Study on epilithic diatoms in the kozluk creek (Arapgir-Malatya, Turkey)

Pala G.¹; Caglar M.¹; Selamoglu Z.^{2*}

Received: April 2016 Accepted: June 2016

- 1-Department of Fundamental Science, Faculty of Fisheries, Firat University, Elazig, Turkey
- 2-Department of Biotechnology, Faculty of Arts and Science, Nigde, Turkey
- * Corresponding author's E-mail: zselamoglu@nigde.edu.tr

Keywords: Kozluk Creek, Diatom, Epilithic, Algae

Introduction

Being the most important members of phytoplankton and phytobenthos, both of which are the primary producers of surface water resources, algae play a very important role in the biological productivity of waters with their production oxygen through photosynthesis and they synthesize the organic materials. Furthermore, with their high levels of protein, algae are used as human and animal food as well as being used in the production of fertilizers organic and organic vitamins. Another reason for algae currently being among the most researched organisms is their easy and inexpensive productions in culture media.

With the recognition of the importance of algae in standing waters and number studies streams, the of conducted on these organisms has rapidly increased. In Turkey, number of studies on algae in streams

is quite high [(Altuner and Gurbuz (1989), Altuner and Gurbuz (1991) Yıldız (1991), Yildiz and Ozkiran (1994), Ertan and Morkoyunlu (1998), Sahin (1998), Cetin and Yavuz (2001), Solak et al. (2012), Sivaci and Dere (2007), Mumcu et al. (2009), Pala and Caglar (2008)].

It is quite important to study the growth of algal communities and identify the physical, chemical and biological factors that affect them in order to make better and more use of streams. In line with this purpose, the epilithic diatoms within the benthic algal communities were researched along with certain physical chemical factors within the context of this study conducted on Kozluk Creek. Identifying the epilithic diatoms will also contribute to creating the species list of Kozluk Creek.

Materials and methods

A district in Malatya Province, Kozluk Creek is located at 39°01'25.85" N 38° 17' 26.81"E (latitude) and (longitude). Kozluk Creek originates in Saricicek Mountains and divides the Arapgir district into two parts (Fig. 1). In this study, samples were collected periodically from two different stations from March 2015 to October 2015 in order to determine the epilithic algae of Kozluk Creek. The first station was chosen from the right side of Kozluk Creek where there are rocky areas, and the second station was chosen from approximately 1 km below the first station.

The temperature and pH values were measured in the field with an Electromagon-site pН meter: electrical conductivity (E.C.µmhoscm⁻ 1) was measured in the fieldwith a YSI Model 33 S-C-T meter; the dissolved oxygen was measured with a YSI Model 51B on-site oxygen meter during sampling; ammonium was measured following Nessler's method whereas nitrate was measured by the spectrophotometric method using salicylate, and chloride was measured in accordance with the Mohr method. The calibrations the above of mentioned portable devices were made with stable solutions before the field surveys (APHA, 1985).

The epilithic samples from both stations were collected by scraping them from mucilaginous big stones with the help of a brush and the epilithic diatoms stuck onto the brush were washed with purified water and placed in sterile sample jars. There was no pollution in the stations and the Creek water was very cold and clear. Species identification and counting of the diatoms, for which permanent slides were prepared, were made with a Nikon microscope. For the species count performed on the permanent slides, relative density was taken as the basis and the results are given as "% organism.

Related sources were used for the identification of diatom species (Hustedt, 1932; Prescott, 1961; Bourelly, 1968; Bourelly, 1972; Germain, 1981;).

Results and discussion

Some hydrological results from each station on Kozluk Creek are given in Table 1.

During the study period, according to its average water temperature (11°C), the water quality of the waterfall was classified as 1st class (Anonymous, 2004). According to the pollution directive, waters with over 8 mg/L dissolved oxygen levels are classified as environments with 1st class quality; and even the lowest dissolved oxygen level at the waterfall was measured to be higher than this value (Anonymous, 2004). According to the directive waters intended for human consumption should have pH values within the range of 6.5 to 9.5 (Anonymous, 2004).



