.02$) were significantly different between the seasons. The average of SD-based trophic state index (53) showed that the reservoir was mesotrophic.

A total of 59 phytoplankton species were identified: 31 from Heterokontophyta, 16 from Chlorophyta, 6 from Cyanobacteria, 3 from Euglenozoa, 2 from Charophyta and 1 from Miozoa (Table 3). Diatoms dominated the community, particularly at the river–reservoir interface.

In winter 2015, seventeen phytoplankton species were identified; *Desmodesmus communis* (E. Hegewald) E. Hegewald from Chlorophyta was the dominant species. In spring 2016, twenty-three species were identified; *Fragilaria capucina* Desmazières, *Navicula*

Table 1

The standardized values of water temperature (T, $^{\circ}\text{C}$), (DO, $\text{mg} \cdot \text{L}^{-1}$), (EC, $\mu\text{s} \cdot \text{cm}^{-1}$), pH, (TSS, $\text{mg} \cdot \text{L}^{-1}$), (SD, m), (TP, $\text{mg} \cdot \text{L}^{-1}$) nitrate-nitrogen ($\text{NO}_3\text{-N}$, $\text{mg} \cdot \text{L}^{-1}$) and (TN, $\text{mg} \cdot \text{L}^{-1}$). The pH and $\text{NO}_3\text{-N}$ values are corrected to realistic ecological ranges.

Variable	Maximum	Minimum	Mean	Std. Dev.
T	20.42	6.43	81.82	5.59
pH	9.5	8.2	8.5	0.65
EC	312	126	228.80	77.99
SD	2.04	0.44	1.26	0.51
DO	8.34	1.33	4.98	2.35
TSS	2.3	1.80	1.27	0.52
$\text{NO}_3\text{-N}$	1.15	0.20	0.675	0.47
TN	2.69	1.612	1.69	0.43
TP	0.22	0.41	0.33	0.05

DO, dissolved oxygen; EC, electrical conductivity; SD, Secchi disk; TN, total nitrogen; TP, total phosphorus; TSS, total suspended solids.

Table 2

The results of ANOVA test run on the standardized values of water temperature (T, $^{\circ}\text{C}$), (DO, $\text{mg} \cdot \text{L}^{-1}$), (EC, $\mu\text{s} \cdot \text{cm}^{-1}$), pH, (TSS, $\text{mg} \cdot \text{L}^{-1}$), (SD, m), (TP, $\text{mg} \cdot \text{L}^{-1}$) nitrate-nitrogen ($\text{NO}_3\text{-N}$, $\text{mg} \cdot \text{L}^{-1}$) and (TN, $\text{mg} \cdot \text{L}^{-1}$).

Comparisons between the stations					
Parameter	Sum of squares	df	Mean square	F	Sig. (p)
T	3.6	2	1.8	0.01	0.99
DO	56.4	2	28.2	8.34	0.01
EC	13.3	2	63.6	0.99	0.39
pH	5.95	2	2.97	0.93	0.41
TSS	870	2	435	3.2	0.05
SD	213	2	106	4.9	0.02
TP	0.02	2	0.01	4.00	0.04
$\text{NO}_3\text{-N}$	0.94	2	0.45	0.04	0.96
TN	0.74	2	0.37	1.52	0.25
Comparisons between the seasons					
Parameter	Sum of squares	df	Mean square	F	Sig. (p)
T	263	3	87	18	0.01
DO	0.3	3	0.08	0.01	0.99
EC	718	3	239	7.5	0.01
pH	6.3	3	2.0	0.7	0.05
TSS	323	3	107	0.8	0.50
SD	2.2	3	0.7	4.4	0.02
TP	0.01	3	0.01	0.9	0.47
$\text{NO}_3\text{-N}$	93	3	31	4.47	0.02
TN	0.75	3	0.25	0.97	0.43

DO, dissolved oxygen; EC, electrical conductivity; SD, Secchi disk; TN, total nitrogen; TP, total phosphorus; TSS, total suspended solids.

