

Epipsammic diatoms in Ađın Region of Keban Dam Lake in Turkey

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Abstract

In this study, the epipsammic diatoms in Ađın Region of Keban Dam Lake were analyzed at two stations between March-November 2016. As a result, 41 diatom taxa in total were recorded; while two of these taxa belonged to the Centrales, 39 of them belonged to the Pennales ordo. The epipsammic diatoms showed their best growth in early months of autumn and in summer when light and temperatures were high. During the study, at both of the stations, the most significant diatoms in terms of their numbers of individuals and frequency of occurrence were *Navicula* spp., *Nitzschia* spp. and *Cymbella* spp.

Keywords: Epipsammic diatoms, Keban Dam Lake, Ađın, Turkey

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Introduction

Water, the main source of life, is the habitat of a large number of species. The number and diversity of the algae, which represent the first ring of the food chain, affect all living beings, including fish, in the aquatic environment. Algae, which are called the "primary producers" since they make their own food through photosynthesis, play an important role in the biological productivity of waters by the organic substances they create through photosynthesis. In this respect, as well as the awareness of their importance in waters, the identification of the algae is necessary for the development and protection of the aquaculture populations in our inland waters (Ahiska and Atici, 2005). The structure of the diatom communities forming an important group of freshwater algae is directly related to the physical and chemical conditions of the water. The immobile algal species

found in mucilaginous and filamentous masses mostly covering the tops of stones and hard rocks constitute the epilithic flora, the species living on sandy sediments constitute the epipsammic flora, and the species living on vegetative organs of plants constitute the epiphytic flora. In our country, many studies on benthic diatoms have been carried out. On the other hand, studies on benthic algae in dam lakes of the Eastern Anatolia Region are quite few in number (Gurbuz and Kivrak, 2003; Pala and Caglar, 2006). This study, which analyzes the epipsammic diatoms in Ağın Region of Keban Dam Lake, aims at making contribution to the productivity of our inland waters.

Materials and methods

In order to analyze the epipsammic diatoms in Ağın Region of Keban Dam Lake, samples were taken from two different parts of the lake (Fig. 1).

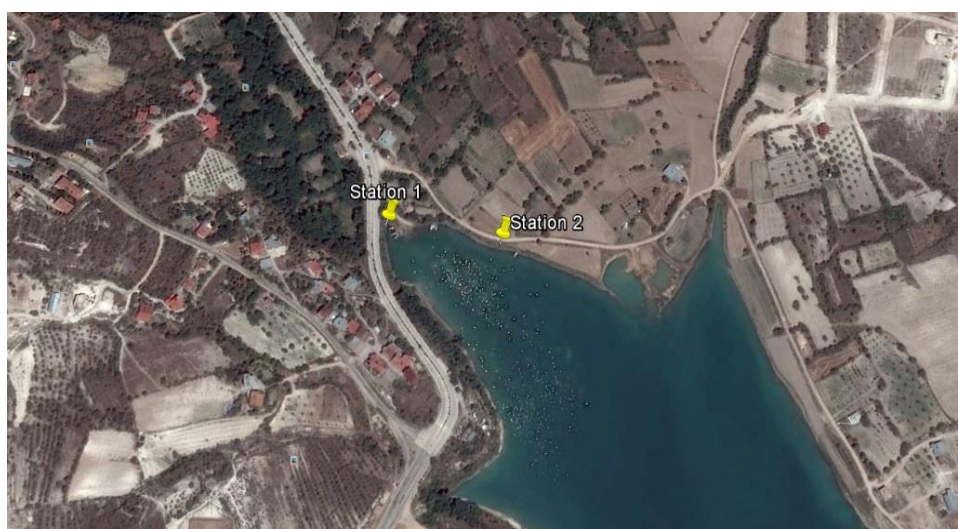


Figure 1: The situation of the stations in Ağın Region of Keban Dam Lake

While the first station is located between north latitudes $38^{\circ} 56' 20.67''$ and east longitudes $38^{\circ} 43' 7.66''$, the second station is located between north latitudes $38^{\circ} 36' 20.03''$ and east longitudes $38^{\circ} 43' 13.31''$ (URL, 1). Sampling was started in March (2016) and ended in October (2016). The method developed by Round (1953) was applied in the collection of the epipsammic algae. For collection, glass rod of 1 cm in diameter and of 100 cm length was used. Permanent prepares of the epipsammic samples were prepared for the exact identification of the diatoms.

