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Planktonic Diatoms of Atatürk Dam Lake (Adıyaman, Türkiye): A Study of Diversity and Ecological Patterns

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ABSTRACT: This study investigated the planktonic algae community and its relationship with key physical and chemical parameters in Atatürk Dam Lake, located in Adıyaman province, between March and November 2020. Planktonic diatoms are an essential component of freshwater ecosystems, playing a crucial role in primary production and nutrient cycling. A total of 19 taxa of planktonic diatoms were identified during the research period. The diatoms exhibited their highest growth during the summer months, coinciding with increased light availability and higher water temperatures, with the highest surface water temperature recorded as 25°C in August. The dissolved oxygen levels were highest in March (8.9 mg/L) and lowest in the summer months, with a direct inverse relationship between temperature and dissolved oxygen concentration. Among the identified diatom genera, Cymbella (4 taxa), Gomphonema, Nitzschia (3 taxa), and Navicula and Surirella (2 taxa each) were the most diverse and abundant in terms of frequency of occurrence and population size within the planktonic diatom community. These findings underscore the seasonal dynamics of planktonic diatoms and their significant role in the ecosystem of Atatürk Dam Lake. This study adds valuable information to the understanding of the lake's algal flora and its potential for future ecological monitoring.

Keywords: Planktonic, Diatom, Atatürk Dam Lake, Adıyaman-Türkiye.

INTRODUCTION

Water plays a critical role in the biological processes of organisms and constitutes essential biological systems in seas, lakes, and other aquatic environments. As such, understanding the physical, chemical, and biological properties of water resources is vital, as they support key human activities such as domestic use, industrial applications, and agriculture (Cirik and Cirik, 2005). Aquatic environments, which are rich in biological diversity, also serve as gene pools, making significant contributions to global biodiversity. Consequently, these ecosystems have been the focus of human research since ancient times and will remain a subject of interest for the foreseeable future.

Most of the world's freshwater reserves are found in shallow lakes, which are more productive and accessible than deep lakes. These shallow bodies of water support dominant littoral communities and are vital to ecological health (Moss, 1998). In addition to natural lakes, human-made dam lakes and reservoirs form unique ecosystems with distinct characteristics. Dam lakes are created when embankments are constructed across streams to capture water for various human needs, including drinking, energy production, flood control, and irrigation. Although dam lakes share the same basic structure as natural lakes, they differ significantly due to human interventions, such as water management, construction, and regulation of water levels. These factors introduce unique dynamics in the physical, chemical, and biological properties of the ecosystem (Sezen, 2008).

Dam lakes, due to their variability in physical and chemical properties, often experience faster changes in algal populations compared to natural lakes (Wehr and Sheath, 2003). Seasonal variations in algae species, their distribution, and density offer valuable insights into the trophic state of these environments, just as they do in natural lakes. Long-term trends in algal dynamics are ecologically significant, highlighting shifts in nutrient cycling and environmental health (Baykal and Yıldız, 2006). Moreover, the human-induced alterations in dam lakes further distinguish them from their natural counterparts, making them particularly important for research.

Globally, 48% of dam lakes are used for irrigation, 20% for energy production, and the remainder serve urban, industrial, or recreational purposes (ICOLD, 1998). The number of dams has surged in the past several decades, from 5,000 in the 1950s to

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over 800,000 today (ICSU-SCOPE, 1972; Naiman and Decamps, 1990; Tundisi, 1993). In Turkey, there are 706 dams, excluding natural lakes, with Atatürk Dam Lake being a key area of interest for this study. The lake covers an area of 817 km² (DSİ, 2014).

The diversity and composition of algae in aquatic ecosystems offer valuable information regarding environmental health and productivity. Algal species, particularly those that serve as pollution indicators, can help assess the degree of environmental contamination and eutrophication. Consequently, examining the planktonic algae in Atatürk Dam Lake and understanding their relationships with the surrounding environment is essential for evaluating the ecological status of the lake.

