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Epipsammic Diatoms of Sülük Lake (Ağın/Elazığ, Türkiye)

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Abstract: In this study, epipsammic diatoms in water sampled from a particular station on Sülük Lake (Ağın/Elazığ) between March-November 2022 were examined. A total of 36 taxa belong to the epipsammic diatoms were identified throughout the investigation. Nitzschia was dominant with 5 taxa, followed by Cymbella and Surirella with 4 taxa. When the water temperature started to rise in the spring and summer, the diatoms reached the highest number. In the summer, water temperature (23.10 °C), dissolved oxygen (8.5 mg/L), and electrical conductivity (331.1 mho/cm) were recorded higher than others. The Sülük Lake is vulnerable to eutrophication because of its coastal structure, small surface area and especially useing as a picnic place in the spring and summer.

Key words: Sülük Lake, Epipsammic, Diatom.

Sülük Gölü Epipsammik Diyatomları (Ağın/Elazığ, Türkiye)

Öz: Bu çalışmada Sülük Gölü (Ağın/Elazığ) üzerindeki belirli bir istasyondan Mart-Kasım 2022 tarihleri arasında örneklenen epipsammik diatomlar incelenmiştir. Araştırma boyunca epipsammik diatomlara ait toplam 36 takson tespit edilmiştir. Nitzschia 5 takson ile baskın olurken, Cymbella ve Surirella 4 takson ile onu takip etmişlerdir. İlkbahar ve yazın su sıcaklığı artışı ile diatomlar en yüksek sayıya erişmiştir. Yaz aylarında göl suyunun sıcaklık (23,10 C), çözünmüş oksijen (8,5 mg/L) ve elektriksel iletkenlik (331,1 mho/cm) değerleri diğer aylara göre daha yüksek seviyelerde gözlemlendi. Sülük Gölü kıyı alanının yapısı, yüzey alanının küçük olması ve özellikle bahar ve yaz aylarında piknik alanı olarak kullanılması nedeniyle ötrofikasyona karşı hassastır.

Anahtar kelimeler: Sülük Gölü, Epipsammik, Diatom.

1. Introduction

Planktonic studies are the ones that initially made algaes existence known. The first link in the food chain and the primary producers of organic materials in aquatic environments are algae. Because they produce their own nutrients through photosynthesis, they are referred to as primary producers.

Diatoms are widespread algae that have significant biological and economic value and are widely distributed around the world [1]. In both fresh and salty water, as well as in benthic areas, diatoms constitute the most significant category of phytoplankton organisms. Those living on mud at the bottom of lakes and rivers is referred to as epipelic, while living on sand is referred to as epipsammic, living on rocks and other natural objects is referred to as epilithic, and dwelling on plants is referred to as epiphytic forms.

Algae are organisms that have high levels of fatty acids, proteins, and carbohydrates. The most significant source of minerals, vitamins, and trace elements for aquatic species is microalgae with high nutritional value. One of the categories that should be studied in order to assess ecosystem biodiversity is microalgae, which are crucial for aquatic ecosystems in terms of the food chain [2].

In recent years, data from research on the identification of Türkiyes freshwater algal flora have been compiled [3]. Studies indicate that the algal flora of a sizable portion of the wetlands in our nation has not been identified yet. The distribution of indicator species, in particular, and research on species diversity can serve as a foundation for assessing the ecological significance of the environment and tracking changes. From this perspective, it is vital to continue the investigations on the identification of the algal flora in all water resources. In terms of species diversity, some small wetlands may include both numerous and unusual species [4]. The importance of studying algae in lotic ecosystems is rising. It is essential to identify the ecological parameters and nutrient content in inland waters in order to assure the efficiency of the aquaculture operations. Therefore, it is important to understand the taxonomy, density, and seasonal variations of the phytoplankton and benthic algae that make up the first link in

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the food chain, as well as the ecological, physical, and chemical variables influencing the corresponding changes. Phytoplankton exhibits the strongest and most rapid changes in the aquatic ecosystems structure. Some pollution indicator algal species are important criteria for determining the degree of environmental pollution and eutrophication in these environments, in addition to information about productivity provided by the number and species richness of algae in aquatic ecosystems [5]. Since the 1980s, Türkiye has been conducting extensive research on the identification of algae species in lotic and lentic ecosystems (lakes, ponds, dam lakes, and rivers) [6-19].