Figure 1: A general view of Kozluk Creek (URL 2).

Table 1: The hydrological variations in Kozluk Creek from March- October 2015.

	March	April	May	June	July	August	September	October	Average	St.
Temperature										dev.
1 st Station.	9.0	9.0	10.0	11.0	12.0	12.0	13.0	12.0	11.00	1.511
2 nd Station	9.0	10.0	9.0	13.0	13.0	14.0	13.0	13.0	11.75	2.052
Oxygen										
1 st Station	9.6	9.5	9.8	9.7	9.5	9.4	9.5	9.7	9.58	0.135
2 nd Station	9.7	9.6	9.9	9.8	9.6	9.7	9.5	9.8	9.70	0.130
pН										
1st Station	8.0	8.2	8.1	8.3	8.2	8.3	8.3	8.3	8.21	0.112
2 nd Station	8.4	8.2	8.0	8.2	8.4	8.3	8.2	8.2	8.23	0.130
Conductivity										
1 st Station	630	620	630	690	710	720	690	680	671.25	39.074
2 nd Station	620	620	640	630	720	710	680	670	661,25	39.798
T.hardness										
1 st Station	119	120	118	117	119	96	98	99	110.75	10.898
2 nd Station	120	120	119	119	114	100	111	100	112.87	8.559
Salinity										
1 st Station	0.69	0.66	0.65	0.63	0.64	0.50	0.52	0.51	0.60	0.076
2 nd Station	0.67	0.64	0.62	0.63	0.61	0.52	0.54	0.53	0.59	0.056
Nitrite										
1 st Station	0.09	0.10	0.11	0.10	0.09	0.11	0.10	0.10	0.10	0.007
2 nd Station	0.12	0.12	0.11	0.10	0.10	0.12	0.11	0.10	0.11	0.009
Nitrate										
1 st Station	1.0	1.0	1.0	1.4	1.8	1.6	1.8	1.7	1.42	0.364
2 nd Station	1.3	1.3	1.5	1.6	1.9	1.8	1.7	1.7	1.60	0.220
Ammonium										
1 st Station	0.18	0.18	0.17	0.18	0.17	0.17	0.18	0.17	0.175	0.005
2 nd Station	0.19	0.18	0.18	0.17	0.19	0.18	0.16	0.53	0.222	0.124

The pH values of both stations in Kozluk Creek were within the range of

8.0 to 8.4. According to the water pollution control directive for quality

criteria for inland water resources, pH value was within 1st class water quality levels (Anonymous, 2004).

According to the water pollution control directive on quality criteria for inland water resources, nitrite was within the 4th class water quality levels (Anonymous, 2004). According to the water pollution control directive on quality criteria for inland water resources, nitrate was within the 1st class water quality levels (Anonymous, 2004), According to the water pollution control directive on quality criteria for inland water resources, ammonium levels were within the

range of 1st class water quality levels (Anonymous, 2004).

Taking Table 2 into consideration, the fact that some species were encountered in the environment and some were not could be taken as a sign for the adaptabilty of the existing species in different habitats. The most significant diatoms at the first station in terms of their frequency of appearance and relative density were *Navicymbula pusilla*, *Navicula tripunctata*, *Nitzschia amphibia* and *Nitzschia tryblionella* (Figs. 2a, b, c and d).

Table 2: The epilithic diatom species recorded at the 1st and 2nd stations in Kozluk Creek (Arangir-Malatya).

