Epilithic algae of Çalgan Creek

Caglar M.[1]; Coskun E.[1]; Selamoglu Z.[2*]

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Abstract

In this study, the epilithic algae in the samples collected from three stations on the Çalgan Creek (Elazığ) in Fırat University between January and June 2016 were investigated in terms of some physical and chemical parameters. During the study, 44 taxa of epilithic algae were recorded. It was observed that Euglenophyta (1 species), Cyanophyta (3 species), Chlorophyta (6 species) and Bacillariophyta (34 species) both had the most species and were the most important algae in the epilithic algal community considering their frequency of occurrence and population size.

Keywords: Algae, Epilithic, Çalgan Creek, Elazığ.

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1-Department of Fundamental Science, Faculty of Fisheries, Firat University, Elazig, Turkey
2-Department of Medical Biology, Faculty of Medicine, Nigde Ömer Halisdemir University, Nigde, Turkey
*Corresponding author's Email: zselamoglu@ohu.edu.tr

Introduction

Water is a very important resource for social and economic developments. As is known, it covers nearly three-quarters of the Earth's surface. Algae are found anywhere there is water. They are the primary producers of aquatic environments. By the pigments they contain, they convert carbon dioxide into carbohydrates under the influence of water and light, and increase the nutritional value and dissolved oxygen rate in the environment. Through photosynthesis, algae produce approximately 70-90% of the oxygen in the atmosphere which is essential for life. Besides, they are also beneficial in economic terms. Some algae are used in medicine, pharmaceutical and cosmetic industry, and even in food industry. Furthermore, algae are used as fertilizer in regions close to the sea (Altuner, 1994).

Algae play a major role in determining the biological productivity of waters. Identification of algae and awareness of their importance in waters are essential for the growth and preservation of aquaculture populations in our waters. Knowledge of the change algae show in time is of high importance in terms of both human benefit and protection of water quality. Because the number and diversity of algae and other organisms may constantly change depending on environmental conditions (Charles, 1994).

It is required to determine the existence of the epiphytic, epilithic, epipsammic and epipelic algae spread in natural lakes and to make the maximum use of them. It would be very useful in terms of national economy to benefit more efficiently from the aquaculture products particularly in Turkey where they make up an important resource but are not used effectively. It is a known fact that in recent years there has been an increase in the number of the studies on inland waters in Turkey. Most of these studies have been conducted on lakes, ponds, dam lakes and streams.

In their studies on the epilithic diatoms of the Keban Dam Lake's İçme region, Pala and Çağlar (2006) recorded a total of 53 diatom species. While *Navicula* (9 species), *Gomphonema* (8 species), *Nitzschia* (7 species) and *Fragilaria* (6 species) were reported as the diatoms represented by the highest number of species in İçme region of the Keban Dam Lake, *Navicula* spp., *Gomphonema* spp. and *Synedra* spp. were the most significant diatoms in the epilithic diatom community considering their frequency of occurrence and the size of their populations. In Akköz and Güler's (2004) study on the composition and seasonal changes of the epilithic and epiphytic algae of the Topçu Pond in Yozgat, while Bacillariophyta (64 taxa) was the group of organisms available and dominant in every season, Chlorophyta, Cyanophyta, Euglenophyta, and Chrysophyta were represented by 14, 12, 5, and 2 taxa, respectively. Considering their seasonal reproduction patterns, the algae grew best in spring and autumn.

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In their study on the composition and seasonal changes of the benthic algae of the Suğla Lake in Konya, Akköz and Yılmaz (2009) also analyzed the physical and chemical properties of the lake water periodically June 2005-May 2006. While Bacillariophyta (54 taxa) was the group of organisms available and dominant in every season in the lake, Chlorophyta, Charophyta, Cyanobacteria, Euglenophyta, and Pyrrophyta were represented by 23, 8, 12, 4, and 1 taxa, respectively. Considering their seasonal reproduction patterns, Bacillariophyta grew best in spring and autumn.

In their study on the seasonal changes of the epilithic algae of the Tersakan Creek, Maraşlıoğlu *et al*. (2016) examined the stone samples collected in monthly periods on June 2007-May 2008 from a selected station at the exit of the Ladik Lake. The frequency and dominance of the species detected in the epilithic algal flora were determined and it was observed that Bacillariophyta members were dominant in the community. Bacillariophyta members *Cyclotella meneghiniana*, *Melosira varians*, *Diatome vulgaris*, *Cocconeis placentula*, *C. placentula* var. *euglypta*, *Gomphonema olivaceum*, *Navicula cincta*, *N. cryptocephala*, *N. rhynchocephala*, *Rhoicosphenia abbreviate*, and *Nitzschia palea* were found to be common species. Moreover, it was noted that Chlorophyta, Cyanobacteria, Euglenophyta, and Charophyta members were represented by very few species. In their study on the composition of the epilithic and epiphytic algae of the Taşmanlı Pond, Gümüş and Gönülol (2017) analyzed the physicochemical properties of the lake water as well as the seasonal changes of the algae March 2008-March 2009. While a total of 70 taxa were recorded in the algal flora, Bacillariophyta species were observed to be dominant in the flora.

