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Research article/Araştırma makalesi

Nine new records from high mountain lakes (Artabel Lakes Nature Park, Gümüşhane/Turkey) for the freshwater diatom flora of Turkey

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Abstract

This study was carried out in 17 high mountain lakes and a pond in the Artabel Lakes Nature Park (Gümüşhane) on August 15, 2013 and August 13, 2016. In the present study, epipelic, epilitic and epiphytic algal flora of lakes were determined and a total of 95 taxa were recorded belonging to Bacillariophyta division. 9 of the taxa belonging to Bacillariophyta were determined to be new records for the freshwater diatom flora of Turkey. These taxa were identified as *Aulacoseira lacustris* (Grunow) Krammer f. *tenuior* Houk, Klee and Passauer, *Orthoseira roeseana* (Rabenhorst) Pfitzer, *Cyclotella ambigua* Grunow, *Planothidium distinctum* (Messikommer) Lange-Bertalot, *Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round, *Diploneis petersenii* Hustedt, *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer, *Eunotia mucophila* (Lange-Bertalot, Nörpel–Schempp and Alles) Lange-Bertalot and *E. paludosa* Grunow

Key words: Diatom, new record, high mountain lakes, Artabel Lakes Nature Park, Turkey

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Türkiye tatlı su diyatome florası için yüksek dağ göllerinden (Artabel Gölleri Tabiat Parkı, Gümüşhane/Türkiye) dokuz yeni kayıt

Özet

Bu çalışma, Artabel Gölleri Tabiat Parkı (Gümüşhane) içerisinde yer alan 17 yüksek dağ gölü ve bir gölette 15 Ağustos 2013 ve 13 Ağustos 2016 tarihlerinde gerçekleştirilmiştir. Araştırmada, göllerin epipelik, epilitik ve epifitik alg florası tespit edilmiş ve Bacillariophyta divizyouna ait toplam 95 takson belirlenmiştir. Bacillariophyta divizyosuna ait taksonlardan 9 'u Türkiye tatlı su diyatome florası için yeni kayıt olarak belirlenmiştir. Bu taksonlar, *Aulacoseira lacustris* (Grunow) Krammer f. *tenuior* Houk, Klee and Passauer, *Orthoseira roeseana* (Rabenhorst) Pfitzer, *Cyclotella ambigua* Grunow, *Planothidium distinctum* (Messikommer) Lange-Bertalot, *Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round, *Diploneis petersenii* Hustedt, *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer, *Eunotia mucophila* (Lange-Bertalot, Nörpel–Schempp and Alles) Lange-Bertalot and *E. paludosa* Grunow olarak tespit edilmiştir.

Anahtar kelimeler: Diyatome, yeni kayıt, yüksek dağ gölleri, Artabel Gölleri Tabiat Parkı, Türkiye

1. Introduction

Diatoms are a large group of algae and they, together with other algal groups are one of the most important primary food sources of aquatic areas (Round et al., 1990; Wichard et al., 2007). They are generally the dominant group of algae in aquatic ecosystems, in terms of both biodiversity and abundance (Zhuzbayeva and Atıcı, 2016). Also, diatoms are one of the important indicators of the ecological conditions of aquatic ecosystems because they react quickly to changes in nutrient concentrations. Therefore, diatom-based indices are being used to determine the trophic status of aquatic ecosystems (Rusanov et al., 2009). Because of these properties, diatoms can give us more information about the

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situation in all times (past, present and future) of aquatic ecosystems (Meriläinen et al., 1982). Because of that researches on diatom species are very important.

Compared to Europe, studies on freshwater algae in Turkey are quite new. In the first published check-list of the Turkish freshwater algae, 1293 taxa were given and 601 of them belong to Bacillariophyta (Gönülol et al., 1996). In the second published check-list of the Turkish freshwater algae, 2030 taxa were given. Of these, 781 belong to diatoms and constitute 38.47% of the total species number of algae (Aysel, 2005). Nowadays, information about algae flora in Turkey is given in the database. In this database there are 4187 taxa spreading in various habitats of Turkey. Of these, 1000 belong to diatoms and constitute 23.88% of the total species number of algae (Gönülol, 2017). However, this number does not reflect the actual situation. Because, Turkey is surrounded on three side by the sea (shoreline length 8333), has a rich freshwater ecosystem (906000 hectares of the lakes, 439800 hectares of dam lakes and ponds and 178000 km long of streams and rivers) (Güner and Aysel, 1996; Sasi and Berber, 2012) and, especially from high mountain lakes, significant contributions are still made to the freshwater algal biodiversity of Turkey (Şahin, 2007, 2009; Akar and Şahin, 2014).

The aim of this research is to make taxonomic definitions of diatom taxa, which are determined as new record for freshwater algal flora of Turkey, to give information about their ecological preferences and distributions in the studied area.