Nikon branded microscope was used for species identification and counting of the diatoms permanent prepares. The counting was based on relative density and the results were given as "organism %".

Relative Density (RD) = $N_A/N \times 100$
 N_A = Total individual number of species
 A

N = Individual number of all species (Kocatas, 1999).

For species identification of the diatoms detected in Ağın Region of Keban Dam Lake, studies by Bourelly (1968, 1972), Germain (1981), Patrick and Reimer (1966, 1975) and Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b) were benefited.

Sorensen (1948) Similarity Index was used to define the similarity between the epipsammic algae.

Sorensen Similarity Index: $Q/S = 2J/A+B$

A = Total number of species in the first

sample

B = Total number of species in the second sample

J = Number of species common to both samples (Sorensen, 1948).

Results

In total 41 epipsammic diatom taxa were recorded at the selected two stations in Ağın Region of Keban Dam Lake. Among the epipsammic diatoms, the types represented by the most species were *Navicula* (7 taxa), *Nitzschia* (7 taxa) and *Cymbella* (4 taxa). While the diatom taxa *Cyclotella meneghiniana*, *Cymatopleura solea*, *Epithemia sorex*, *Sellaphora bacillum*, *Navicula tripunctata* and *Navicula viridula* were recorded only at the first station, *Cymbella leptoceros*, *Gyrosigma acuminatum*, *Navicula cuspidata* and *Nitzschia sigmoidea* were recorded only at the second station.

Availability of the epipsammic diatoms at the first and second stations is shown in Table 1.

Sorensen similarity index was calculated as 91% at both of the stations. Monthly changes in the relative densities of the epipsammic diatoms recorded at the first station are given in Table 2.

At the first station, in total 37 epipsammic diatom taxa, 2 of which belonged to the centrales and 35 of which belonged to the pennales ordo, were recorded.

Table 1: Availability of the epipsammic diatoms in Ağın Region of Keban Dam Lake according to the stations

Diatom Taxa	1st Station	2nd Station
Centrales		
<i>Cyclotella meneghiniana</i> Kütz.	+	-
<i>Pantocsekiella ocellata</i> (Pantocsek) K.T. Kiss & E.Acs	+	+
Pennales		
<i>Amphora ovalis</i> Kütz.	+	+
<i>Cocconeis placentula</i> Ehr.	+	+
<i>Cocconeis pediculus</i> Ehr.	+	+
<i>Cymbella affinis</i> Kütz.	+	+
<i>Cymbella cistula</i> (Ehr.) O. Kirchner	+	+
<i>Cymbella cymbiformis</i> Agardh	+	+
<i>Cymbella leptoceros</i> (Ehr.) Kütz.	-	+
<i>Cymatopleura solea</i> (Breb.) W. Smith	+	-
<i>Diatoma vulgare</i> Bory.	+	+
<i>Odontidium hyemale</i> (Roth) Kütz.	+	+
<i>Encyonema minutum</i> (Hilse) D.G. Mann	+	+
<i>Encyonema ventricosum</i> (Agardh) Grun.	+	+
<i>Epithemia turgida</i> (Ehr) Kütz.	+	+
<i>Epithemia sores</i> Kütz.	+	-
<i>Gomphonema angustatum</i> (Kütz.) Rabh.	+	+
<i>Gomphonema olivaceum</i> (Hornemann) Brebisson	+	+
<i>Gomphonema parvulum</i> (Kütz.) Kütz.	+	+
<i>Gyrosigma acuminatum</i> (Kütz.) Rabenhorst	-	+
<i>Gyrosigma constrictum</i> (Grun.) Cleve	+	+
<i>Sellaphora bacillum</i> (Ehr.) D.G. Mann	+	-
<i>Navicula cari</i> Ehr.	+	+
<i>Navicula cuspidata</i> (Kütz.) Kütz.	-	+
<i>Navicula gregaria</i> Donkin	+	+
<i>Navicula lanceolata</i> Ehr.	+	+
<i>Navicula radiosa</i> Kütz.	+	+
<i>Navicula tripunctata</i> (O.F.Müller) Bory	+	-
<i>Navicula viridula</i> (Kütz.) Ehr.	+	-
<i>Nitzschia amphibia</i> Grun.	+	+
<i>Nitzschia dissipata</i> (Kütz.) Rabenhorst	+	+
<i>Nitzschia palea</i> (Kütz.) W. Smith	+	+
<i>Nitzschia sigmoidea</i> (Nitzsch.) W. Smith	-	+
<i>Nitzschia sigma</i> (Kütz.) W. Smith	+	+
<i>Nitzschia tenuis</i> W. Smith	+	+
<i>Nitzschia tryblionella</i> Hantzsch	+	+
<i>Pinnularia viridis</i> (Nitzsch.) Ehr.	+	+
<i>Rhoicosphenia abbreviata</i> (Agardh) Lange-Bertalot	+	+
<i>Surirella ovalis</i> Brebisson	+	+
<i>Surirella minuta</i> Breb ex Kütz.	+	+
<i>Ulnaria ulna</i> (Nitzsch.) Compere	+	+