Tokatlı and Dayıoğlu (2011) determined the epilithic diatom flora of the Murat Creek through the samples collected monthly on September 2007-April 2008 from selected 5 stations. In the study, a total of 75 diatom taxa, 70 belonging to Pennales and 5 belonging to Centrales, were recorded. Taş *et al*. (2015) investigated the epipelic diatom flora of the Lower Melet Stream which is the most important drinking water resource of Ordu. In the analysis carried out periodically between March-November 2012, a total of 56 diatom taxa were recorded. Cymbellales (14 taxa) and Naviculales (16 taxa) made up 54% of the diatom diversity. In the epipelic community, *Diatoma vulgaris*, *Melosira varians*, *Navicula gregaria*, *N. tripunctata*, and *Nitzschia sigmoidea* species were found to be dominant.

Through monthly samples collected between December 2013-November 2014 from selected 3 stations on the Pınargözü Spring, Ateş and Ertan (2017) analyzed the physicochemical properties of the spring water and the distribution and development of the epilithic algae. A total of 97 algal taxa, 80 belonging to Bacillariophyta, 11 belonging to Cyanobacteria, 5

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belonging to Chlorophyta, and 1 belonging to Charophyta, were recorded. It was observed that Bacillariophyta were more dominant compared to the other algae considering their numbers of taxa and individuals. Çiçek and Ertan (2015), who carried out a study to determine the water quality of the Köprüçay River (Antalya) by the epilithic diatoms, recorded a total of 119 Bacillariophyta taxa. *Navicula*, *Nitzschia*, *Cymbella*, and *Gomphonema* were the diatoms with the highest number of species.

Material and methods

The Çalgan Creek is located 5 km northwest of Elazığ, in Fırat University campus. It flows freely for some distance in the northern part of the campus, and then runs through a closed system towards the southwest of the city. It is used for the irrigation of the surrounding cultivation areas. It dries up at times during the summer months when the air temperature is high. In this study, three different sampling stations were selected along the Çalgan Creek in Fırat University (Fig. 1).

The station I was taken as the creek's source, the station II was selected 500 m away from the source, and the station III was selected 500-600 m away from the station II. The epilithic samples were collected between January (2016) and June (2016). At the stations, in situ measurements were carried out using a portable ORION 3 STAR pH meter for pH and temperature determinations, and an YSI 55 DO digital oxygen meter for dissolved oxygen determinations.

The stones collected from the stations were taken to the laboratory in sterilized glass jars. Due to the fact that in the microscopic examination, the number of plankton per unit volume of water was observed to be very low or generally no plankton was detected, the water samples were concentrated by centrifugation. Temporary preparations were prepared for the determination of the algae other than the diatoms while permanent preparations were prepared in order to be able to exactly determine the diatoms and examine them for a longer period of time. For the permanent preparations, samples of certain volume (10 mL) were allowed to react with 5 ml HNO_3+5 ml H_2SO_4 acid and boiled for 15 minutes at 120°C on a heating stage whereby the organic matters in the diatom cells were oxidized and only diatom shells composed of silisium were left in the beaker. For deacidification, the acidic water in the beaker was carefully poured and distilled water was added to the diatom shells left at the bottom of the beaker until a nearly neutral environment was obtained. One drop of the sample containing the diatom shells was taken and placed on the cover glass, and then it was left to dry at room temperature. Later, the cover glasses were lifted with the help of a forceps, turned upside down and put on the slide on which entellan was dropped beforehand. In order to avoid air bubbles in the preparation, soft pressure was applied on the cover glasses after

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the slides were fixed to each other (Round, 1953).

For the species determination of the diatoms detected in the researched pond water, primarily the studies by Germain (1981), Grimes and Rushforth (1982), Krammer and Lange-Bertalot (1986, 1988, 1991 a, b) were taken as a basis. For the determination of the algae other than the diatoms, on the other hand, the studies by Smith (1950) and John *et al*. (2002) were benefited from.

Results

Monthly changes in the water temperature values measured at the selected stations on the Çalgan Creek throughout (Fig. 1).

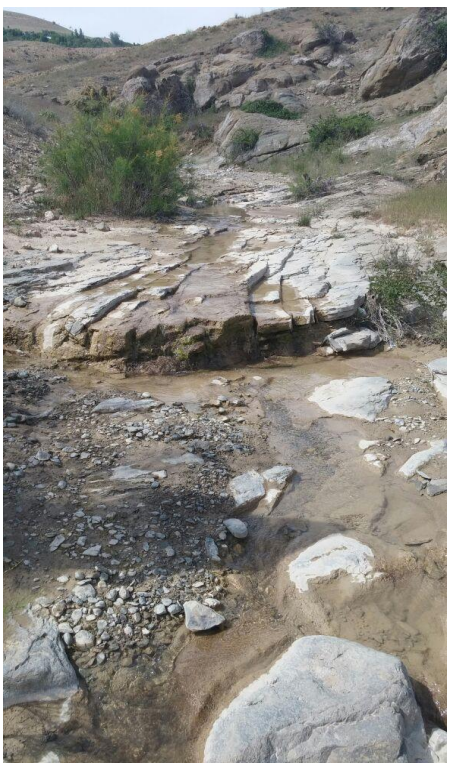

Figure 1: A general view of the Çalgan Creek.