2. Materials and methods

2.1. Description of study area

Artabel Lakes Nature Park which located within Torul district, Gümüşhane province in the Eastern Black Sea region of Turkey was included as a nature park in the list of Turkey's nature parks by the Turkish Republic Ministry of Forestry in 1998. The park, which has 5859 hectares, is located between 39º0'24"-39º8'23" east longitudes and 40º21'36"-40º26'42" northern latitudes. Artabel Lakes Nature Park is formed result of volcanic activities that take place in two different geological time periods. Gümüşhane has semi-arid and humid climate. While annual weather temperature averages in the lower parts of the valleys (2100 m) in the park is 4 ºC, it is between 0 and 1 ºC at the altitudes where the lakes (2600-3000 m) and however the temperature at the summit of the area (above 3000 m) is below -3 ˚C. There are four large soil groups which are colluvial, non-calcareous brown, high mountain meadow soils and bare rocks and debris in the Artabel Lakes Nature Park (Anonymous, 2013).

Artabel Lakes Nature Park has very rich invaluable terrestrial and aquatic ecosystems and it is a very important factor in the conservation of biodiversity in Turkey. There are many endemic taxa which are included in the International Union for Conservation of Nature (IUCN) and Bern Convention Annex I, II and III lists (Anonymous, 2013).

In Artabel Lakes Nature Park, aquatic ecosystem consist of three sub-basins belonging to three different stream systems which are Artabel Stream basin (Artabel Lakes), the Gümüştuğ Stream basin (Kara and Beş Lakes) and the Kongel Stream basin (Yıldız and Acembol Lakes). The total basin area is approximately 58.2 km^2. There are 23 glaciers lakes, which are Artabel Lakes (6), Beş Lakes (5), Kara Lakes (6), Yıldız Lakes (3) and Acembol Lakes (3). They are superficially connected to each other or independent, in different locations and in different sizes (Figure 1). There are also a small pond and one lake which are not named before. Abbreviations have been made in the names of the lakes for convenience. For example; Artabel Lakes (ARL), Beş Lakes (BL), Kara Lakes (KL), Yıldız Lakes (YL) and Acembol Lakes (ACL). This system was taken from the report (Anonymous, 2013). Others names (İsimsiz Lake (IL) and Yıldız Lakes Pond (YLP)) were put on by us, following the same rule.

2.2. Sampling and laboratory studies

Due to the difficulty of the land conditions, Kara Lakes (6) were not visited. Also, there was no water in the BL5 lake, so algal and water samples could not be taken. A total of 43 samples of epipelic, epilithic and epiphytic were taken from littoral zone of 17 lakes and a pond in 15 August 2013 and in 13 August 2016. Samples of epipelic diatom were collected by means of a glass tube from sediment surface at all the water bodies except Lake BL2. Epilithic samples were taken from ARL1, ARL2, BL2, ACL1, ACL2, ACL3 and IL lakes. Randomly chosen stones were scraped with a toothbrush and then washed into plastic bottles. For epiphytic diatom samples, mosses (*Hygrohypnum luridum* (Hedw.) Jenn.) and filamentous algae (*Microspora* sp.) were taken from ARL1, ARL3, YL1, YL2, YL3, ACL2, ACL3, IL lakes and YLP Pond. All samples were fixed in solution of 4% formaldehyde. In order to identify diatoms, organic compounds must be removed from diatom samples. So it was treated with H_2SO_4 and HNO_3, and then the acidity of the samples was removed by washing a few times with distilled water. After that, they dried on the cover glasses were identified in Entellan microscope mounting medium (Round, 1953; Sládečková, 1962). Microscopic examinations of diatom samples were performed on a Leica DM 2500 model light microscope and it was photographed camera Leica DFC 290 attached the microscope.

Physical and chemical parameters (dissolved oxygen, electrical conductivity, pH and water temperature) of all lakes were measured with portable devices Orion-4Star and YSI-55. For taxonomic identification Hustedt (1930); Huber-

Pestalozzi (1962); Patrick and Reimer (1966); Krammer and Lange-Bertalot (1986, 1991a,b); Joh (2010, 2012); Genkal et al. (2008); Buczkó et al. (2013) and Jovanovska et al. (2015) books and articles were used. The validity of the taxa name was checked from AlgaeBase (Guiry and Guiry, 2017) and the new record taxa were checked from Gönülol (2017).

Frequencies of diatom taxa were determined according to the following scale based on the number of lakes studied in Artabel Lakes Nature Park. Very rare (VR): taxa recorded in %1-20 of investigated lakes; rare (R): taxa recorded in %21-40 of investigated lakes; common (C): taxa recorded in %41-60 of investigated lakes; frequent (F): taxa recorded in %61-80 of investigated lakes; very frequent (VF): taxa recorded in %81-100 of investigated lakes (Kocataş, 1992).