While *Navicula* (6 species) and *Nitzschia* (6 species) had the highest numbers of species, the most significant ones in terms of their frequency of occurrence and number of individuals were *Ulnaria*, *Gomphonema*, *Cymbella*, *Navicula* and *Nitzschia*. During the

period of the study at this station, the highest relative density (11.69%), which belonged to *Ulnaria ulna*, was recorded in October (2016).

Table 2: Monthly changes in the relative densities of the epipsammic diatoms recorded at the first station.

Diatom Taxa	Mar. 2016	Apr. 2016	May. 2016	Jun. 2016	Jul. 2016	Aug. 2016	Sep. 2016	Oct. 2016	Nov. 2016
<i>C. meneghiniana</i>	6.28	6.25	1.83	5.53	2.36	2.72	4.34	4.03	4.43
<i>P. ocellata</i>	-	3.64	5.04	1.27	-	3.85	3.76	3.22	5.69
<i>A. ovalis</i>	4.23	2.60	5.04	2.97	4.25	5.44	5.79	6.04	6.96
<i>C. placentula</i>	3.77	2.60	3.66	-	1.89	3.17	3.47	4.83	1.89
<i>C. pediculus</i>	-	2.08	1.37	2.12	1.89	1.58	2.89	-	-
<i>C. affinis</i>	6.91	5.20	3.66	5.53	2.83	4.98	5.21	1.61	4.43
<i>C. cistula</i>	1.25	3.64	5.96	6.80	4.72	2.49	2.31	1.61	2.53
<i>C. cymbiformis</i>	4.40	0.52	2.29	2.97	3.07	3.17	2.89	-	1.26
<i>C. solea</i>	-	-	0.91	-	0.94	0.68	0.28	0.80	-
<i>D. vulgaris</i>	2.51	3.12	10	-	1.18	-	-	4.43	3.16
<i>O. hyemale</i>	1.25	1.56	-	-	-	1.81	-	-	-
<i>E. minutum</i>	0.62	-	-	1.27	-	0.90	-	0.40	-
<i>E. ventricosum</i>	-	2.08	0.91	-	1.65	-	2.31	0.80	-
<i>E. turgida</i>	2.51	-	0.91	-	0.70	0.68	-	-	0.63
<i>E. sorex</i>	0.62	-	0.45	-	0.47	0.22	0.28	0.80	0.63
<i>G. angustatum</i>	2.51	2.60	6.42	7.65	4.96	-	4.05	2.82	3.79
<i>G. olivaceum</i>	1.25	6.25	3.66	1.70	2.83	1.58	1.44	1.20	-
<i>G. parvulum</i>	9.43	5.20	5.04	5.53	2.36	3.40	2.02	4.03	5.06
<i>G. constrictum</i>	1.88	2.60	1.83	2.97	1.89	0.90	1.73	2.01	0.63
<i>S. bacillum</i>	-	2.08	3.66	-	0.94	2.49	-	1.20	-
<i>N. cari</i>	3.14	1.04	1.83	5.10	6.61	5.44	4.34	3.22	1.89
<i>N. gregaria</i>	3.77	4.16	3.66	2.55	2.60	2.94	5.79	2.82	1.26
<i>N. lanceolata</i>	1.88	-	2.29	4.68	4.25	5.66	2.89	3.62	4.43
<i>N. radiosa</i>	4.40	2.60	4.59	7.23	2.36	4.76	6.95	7.66	6.96
<i>N. tripunctata</i>	2.51	5.72	3.66	1.70	2.60	1.58	3.76	1.20	5.69
<i>N. viridula</i>	-	3.64	-	-	-	0.90	-	-	-
<i>N. amphibia</i>	3.14	7.81	5.96	7.23	9.69	9.07	8.98	9.67	6.96
<i>N. dissipata</i>	-	2.60	-	-	8.74	-	-	8.46	10.12
<i>N. palea</i>	3.14	4.68	2.29	4.68	2.60	4.53	3.76	-	10.75
<i>N. sigma</i>	0.62	-	3.66	2.12	2.36	2.72	-	1.20	-
<i>N. tenuis</i>	2.51	1.56	0.45	2.55	2.83	4.08	1.73	-	0.63
<i>N. tryblionella</i>	4.40	2.60	3.66	5.10	3.30	3.85	3.18	2.41	1.26
<i>P. viridis</i>	-	-	-	2.97	1.18	1.58	0.28	-	-
<i>R. abbreviata</i>	9.43	5.20	2.75	1.70	4.25	5.44	6.37	5.24	6.96
<i>S. ovalis</i>	1.25	-	1.37	-	1.41	-	2.89	2.01	0.63
<i>S. minuta</i>	0.62	2.60	-	3.40	1.65	1.13	-	0.80	1.26
<i>U. ulna</i>	8.80	3.64	6.42	2.55	4.49	6.12	6.08	11.69	-