This research aims to characterize the planktonic algal flora of Atatürk Dam Lake, track the seasonal variations in algal populations, and assess the physical and chemical factors that influence these changes. Additionally, the study seeks to contribute to the broader understanding of water quality by examining the diatom composition, an essential component in determining the biological health of the lake.

MATERIALS AND METHODS

Atatürk Dam is located on the Euphrates River, straddling the borders of Adıyaman and Şanlıurfa provinces in Turkey. It serves dual purposes for energy generation and irrigation (URL, 1). The dam, part of the Southeastern Anatolia Project (GAP), is situated 180 meters downstream from Karakaya Dam. It is approximately 51 km from Adıyaman province and 24 km from Bozova district in Şanlıurfa province.

Construction of Atatürk Dam began on November 4, 1983, and it became operational in 1994. The dam is equipped with eight turbines and reaches a height of 169 meters. It is a rock-filled dam, built primarily for irrigation and energy production. With an 84.4 million cubic meters fill volume of rock and earth, Atatürk Dam ranks fifth globally in terms of fill volume. The resulting lake area spans 817 km² (Figure 1).

During the study, surface water temperature, pH, and dissolved oxygen levels were measured directly in the field using portable water quality measurement devices. Planktonic sampling commenced in March 2020 and continued monthly for nine months, concluding in November 2020. Pre-sterilized wide-mouthed glass jars with lids were used to collect the planktonic samples. To concentrate the plankton, the centrifugation method was employed, as planktonic organisms are generally present in low densities in large volumes of water. Despite the concentration efforts, obtaining quantitatively reliable data was challenging. As a result, planktonic algae densities were expressed as relative density percentages, similar to benthic algae quantification.

Permanent preparations of the planktonic samples were made following the method described by Round (1953). Species identification and counting of diatoms in the permanent preparations were conducted using a Nikon microscope. The relative density method was used for counting, with the results expressed as "organism%."

Relative density (Rd) = NA/N x 100

NA = Total number of A species individuals

N = Number of all species individuals (Kocataş, 1999).

Water pH and temperature were measured using a portable ORION 3 STAR pH meter, and dissolved oxygen was measured using a portable YSI 55 DO digital oxygen meter in the field.

To ensure accurate diatom identification and enable long-term observation, permanent preparations were made from the planktonic samples. Identification followed taxonomic references, including Prescott (1951), Bourelly (1968, 1972), Patrick and Reimer (1966, 1975), Germain (1981), Grimes and Rushforth (1982), and Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b).

Figure 1. *A view from Atatürk Dam Lake (Adıyaman) sampling area (URL.1).*

RESULTS AND DISCUSSION

Water Temperature

The water temperature values recorded during the study in Atatürk Dam Lake are shown in Table 1. The temperature ranged from a minimum of 19.0°C in March to a maximum of 25.0°C in August. The temperature generally increased in parallel with air temperature throughout the study period.

Table 1. *Temperature (°C) values recorded in Atatürk Dam Lake*

Parameters	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Temperature (°C)	19.0	19.8	19.8	21.0	23.0	25.0	23.0	20.1	19.3

Dissolved Oxygen

The oxygen concentration (mg O_2/L) in Atatürk Dam Lake, as shown in Table 2, fluctuated throughout the year. The highest oxygen level (8.9 mg O_2/L) was recorded in March, while the lowest (7.0 mg O_2/L) was observed in June, July, and August. These oxygen fluctuations may be associated with the water temperature changes, with lower oxygen levels corresponding to warmer months.

Table 2. *Oxygen (mgO_2/L) values recorded in Atatürk Dam Lake*

Parameters	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Oxygen (mgO2/L)	8.9	8.6	7.7	7.0	7.0	7.0	8.0	8.0	8.4

pH Levels

Table 3 presents the monthly pH values for Atatürk Dam Lake. The pH levels ranged from a minimum of 7.20 in August to a maximum of 7.80 in March. This variation may reflect seasonal changes, such as increased biological activity during warmer months.

