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Diversity and Seasonal Distribution of Epipsammic Diatoms in Tahar Stream (Tunceli, Turkey)

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ABSTRACT: Freshwater ecosystems are important indicators of environmental health, with diatom communities playing a key role in assessing water quality and ecological dynamics. This study investigates the epipsammic diatoms of Tahar Stream, located 135 km from Tunceli, fed by Kırklar Creek originating from Kırklar Mountain, and discharging into Keban Dam Lake near the western part of Çemişgezek district. Epipsammic diatom samples were collected monthly from two stations between March and November 2021. In addition to diatom analysis, water temperature, dissolved oxygen, and pH levels were also recorded. A total of 26 diatom taxa were identified at each of the two stations, with Ulnaria ulna being the most abundant species at both sites. Seasonal variations in diatom abundance were observed, with peak densities occurring in March and April, coinciding with increased sunlight intensity and temperatures. The stream's water quality, indicated by pH (ranging from 7.0 to 7.3) and dissolved oxygen (7.0-8.7 mg/L), categorized the stream as Class I, signifying high-quality water. These findings contribute to the understanding of the epipsammic diatom community in the region and provide a baseline for future ecological studies of the Tahar Stream and similar freshwater habitats in Turkey.

Keywords: Epipsammic diatoms, Tahar stream, water quality, seasonal variation, biodiversity.

INTRODUCTION

Water, which is the main source of life, contains many living things. The number and diversity of algae forming the first link of the food chain affect all living things in the aquatic environment, including fish. With its streams and lakes, Turkey has significant water resources in an area of 10,000 km2. 135 wetlands within its borders have international importance. 12 of these wetlands were declared as Ramsar sites (Anonymous, 2009). Considering Turkey's regions, Eastern Anatolia is the richest region in terms of lakes and streams. Among these, Aras, Kura, Tigris, and Euphrates are the most important ones and many streams feeding these rivers are located in this region. In Turkey, which is in the process of becoming a member of the European Union (EU), studies continue to be conducted to align with the EU legislation in effect. In the EU, the Water Framework Directive entered into force in 2000. This directive aims to ensure the sustainable use of surface water and groundwater. According to the Directive, surface waters are divided into four categories as lakes, streams, transitional waters, and coastal waters (Anonymous, 2003).

The structure of diatom communities is directly related to the physical and chemical characteristics of water. Therefore, diatoms are used in the calculation and comparison of the water qualities of rivers with different morphodynamics (Allan, 1995). The Water Framework Directive has determined diatom communities as well as the physio-chemical parameters of water as indicators in river systems (APHA, 1985). Immobile algal species, which are generally found as mucilaginous and filamentous masses covering stones and hard rocks, constitute the epipsammic flora (Dere and Sıvacı, 1995). In Turkey, there are many studies on epipsammic diatoms. While some of these studies are on rivers, some of them are on creeks that dry or freeze in certain periods (Altuner and Gürbüz, 1988; Yıldız and Atıcı, 1996; Pala and Çağlar, 2006; Pala and Çağlar, 2008; Çiçek et al., 2010; Öcalan and Saler, 2016).

Algae studies on the streams in the Eastern Anatolia Region are quite limited (Pala and Çağlar, 2008; Kıvrak and Gürbüz, 2010; Fakıoğlu et al., 2012). This research aims to determine the epipsammic diatoms and certain water quality parameters of Tahar Stream. This study is important because it is the first research on the epipsammic diatoms of Tahar Stream.

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MATERIALS AND METHODS

The study was conducted at Tahar Stream, located approximately 135 km from the city center of Tunceli, Turkey. The stream originates from Kırklar Stream, which flows from Kırklar Mountain, and eventually discharges into the Keban Dam Lake to the west of Çemişgezek District. Due to its geographical location, Tahar Stream is not significantly influenced by high mountain water sources. Consequently, the water flow in the stream is primarily dependent on spring waters and seasonal precipitation.

Samples were collected from two distinct stations along the Tahar Stream (Figure 1). Station I is situated at 39°09'37.74" N latitude and 39°28'24.50" E longitude, while Station II is located at 39°09'55.07" N latitude and 39°28'24.50" E longitude. To collect epipsammic diatom samples, a glass rod with a diameter of 1 cm and a length of 100 cm was employed. Permanent slide preparations were made from the epipsammic samples to facilitate accurate diatom identification. For species identification and counting of diatoms in the permanent preparations, a Nikon microscope was used. The counting method was based on the relative density of diatoms, and the results are presented as "organism %."