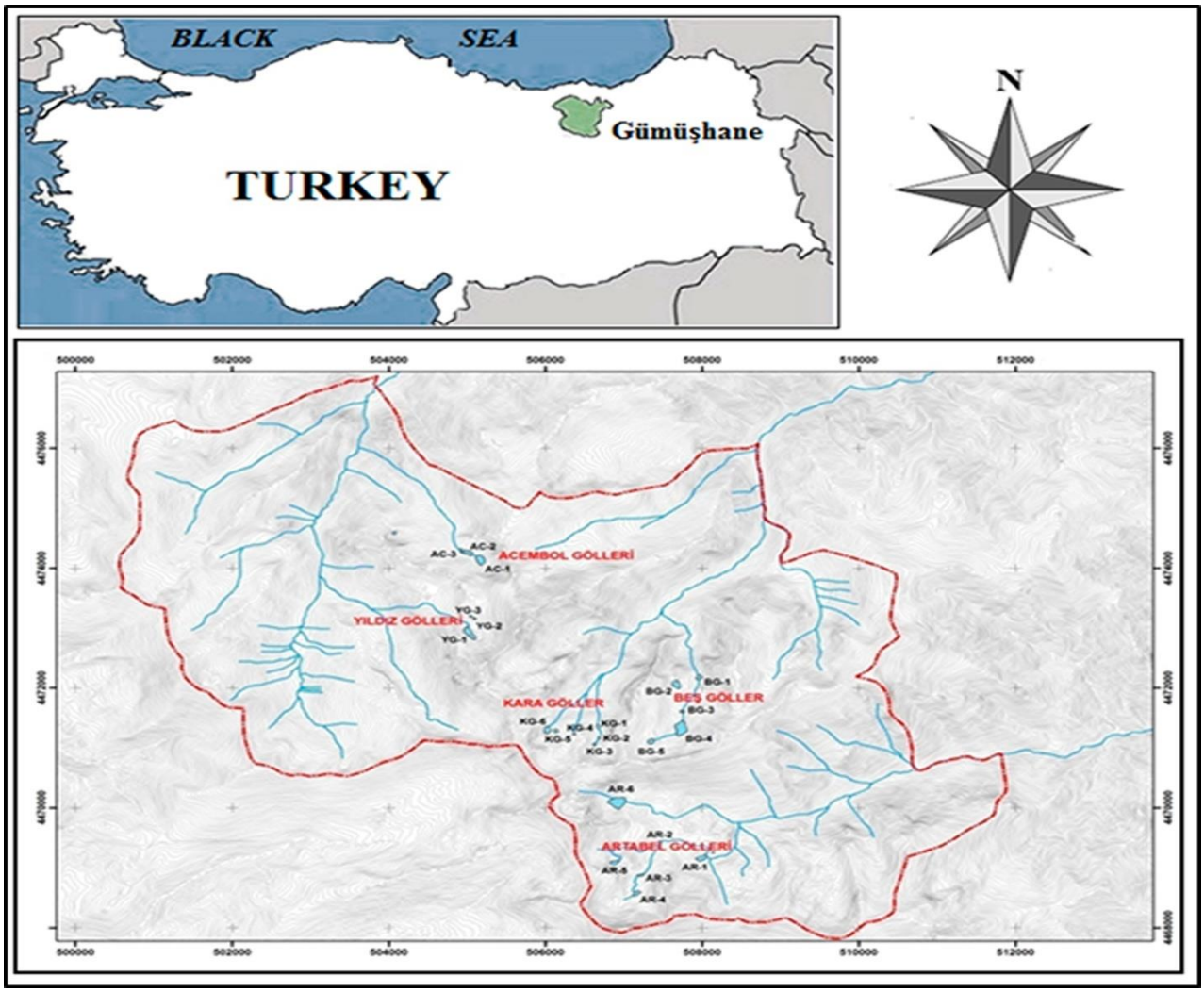

Figure 1. Map of Artabel Lakes Nature Park (Anonymous, 2013)

3. Results

At the end of study, 95 taxa belonging Bacillariophyta is determined and 9 of these has been identified as new records for diatom flora of Turkey.

Phylum: Bacillariophyta
Subphylum: Coscinodiscophytina
Class: Coscinodiscophyceae
Order: Aulacoseirales
Family: Aulacoseiraceae
Genus: Aulacoseira

***Aulacoseira lacustris* (Grunow) Krammer f. *tenuior* Houk, Klee and Passauer 2007 (Figure 2a)**

Krammer and Lange-Bertalot, 1991a, p. 39, pl. 36, figs. 3-18.
Basionym: *Melosira lyrata* f. *tenuior* Grunow in Van Heurck 1882, pl. 87, fig. 3.
Homotypic synonym: *Melosira lyrata* f. *tenuior* Grunow 1882.
Heterotypic synonym: *Aulacoseira tenuior* Krammer 1991.