At the station I selected on the Çalgan Creek, the lowest water temperature ($6,6^0$C) was recorded in February while the highest one (21.7^0C) was recorded in June. At this station, the average water temperature of the Çalgan Creek was found to be 14.15^0C. At the station II, the lowest water temperature (7^0C) was recorded in February while the highest one (21.3^0C) was recorded in June. At this station, the average water temperature of the creek was found to be 14.15^0C. At the station III, similar to the other stations, the lowest water temperature (7.4^0C) was recorded in February while the highest one (20.9^0C) was recorded in June. At this station, the average water temperature of the creek was found to be 14.15^0C (Fig. 2).

In aquatic habitats, solubility of oxygen, like all the other gases, is inversely proportional to temperature. The values of dissolved oxygen recorded during the study period generally supported this. Monthly changes in the dissolved oxygen concentrations measured through the water samples taken from the selected stations on the Çalgan Creek (Fig. 2).

At the station I selected on the Çalgan Creek, the lowest dissolved oxygen concentration (5.41 mg/L) was recorded in June while the highest one (11.6 mg/L) was recorded in January. At this station, the average dissolved oxygen concentration of the Çalgan Creek was found to be 7.8 mg/L.

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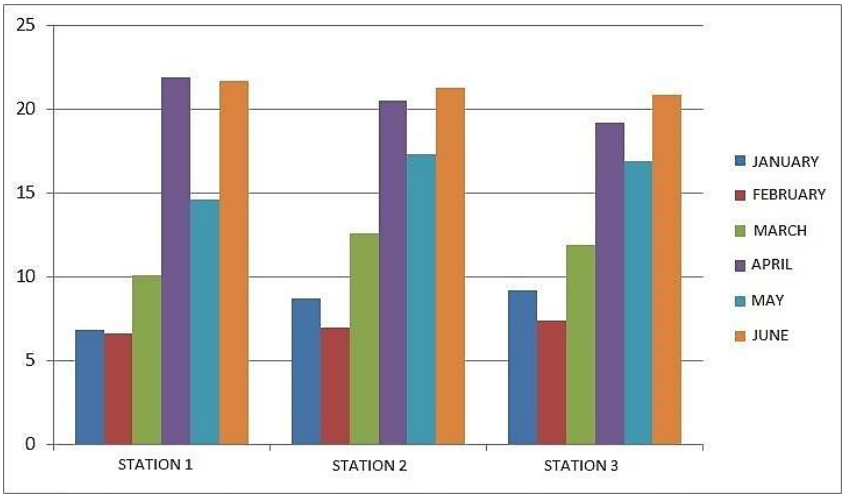

Figure 2: Monthly temperature changes at the stations on the Çalgan Creek.

At the station II, the lowest dissolved oxygen concentration (5.42 mg/L) was recorded in June while the highest one (10.9 mg/L) was recorded in January. The average dissolved oxygen concentration of this station was found to be 8.16 mg/L. At the station III, the lowest dissolved oxygen concentration (5.4 mg/L) was recorded in June while the highest one (10.4 mg/L) was recorded in January. The average dissolved oxygen concentration of this station was found to be 7.92 mg/L. Monthly changes in the pH values measured in the water samples taken from the selected stations on the Çalgan Creek (Fig. 3).

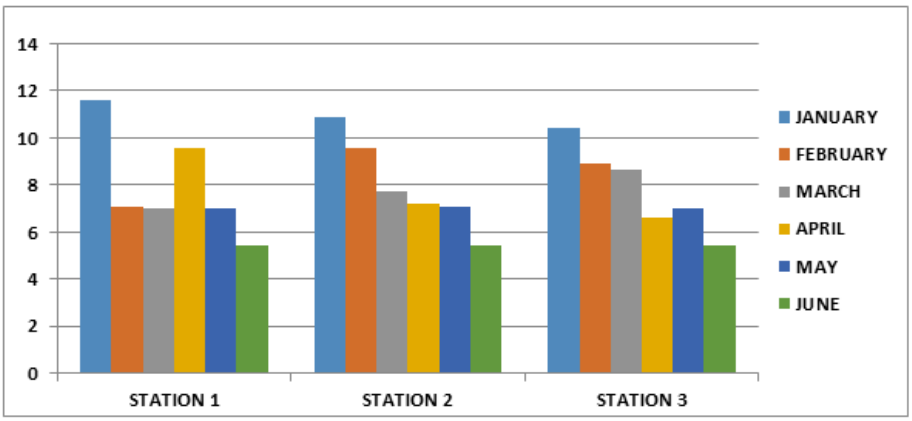

Figure 3: Monthly changes in the dissolved oxygen concentrations at the stations on the Çalgan Creek.