It was also remarkable that *Ulnaria ulna* which reached the maximum relative density level in October was not detected in the samples taken in November. After *Ulnaria ulna*, the highest relative densities belonged to *Nitzschia amphibia* (July, October), *Rhoicosphenia abbreviata* and

Gomphonema parvulum (March). While the lowest numbers of individuals belonging to all species were recorded in November, the highest numbers of individuals were recorded in July and August when the temperature raised.

At the second station, in total 35 diatom taxa, 1 of which belonged to the Centrales and 34 of which belonged to the Pennales ordo, were recorded.

Nitzschia (7 species), Navicula (5 species) and Cymbella (4 species) had the highest numbers of species.

Table 3: Monthly changes in the relative densities of the epipsammic diatoms recorded at the second station.

Diatom taxa	Mar. 2016	Apr. 2016	May. 2016	Jun. 2016	Jul. 2016	Aug. 2016	Sep. 2016	Oct. 2016	Nov. 2016
<i>P. ocellata</i>		0.62	1.83	1.21	1.94	1.96	1.41	1.31	1.80
<i>A. ovalis</i>	1.48	3.75	3.14	2.81	2.33	1.31	1.94	0.65	2.16
<i>C.placentula</i>	6.31	5.31	5.49	4.83	3.89	2.94	2.99	2.19	0.72
<i>C. pediculus</i>	-	7.50	-	3.01	-	-	2.64	-	-
<i>C. affinis</i>	7.81	5.62	7.06	4.22	4.28	8.02	9.17	8.75	9.75
<i>C. cistula</i>	7.06	3.12	-	2.01	-	-	2.47	1.97	2.53
<i>C.cymbiformis</i>	-	0.62	3.66	3.62	1.94	3.93	0.35	4.59	-
<i>C. leptoceros</i>	1.85	2.50	5.76	-	2.53	2.78	6.52	-	0.36
<i>D. vulgaris</i>	-	8.12	-	4.22	3.50	1.80	4.23	3.93	4.33
<i>O. hyemale</i>	0.37	2.19	-	2.41	-	2.45	-	2.40	3.24
<i>E. minutum</i>	1.11	2.50	3.14	1.01	1.94	1.14	1.59	1.31	0.36
<i>E.ventricosum</i>	0.74	0.31	1.04	1.40	1.55	2.45	2.99	1.31	1.08
<i>E. turgida</i>	-	-	1.04	1.40	1.16	1.80	1.41	0.65	-
<i>G.angustatum</i>	2.60	3.43	3.66	3.62	3.50	3.43	4.76	7.00	6.49
<i>G. olivaceum</i>	1.85	2.50	4.18	2.81	4.47	4.42	2.47	2.19	3.24
<i>G. parvulum</i>	16.73	-	6.54	2.41	-	1.63	2.64	-	-
<i>G.acuminatum</i>	4.83	3.75	4.18	4.22	3.30	4.09	3.70	3.93	8.66
<i>G. constrictum</i>	1.11	4.37	2.35	2.01	1.56	1.96	-	1.53	1.44
<i>N. cari</i>	1.85	-	3.66	2.61	3.30	3.27	2.64	2.62	3.97
<i>N.cuspidata</i>	2.60	3.43	3.92	2.41	2.72	4.41	2.64	1.75	1.08
<i>N. gregaria</i>	3.71	1.56	-	3.62	3.50	3.43	2.47	-	1.80