Description: The filament of this taxon was not observed. The identification of taxon was made according to valve shape. Valve is circular. The medium area of the valve is flat and limited by a wall-like raised ring. Very thin and uniform areolae form stripe patterns. Diameter: 12.22 µm, striae 13-14 in 10 µm.
Ecology: This taxon was found in Finland, Northgland, Scotland, Sweden and USA in low electrolyte waters (Krammer and Lange-Bertalot, 1991a). In our study, *Aulacoseira lacustris* f. *tenuior* was only found in epipelic habitat of the ARL3 with abundance very rare (VR). It was also collected in habitat with altitude: 2875 m asl, water temperature: 16.3 ºC, dissolved oxygen 8.76 mg/L, pH: 6.19, TDS: 24 mg/L and conductivity: 49.9 µS/cm.
Distribution: No information is available on the geographical distribution of the species (Guiry and Guiry, 2017).
Subclass: Melosirophycidae
Order: Melosirales
Family: Orthoseiraceae
Genus: Orthoseira
***Orthoseira roeseana* (Rabenhorst) Pfitzer 1871 (Figure 2b)**
Hustedt, 1930, p. 93, fig. 59.
Krammer and Lange-Bertalot, 1991a, p. 13, pl. 10, figs. 1-11.
Joh, 2010, p. 117, fig. 90.
Basionym: *Melosira roeseana* Rabenhorst
Homotypic Synonyms: *Melosira roeseana* Rabenhorst 1853
Gaillonella roeseana (Rabenhorst) Petit 1880
Melosira dendroteres var. *roeseana* (Rabenhorst) R.Ross 1947
Heterotypic Synonym: *Melosira roeseana* var. *typica* Grunow 1882
Description: Valve is circular and 26.16 µm in diameter, striae 14-20 in 10 µm. Valve has a flat face. Areolate punctas on valve arranged in radiating pattern and fainter from the margin to the central. There are 2 carinoportulae which are a type of pore specific to the genus Orthoseira, on the central part of the valve.
Ecology: According to Krammer and Lange-Bertalot (1991a), *Orthoseira roeseana* is commonly an aerophytic diatom on wet rock faces, bryophytes and trees, especially in alkaline areas all over the World. In addition, Joh (2010) pointed out that this taxon is a cold water taxon and is frequently observed in arctic regions. In this study, it was observed at epipelic habitat of the YL3 with abundance very rare (VR). It was also collected in habitat with altitude: 2980 m asl, water temperature: 14.1 ºC, dissolved oxygen 3.12 mg/L, pH: 7.01, TDS: 24.05 mg/L and conductivity: 29.5 µS/cm.
Distribution: (as *Melosira roeseana* Rabenhorst) *Europe* (France, Ireland, Romania, Slovakia, Spain), *Atlantic Islands* (Iceland), *North America* (Alaska, Great Lakes, Northwest Territories, Ohio, United States of America), *South America* (Argentina, Brazil), *Africa* (Ghana), *South-west Asia* (Iraq), *Asia* (Taiwan), (as *Orthoseira roeseana* (Rabenhorst) Pfitzer) *Europe* (Baltic Sea, Britain, France, Germany, Hungary, Ireland, Macedonia, Romania, Slovakia, Spain), *North America* (Mexico, NW USA, Tennessee, United States of America), *Asia* (Korea, Russia (Far East), Taiwan), *Australia and New Zealand* (New Zealand), *Antarctic and the subantarctic islands* (Maritime Antarctica) (Guiry and Guiry, 2017).
Subphylum: Bacillariophytina
Class: Mediophyceae
Subclass: Thalassiosirophycidae
Order: Stephanodiscales
Family: Stephanodiscaceae
Genus: Cyclotella
***Cyclotella ambigua* Grunow 1880 (Figure 2c)**
Hustedt, 1930, p. 102, fig. 71.
Huber-Pestalozzi, 1962, p. 397, fig. 482.
Krammer and Lange-Bertalot, 1991a, p. 46, pl. 45, figs. 5a-b.
Genkal et al., 2008, p. 8, fig. 1.
Homotypic synonym: *Cyclotella striata* var. *ambigua* (Grunow) Grunow 1882
Description: Valve is round and a diameter of 24.27 µm, striae 8-10 in 10 µm. The marginal zone occupies about 1/3 of the valve diameter. There are more or less regularly distributed indentations and elevations in the central area of the valve. Striae are equal in length. Hustedt (1930) and Huber-Pestalozzi (1962) have reported that the diameter of the valve does not usually exceed 30 µm. Our findings support this data.
Ecology: This taxon is cosmopolitan in the littoral zone of the brackish and marine waters (Krammer and Lange-Bertalot, 1991a). Genkal et al., (2008) stressed that *Cyclotella ambigua* is a planktonic in brackish water and freshwater. In this study, it was recorded at epipelic habitat in the ARL4 with abundance very rare (VR). It was also collected in habitat with altitude: 2890 m asl, water temperature: 15.7 ºC, dissolved oxygen 9.45 mg/L, pH: 6.73, TDS: 10 mg/L and conductivity: 21.5 µS/cm.
Distribution: (as *Cyclotella ambigua* Grunow) *Europe* (Netherlands), (as *Cyclotella striata* var. *ambigua* (Grunow) Grunow) *Europe* (Britain), *North America* (United States of America), *Asia* (Taiwan), *Australia and New Zealand* (New South Wales) (Guiry and Guiry, 2017).
Class: Bacillariophyceae
Subclass: Bacillariophycidae
Order: Cocconeidales
Family: Achnanthidiaceae
Genus: Planothidium
***Planothidium distinctum* (Messikommer) Lange-Bertalot 1999 (Figure 2d)**