At the station I selected on the Çalgan Creek, the lowest pH (6.1) was recorded in June while the highest one (8.3) was recorded in March. The average pH at this station was found to be 7.2. At the station II, the lowest pH (6.2) was recorded in June while the highest one (8.6) was recorded in April.

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The average pH at this station was found to be 7.4. At the station III, the lowest pH (6.1) was recorded in June while the highest one (8.7) was recorded in April. At this station, the average pH of the creek was found to be 7.4 (Fig. 4).

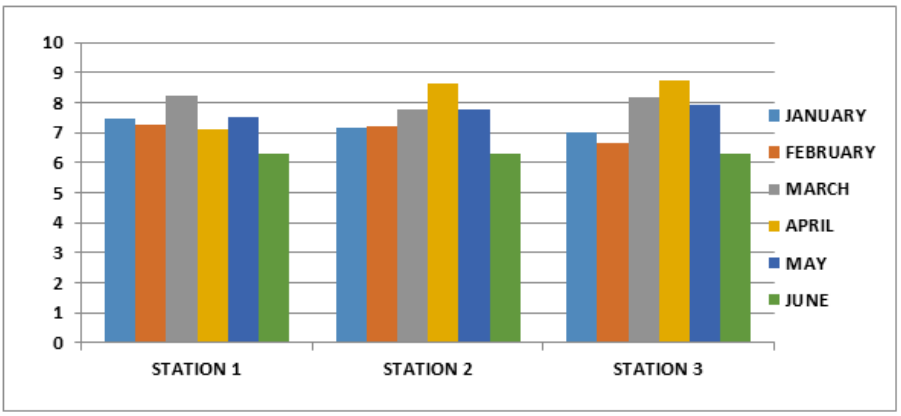

Figure 4: Monthly pH changes at the stations on the Çalgan Creek.

The availability of the epilithic algae at stations during the study period were shown in table 1. The algae are listed in alphabetical order under the divisions they belong to. At the first station, a total of 28 taxa, 2 belonging to Cyanophyta and 26 belonging to Bacillariophyta, were recorded. At this station, no members of Chlorophyta or Euglenophyta were detected. At the second station, a total of 33 taxa, 2 belonging to Cyanophyta, 5 belonging to Chlorophyta, 1 belonging to Euglenophyta and 25 belonging to Bacillariophyta, were recorded. And at the third station, a total of 34 taxa, 3 belonging to Cyanophyta, 1 belonging to Chlorophyta, 1 belonging to Euglenophyta and 29 belonging to Bacillariophyta, were recorded (Table 1).

Table 2 shows monthly relative densities and frequencies of occurrence of the epilithic diatoms recorded at the first station. The frequency of occurrence of the diatoms recorded at the first station varied between 16.66-83.33%. The species with the highest frequency of occurrence were found to be *Gomphonema angustatum*, *Sellaphora pupula* and *Ulnaria ulna*. At this station, the highest relative density (39.75%) recorded during the study period was that of *Diatoma elongate* in April. The lowest relative densities (0.62%) were recorded in April and belonged to *Cocconeis placentula*, *Gomphonema acuminatum* and *Sellaphora pupula* (Table 2).

Monthly relative densities and frequencies of occurrence of the epilithic diatoms recorded at the second station.

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Table 1: Availability of the epilithic algae at the stations.