Table 3

The list of phytoplankton species identified in Manyas Reservoir.

Heterokontophyta
<i>Anomoeoneis sphaerophora</i> Pfitzer
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen
<i>Cyclotella meneghiniana</i> Kützing
<i>Diatoma tenuis</i> C. Agardh
<i>Diatoma vulgare</i> Bory
<i>Fragilaria capucina</i> Desmazières
<i>Fragilaria crotonensis</i> Kitton
<i>Gomphonema caperatum</i> Ponader & Potapova
<i>Gyrosigma attenuatum</i> (Kützing) Rabenhorst
<i>Luticola ventricosa</i> (Kützing) D. G. Mann

(Continued)

Table 3: Continued.

Heterokontophyta
<i>Melosira varians</i> C. Agardh
<i>Meridion circulare</i> (Greville) C. Agardh
<i>Navicula radiosa</i> Kützing
<i>Navicula trivialis</i> Lange-Bertalot
<i>Nitzschia amphibia</i> Grunow
<i>Nitzschia gracilis</i> Hantzsch.
<i>Nitzschia hamburgiensis</i> Lange-Bertalot
<i>Nitzschia lorenziana</i> Grunow
<i>Nitzschia sigmaidea</i> (Nitzsch) W. Smith
<i>Nitzschia thermalis</i> (Ehrenberg) Auerswald
<i>Pinnularia abaujensis</i> var. <i>linearis</i> (Hustedt) R. M. Patrick
<i>Pinnularia biceps</i> W. Gregory
<i>Pinnularia polyonca</i> (Brébisson) W. Smith
<i>Stephanodiscus niagarae</i> Ehrenberg
<i>Stephanodiscus reimeri</i> Theriot & Stoermer
<i>Stephanodiscus rotula</i> (Kützing) Hendey
<i>Tetracyclus rupestris</i> (Kützing) Grunow
<i>Thalassiosira angustelineata</i> (A.W. F. Schmidt) G. Fryxell & Hasle
<i>Trinacria ventricosa</i> Grove & Sturt
<i>Ulnaria acus</i> Kützing
<i>Ulnaria ulna</i> (Nitzsch) Ehrenberg
Chlorophyta
<i>Actinastrum hantzschii</i> Lagerheim
<i>Coelastrum proboscideum</i> Bohlin
<i>Comasiella arcuata</i> (Lemm.) E. Hegewald, M. Wolf, Al. Keller, Friedl & Krienitz
<i>Cymbella suburgidula</i> Krammer
<i>Desmodesmus abundans</i> (Kirchner) E. Hegewald
<i>Desmodesmus communis</i> (E. Hegewald) E. Hegewald
<i>Desmodesmus insignis</i> (West & G. S. West) E. Hegewald
<i>Desmodesmus protuberans</i> (F. E. Fritsch & M. F. Rich) E. Hegewald
<i>Dictyosphaerium ehrenbergianum</i> Nägeli
<i>Pediastrum boryanum</i> (Turpin) Meneghini
<i>Pediastrum simplex</i> Meyen
<i>Scenedesmus acuminatus</i> (Lagerheim) Chodat
<i>Scenedesmus ecornis</i> (Ehrenberg) Chodat
<i>Sphaerocystis schroeteri</i> Chodat
<i>Tetraëdron caudatum</i> (Corda) Hansgirg
<i>Tetraëdron minimum</i> (A. Braun) Hansgirg
Cyanobacteria
<i>Aphanizomenon flos-aquae</i> var. <i>klebahnii</i> Elenkin
<i>Chroococcus turgidus</i> (Kützing) Nägeli
<i>Leptolyngbya boryana</i> (Gomont) Anagnostidis & Komárek

(Continued)

Table 3: Continued.