The relative density (Rd) of a species is calculated using the following formula:

Relative Density (Rd) = (NA/N) * 100

Where:

NA = Total number of individuals of species A

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

Species identification followed the taxonomic guidelines provided by Germain (1981), Patrick and Reimer (1966, 1975), and Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b). In addition to diatom sample collection, in situ measurements of water quality parameters were carried out monthly at both stations. Water temperature was recorded using a mercury thermometer with 1°C graduations. Oxygen levels and electrical conductivity were measured using a portable YSI 55 DO digital oxygen meter.

Figure 1. *Satellite image of Station I and Station II on Tahar Stream*

RESULTS AND DISCUSSION

The recorded water quality parameters-temperature (°C), dissolved oxygen (DO) (mg/L), and pH-at Tahar Stream during the study period are summarized in Table 1.

Table 1. *Water temperature, dissolved oxygen, and pH values recorded during the study in Tahar Stream*

Months	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Temperature (°C)	9.6	10.9	14.7	16.0	16.9	18.3	17.3	16.9	13.6
DO (mg/L)	8.7	8.7	8.6	7.2	7.0	7.0	7.4	7.9	8.0
pH	7.0	7.0	7.1	7.3	7.2	7.2	7.2	7.0	7.0

During the study, the average water temperature in Tahar Stream was recorded at 14.91°C. The highest temperature of 18.3°C was observed in August, while the lowest temperature of 9.6°C occurred in March. The average dissolved oxygen (DO) level

was 7.83 mg/L, with the highest value (8.7 mg/L) recorded in both March and April, and the lowest value (7.0 mg/L) observed in July and August. The average pH value was 7.11, with the highest pH (7.3) recorded in June and the lowest pH (7.0) measured in March, April, October, and November. Table 2 presents the relative densities of epipsammic algae at Station I of Tahar Stream during the study period.

Table 2. *Relative densities of the epipsammic algae recorded at Station I on Tahar Stream*

	Mar.	**Apr.**	**May.**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**
Cymbella affinis Kützing	-	8.69	5.08	4.14	3.51	2.98	3.19	5.00	3.57
Cymbella cistula (Ehrenberg) O.Kirchner	-	-	0.84	1.77	2.51	2.23	2.12	1.66	3.57
Cymbella parva (W.Smith) Kirchner	-	4.34	5.93	3.55	3.51	2.98	3.19	3.33	-
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	7.40	5.79	6.77	5.32	4.52	3.73	5.31	6.66	7.14
Diatoma vulgaris Bory	7.40	4.34	4.23	4.14	4.02	4.47	4.25	3.33	3.57
Encyonema elginense (Krammer) D.G.Mann	-	-	0.84	1.77	2.51	2.98	3.19	3.33	-
Encyonema ventricosum (C.Agardh) Grunow	-	-	1.69	1.77	3.01	2.23	3.19	1.66	-
Fragilaria tenera (W.Smith) Lange-Bertalot	-	1.44	2.54	2.95	4.02	4.47	4.25	3.33	3.57
Gomphonema angustatum (Kützing) Rabenhorst	7.40	5.79	5.93	5.32	4.52	4.47	4.25	3.33	3.57
Gomphonema olivaceum (Hornemann) Brébisson	11.11	7.24	6.77	6.50	5.02	5.97	6.38	6.66	10.71
Lindavia comta (Kützing) Nakov, Gullory, Julius, Theriot & Alverson	-	-	-	1.18	2.01	2.23	3.19	3.33	-
Navicula cryptocephala Kützing	14.81	8.69	5.93	7.10	6.53	6.71	5.31	6.66	7.14
Navicula gregaria Donkin	-	2.89	4.23	4.14	4.02	3.73	3.19	3.33	3.57
Navicula radiosa Kützing	11.11	8.69	5.08	5.32	4.02	2.98	4.25	3.33	7.14
Nitzschia palea (Kützing) W.Smith	-	2.89	3.38	4.73	4.52	5.22	5.31	5.00	3.57
Nitzschia sigma (Kützing) W.Smith	-	-	1.69	2.95	3.51	2.98	3.19	3.33	3.57
Nitzschia tenuis W.Smith	-	2.89	2.54	3.55	4.02	3.73	2.12	3.33	3.57
Nitzschia terrestris (J.B.Petersen) Hustedt	-	-	1.69	2.36	3.51	4.47	4.25	1.66	-
Pinnularia divergens W.Smith	-	-	1.69	1.77	3.01	3.73	3.19	3.33	3.57
Pinnularia nobilis (Ehrenberg) Ehrenberg	-	-	2.54	2.95	3.51	2.98	2.12	1.66	-
Pinnularia viridis (Nitzsch) Ehrenberg	-	2.89	3.38	3.55	3.01	2.23	1.06	-	-
Surirella angusta Kützing	7.40	5.79	4.23	4.73	4.52	4.47	4.25	5.00	7.14
Surirella minuta Brébisson ex Kützing nom illeg	7.40	7.24	5.93	4.14	4.02	3.73	3.19	3.33	3.57
Surirella ovalis Brébisson	11.11	8.69	6.77	5.32	4.52	5.22	5.31	6.66	7.14
Ulnaria acus (Kützing) Aboal	-	2.89	2.54	2.95	3.51	3.73	3.19	3.33	3.57
Ulnaria ulna (Nitzsch) Compère	14.81	8.69	7.62	5.91	4.52	5.22	7.44	8.33	10.71