<i>N. lanceolata</i>	4.46	3.12	4.71	4.22	4.67	4.41	3.70	4.16	1.80
<i>N. radiosa</i>	-	1.87	6.28	4.83	4.28	4.58	4.94	5.90	9.38
<i>N. amphibia</i>	0.37	2.81	3.66	12.67	4.08	2.45	1.76	1.09	6.14
<i>N. dissipata</i>	-	5.31	-	3.01	2.53	2.94	6.35	3.28	2.16
<i>N. palea</i>	4.83	3.43	3.66	3.42	5.45	3.43	3.35	3.93	2.53
<i>N. sigmoidea</i>	2.60	0.62	4.18	2.01	2.72	2.12	1.41	2.40	0.72
<i>N. sigma</i>	4.83	-	1.30	-	9.34	4.42	-	4.15	2.88
<i>N. tenuis</i>	1.48	3.43	-	2.81	1.36	0.98	2.47	1.97	4.33
<i>N. tryblionella</i>	3.34	-	2.87	3.42	3.11	3.11	3.70	3.93	1.08
<i>P. viridis</i>	-	0.93	1.83	-	0.97	2.94	0.52	2.40	-
<i>R. abbreviata</i>	6.32	5.94	6.54	3.21	7.19	6.38	7.23	5.68	6.49
<i>S. ovalis</i>	1.85	2.81	-	-	3.30	0.65	0.70	1.75	0.72
<i>S. minuta</i>	-	-	-	1.61	-	1.14	2.47	2.62	-
<i>U. ulna</i>	7.81	8.43	4.18	2.81	3.50	3.35	2.29	8.53	8.66

The most significant species in terms of their frequency of occurrence and number of individuals were *Cocconeis placentula*, *Cymbella affinis*, *Epithemia minutum*, *Gyrosigma acuminatum*,

Navicula lanceolata, *Nitzschia amphibia*, *Nitzschia palea*, *Rhicosphenia abbreviata* and *Ulnaria ulna*. The relative density of *Gomphonema parvulum* in March

(16.73%) was the highest among all. With regard to relative density, this diatom was followed by *Nitzschia amphibia* (June), *Cymbella affinis* (September, November) and *Nitzschia sigma* (July). Relative densities belonging to the other diatoms were not above 9%.

Monthly changes in the relative densities of the epipsammic diatoms recorded at the second station are given in Table 3.

Discussion and conclusion

During the study, 41 taxa belonging to the epipsammic diatoms in Ağın Region of Keban Dam Lake were recorded. Because compared to other algae, diatoms are more dominant in terms of their number of individuals and frequency of occurrence, the other algae were ignored in the study. It was also reported in similar studies carried out in different regions of our country and abroad (Pala, 2014; Pala ve Caglar, 2006, 2008; Pala vd., 2016; Round, 1981; Sahin, 1998). Those diatoms were more dominant in terms of their number of individuals and frequency of occurrence, and therefore the other algal groups were ignored in the studies.