Cyanobacteria
<i>Merismopedia elegans</i> A. Braun ex Kützing
<i>Oscillatoria limosa</i> C. Agardh ex Gomont
<i>Oscillatoria tenuis</i> C. Agardh ex Gomont
Euglenozoa
<i>Trachelomonas armata</i> (Ehrenberg) F. Stein
<i>Trachelomonas gracilis</i> (Playfair) Deflandre
<i>Trachelomonas volvocina</i> (Ehrenberg) Ehrenberg
Charophyta
<i>Mougeotia ventricosa</i> (Wittrock) Collins
<i>Staurastrum crenulatum</i> var. <i>britannicum</i> E. Messikommer
Miozoa
<i>Ceratium hirundinella</i> (O. F. Müller) Dujardin

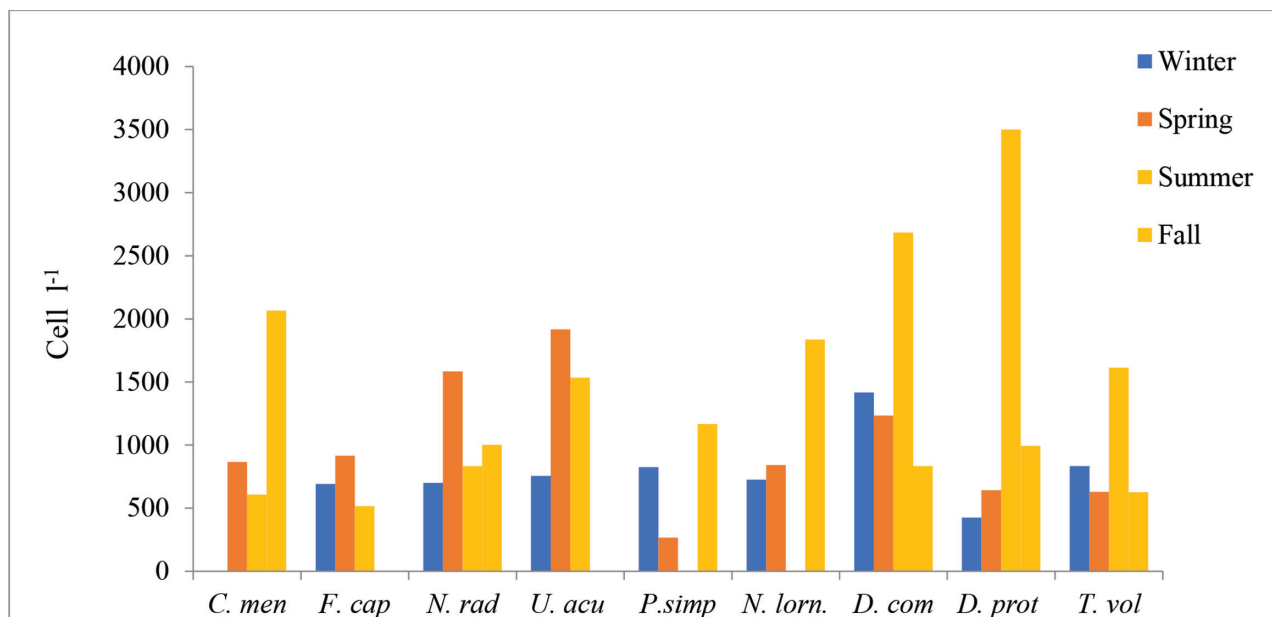
radiosa Kützing and *Ulnaria acus* Kützing from Heterokontophyta were dominant species. In summer 2016, forty-six phytoplankton species were identified; *D. communis*, *Desmodesmus protuberans* (F. E. Fritsch & M. F. Rich) E. Hegewald from Chlorophyta; *Cyclotella meneghiniana* Kützing, *U. acus* from Heterokontophyta and *Trachelomonas volvocina* (Ehrenberg) Ehrenberg from Euglenozoa were dominant species. In fall 2016, thirty-one species were identified; *C. meneghiniana* and *Nitzschia lorenziana* Grunow from Heterokontophyta and *Pediastrum simplex* Meyen from Chlorophyta were dominant species (Fig. 2).