Krammer and Lange-Bertalot, 1991b, p. 32, pl. 18, figs. 1-8.
Buczko et al., 2013, p. 6, figs. 1-10, 19-28.
Basionym: *Achnanthes distincta* Messikommer 1954
Homotypic Synonyms: *Achnanthes distincta*
Achnanthes hirta Carter 1970
Achnantheiopsis distincta (Messikommer) Lange-Bertalot 1997
Description: Valve 17 µm in lenght and 8.5 µm in breadth, striae 14-18 in 10 µm. Valve lanceolate with broadly protracted, rounded apices. Raphe straight, filiform, terminal fissures turned in opposite directions. Central area is small, transversely rectangular and asymmetrical. In addition, there are 1-2 asymmetrically shortened striae in central area. Striae are radiate throughout valve.
Ecology: Krammer and Lange-Bertalot (1991b) indicated that *Planothidium distinctum* is distributed in oligotrophic, circumneutral and electrolytically poor mountain waters in the northern hemisphere. In this study, it was recorded at epipelic habitat in the BL4 with abundance very rare (VR). It was also collected in habitat with altitude: 2924 m asl, water temperature: 15.5 ºC, dissolved oxygen 8.30 mg/L, pH: 7.04, TDS: 6 mg/L and conductivity: 13.2 µS/cm.
Distribution: (as *Achnanthes distincta* Messikommer) *Europe* (Britain, Germany), (as *Achnantheiopsis distincta* (Messikommer) Lange-Bertalot) *Europe* (Romania), (as *Planothidium distinctum* (Messikommer) Lange-Bertalot) *Europe* (Romania) (Guiry and Guiry, 2017).
Genus: Psammothidium
***Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round 1996 (Figure 2e)**
Krammer and Lange-Bertalot, 1991b, p. 18, pl. 10, figs. 12-27.
Joh, 2012, p. 70, fig. 65.
Basionym: *Achnanthes austriaca* var. *helvetica* Hustedt 1933
Homotypic Synonyms: *Achnanthes austriaca* var. *helvetica*
Achnanthes helvetica (Hustedt) Lange-Bertalot 1989
Achnanthidium helveticum (Hustedt) O.Monnier, Lange-Bertalot and Ector 2007
Heterotypic Synonym: *Achnanthidium lauenburgianum* (Hustedt) Monnier, Lange-Bertalot and Ector 2007
Description: Valve is linear-elliptical shaped and apices are obtusely rounded. Raphe straight, axial area narrow and linear and central area rectangular up to the margin. Valve 18.28 µm in length and 7.5 µm in breadth, striae 23-28 in 10 µm.
Ecology: According to Krammer and Lange-Bertalot (1991b) this taxon occurs in oligotrophic to dystrophic, low nutrient content, circumneutral to slightly acidic habitats in mountain waters. Catalan et al., (2009) pointed out that *Psammothidium helveticum* was an indicative taxon in 235 alpine lakes in the Alps, the Pyrenees and the Tatra Mountains in Europe. In the Artabel Lakes Nature Park, the taxon was only found in epipelic habitat of the ARL6 with abundance very rare (VR). It was also collected in habitat with altitude: 2863 m asl, water temperature: 15.9 ºC, dissolved oxygen 8.97 mg/L, pH: 6.98, TDS: 10 mg/L and conductivity: 21.3 µS/cm.
Distribution: (as *Achnanthes austriaca* var. *helvetica* Hustedt) *Europe* (Britain, France, Netherlands, Slovakia), *North America* (Québec, United States of America), (as *Achnanthes helvetica* (Hustedt) Lange-Bertalot) *Arctic* (Canada (Arctic), Ellesmere Island), *Europe* (Germany, Ireland, Netherlands, Romania, Russia (Europe), Slovakia), *North America* (Canada, Tennessee, United States of America), *South America* (Colombia), *Asia* (Korea), (as *Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round) *Arctic* (Ellesmere Island, *Europe* (Britain, Czech Republic, France, Macedonia, Netherlands, Poland, Romania), *North America* (NW USA, Tennessee, United States of America), *Asia* (Bering Island, Russia (Far East)), *Antarctic and the subantarctic islands* (Maritime Antarctica), (as *Achnanthidium helveticum* (Hustedt) O.Monnier, Lange-Bertalot and Ector) *Europe* (France, Germany, Ireland, Romania), (as *Achnanthidium lauenburgianum* (Hustedt) Monnier, Lange-Bertalot and Ector) *Europe* (France, Germany) (Guiry and Guiry, 2017).
Order: Naviculales
Suborder: Diploneidineae
Family: Diploneidaceae
Genus: Diploneis
***Diploneis petersenii* Hustedt 1937 (Figure 2f)**
Krammer and Lange-Bertalot, 1986, p. 293, pl. 110, figs. 16,17.
Jovanovska et al., 2015, p. 238, figs. 246-249.
Homotypic synonym: *Diploneis minuta* var. *peterseni* (Hustedt) A.Cleve 1953
Description: Valve is lanceolate-elliptical with convex margins and rounded apices. Axial area is linear throughout the whole length. Central area is small and rectangular. Raphe is straight. Valve length is 28.67 µm and breadth is 9.80 µm, striae 26-27 in 10 µm.
Ecology: The optimal distribution of *Diploneis petersenii* is in circumneutral and oligosaprobic waters (Van Dam et al., 1994). This species prefers oligosaprobic waters with low to moderate electrolyte content in northern alps (Krammer and Lange-Bertalot, 1991b). Jovanovska et al., (2015) pointed out that *Diploneis petersenii* was found on rocks in shallow habitats in southern Lake Hövsgöl and in small streams in Arkhangai province. In this study, this taxon has been recorded in epiphytic samples in YLP with abundance very rare (VR). It was also collected in habitat with altitude: 2980 m asl, water temperature: 14.5 ºC, dissolved oxygen: 2.34 mg/L, pH: 7.20, TDS: 23.40 mg/L and conductivity: 29.2 µS/cm.
Distribution: *Arctic* (Svalbard (Spitsbergen)), *Europe* (Britain, France, Germany, Ireland, Macedonia, Netherlands, Poland, Romania), *Atlantic Islands* (Iceland), *North America* (Alaska, Great Lakes, Mexico, NW USA, Tennessee, United States of America), *Africa* (Sudan) (Guiry and Guiry, 2017).
Suborder: Neidiineae