Species	1st Station	2 nd Station
Amphora ovalis Kützing	+	+
Amphora pediculus (Kütz.)Grunow & A.Schmidt	+	_
Cyclotella meneghinianaKützing	+	_
Cymbella cymbiformis C. Agardh	+	_
Cymbella affinisKützing	+	+
Cymbella cistula (Ehr.) O. Kirchner	-	+
Cymbella parva (W. Smith) Kirchner	+	+
Cymbella porximaReimer	+	_
Cymbopleuralata(Grunow ex Cleve) Krammer	+	+
Lindaviaocellata (Pantocksek) T.Nakov et al.	+	+
Lindaviacomta (Kütz.)Nakov, Gullory, Julius, Alverson&Theriot	+	+
Navicula cincta(Ehrenberg) Ralfs	+	_
Navicula cryptocephalaKütz.	+	_
Navicula protracta (Grunow) Cleve	-	_
Navicula salinarumGrunow	+	+
Navicula tripunctata(O.F. Müller) Bory.	+	+
Navicymbulapusilla (Grunow) Krammer	-	+
Nitzschia amphibiaGrunow	+	+
Nitzschia gracilisHantzsch	+	+
Nitzschia palea(Kützing) W. Smith	+	+
Nitzschia tryblionellaHantzsch	+	+
Sellaphora bacillum (Ehrenberg) D.G. Mann	+	_
Surirella ovalisBrebisson	+	+
Surirella robusta Ehrenberg	+	_
Ulnariaacus (Kützing) M. Aboal	+	_
Ulnaria ulna (Nitzsche) P. Compere	+	+

^{+:} found -: not found

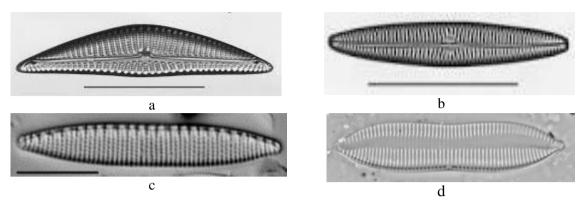


Figure 2: Navicymbula pusilla(a), Navicula tripunctata(b), Nitzschia amphibia (c) and Nitzschia tryblionella (d) (URL 3).

The highest relative density (3.08%) of N. pusilla at this station was recorded in April whereas its lowest relative density (1.68%) was recorded in September. At the first station, N. tripunctata reached its highest relative density (8.49 %) in October, and dropped to its lowest relative density (4.34%) in May; highest relative density (6.60%) for N. amphibia was in October whereas its lowest relative density (3.58%) was recorded in March; and the highest relative density (4.66%) for N. tryblionella was in March and its lowest relative density (1.68%) in September (Fig. 3).

Even though there were other diatoms in the first station with high relative densities during certain months, they could not be shown with figures due to their irregular frequencies of appearance.

The most significant species in the second station in terms of frequency of appearance and relative density were *Cymbopleura lata*, *Cymbella parva*, *N. tripunctata* and *Nitzschi agracilis*. At

this station, C. lata reached its highest relative density (7.20%) in March and dropped to its lowest relative density (2.35%) in October; whereas for C. parva, highest relative density (9.01%) was recorded in March and its lowest relative density (4.57%) in September. Highest relative density (11.76 %) for N. tripunctata was recorded in October and its lowest relative density (6.57%) in April and June, while N. gracilis showed its highest relative density (9.15%) in the second station in September, and its lowest relative density (4.66%) was recorded in July (Fig. 4).

Another remarkable species at this station with regards to its frequency of appearance was *N. amphibia*. The relative density of this diatom in June (9.62%) was the highest relative density among other diatoms; whereas the relative density for *Ulnaria ulna* in the same month was the lowest relative density (1.88%) among all diatoms.

The photographs of *C. lata, C. parva* and *N. gracilis*, which were significant in the second station in terms of their relative densities and frequencies of appearance, are given in Figs. 5a, b and c.

Another remarkable species at this station with regards to its frequency of appearance was *N. amphibia*. The relative density of this diatom in June (9.62 %) was the highest among other diatoms; whereas that for *U. ulna* in the same month was the lowest relative density (1.88 %) among all diatoms.

The photographs of *C. lata*, *C. parva* and *N. gracilis*, which were significant in the second station in terms of their relative densities and frequencies of appearance, are given in Fig. 5.

Other significant species in the second station with regards to their relative densities were *Nitzschia palea*, *N. tryblionela* and *U. ulna*. However, they were not shown with figures due to their irregular frequencies of appearance.