During the period of the study, while *Pantocksekiella ocellata*, *Amphora ovalis*, *Cocconeis placentula*, *Cocconeis pediculus*, *Cymbella affinis*, *Cymbella cistula*, *Cymbella cymbiformis*, *Diatoma vulgare*, *Odontidium hyemale*, *Encyonema minutum*, *Encyonema ventricosum*,

epithemia turgida, *Gomphonema angustatum*, *Gomphonema olivaceum*, *Gomphonema parvulum*, *Gyrosigma constrictum*, *Navicula cari*, *Navicula gregaria*, *Navicula lanceolata*, *navicula radiosa*, *Nitzschia amphibia*, *nitzschia dissipata*, *Nitzschia palea*, *Nitzschia sigma*, *Nitzschia tenuis*, *Nitzschia tryblionella*, *Pinnularia viridis*, *Rhoicosphenia abbreviata*, *surirella ovalis*, *Surirella minuta* and *Ulnaria ulna* were recorded to be the species common to both stations, *Cyclotella meneghiniana*, *Cymatopleura solea*, *Epithemia sorex*, *Sellahhora bacillum*, *Navicula tripunctata* and *Navicula viridula* were recorded only at the first station, and *Cymbella leptoceros*, *Gyrosigma acuminatum*, *Navicula cuspidata* and *Nitzschia sigmoidea* were recorded only at the second station. Based on this finding, it may be interpreted that the diatoms prefer some substrates to hold on.

At both of the stations selected from Ağın Region of Keban Dam Lake, the diatoms represented by the highest number of species were *Navicula* and *Nitzschia*. In the relative densities of the species recorded at both stations, considerable decreases were observed at the end of autumn. And this may have resulted from the decrease in water temperature and turbidity caused by non-living solid particles. In our study, at the first station, *Odontidium hyemale*, *Navicula viridula*, *Encyonema minutum*, *Nitzschia dissipata*, *Pinnularia viridis*, and at the second station, *Cocconeis pediculus*,

Gomphonema parvulum and *Surirella minuta* were recorded to be the diatom taxa occurring less frequently compared to the other species.

Cymbella spp., *Navicula* spp. and *Ulnaria* spp. recorded among the epipsammic diatoms in Ağın Region of Keban Dam Lake were reported as typical benthic species of inland waters in general (Hutchinson, 1957).

Chessman (1986) stated that *Navicula* and *Nitzschia* were cosmopolitan species. This assumption is supported by the fact that *Navicula* and *Nitzschia* were also detected in various studies carried out in our country (Pala ve Caglar, 2006, 2008). In accordance with their frequency of occurrence and number of species, *Navicula* and *Nitzschia* were also frequently encountered at both stations in Ağın Region of Keban Dam Lake.

In studies on identification of the benthic algae in lakes, ponds, rivers, and dam lakes in other regions of our country, the Centrales members known as planktonic forms were detected on the sediments, in negligible small quantities, though (Altuner and Gurbuz, 1996; Pala and Caglar, 2006, 2008; Pala *et al.*, 2016). The Centrales members (*Cyclotella meneghiniana*, *Pantocsekiella ocellata*) were also found among the epipsammic diatoms in Ağın Region of Keban Dam Lake.

The fact that diatoms are always present in benthic algal community shows they are cosmopolitan and may frequently be found on any kind of substratum, and that these algae have a

better ability of adaptation compared to the others.

Cox (1984) stated that light is the most important factor in the seasonal distribution of diatoms. Round (1973) stated that diatoms grow well in phytoplankton in early spring and summer, and they show less growth during the period between July-October (Round, 1973). Furthermore, Lund (1965) noted that temperature and light are the most important factors which have effect on the growth of algae. Accordingly, in our study, the species richness and number of individuals of the diatoms showed difference in summer when the temperature and light increased. The poorest period of the epipsammic diatoms in the lake in terms of species composition and number of individuals was November. This finding supports the idea that water temperature and light have impact on the growth of diatoms.

In this study, the epipsammic diatoms in Ağın Region of Keban Dam Lake were analyzed, and the number of species at the first station was found to be a bit more than that of the second station. This results from the fact that the first station is located closer to the inside compared to the second one. In conclusion, this study provides the first data belonging to Ağın Region of Keban Dam Lake. The identification of ecological features of our water sources, analysis and development of water sources in different regions, through monitoring programs for their

sustainable use, are important in this regard.

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