Family: Amphipleuraceae
Genus: Frustulia
***Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer 1996 (Figure 2g)**
Patrick and Reimer, 1966, p. 307, pl. 22, fig. 1.
Krammer and Lange-Bertalot, 1986, p. 258, pl. 95, figs. 6,7
Basionym: *Navicula crassinervia* Brébisson ex W.Smith
Homotypic Synonyms: *Navicula crassinervia* Brébisson ex W.Smith 1853
Navicula rhomboides var. *crassinervia* (Brébisson) Grunow 1880
Frustulia rhomboides var. *crassinervia* (Brébisson ex W.Smith) Ross 1947
Heterotypic Synonym: *Frustulia rhomboides* f. *undulata* Hustedt 1930
Description: The length of the valve is 40.58-45.69 µm and breadth is 11.86-12.35 µm, striae 40 in 10 µm. The valve of the taxon is rhomboid shape and has undulate margins. Apices are narrowly rounded and moderately protracted. Both the raphe and the longitudinal ribs are slightly curved. At valve center, the ribs are slightly constricted.
Ecology: Patrick and Reimer (1966) pointed out that this taxon usually prefers oligotrophic water. This taxon is very well represented in Artabel Lakes Nature Park, it was found in epipelic and epiphytic samples in the ARL1 (altitude: 2687 m asl, water temperature: 17.5 ºC, dissolved oxygen: 8.71 mg/L, pH: 6.19, TDS: 16 mg/L and conductivity: 32.6 µS/cm), BL1 (altitude: 2831 m asl, water temperature: 13.9 ºC, dissolved oxygen: 9.14 mg/L, pH: 7.06, TDS: 10 mg/L and conductivity: 21.4 µS/cm), BL4 (altitude: 2924 m asl, water temperature: 15.5 ºC, dissolved oxygen: 8.30 mg/L, pH: 7.04, TDS: 6 mg/L and conductivity: 13.2 µS/cm), YL2 (altitude: 2980 m asl, water temperature: 11.5 ºC, dissolved oxygen: 2.88 mg/L, pH: 6.89, TDS: 26.66 mg/L and conductivity: 30.7 µS/cm) and YLP (altitude: 2980 m asl, water temperature: 14.5 ºC, dissolved oxygen: 2.34 mg/L, pH: 7.20, TDS: 23.40 mg/L and conductivity: 29.2 µS/cm) with abundance rare (R).
Distribution: (as *Navicula crassinervia* Brébisson ex W.Smith) *Europe* (Slovakia), (as *Frustulia rhomboides* var. *crassinervia* (Brébisson ex W.Smith) Ross) *Europe* (Britain, Germany, Ireland, Netherlands, Russia (Europe)), *North America* (Great Lakes, Québec, United States of America), *Pacific Islands* (Hawaiian Islands), (as *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer) *Europe* (Belgium, Czech Republic, France, Germany, Ireland, Italy, Netherlands, Norway, Romania, Russia (Europe), Sweden), *North America* (NW USA, Tennessee, United States of America), *South America* (Brazil, Colombia), *Africa* (Sudan), *Asia* (Bering Island, Russia (Far East), Tajikistan), *Australia and New Zealand* (New Zealand) (Guiry and Guiry, 2017).
Subclass: Eunotiophyceae
Order: Eunotiales
Family: Eunotiaceae
Genus: Eunotia
***Eunotia mucophila* (Lange-Bertalot, Nörpel Schempp and Alles) Metzeltin, Lange-Bertalot in Metzeltin and Lange-Bertalot 2007 (Figure 2h)**
Krammer and Lange-Bertalot, 1991a, p. 180, pl. 138, figs. 10-24.