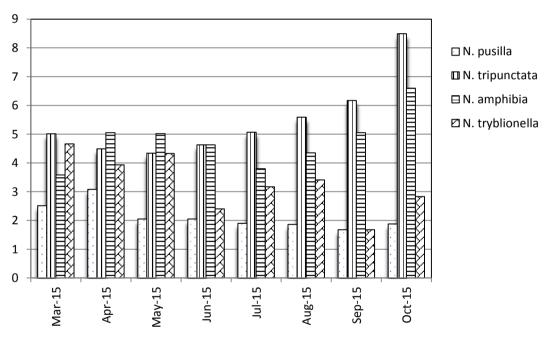


Figure 3: Relative densities of *Navicymbula pusilla*, *Navicula tripunctata*, *Nitzschia amphibia* and *Nitzschi atryblionella* during monthly samplings in the first station.

According to physical and chemical analyses, except for nitrite, Kozluk Creek has first class quality (Anonymus, 2004).

Throughout the study, 26 taxa of epilithic diatoms were recorded at Kozluk Creek. Other algae were not included in this study as diatoms are

more dominant than other algae with regards to numbers of individuals and frequencies of appearance. This can be seen as a sign that means diatoms make better use of their surrounding conditions compared to other algal groups.

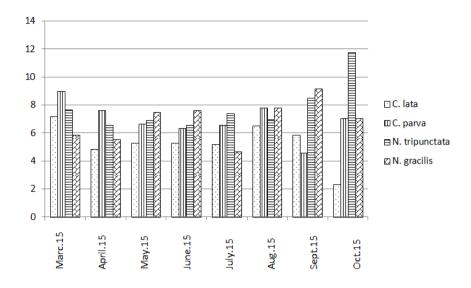


Figure 4: Monthly variations in the relative densities of *Cymbopleura lata*, *Cymbella parva*, *Navicula tripunctata andNitzschia gracilis* in the second station.

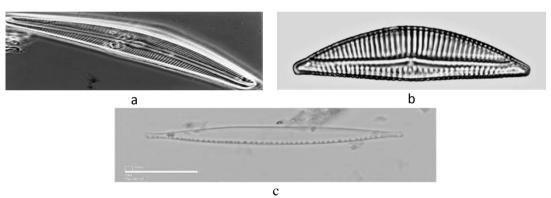


Figure 5: Cymbopleura lata(a), Cymbella parva (b)and Nitzschia gracilis(c) (URL 3).

This has been reported numerous times in other algae studies conducted on streams, as well. Some of those studies are mentioned below.

Diatoms were the dominant group in the study conducted on the epipelic algal flora of Karasu (Euphrates) River by Altuner and Gurbuz (1991), as well. Navicula cryptocephala, Cymbella affinis, Cymbella ventricosa, Amphora ovalis, N. palea and Synedra ulna were observed as the dominant species within this group. The significant diatoms in the epilithic diatom flora of

Kozluk (Arapgir) Creek in terms of frequency of appearance and number of individuals were *Navicymbula pusilla, Cymbopleur alata, C. parva, N. tripunctata, N. amphibia, N. tryblionella* and *Nitzschia gracilis.* There were similarities among the diatoms in both studies on a speciebasis.

Gonulol and Arslan (1992) studied algal flora of Samsun-IncesuStream, and found that the dominant species among epilithic algae were *Cocconeis*, *Cymbella* and *Gomphonema*. Even

though the *Cocconeis* and *Gomphonema* species were not encountered in Kozluk Creek, the *Cymbella* specie was among the dominant species of this Creek, as well.

In the research conducted by Yıldız (1987) on the algal communities of AltınapaDam Lake and Meram Creek, diatoms were more prevalent and dominant in both these waters compared to other algae. The dominant species among the epiphytic and epilithic diatoms of Altınapa Dam Lake were Synedra delicatissima, Navicula cryptocephala, N. palea, Cymbella microcephala, Cymbella amphicephala. Gomphonema olivaceum and Navicula cryptocephala. This finding does not show any species similarity with the findings of our study with the exceptions of N. palea and Navicula cryptocephala species.