Taxa	Station I	Station II	Station III
Cyanophyta			
Chroococcus minutus (Kütz.) Naegeli	-	-	+
Phormidium diguetti Gomont	+	+	+
Trichormus variabilis (Kütz ex Bornet &Flahault) Kamarek& Anagnestidis	+	+	+
Chlorophyta			
Cladophora glomerata (Linneaus) Kütz.	-	-	+
Pseudopediastrum boryanum (Turpin) E. Hegewald	-	+	-
Spirogyra gracilis Kütz.	-	+	-
Tetraedrön sp.	-	+	-
Trachelomonas sp.	-	+	-
Zygnema sp.	-	+	-
Euglenophyta			
Euglena viridis (O.F. Muller) Ehr.	-	+	+
Bacillariophyta			
Achnanthidium affine (Grunow) Czarnecki	-	-	+
Achnanthidium minutissimum (Kütz.) Czarnecki	+	+	+
Amphora ovalis (Kütz.) Kütz.	+	+	+
Cocconeis placentula Ehr.	+	-	+
Cymbella affinis Kütz.	+	+	+
Cymbella cymbiformis C. Agardh	+	+	+
Cymbella helvetica Kütz.	+	-	+
Diatoma elongata (Lyngbya) C.Agardh	+	+	+
Encyonema elginense (Krammer) D.G.Mann	+	+	+
Encyonema ventricosum (C.Agardh) Grunow	+	-	-
Fragilaria bidens Heiberg	+	-	+
Fragilaria crotonensis Kitton	-	+	+
Fragilariaforma bicapitata (A.Mayer) D.M.Williams& Round	+	+	+
Gomphonema angustatum (Kütz.) Rabenhorst	+	+	+
Gomphonema parvulum (Kütz.) Kütz.	+	+	+
Gomphonema pupula Ehr.	-	+	-
Gyrosigma acuminatum (Kütz.) Rabenhorst	+	-	+
Navicula cryptocephala Kütz.	+	+	+
Navicula gregaria Donkin	+	+	-
Navicula phyllepta Kütz.	+	+	+
Navicula trivialis Lange_Bertalot	-	-	+
Navicula trivialis Lange-Bertalot	+	+	+
Nitzschia gracilis Hantzsch	+	+	+
Nitzschia linearis W. Smith	+	+	+
Nitzschia palea (Kütz.) W. Smith	-	-	+
Nitzschia sigmoidea (Nitzsch.) W.Smith	-	+	-
Odontidium hyemela (Roth) Kütz.	+	+	+
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot	+	+	+
Sellaphora pupula (Kütz.) Mereschkovsky	+	+	+
Surirella angusta Kütz.	-	+	+
Surirella minuta Brebisson ex Kütz.	+	-	+
Tryblionella angustata W.Smith	-	+	-
Ulnaria acus (Kütz.) Aboal	+	+	+
Ulnaria ulna (Nitzsch.) Compere	+	+	+

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Table 2: Monthly relative densities and frequencies of occurrence of the epilithic diatoms recorded at the first station.

Taxa	Relative density (%) Months (2016)						Frequency of occurrence (%)
	January	February	March	April	May	June	
Bacillariophyta							
Achnanthidium minutissimum	-	-	-	3.72	5.22	14.63	50
Amphora ovalis	11.11		2.33	-	-	-	33.33
Cocconennis placentula	-	-	-	0.62	-	4.87	33.33
Cymbella cymbiformes	-	-	-	-	10.45	-	16.66
Cymbella helvetica	-	2.59	-	-	-	-	16.66
Diatoma elongata	.	-	-	39.75	3.26	-	50
Encyonema elginense	-	-	-	3.72	-	-	16.66
Encyonema ventricosum	11.11	-	-	-	-	-	16.66
Fragilaria bidens	11.11	-	-	-	-	-	16.66
Fragilariforma bicapitata	-	-	1.86	-	-	-	16.66
Gomphonema acuminatum	-		-	0.62	-	-	16.66
Gomphonema angustatum	19.44	6.49	34.57	6.21	13.07	-	83.33
Gomphonema parvulum	-	24.67	-	26.70	-	-	33.33
Navicula cryptocephala	2.77	14.28	-	-	1.96	-	50
Navicula gregaria	-	5.19	-	-	-	-	16.66
Navicula phyllepta	-	-	31.77	4.34	-	-	33.33
Navicula trivialis	-	-	-	-	4.57	-	16.66
Nitzschia gracilis	25	-	-	-	-	-	16.66
Nitzschia linearis	-	-	-	-	9.15	-	16.66
Odontidium hyemala	-	-	1.40	-	1.30	-	33.33
Rhoicosphenia abbreviata	-	-	-	-	1.30	17.07	33.33
Sellaphora pupula	-	2.59	2.80	0.62	8.49	12.19	83.33
Surirella minuta	2.77	-	-	-	-	-	16.66
Ulnaria acus	-	-	-	3.10	-	-	16.66
Ulnaria ulna	8.33	3.89	3.27	4.96	13.07	-	83.33

At the second station, a total of 25 taxa belonging to the epilithic diatoms were recorded. At this station, *Navicula* was found to be the diatom represented by the highest number of species. *Ulnaria ulna*, on the other hand, was the one with the highest frequency of occurrence (100%) and relative density. The relative densities of this diatom recorded in March (40.56%) and May (40.36%) were the highest relative densities at this station. Considering the increase in the number of the algae together with temperature rise, it is remarkable that at this station, few diatoms were detected in June (Table 3).

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Table 3: Monthly relative densities and frequencies of occurrence of the epilithic diatoms recorded at the second station.