The first two axes of CCA explained 84.1% of the cumulative variance in environmental factors and dominant species relationships (Table 4). CCA results confirm significant correlations between TN, NO₃-N, EC, DO and dominant taxa. In CCA diagram, *N. radiosa* was closely related to NO₃-N, *D. communis* to T, *T. volvocina* to DO and *D. protuberans* to TP. The rest of the dominant species (*F. capucina*, *N. lorenziana*, *U. acus* and *P. simplex*) were not associated with any measured physical or chemical variables (Fig. 3).

4. Discussion

The ANOVA results showed that DO, TP and TSS were significantly different among the stations, while T, EC, SD, pH and NO₃-N values showed significant seasonal differences. The better oxygenation of the first and the second stations than the deepest third station was a probable cause of the difference in DO concentrations. The sediments in the deep third station have longer-lasting anaerobic conditions in the hypolimnion, which probably cause the internal loading of TP from sediments and this probably



**Figure 2**

The seasonal distribution of the dominant phytoplankton species (abbreviations: *N. rad*: *Navicula radiosa*; *P. simp*: *Pediastrum simplex*; *D. com*: *Desmodesmus communis*; *D. prot*: *Desmodesmus protuberans*; *N. lorn.*: *Nitzschia lorenziana*; *T. vol*: *Trachelomonas volvocina*; *F. cap*: *Fragilaria capucina*; *C. men*: *Cyclotella meneghiniana* and *U. acu*: *Ulnaria acus*).

Table 4

Summary statistics for CCA run on the standardized values of physicochemical measurements.

Axes	1	2	3	4	Total inertia
Eigenvalues	0.13	0.03	0.02	0.01	0.28
Species–environment correlations	0.88	0.84	0.89	0.74	
Cumulative percent variation in species data	48.3	59.1	65.1	67.9	
Cumulative percent variation in species–environment relationships	68.8	84.1	92.6	96.6	
Sum of all eigenvalues					0.64
Sum of all canonical eigenvalues					0.47

CCA, canonical correspondence analysis.

results in the spatial variability in DO and TP levels (Kowalczywska-Madura et al., 2015).

The TSS were higher at the first station than the others. The high suspended solids at the first station are primarily due to their location since this station is the entrance point of the feeding stream to the reservoir. Suspended solids are regulated by water flow causing erosion and resuspension of sediments (Effler & Matthews, 2004).

T, EC, SD, pH and NO₃-N showed significant seasonal differences in the reservoir. The fluctuating water temperatures have a significant impact on phytoplankton, affecting metabolic rates, oxygen levels and species distribution (Hao et al., 2024). The reservoir had high pH values in spring and summer.

Ma et al. (2025) state that conspicuous phytoplankton development during spring and summer in lakes results in high photosynthetic rates and a consequent high pH.

The TN concentration is inversely proportional to pH in lakes. When pH is high in the water column, denitrification would be hindered at the water–sediment interface, resulting in the accumulation of TN in the overlying water. When pH is low, there is a large amount of H⁺ in the water, and H⁺ competes with the exchangeable nitrogen ions such as NH₄-N and NO₃-N adsorbed in the sediment, forcing the nitrogen in the sediment to be released into the overlying water. On the other hand, at high pH, it is difficult for the sediments to release nitrogen (Zhu et al., 2022).