Basionym: *Eunotia bilunaris* var. *mucophila* Lange-Bertalot, Nörpel-Schempp and E.Alles
Homotypic synonym: *Eunotia bilunaris* var. *mucophila* Lange-Bertalot, Nörpel-Schempp and E.Alles.
Description: The valve is slender and arcuate. Dorsal and ventral margins parallel. Apices are rounded. Terminal nodules are small and raphe is indistinct. The overall contour of the valve has a smooth appearance. Length: 35.39-59.51 µm. Breadth: 5-7.88 µm, striae 20-28 in 10 µm.
Ecology: This taxon is very well represented in Artabel Lakes Nature Park, it was found in epipelic, epilithic and epiphytic samples in the ARL1 (altitude: 2687 m asl, water temperature: 17.5 ºC, dissolved oxygen: 8.71 mg/L, pH: 6.19, TDS: 16 mg/L and conductivity: 32.6 µS/cm), ARL3 (altitude: 2875 m asl, water temperature: 16.3 ºC, dissolved oxygen: 8.76 mg/L, pH: 6.19, TDS: 24 mg/L and conductivity: 49.9 µS/cm), ACL2 (altitude: 2712 m asl, water temperature: 15.3 ºC, dissolved oxygen: 2.10 mg/L, pH: 7.09, TDS: 30.55 mg/L and conductivity: 38.5 µS/cm), YL2 (altitude: 2980 m asl, water temperature: 11.5 ºC, dissolved oxygen: 2.88 mg/L, pH: 6.89, TDS: 26.66 mg/L and conductivity: 30.7 µS/cm), IL (altitude: 2668 m asl, water temperature: 19.1 ºC, dissolved oxygen: 4.25 mg/L, pH: 6.78, TDS: 9.10 mg/L and conductivity: 12.0 µS/cm) with abundance rare (R). This taxon is commonly found in water of low mineral content and commonly found in acid water (Krammer and Lange-Bertalot, 1991a). In addition, Krammer and Lange-Bertalot (1991a) reported that this taxon is found on filamentous algae, mosses and silicate rocks.
Distribution: (as *Eunotia bilunaris* var. *mucophila* Lange-Bertalot, Nörpel-Schempp and E.Alles) *Europe* (Baltic Sea, Belgium, France, Germany, Netherlands, Poland, Russia (Europe), Slovakia), *North America* (Arkansas, Québec, United States of America), *South America* (Colombia), *Asia* (Korea), (as *Eunotia mucophila* (Lange-Bertalot, Nörpel-Schempp and Alles) Lange-Bertalot) *Europe* (France, Macedonia, Netherlands, Poland, Romania), *South America* (Colombia). *Asia* (Bering Island, Russia (Far East)), *Australia and New Zealand* (New Zealand) (Guiry and Guiry, 2017).
***E. paludosa* Grunow 1862 (Figure 2i)**
Hustedt, 1930, p. 178, fig. 228.
Krammer and Lange-Bertalot, 1991a, p. 203, pl. 155, figs. 1-20.
Homotypic synonym: *Himantidium paludosum* (Grunow) Lagerstedt 1873
Description: Valve is weakly curved. Ventral margin is moderately concave. Dorsal margin is convex. Valve apices are rounded and slightly dorsally reflexed. Striae are parallel. Length: 73.74 µm, Breadth: 4.62 µm, striae 19-25 in 10 µm.
Ecology: Patrick and Reimer (1966) pointed out that *Eunotia paludosa* is usually attached on mosses in acidic waters having low mineral content, also it is present in bogs and small streams. In addition, Van Dam et al. (1994) reported that this taxon is