Taxa	Relative density (%) Months (2016)						Frequency of occurrence (%)
	January	February	March	April	May	June	
Bacillariophyta							
Achnanthidimum minutissimum	-	-	-	10.72	13.25	-	50
Amphora ovalis	9.67	-	-	1.75	1.49	-	50
Cymbella affinis	9.67	5.26	4.71	1.75	-	-	66.66
Cymbella cymbiformis	-	-	-	1.53	14.45	-	33.33
Diatoma elangata	-	-	3.77	7.0	2.40	-	50
Encyonema elginense	-	-	1.88	0.87	-	-	33.33
Fragilaria crotonesis	-	1.05	1.88	-	-	-	33.33
Fragilariforma bicapitata	3.22	2.10	8.49	0.21	-	-	66.66
Gamphonema angustatum	12.90	7.36	4.71	10.28	-	14.92	83.33
Gomphonema parvulum	-	1.05	-	2.18	-	-	33.33
Gomphonema pupula	16.12	-	27.35	5.25	75	-	66.66
Navicula cryptocephala	-	-	-	2.18	1.80	-	33.33
Navicula gregaria	-	4.21	-	-	-	-	16.66
Navicula phyllepta	-	-	-	1.53	-	-	16.66
Navicula trivialis	-	15.78	-	5.68	2.40	32.83	66.66
Nitzschia gracilis	6.45	-	-	0.87	-	-	33.33
Nitzschia linearis	-	1.05	-	-	-	-	16.66
Nitzschia sigmoidea	-	-	-	-	-	4.47	16.66
Odontidium hyemala	-	16.84	-	1.09	-	-	33.33
Rhoicosphenia abbreviata	-	1.05	-	2.18	-	-	33.33
Sellaphora pupula	22.58	-	27.35	5.25	13.25	-	66.66
Surirella angustatum	-	-	-	0.65	-	-	16.66
Tryblionella angustata	-	27.36	-	-	-	-	16.66
Ulnaria acus	-	-	-	4.37	16.26	-	33.33
Ulnaria ulna	6.45	5.26	40.56	22.10	40.36	32.83	100

Monthly relative densities and frequencies of occurrence of the epilithic diatoms recorded at the third station. At this station, the diatoms with the highest frequencies of occurrence were *Diatoma elongata*, *Gomphonema angustatum*, *Sellaphora pupula* and *Ulnaria ulna* (83.33%). The highest relative density (38.14%) was that of *Sellaphora pupula* in March. The lowest relative density (0.51%), on the other hand, was recorded in March and belonged to *Encyonema ventricosum* and *Navicula trivialis* (Table 4).

During the research, Cyanophyta, Chlorophyta and Euglenophyta members were also detected in the Çalgan Creek. However, compared to the diatoms, these algae were of no much significance considering their frequency of occurrence and number of individuals.

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Table 4: Monthly relative densities and frequencies of occurrence of the epilithic diatoms recorded at the third station.

Taxa	Relative density (%) Months (2016)						Frequency of occurrence (%)
	January	February	March	April	May	June	
Bacillariophyta Pennales							
Achnanthidium affine	-	-	-	2.21	-	-	16.66
Achnanthidium minutissimum	-	24.13	-	5.53	9.09	6.69	66.66
Amphora ovalis	2.17	-	-	-	-	-	16.66
Cymbella affinis	4.37		13.91	3.99	1.39	12.94	66.66
Cymbella cymbiformes	-	-	-	3.10	12.58	3.125	50
Cymbella helvetica	-	13.79	-	-	-	-	16.66
Cymbella trivialis	-	-	-	2.43	-	-	16.66
Diatoma elongata	13.04	-	2.04	3.32	3.49	5.35	83.33
Encyonema ventricosum	-	-	0.51	3.10	2.44	-	50
Fragilaria bidens	-	-	1.03	-	-	-	16.66
Fragilaria crotonesis	-	13.79	3.09	-	-	-	33.33
Fragilariforma bicapitata	6.52	-	4.12	3.54	-	-	50
Gomphonema angustatum	28.26	31.03	5.15	6.87	-	6.25	83.33
Gomphonema acuminatum	-	-	-	0.88	1.06	-	33.33
Gomphonema parvulum	-	7.69	-	6.81	-	9.37	50
Gyrosigma acuminatum	-	-	-	-	-	0.89	16.66
Navicula cryptocephala	-	-	-	3.32	4.54	4.46	50
Navicula phyllepta	-	-	-	2.88	-	-	16.66
Navicula trivialis	-	-	0.51	1.99	3.14	-	50
Nitzschia gracilis	-	-	-	0.88	-	-	16.66
Nitzschia linearis	-	-	-	-	-	5.80	16.66
Nitzschia palea	2.17	-	-	2.88	-	-	33.33
Odontidium hymeala	-	-	-	1.77	-	2.23	33.33
Rhoicosphenia abbreviata	-	-	-	3.10	6.64	4.91	50
Sellaphora pupula	34.78		38.14	3.76	5.24	16.07	83.33
Surirella angusta	-	-	-	-	-	1.33	16.66
Surirella minuta	-	-	-	0.66	20.62	-	33.33
Ulnaria acus	-	-	-	5.98	-	6.25	33.33
Ulnaria ulna	8.69	-	27.31	19.73	29.72	14.28	83.33