Table 3. *pH values recorded in Atatürk Dam Lake*

Parameters	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
pH	7.80	7.74	7.70	7.30	7.30	7.20	7.50	7.55	7.60

Planktonic Algal Relative Densities

The monthly relative densities of planktonic algae recorded at a selected station in Atatürk Dam Lake during the study are presented in Table 4. A variety of diatom species were recorded throughout the year, including *Amphora ovalis, Cymbella affinis, Cymbella cistula, Cymbella helvetica, Cymbella parva, Cymbella proxima, Diatoma vulgaris, Encyonema ventricosum, Gomphonema acuminatum, Gomphonema gracile, Gomphonema olivaceum, Navicula cari, Navicula tripunctata, Nitzschia amphibia, Nitzschia palea, Nitzschia sigmoidea, Surirella minuta, Surirella ovalis,* and *Ulnaria ulna*. The highest relative density among the diatoms was recorded for *Ulnaria ulna* in November (12.90%), while the lowest relative density (2.17%) was recorded for *Surirella ovalis* in October. These findings indicate temporal variability in planktonic diatom populations, with species like *Ulnaria ulna* reaching peak density in colder months.

Table 4. *Monthly relative densities of the planktonic algae at a station selected from Atatürk Dam Lake.*

	Mar.	Apr.	May	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Amphora ovalis (Kütz.)Kütz.	5.88	4.47	5.00	5.42	5.38	5.05	2.89	4.34	3.22
Cymbella affinis Kütz.	14.70	7.46	7.00	6.20	6.92	6.06	4.34	6.52	6.45
Cymbella cistula (Ehr.)O.Kirchner	2.94	2.98	4.00	3.87	5.38	4.04	5.79	4.34	3.22
Cymbella helvetica Kütz.	2.94	4.47	5.00	4.65	4.61	5.05	4.34	4.34	6.45
Cymbella proxima Reimer	5.88	5.97	6.00	5.42	4.61	5.05	4.34	4.34	3.22
Cymbella parva (W.Smith) Kirchner	5.88	4.47	5.00	5.42	3.84	4.04	4.34	4.34	3.22
Diatoma vulgaris Bory	2.94	2.98	3.00	3.87	4.61	4.04	2.89	2.17	3.22
Encyonema ventricosum (C.Agardh) Grunow	2.94	4.47	5.00	4.65	3.84	4.04	4.34	4.34	3.22
Gomphonema acuminatum Ehr.g	5.88	5.97	6.00	6.20	6.15	6.06	7.24	8.69	9.67
Gomphonema gracile Ehr.	5.88	4.47	5.00	6.20	4.61	5.05	5.79	4.34	3.22
Gomphonema olivaceum (Horneman)Br ébisson	2.94	4.47	5.00	5.42	5.38	5.05	5.79	6.52	6.45
Navicula cari Ehr.	2.94	2.98	3.00	3.87	3.84	4.04	4.34	4.34	3.22
Navicula tripunctata (O.F Müller) Bory	5.88	5.97	7.00	6.20	6.15	7.07	7.24	8.69	9.67
Nitzschia amphibia Grun.	2.94	2.98	3.00	3.87	3.84	3.03	2.89	2.17	3.22
Nitzschia palea (Kütz.) W.Smith	5.88	7.46	7.00	5.42	6.15	7.07	7.24	8.69	6.45
Nitzschia sigmoidea (Nitzsch) W.Smith	2.94	4.47	5.00	4.65	4.61	4.04	5.79	4.34	3.22
Surirella minuta Brébisson ex Kützing	5.88	7.46	6.00	5.42	6.15	6.06	5.79	4.34	6045
Surirella ovalis Brébisson	2.94	4.47	4.00	5.42	5.38	5.05	4.34	2.17	3.22
Ulnaria ulna(Nitzsch) Compère	11.76	11.94	9.00	7.75	7.69	10.10	10.14	10.86	12.90

The planktonic diatom species recorded during the study, particularly *Ulnaria ulna*, exhibited notable temporal fluctuations in relative density. These changes are likely influenced by environmental conditions, such as water temperature, pH, and oxygen levels, which vary seasonally. The dominance of *Ulnaria ulna* in colder months and lower relative densities in warmer months, particularly for species like Surirella ovalis, suggest a relationship between species distribution and environmental variables, which warrants further investigation.