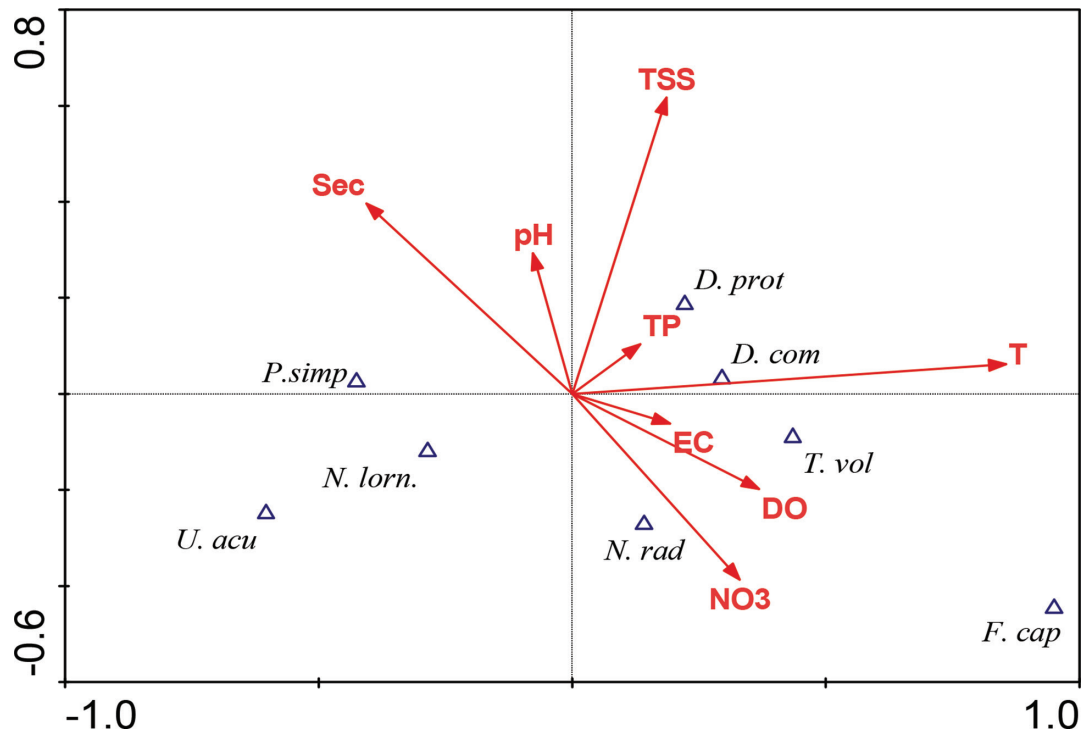


Figure 3

The CCA diagram (abbreviations: *P. simp*: *Pediastrum simplex*; *D. com*: *Desmodesmus communis*; *D. prot*: *Desmodesmus protuberans*; *N. lorn*: *Nitzschia lorenziana*; *T. vol*: *Trachelomonas volvocina*; *F. cap*: *Fragilaria capucina* and *U. acu*: *Ulnaria acus*). CCA, canonical correspondence analysis; EC, electrical conductivity; DO, dissolved oxygen; TP, total phosphorus; TSS, total suspended solids.

EC values were high in spring probably due to agricultural runoff from the surrounding land. Musungu et al. (2023) identified a correlation between high EC values and runoff from commercial agriculture, particularly during the wet season in Lake Victoria.

The significant seasonal variations in SD transparency in Manyas Reservoir was probably a result of higher phytoplankton abundance in spring and summer. Song et al. (2024) noticed that phytoplankton biomass was highly negatively correlated with SD in a tropical reservoir in China. They stated that high water temperature caused high algal abundance resulting in a decrease in the transparency of the reservoir.

In Manyas Reservoir, Heterokontophyta made up 54.3% of the total number of species, dominating the phytoplankton community during the study. *C. meneghiniana*, *F. capucina*, *N. lorenziana*, *N. radiosa* and *U. acus* were the dominant diatom species. Algological studies on Turkish freshwaters have shown that Heterokontophyta is usually the dominant group in this region (Solak et al., 2012).

Diatoms were most abundant at the first station, where the Kocaçay Stream enters the reservoir. The

inflow of Kocaçay Stream at the first station causes high turbulence, promoting fast-growing taxa, such as diatoms, and disadvantaging organisms that require stable water columns for growth, including colonial cyanobacteria (Stockwell et al., 2020).

The silica-made cell wall of diatoms confers them a certain degree of resistance to the shear stress induced by turbulence (Liu et al., 2024). Different cell morphology of algae is the key factor influencing the different shear thresholds. Additionally, turbulence could impact light and nutrient availability. Thus, diatoms might have been favored by turbulence, as it reduces the sinking rate at the turbulent first station where the feeding stream enters the reservoir.