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In the study, 3 species belonging to Cyanophyta, 6 species belonging to Chlorophyta and 1 species belonging to Euglenophyta were recorded. In this station richest in species diversity was the second one. Also, *Trichormus variabilis* (6.45%) from Cyanophyta (blue-green algae), and *Tetraedron* sp. (16.12%) and *Trachelomonas* sp. (3.22%) from Chlorophyta (green algae) were detected in January. And in the samples taken in February, while the relative density of *Trichormus variabilis* was measured to be 5.26%, the relative density of *Zygnema* sp. from green algae was found as 4.21%. At the second station, *Trichormus variabilis* (3.77%) and *Phormidium diguetti* (2.83%) from Cyanophyta, and *Spirogyra gracilis* (0.94%) from Chlorophyta were detected in March. In the samples taken from the second station in April, *Trichormus variabilis* (0.43%) and *Phormidium diguetti* (0.23%) belonging to Cyanophyta, *Pseudopediastrum boryanum* (0.21%) belonging to Chlorophyta, and *Euglena viridis* (5.03%) belonging to Euglenophyta were recorded. No algae other than diatoms were found in the samples taken in May and June. At the third station, no algal groups (Cyanophyta, Chlorophyta, and Euglenophyta) other than diatoms were detected in January, February, May and June. At this station, *Trichormus variabilis* (1.03%) and *Phormidium diguetti* (2.06%) from Cyanophyta, and *Cladophora glomerata* (1.03%) from Chlorophyta were recorded. In the samples taken in April, *Chroococcus minutus* (8.86%) from Cyanophyta, and *Euglena viridis* (2.43%) from Euglenophyta were found. The relative density of *Chroococcus minutus* was the highest one among the relative densities of the algal groups other than diatoms. This indicates that this alga makes use of the environmental conditions better than the other algae (Table 5).

Table 5: Distribution of the algal species other than diatoms (Cyanophyta, Chlorophyta, Euglenophyta) according to months and habitat features at the stations.

Months	Station I	Station II	Station III
January	-	*Trichormus variabilis* *Tetraedron* sp *Trachelomonas* sp.	-
February	*Trichormus variabilis*	*Trichormus variabilis* *Zygnema* sp.	-
March	-	*Trichormus variabilis* *Phormidium diguetti* *Spirogyra gracilis*	*Trichormus variabilis* *Phormidium diguetti* *Cladophora glomerate*
April	*Phormidium diguetti*	*Trichormus variabilis* *Phormidium diguetti* *Pseudopediastrum boryanum* *Euglena viridis*	*Chroococcus minutus* *Euglena viridis*
May	-	-	-
June	-	-	-

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Discussion

In this study, a total of 44 taxa, 3 belonging to Cyanophyta, 6 belonging to Chlorophyta, 1 belonging to Euglenophyta and 34 belonging to Bacillariophyta, were recorded. Some water quality parameters obtained as part of the research were compared with the standard values defined under the Regulation Concerning Water Intended for Human Consumption (Anonymous, 2005). The water quality classes of the Çalgan Creek were determined by taking into consideration the values (Table 6).

Table 6: Class-based quality criteria of the intra-continental water resources (Anonymous, 2005).

	Water quality classes			
Water quality parameters	**I**	**II**	**III**	**IV**
Temperature (^oC)	25	25	30	> 30
pH	6.5–8.5	6.5–8.5	6.0–9.0	other than 6.0–9.0
Dissolved oxygen (mg O_2/L)	8	6	3	< 3

Considering the average temperature values according to the water quality classes in the Water Pollution Control Regulation (Anonymous, 2005), it was observed that all of the stations on the Çalgan Creek where the study was carried out fall under the class of high-quality waters. Dissolved oxygen concentration in uncontaminated natural clear waters is generally around 10 mg/L. The fact that the dissolved oxygen concentrations measured in the Çalgan Creek varied between 5.41-11.6 mg/L shows that the creek is included in the first class, i.e. the class of high-quality waters, in terms of the average dissolved oxygen values.The pH values measured at the selected stations throughout the study period varied 6.1-8.7. This reveals that the Çalgan Creek has slightly alkaline water. According to the intra-continental water resources quality criteria, the Çalgan Creek is observed to have first class water quality in terms of pH values (Anonymous, 2005).

In the study, a total of 34 species belonging to Bacillariophyta, all of which were Pennales members, were recorded. Among the pennate diatoms, *Achnanthidium* was represented by 2, *Amphora* by 1, *Cocconeis* by 1, *Cymbella* by 3, *Diatoma* by 1, *Encyonema* by 2, *Fragilaria* by 2, *Fragilariforma* by 1, *Gomphonema* by 3, *Gyrosigma* by 1, *Navicula* by 5, *Nitzschia* by 4, *Odontidium* by 1, *Rhoicosphenia* by 1, *Sellaphora* by 1, *Surirella* by 2, *Tryblionella* by 1, and *Ulnaria* by 2 taxa. In the studies carried out in the streams abroad (Round, 1973), it was also reported that *Navicula*, *Nitzschia* and *Cymbella* were rich in numbers of taxa in the algal flora. Considering their numbers of taxa and individuals, *Navicula*, *Nitzschia* and *Cymbella* were found to be significant diatoms in the Çalgan Creek, too. Furthermore, Chessman (1986), who noted that the species *Navicula* and *Nitzschia* are cosmopolitan, supported the finding that these diatoms are the

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prevalent ones in lakes and streams. Round (1973) reported that *Fragilaria* and *Navicula* species are the dominant diatoms of some streams. In the Çalgan Creek, at the first station, *Fragilaria bidens* (January, 11.11%), and at the third station, *Fragilaria crotonensis* (February, 13.79%) were recorded with high relative densities. There were also months in which *Navicula* species were recorded with relative densities of over 30% particularly at the first and second station.