Algae, which are found all over the world in a variety of habitats (such as water, soil, snow, etc.), contain indicator species that reveal the composition of their surroundings. In order to more effectively utilize the inland waters and transform them into a source of food and money in Türkiye, which has a highly rich supply of inland water resources, it is required to identify the algae present in the environment. Particularly in shallow lakes, benthic algae make up the majority of the algal flora and significantly increase the lakes production. The significance of this work is therefore elevated by the identification of the algae present in the Sülük Lakes bottom region and the clarification of their ecological interactions. The Sülük Lake within the borders of Balkayası Village of Ağın located 77 km away from the center of Elazığ are worth seeing with their natural beauty and surrounding green areas. The recreational areas, picnic sites, camellias and social facilities made of wood on the shores of the Sülük Lake have made it a preferable place in the district. The removal of the lakes reeds and landscaping will both greatly contribute in the growth of tourism in the area. Additionally, a Natural Park could be established here. Determining the epipsammic diatoms of the Sülük Lake and their monthly variations is the goal of this study.

2. Material and Methods

In this study, the epipsammic algae of the Sülük Lake (38° 55 06" N - 38°34 34" E) located in Ağın district of Elazığ were studied (Figure 1).

Figure 1. A satellite view of Sülük Lake (Ağın/Elazığ-Türkiye) [20].

Epipsammic algae were sampled by using the methods [21] from the Sülük Lake between March and November (2022). For this purpose, a glass rod with a diameter of 1 cm and a length of 100 cm was used. Permanent preparations were made from the epipsammic samples in order to be able to diagnose the diatoms accurately. For this purpose, samples taken in a certain volume (10 ml) were treated with 5 ml HNO_3 + 5 ml H_2SO_4 acid and boiled on a heat plate at 120 °C for 15 minutes, thus oxidizing the organic substances inside the diatom cells and only the diatom shells consisting of silicon remained in the beaker. This process was carried out in order to observe the shell structures of diatoms called frustules in more detail. The boiled samples were placed in Erlenmeyer flasks that were previously sterilized and passed through pure water. In order to eliminate the acidity of the acidic environment in which the diatom shells were located, the acidic water in the beaker was carefully poured and pure water was added to the diatom shells remaining at the bottom of the beaker. This process was continued until the environment was close to neutral [21]. A drop of the sample containing the diatom shells was taken on a coverslip and left to dry at room temperature. Afterwards, the coverslips were lifted with a pair of forceps and closed by turning them upside down on the slide on which entellan had been previously dripped. In order to avoid leaving air bubbles in the preparation, light pressure was applied to the coverslip after the slide and coverslip were glued [21]. Species identification and counting of the diatoms were made by using a Nikon (model Alphaphot-2 YS2-H) inverted microscope. The counting was based on relative density (Eq.1) and the results are given as organism %.

$$\text{Relative density (Rd)} = (\text{NA}/\text{N})\text{x}100 \quad (1)$$

NA =Total number of a species individuals
N= Number of all species individuals [22].

Some studies [23-27] were used for the species identification of the diatoms found in the Sülük Lake. The temperature of the water at the stations was measured by using 1 ºC graduated mercury thermometer. Oxygen and electrical conductivity were measured in situ by using a portable YSI 55 DO digital oxygen meter which is calibrated just before of using.

3. Results

Monthly changes in some physical and chemical parameters of the Sülük Lake (Ağın) are shown in Table 1.

Table 1. Monthly changes in some physical and chemical parameters of the Sülük Lake.

Parameters	**Mar.**	**Apr.**	**May.**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**
Temperature (ºC)	20	20	24	26	27	27	27	19	18
Dissolved Oxygen (mgO_2/L)	9.5	9.5	8.0	7.5	7.0	7.1	8.9	9.7	9.7
Electrical Conductivity (μmho/cm)	380	380	307	320	320	321	318	318	316

During the study, the highest temperature (27°C) was recorded in July, August and September; the lowest temperature (18°C) was recorded in November; the highest dissolved oxygen value (9.7mg O_2/L) was recorded in October and November; the lowest dissolved oxygen value (7.0mg O_2/L) was recorded in July; the highest electrical conductivity (380 μmho/cm) was recorded in March and April; and the lowest electrical conductivity (316 μmho/cm) was recorded in November.

The epipsammic diatoms recorded in the Sülük Lake in Ağın (Elazığ) and their relative densities are shown in Table 2. When Table 2 is examined, it can be seen that a total of 36 taxa belonging to the diatoms were recorded in the Sülük Lake: Cymatopleura (1 taxon), Cymbella (4 taxa), Cymbopleura (1 taxon), Delicatophycus (1 taxon), Diatoma (2 taxa), Encyonema (2 taxa), Encyonopsis (1 taxon), Fragilaria (1 taxon), Gomphonema (3 taxa), Lindavia (1 taxon), Mayamaea (1 taxon), Navicula (3 taxa), Nitzschia (5 taxa), Pantocsekiella (1 taxon), Pinnularia (3 taxa), Surirella (4 taxa) and Ulnaria (2 taxa). The maximum number of species belonged to Nitzschia with 5 taxa.