Çelik and Sevindik (2015) identified 192 phytoplankton taxa in the Çaygören Reservoir, Turkey, which is located in the same basin as Manyas Reservoir. In that study, Heterokontophyta was also a dominant group. A study on Kocaçay Stream (Çelik, 2022) showed that Heterokontophyta was the dominant phytoplankton group, and the other groups had fewer species compared with those observed in the present study. The reason for the fewer species found



in that study was probably because only the Kocaçay Stream was sampled, whereas in the present study, both the Kocaçay Stream and the Manyas Reservoir were sampled. Additionally, high rates of water flow in Kocaçay Stream might have caused low diversity and abundance of phytoplankton as they might have been drifted away (Li et al., 2013).

N. radiosa, *D. communis* and *T. Volvocina* were dominant species in Manyas Reservoir and they were also observed as dominant in Kocaçay Stream (Çelik, 2022). This suggests that Kocaçay Stream may not only be the source of water but also be a source of planktonic organisms to the reservoir. A notable difference between the two studies is the number of Cyanobacteria. Çelik (2022) reported only one species of Cyanobacteria, *Oscillatoria tenuis* C. Agardh ex Gomont, whereas in this study, six Cyanobacteria species were identified. This was probably due to the high flow and turbulence in the Kocaçay Stream. In running waters, most Cyanobacteria fail to grow at high flow rates (Mitrovic et al., 2011).

Zünbülçil Ünsal (2024) studied the planktonic and benthic diatom community structure of the Kocaçay Delta between 2018 and 2019 and identified 357 taxa. The number of taxa that were identified in that study was about six times higher than those in our findings. This was probably because that study covered more habitat types (floodplain forest, lagoons and streams).

CCA showed that *F. capucina* was closely related to TN. This species is commonly collected in Turkish lakes (Koçer et al., 2012). Gregersen and Simon (2022) observed that *F. capucina* positively responded to increasing TN levels in a nutrient enrichment study. In Manyas Reservoir, this species was abundant at the first station (the riverine zone), which is usually turbulent, and nutrients are brought up from the sediment by resuspension.

CCA placed *N. radiosa* near the pH vector. This species was dominant in spring when the pH was high in the reservoir. Kılınç and Sivacı (2001) reported that *N. radiosa* was a common member of diatom flora of the alkaline Hafik and Tödürge lakes in northeastern Turkey. Han et al. (2023) also found that *N. radiosa* was abundant in moderately alkaline lakes in Northeastern China.

CCA placed *T. volvocina* near the NO₃-N vector. This species is widespread in lakes and reservoirs in Turkey (Öterler, 2013). *T. volvocina* is a typical indicator of medium to high levels of organic matter, and it is usually associated with high nitrogen levels (Balzer et al., 2023). The high nitrogen concentrations from runoff of farmlands might have stimulated the growth of this euglenoid in Manyas Reservoir.

CCA showed that *D. communis* was closely related to EC. Ersanlı and Gönülol (2003) stated that *D. communis* was a common member of the phytoplankton of Lake Simenit, Turkey, which has high EC. The other dominant diatom species *C. meneghiniana*, *N. lorenziana*, *D. protuberans* and *P. simplex* did not show any specific association with any measured physical or chemical variables. These species are typically cosmopolitan and widely distributed in inland waters of all continents (Klimaszky et al., 2022).

High pH values in the reservoir probably favored *C. meneghiniana*, which dominated phytoplankton. According to Vidaković et al. (2024), *C. meneghiniana* is an alkalophilic diatom that thrives well at high pH levels.

In conclusion, environmental gradients in Manyas Reservoir strongly regulated phytoplankton community structure, particularly favoring cosmopolitan diatom species in turbulent inflow regions. T, EC, TN, NO₃-N, DO and pH played a significant role in driving the seasonal distribution of dominant phytoplankton species in the reservoir. The interpretation of the dataset shows the ecological reliability and scientific value of this study. Finally, due to the importance of the Manyas Reservoir as a water resource for irrigation, flood control and hydropower production, monitoring and management of the reservoir in the future is recommended.

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