The diatoms (Bacillariophyta) were found to be the most significant algae of the Çalgan Creek in terms of both their number of species and the frequency of occurrence and number of individuals among the epilithic algae. Although the diatoms appeared in all months, they reached the highest numbers and frequencies of occurrence in April. In this study carried out in the Çalgan Creek, some diatoms (*Cymbella affinis*, *Diatoma elongata* and *Ulnaria ulna*) were detected every month, some of them (*Achnanthidium affine*, *Cymbella helvetica*, *Navicula trivialis*, *Gomphonema pupula*, *Gyrosigma acuminatum*, *Nitzschia sigmoidea*) were detected only in one month, and the rest were detected in specific months. Among the epilithic diatoms of the Çalgan Creek, *Diatoma elongate* had the highest relative density (39.75%) at the first station, *Ulnaria ulna* had the highest relative density (40.56%) at the second station, and *Sellaphora pupula* had the highest relative density (38.14%) at the third station. In addition, in the epilithic algal flora, *Ulnaria*, *Sellaphora*, *Cymbella*, *Navicula* and *Gomphonema* were found to be the most significant diatoms of the Çalgan Creek considering their high frequencies of occurrence and relative densities. In the previous studies conducted in the streams of Turkey's different regions, the taxa belonging to these genera drew attention for their frequencies of occurrence and high numbers of individuals among the algal communities (Yıldız 1987a, 1987b; Altuner and Gürbüz 1989, 1991; Yıldız and Özkıran, 1991; Gönülol and Arslan, 1992; Pala and Çağlar, 2008; Fakıoğlu *et al*., 2012; Pala *et al*., 2017).

While some diatom taxa (*Sellaphora*, *Ulnaria*, *Gomphonema*) could reproduce generally always in the Çalgan Creek, the other diatom species reproduced better compared to the others only in certain seasons. For the epilithic algal community, especially April was the richest month in terms of both the number of individuals and relative densities, in general.

Differences were observed in the monthly distribution of the diatom species recorded in the Çalgan Creek. Particularly June at the first and second station, and February at the third station were the poorest months considering the species diversity? As an important point, while there was a direct proportion between temperature rise and increase in the number of the algae at the third station, temperature rise and increase in the species numbers were inversely proportional at the first and second station. This could be associated

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with the fact that the creek's water is reduced in June.

During the study period, apart from the diatoms, Cyanophyta, Chlorophyta and Euglenophyta members were also seen in the Çalgan Creek. The numbers of taxa belonging to these divisions were considerably low compared to the diatoms. At the first station, only Cyanophyta members were detected in the epilithon in February and April. At the second station, Cyanophyta and Chlorophyta members were detected in January, February and March, and Cyanophyta, Chlorophyta and Euglenophyta members were detected in April. At the third station, only Cyanophyta and Chlorophyta members were detected in March while Cyanophyta and Euglenophyta members were detected in April. While Cox (1984) stated that light is the most important factor in the seasonal distribution of diatoms, Round (1973) noted that diatoms grow well in phytoplankton in early spring and summer, and they show less growth during the period between July-October. Furthermore, Lund (1965) underlined that temperature and light is the most important factors which have effect on the growth of algae. It is observed that as the light and temperature started to increase in spring and summer months, both the number of taxa of the algae and the number of individuals belonging to these taxa increased especially in March and April at all of the three stations of the Çalgan Creek. The findings we have obtained through this research support the findings by the abovementioned researchers. It is thought that besides temperature and light intensity, also some other factors have effect on the reproduction of the diatoms considering the fact that while some of the diatom species appeared and reproduced well in every season, some of them did so in January and February.

It was reported that *Ulnaria ulna* and *Navicula cryptocephala* species were the characteristic organisms in waters polluted by wastewater and they were abundant in eutrophic waters (Albay and Aykulu, 1994). And Açıkgöz (1997) noted that the species defined as the indicator of pollution such as *Amphora ovalis* and *Nitzschia palea* were prevalent in the Kirmir Creek. In the Çalgan Creek, while *Nitzschia palea* was recorded only at the third station, *Ulnaria ulna*, *Amphora ovalis* and *Navicula cryptocephala* were the diatoms recorded at all of the three stations. It was especially remarkable that *Ulnaria ulna* had high individual numbers at each and every station. Nevertheless, the existence of these species in the Çalgan Creek can be associated with the fact that the creek is polluted or eutrophic.

In this study carried out in the Çalgan Creek, no new record was detected. However, this study, which is the first one conducted in this creek, will contribute to the creation of the database of the algae in Turkey.

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