Among the epipsammic algae at Station I, the highest relative densities in March were observed for *Navicula cryptocephala* and *Ulnaria ulna* (14.81%). The highest relative densities in August (5.97%) were recorded for *Gomphonema olivaceum* and *Navicula cryptocephala*. The species composition and density varied through the seasons, with changes reflecting temperature and water quality fluctuations. The relative densities of the epipsammic algae found at Station II on Tahar Stream during the study period are given in Table 3.

Table 3. *Relative densities of the epipsammic algae recorded at Station II on Tahar Stream*

	Mar.	**Apr.**	**May.**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**
Cymbella affinis Kützing	-	3.44	3.06	3.31	3.93	4.04	3.73	3.33	2.08
Cymbella cistula (Ehrenberg) O.Kirchner	-	-	3.06	4.02	5.05	5.78	5.22	4.44	6.25
Cymbella parva (W.Smith) Kirchner	-	5.17	5.10	4.69	3.93	3.46	4.47	3.33	2.08
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	9.52	6.89	5.10	5.36	5.05	6.35	7.76	10.00	8.33
Diatoma vulgaris Bory	4.76	5.17	6.12	4.69	3.37	5.20	5.97	5.55	6.25
Encyonema elginense (Krammer) D.G.Mann	-	-	3.06	3.35	2.24	2.89	2.23	2.22	-
Encyonema ventricosum (C.Agardh) Grunow	-	-	1.02	2.01	2.80	2.31	2.23	-	-
Fragilaria tenera (W.Smith) Lange-Bertalot	-	3.44	4.08	5.36	5.36	5.20	4.47	3.33	4.16
Gomphonema angustatum (Kützing) Rabenhorst	4.76	5.17	3.06	3.35	3.93	4.62	3.73	3.33	4.16
Gomphonema olivaceum (Hornemann) Brébisson	9.52	6.89	6.12	6.04	5.05	4.62	5.22	5.55	6.25
Lindavia comta (Kützing) Nakov, Gullory, Julius, Theriot & Alverson	-	-	-	2.68	2.80	2.31	2.23	2.22	-
Navicula cryptocephala Kützing	14.28	8.62	7.14	6.04	6.17	5.78	6.71	7.77	8.33
Navicula gregaria Donkin	-	3.44	3.08	3.35	2.24	2.31	2.23	2.22	2.08
Navicula radiosa Kützing	9.52	6.89	6.12	6.04	5.61	5.20	6.71	6.66	8.33
*Nitzschia palea (*Kützing) W.Smith	-	3.44	3.06	3.35	4.49	3.46	3.73	3.33	4.16
*Nitzschia sigma (*Kützing) W.Smith	-	-	2.04	2.68	2.88	2.31	2.23	3.33	2.08
Nitzschia tenuis W.Smith	-	3.44	2.04	2.01	2.80	1.73	2.23	2.22	2.08
Nitzschia terrestris (J.B.Petersen) Hustedt	-	-	1.02	1.34	2.24	2.89	1.49	1.11	-
Pinnularia divergens W.Smith	-	-	2.04	1.34	1.68	2.31	2.23	2.22	2.08
Pinnularia nobilis (Ehrenberg) Ehrenberg	-	-	1.02	1.12	2.24	2.31	2.23	1.11	-
Pinnularia viridis (Nitzsch) Ehrenberg	-	3.44	3.06	3.35	2.24	2.31	1.49	2.22	-
Surirella angusta Kützing	4.76	5.17	5.10	2.68	2.80	2.31	1.49	2.22	4.16
Surirella minuta Brébisson ex Kützing nom illeg	9.52	6.89	5.10	4.02	3.93	3.46	2.98	3.33	4.16
Surirella ovalis Brébisson	14.28	8.62	7.14	6.72	6.74	6.93	6.71	7.77	8.33
Ulnaria acus (Kützing) Aboal	-	3.44	4.08	2.68	3.37	2.89	2.98	2.22	2.08
Ulnaria ulna (Nitzsch) Compère	19.04	10.34	8.16	6.74	7.30	6.93	7.76	8.88	12.5