According to Table 2, the highest relative density (5.82%) during the study belonged to *Ulnaria ulna* species. The relative densities of *U. ulna* did not fall below almost 4% during the study. The lowest relative density (0.96%) among the epipsammic diatoms belonged to *Surirella librile*. The relative densities of this diatom were recorded to be below 2% in all months except for August. The relative densities of Encyonema elginense and Navicula gregaria species in November (4.85%) were the second highest relative densities. Furthermore, the recorded relative densities of Cymbella affinis, Cymbella cistula, Cymbella parva, Navicula cryptocephala, Navicula radiosa and Ulnaria ulna never fell below 3% in any of the months. The relative density of Surirella angusta, on the other hand, never reached 2% in any month.

Table 2. Presence and relative densities of the epipsammic diatoms recorded in the Sülük Lake by months.

	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Cymatopleura elliptica Brebisson W.Smith	2.23	1.92	1.83	2.04	1.93	1.84	1.92	1.42	1.94
Cymbella affinis Kützing	3.73	3.84	3.67	3.79	3.62	3.91	3.20	3.31	3.88
Cymbella cistula (Ehrenberg) O.Kirchner	4.47	4.32	3.30	3.49	3.86	3.45	4.80	3.79	3.88
Cymbella helvetica Kützing	2.23	2.40	2.94	2.91	2.65	2.99	2.88	3.31	1.94
Cymbella parva (W.Smith) Kirchner	3.73	3.36	3.30	3.20	3.14	3.22	3.20	3.79	3.88
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	4.47	3.84	3.30	3.20	3.14	2.76	3.20	3.31	3.88
Delicatophycus delicatulus (Kützing) M.J.Wynne	2.98	2.88	3.30	3.49	3.38	3.68	4.16	3.79	2.91
Diatoma elongata (Lyngbye) C.Agardh	2.98	2.88	2.57	3.20	3.14	2.30	2.56	2.84	1.94
Diatoma vulgaris Bory	3.73	2.40	2.94	2.91	2.65	2.99	2.24	2.36	2.91
Encyonema elginense (Krammer) D.G.Mann	3.73	3.36	2.57	2.91	2.65	2.99	3.20	2.36	4.85
Encyonema ventricosum (C.Agardh) Grunow	4.47	3.84	3.67	2.91	2.89	2.53	2.56	2.84	3.88
Encyonopsis microcephala (Grunow) Krammer	1.49	3.36	2.94	2.62	2.41	2.76	2.24	2.36	0.97
Fragilaria tenera (W.Smith) Lange-Bertalot	1.49	2.40	2.57	2.04	1.93	2.07	2.56	2.84	2.91
Gomphonema acuminatum Ehrenberg	2.98	1.92	2.20	2.33	2.65	2.99	2.88	2.36	1.94
Gomphonema angustatum (Kützing) Rabenhorst	2.98	2.88	2.94	3.20	3.14	3.15	3.20	3.79	2.91
Gomphonema olivaceum (Hornemann) Brébisson	3.73	2.40	2.57	2.62	2.89	3.22	2.88	3.31	2.91
Lindavia comta (Kützing) Nakov, Gullory, Julius, Theriot & Alverson	1.49	2.40	2.57	2.62	3.14	2.99	2.56	1.89	1.94
Mayamaea atomus (Kützing) Lange-Bertalot	2.98	3.36	2.57	2.91	2.65	2.76	2.56	2.84	2.91
Navicula cryptocephala Kützing	4.47	4.32	3.67	3.79	3.86	3.91	4.48	4.26	3.88
Navicula gregaria Donkin	2.98	2.88	4.08	3.49	3.14	2.76	2.88	2.84	4.85
Navicula radiosa Kützing	4.47	3.84	4.08	3.79	3.62	2.53	2.88	1.89	3.88
Nitzschia palea (Kützing) W.Smith	3.73	3.36	3.30	3.20	3.14	3.45	2.88	2.84	2.91
Nitzschia sigma (Kützing) W.Smith	2.23	1.44	1.47	1.45	1.69	2.07	1.92	2.36	2.91
Nitzschia sigmoidea (Nitzsch) W.Smith	2.98	2.40	2.20	2.33	2.41	2.07	2.24	2.36	1.94
Nitzschia tenuis W.Smith	1.49	2.88	3.30	3.20	3.14	3.22	3.20	3.79	2.91
Nitzschia terrestris (J.B.Petersen) Hustedt	1.49	1.92	1.83	2.04	2.17	1.61	1.60	1.42	0.97
Pantocsekiella ocellata (Pantocsek) K.T.Kiss & Ács tella ocellata	0.74	1.44	1.83	2.33	2.17	2.30	2.24	1.89	1.94
Pinnularia divergens W.Smith	1.49	1.92	1.83	2.04	2.41	2.07	2.24	2.36	0.97
Pinnularia nobilis (Ehrenberg) Ehrenberg	2.23	2.40	2.20	2.62	2.65	2.76	2.88	3.31	2.91
Pinnularia viridis (Nitzsch) Ehrenberg	2.98	2.88	2.94	2.33	2.41	2.53	2.56	2.36	1.94
Surirella angusta Kützing	1.49	1.44	1.47	1.16	1.69	1.84	1.92	1.89	1.94
Surirella librile (Ehrenberg) Ehrenberg	1.49	0.96	1.47	1.45	1.69	2.07	1.92	1.42	0.97
Surirella minuta Brébisson ex Kützing nom illeg	1.48	2.88	3.30	3.20	3.14	3.22	2.56	3.31	2.91
Surirella ovalis Brébisson	2.23	2.40	2.94	2.91	2.89	2.53	2.24	2.36	1.94
Ulnaria acus (Kützing) Aboal	1.49	1.92	1.83	2.04	2.24	2.07	1.92	1.89	1.94
Ulnaria ulna (Nitzsch) Compère	4.47	4.80	4.41	4.08	3.62	3.91	4.48	4.73	5.82