Algae play a crucial role in aquatic ecosystems, producing oxygen during photosynthesis while simultaneously consuming it during respiration (Jones-Lee and Lee, 2005). In Atatürk Dam Lake, the highest surface water temperature recorded was 25.0°C in August, while the lowest temperature was 19.0°C in March. The highest dissolved oxygen value was measured at 8.9 mg/L in March, and the lowest dissolved oxygen value was measured at 7.0 mg/L in June, July, and August. It has been determined that the dissolved oxygen concentration is inversely proportional to the temperature, as the amount of dissolved oxygen decreases

with rising temperatures. The average temperature in the research area was 21.11°C, and the average dissolved oxygen value was 7.84 mg/L. According to the Water Pollution Control Regulation (SKKY, 2008), the water quality falls under Class I in terms of dissolved oxygen and temperature. In uncontaminated natural waters, oxygen concentration is generally around 10 mg/L (Anonymous, 1998). Biological respiration and the decomposition of various organisms in water contribute to a decrease in dissolved oxygen. When oxygen concentration drops below 5 mg/L, the life functions of biological communities are compromised (Şişli, 1999).

As an indicator of the acidity of the water, pH is one of the critical factors affecting the survival of aquatic organisms. The flora of a lake is significantly influenced by the pH of the water. In non-contaminated lake waters, the pH typically ranges from 6 to 9 (Tanyolaç, 2009). The pH values recorded during the study in the research area ranged from 7.20 to 7.80, with an average value of 7.52. This indicates that Atatürk Dam Lake has alkaline characteristics. According to the Water Pollution Control Regulation (SKKY, 2008), the water quality is categorized as Class I in terms of pH (Table 3). Based on these findings, it is evident that the water quality and biological activity of Atatürk Dam Lake (Adıyaman) are suitable for supporting fish production.

In this study, a station was designated to identify the planktonic diatoms of Atatürk Dam Lake (Adıyaman), with sand samples taken from this station monthly between March and November 2020. Cox (1984; 1996) emphasized the importance of light in the seasonal distribution of diatoms. Although our study was not seasonal, an increase in the number of planktonic diatoms was observed during the summer months. A total of 19 taxa belonging to Bacillariophyta were identified. The diatom species recorded with the highest number of taxa during the study were Cymbella (5 taxa), Gomphonema, Nitzschia (3 taxa), and Navicula, Surirella (2 taxa). This finding suggests that species within these genera are better able to utilize their environment. Other studies on algae in surface water sources (Yıldız and Atıcı, 1996; Açıkgöz and Baykal, 2005; Caglar and Selamoglo, 2021) have also shown that Cymbella and Nitzschia genera are represented by numerous species. Chessman (1986) noted that Navicula and Nitzschia species are cosmopolitan. The presence of Navicula and Nitzschia species in Atatürk Dam Lake further supports this conclusion.

While Centrales members, known as planktonic forms, were detected in sediments, they were not found in significant numbers in the planktonic diatom community of Atatürk Dam Lake, in contrast to studies identifying benthic algae in lakes, ponds, rivers, and dam lakes in other regions of Turkey (Altuner and Gürbüz, 1996; Şahin, 1998). Round (1981) also suggested that pennate diatoms, which are typically benthic forms, rise to the phytoplankton layer due to water mixing. This finding aligns with the observations of our study.

CONCLUSION

Considering the continuous presence of diatoms in the planktonic algal community, it can be concluded that diatoms are cosmopolitan and thrive in various substrates. In conclusion, this study conducted in Atatürk Dam Lake (Adıyaman/Elazığ) is expected to contribute to the understanding of Turkey's freshwater algal flora

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CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

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