In Altuner's (1988) study on the diatom flora of Aras River, the most encountered diatoms were Achnanthes Fragilariaca pucina, affinis, Gomphonema olivaceum, Naviculacry ptocephala var. veneta, Nitzschia intermedia. Ν. subcapitellata Surirella ovata. None of these diatom species were encountered in Kozluk Creek.

In Pala and Caglar's (2008) study titled Epilithic diatoms in Peri Stream (Tunceli) and Their Seasonal Variations, 36 diatom species were recorded in total. *Gomphonema, Fragilaria, Cymbella* were the diatom

genera represented with the highest number of species in the researched whereas Cymbella area spp., Gomphonema spp. and Fragilaria spp. were the most important diatoms in terms of frequency of appearance and populationsizes within the epilithic diatom community. In Kozluk Creek, on the other hand, the most significant diatom genera both in terms representation rates and their frequencies of appearance and population sizes were Cymbella spp., Navicula spp. and Nitzschia spp.

Sivaci and Dere (2007) examined the monthly changes in the epilithic diatom communities of Melendiz Creek (Aksaray-Ihlara) and the effect of water flow on the organisms and stated that Cocconeis placentula var. Navicula cryptocephala, euglypta, Navicula Encyonema tripunctata, minutum, N. amphibian and N. palea diatoms were the dominant species within the communities of Melendiz Creek. This finding showed similarity with the findings of Kozluk Creek with the exclusions of C. placentula var. euglypta and E. minutum.

In Round's (1957) and Butcher's (1946) studies, the majority of the diatoms were described as species that favour alkaline waters. *C. placentula, Cymbella ventricosa, Gomphonema parvulum* and *Gomphonema olivaceum*, in particular, were found to be the dominant organisms in high alkaline waters. Even though Kozluk Creek's water displayed alkali

characteristics, these diatoms were not found in it.

Cymbella spp., Navicula spp. and Ulnaria spp., which were identified among the epilithic diatoms of KozlukCreek, are generally reported as the typical benthic species of inland waters (Hutchinson, 1957).

Chessman (1986) stated that the species of *Navicula* and *Nitzschia* are cosmopolitan. The fact that the species of *Navicula* and *Nitzschia* were encountered at both of the stations in Kozluk Creek, as well, supports this finding.

Even though some of the diatoms encountered in Kozluk Creek (*S. ovalis, Navicula salinarum, U. ulna* and *N. palea*) were not significant within the epilithic algal community in terms of frequency of appearance, they were remarkable with the relative densities they reached during some months. This finding points to the possibility that given the appropriate conditions, there can be a succession among diatoms, as well.

The fact that diatoms are always present within the epilithic algal community shows that diatoms are cosmopolitan and that they are one of the algae encountered in all kinds of substratum.

Acknowledgement

Our gratitude goes to Dr. Metin Calta at Firat University in Turkey.

References

- **Altuner, Z., 1988.** A study of the diatom flora of the Aras River, *Nova Hedwigia, Stutgart*, 46(1-2), 225-263.
- Altuner Z. and Gürbüz, H., 1989. Karasu (Fırat) Nehrifito plankton üzerind bir araştırma. İstanbul Üniversitesi Su Ürünleri Dergisi, 3(1-2), 151-176.
- Altuner, Z. and Gürbüz, H., 1991. Karasu (Fırat) Nehri epipelik alg flo-sı üzerinde bir araştırma. Doğa Turkish Journal of Botany, 15, 253-267.
- **Anonymus, 2004.** Su Kirliliği kontrol yönetmeliği. 31 Aralık 2004 tarihve 25687 sayılı Resmi Gazete, Ankara.
- **APHA, 1985.** Standart methods forthe examination of water and waste water. 16th ed., Washington.
- **Bourelly, P., 1968.** Les algues d' eau douce algues jaunes et brunes. N. Baunes. Paris, 439P.
- **Bourelly, P., 1972.** Les Igues d' eau douce tome :1, Editions N. Boubee and C^{ie} 3, Place Saint-Andre-Des_Arts, Paris, 569.
- **Butcher, R.W., 1946.** The algal growth in certain highly calcareous streams. *Journal of Ecology*, 33, 268-283.
- Chessman, B.C., 1986. Diatom flora of an Australian River system: Spatial patterns and environmental relationships. *Freshwater Biology*, 16, 805-819.
- Çetin, A.K. and Yavuz, O.G., 2001. Cip Çayı (Elazığ/Türkiye) epipelik, epilitik ve epifitik alg florası, *Fırat*

- Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 13(2), 9-14.
- Ertan, O.Ö. and Morkoyunlu, A., 1998. The algae flora of Aksu Stream (Isparta-Turkey), *Turkish Journal of Botany*, 22, 239-255.
- **Germain, 1981.** Flora Des Diatomees diatomophycees. Societye Nouvelle Des Editions Boubee, Paris.
- Gönülol, A. and Araslan, N., 1992. Samsİncesu deresinin alg florası üzerinde araştırmalar. *Doğa Turkish Journal of Botany*, 16, 311-314.
- Hustedt, F., 1932.Bacillariophyta (Diatome) Heft. 10. İn pascher, Die Süsswasser Flora Mitteleuropas, Gustav Fischer Pub, Jena, Germany.
- Hutchinson, G.E., 1957. A treatise on Limnology. Vol II. Introduction to lake biology and the limnoplankton. John Wiley and Sons, New York.
- **Kocataş, A., 1999.** Ekolojive Çevre biyolojisi ders kitabı, Ege Üniversitesi Basımevi, 564. Bornova-İzmir.
- Mumcu, F., Barlas, M. and Kalyoncu, H., 2009. Dipsiz-Çine caylarının (Muğla-Aydın) epilitik diyatomeleri. *SDÜ Fen Dergisi*, 4(1), 23-34.
- Pala, G.andÇağlar, M., 2008.

 PeriÇayı (Tunceli/Türkiye) epilitik diyatomeleri ve mevsimsel değişimleri. Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 20(4), 557-562.
- **Prescott, G.W., 1961.** Algae of the western great lake area. Brown comp. Pub. Dubuque Iowa.

- **Round, F.E., 1957.** Studies of the English Lake part II. The distribution of Bacillariophyceae on the sediments. *Journal of Ecology*, 45, 343-360.
- Sıvacı, E.R. and Dere, Ş., 2007. MelendizÇayı' nın (Aksaray-Ihlara) epilitik diyatome topluluklarını aylık değişimi ve su akışının toplam organizmaya etkisi. *Ekoloji-Cevre Dergisi*, 16(64), 29-36.
- Solak, C.N., Ector, E., Agata, Z. W., Eva, A. and Morales, E.A., 2012.

 A review of investigations on diatoms (Bacillariophyta) in Turkish inland waters, Nova Hedwigia, Beiheft, 141, 431-462.
- Şahin, B., 1998. Sera Deresi (Trabzon)' nin bentik alg florası, XIV. Ulusal Biyoloji Kongresi (7-10 Eylül 1998), Cilt II, 272-281, Samsun.
- **URL 2.** https:// https://www.google.com.tr/ kozlukgörseller.
- URL 3. https://www.google.com.tr.
- Yıldız, K. and Özkıran, Ü., 1994. Çubuk Çayıdiyatomeleri. *Doğa Turkish Journal of Botany*, 18, 313-329.
- Yıldız, K., 1987. Altınapa baraj Gölü ve bu çıkan Meram Çayı alg toplulukları üzerinde bir araştırma. Cumhuriyet Üniversitesi Fen-Edebiyat Fakültesi Fen Bilimleri Dergisi, 5, 191-207.
- **Yıldız, K., 1991**. Kızılırmak nehri diyatomeleri. *Doğa Turkish Journal of Botany*, 15, 166-188.