4. Discussion and Conclusion

In this study, some physical and chemical data were analyzed along with the benthic samples that were collected from the Sülük Lake on a monthly basis between March and November 2022 in order to identify the epipsammic diatoms. In this investigation, a total of 36 Bacillariophyta taxa were identified.

According to Reynolds [28], the optimum temperature for the development of algae is 25 ºC. Some algae species, though, prefer colder or warmer temperatures. In general, algae can endure temperatures between 10 and 30 °C. Biological, chemical, and physical processes, as well as changes in various concentrations, all have an impact on water activity. The environments species metabolic and respiration rates rise with temperature, which also causes an increase in oxygen consumption. Due of the reduced temperature and sunlight in winter, algaes reproduction rates and biomass decline. In the spring, phytoplanktonic organisms begin to proliferate as a result of the rise in temperature and length of the heating period, which causes the bacterial activity that results in the breakdown of nutrients into inorganic compounds. The average water temperature of the Sülük Lake was measured as 23.1 ºC which is below the optimum water temperature (25 ºC) required for the development of algae [28]. This prevented the diatoms from reaching high taxa numbers.

Round noted that diatoms developed well in phytoplankton in the spring and early summer and showed less development between July and October [29], contrary to Cox who claimed that light is the most significant component in the seasonal distribution of diatoms [30]. The results of this investigation, which was done in the Sülük Lake, were similar to those previously mentioned. The dissolved oxygen values of the Sülük Lake ranged from 7.0 to 9.7 mgO_2/L. The average amount of dissolved oxygen was 8.5 mg/L. The average electrical conductivity of the lake was 331.1 µmho/cm and the average temperature was measured as 23.1 ºC.

It was found that Bacillariophyta members have to be dominant [31]. It was observed that Navicula gregaria, Navicula rhyncocephala, Nitzschia palea, Amphora ovalis and Cymbella affinis species of these diatoms reached significant numbers.

The majority of the Sülük Lakes algae were diatoms (Bacillariophyta), which were significant in terms of the number of species, frequency of occurrence, and number of individuals. Due to their extreme rarity in terms of emergence frequency and individual number, other algae were overlooked. There were no Centrales diatom taxa found in the lake, and all diatom taxa that were recorded were Pennales. It was noted that the members of the Pennales order were not true planktonic species and that pennate diatoms were mostly found in phytoplankton when lakes were turbulent [32, 32, 34]. The epipsammic diatoms of the Sülük Lake are also composed of only pennate diatoms.

Diatoms were observed over the entire study period, which may suggest that they are cosmopolitan, adaptable to a variety of environments, and have a broad tolerance range. According to Chessman (1986) Navicula and Nitzschia species are widespread in distribution. In this study conducted in the Sülük Lake, the identification of Navicula and Nitzschia species in all months and with more taxa supports the idea that the species belonging to these genera are cosmopolitan [35].

Species belonging to Navicula and Nitzschia were recorded to be dominant in the studies carried out in the Central Anatolia Region [36]. Especially Nitzschia palea, N. sigma, N. sigmoide, N. terrestris and N. tenuis, Navicula cryptocephala, N. gregaria and N. radiosa were identified to be abundant and widespread in the Sülük Lake.

Cox stated that species such as Cymbella amphicephala, C. aspera, C. cymbiformis, C. leptoceros, C. lanceolata, Gomphonema angustum, G. subtile, Eunotia monodon are more common in oligotrophic waters [37]. Similarly, Eunotia, Frustulia, Pinnularia, and Neidium species are generally found in oligotrophic lakes [38]. Only Gomphonema angustatum among these organisms was detected in the Sülük Lake.

In conclusion, as the first algological study conducted in the Sülük Lake (Ağın/Elazığ), this study is expected to contribute to the identification of freshwater algal flora of both the Sülük Lake and Türkiye.

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