acidobiontic: optimal occurrence at pH<5.5. This taxon is not very well represented in the study area, it was observed only in the IL with abundance very rare (VR). It was collected in epilithic habitat with pH: 6.78, TDS: 9.10 mg/L, conductivity: 12.0 µS/cm.

Distribution: *Europe* (Belgium, Britain, Czech Republic, France, Germany, Hungary, Netherlands, Poland, Romania, Russia (Europe), Slovakia), *North America* (NW USA, Tennessee, United States of America), *South America* (Brazil, Colombia), *Asia* (Bering Island, Korea, Russia (Far East)), *Australia and New Zealand* (Australia, Queensland) (Guiry and Guiry, 2017).

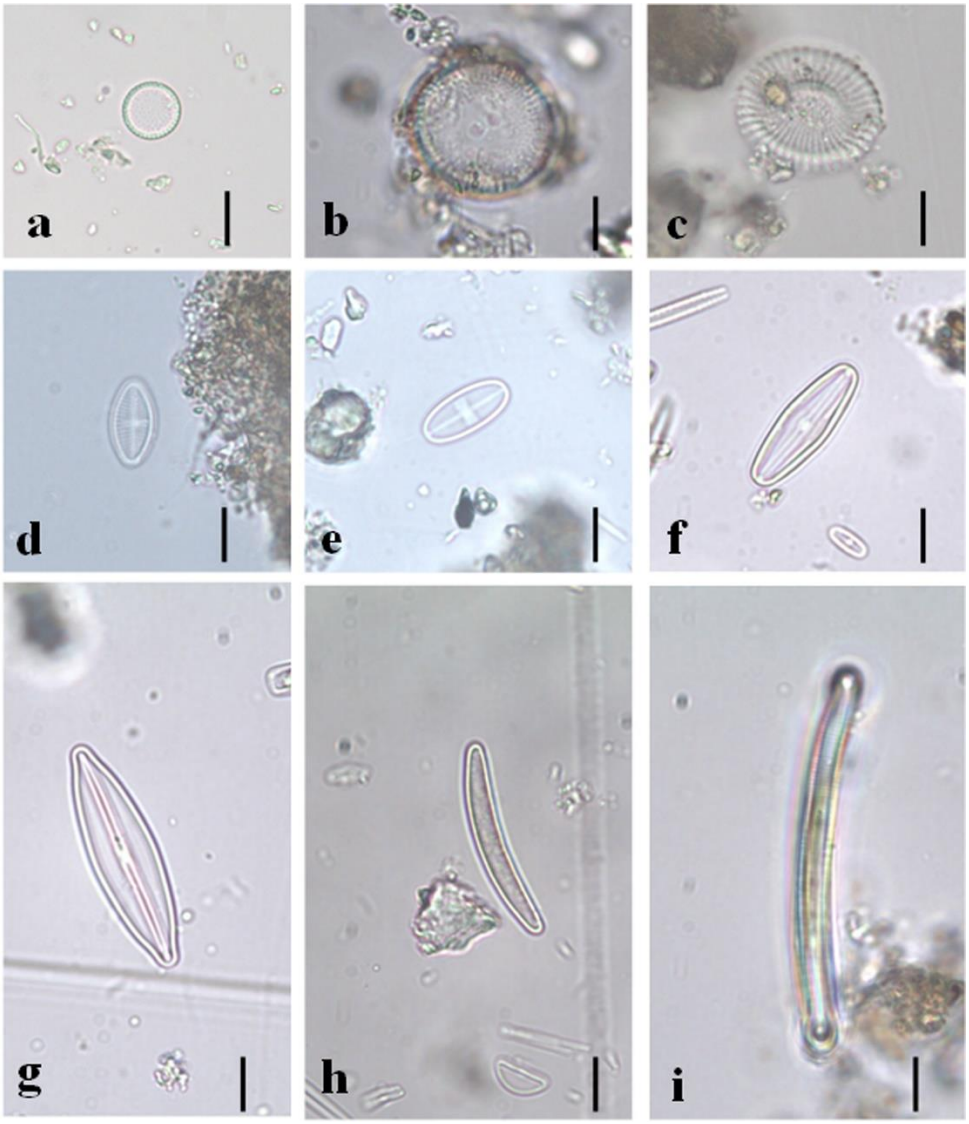

Figure 2. a. *Aulacoseira lacustris* f. *tenuior*, b. *Orthoseira roeseana*, c. *Cyclotella ambigua*, d. *Planothidium distinctum*, e. *Psammothidium helveticum*, f. *Diploneis petersenii*, g. *Frustulia crassinervia*, h. *Eunotia mucophila*, i. *Eunotia paludosa*, Scale bar 10 µm.

4. Conclusions and discussion

Turkey has different geographical and climatic characteristics. Therefore, it has a rich biological diversity. Although biodiversity in terrestrial ecosystems is largely determined, it is not sufficient in freshwater ecosystems. Studies on the freshwater algae in Turkey will contribute to the as ecological monitoring and determination of the aquatic biodiversity of the inland waters. The Turkish Government has decided to follow the European Water Framework Directive and try to improve specific diatom indices for freshwaters. Therefore, studies that take the subject of diatoms are very important. In conclusion, this study showed that as the number of studies on water ecosystems in high mountains of Turkey increases, the numbers of diatom will also increase.

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