At Station II of Tahar Stream, the epipsammic algae species with the highest relative densities were Ulnaria ulna, recorded at 19.04% in March, and both Navicula cryptocephala and Surirella ovalis, each with a relative density of 14.28% in the same month. The lowest relative density was recorded for Encyonema ventricosum, Nitzschia terrestris, and Pinnularia nobilis in May, each at 1.02%.

This study aimed to investigate the epipsammic algae of Tahar Stream (Tunceli/Turkey) by selecting two stations along the stream. Monthly epipsammic samples were collected from stones between March and November 2021 and analyzed alongside key physical and chemical parameters. A total of 26 taxa of epipsammic algae were identified across both stations, including Cymbella (3 taxa), Cymbopleura (1 taxon), Diatoma (1 taxon), Encyonema (2 taxa), Fragilaria (1 taxon), Gomphonema (2 taxa), Lindavia (1 taxon), Navicula (3 taxa), Nitzschia (4 taxa), Pinnularia (3 taxa), Surirella (3 taxa), and Ulnaria (2 taxa).

To evaluate water quality, parameters such as temperature, pH, and dissolved oxygen were compared to the standards set by the Regulation Concerning Water Intended for Human Consumption (Anonymous, 2003). According to the Water Pollution Control Regulation, inland waters are classified into four categories: Class I (high quality), Class II (slightly polluted), Class III (polluted), and Class IV (highly polluted). Based on the average temperature, Tahar Stream was classified as Class I, indicating high water quality. Monthly temperature variations ranged from 9.6°C in March to 18.3°C in August. This temperature fluctuation reflects seasonal changes, with temperatures rising in the summer months and decreasing as the weather cooled in November. Snowfall in winter also contributes to temperature reduction, particularly in the colder months.

The stream's pH ranged from 7.0 to 7.3, placing it in the slightly alkaline category, consistent with Class I water quality standards. These values are comparable to those observed in other Turkish rivers, such as the Asi River, where pH values ranged from 7.4 to 8.9 (Taşdemir & Göksu, 2001). The dissolved oxygen levels in Tahar Stream fluctuated between 7.0 and 8.7 mg/L, which is typical of clean, unpolluted waters. Since levels above 5 mg/L support aquatic life, the oxygen concentrations in Tahar Stream indicate a healthy environment for aquatic organisms.

Throughout the study, diatoms were the dominant group among the epipsammic algae. At both stations, Ulnaria ulna was the most abundant species, and diatoms generally showed their highest relative densities in March and April. These months also represented the peak of algal productivity. The seasonal variation in diatom populations, with a decline in July and August, correlates with changes in sunlight intensity and temperature, as reported by previous studies (Round, 1973; Cox, 1984). The decrease in species diversity during the summer months aligns with these environmental factors, particularly the angle of light incidence and higher temperatures.

CONCLUSION

The study revealed that certain species, such as Navicula cryptocephala and Ulnaria ulna, are characteristic of eutrophic, possibly wastewater-contaminated waters, and their presence suggests that nutrient levels may influence their proliferation in the stream. The findings of this study not only highlight the seasonal dynamics of diatoms in Tahar Stream but also provide a comprehensive baseline for future studies of algal biodiversity in Turkey. This research represents the first comprehensive algological study conducted in Tahar Stream and will contribute significantly to the knowledge of algal species in Turkey, providing essential data for future ecological monitoring and environmental conservation efforts.

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CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

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