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SHORT PAPER

New Desmid Records of Karagöl Lake in Karagöl-Sahara National Park (Şavşat-Artvin/Turkey)

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Abstract

The benthic algal flora of Karagöl Lake (Şavşat, Artvin) was investigated between October 2008 and September 2010. *Actinotaenium diplosporum* var. *americanum*, *Cosmarium pseudoexiguum*, *Gonatozygon kinahanii*, *Staurastrum boreale* var. *quadriradiatum*, *S. hantzschii* and *Staurodesmus dejectus* var. *apiculatus* were recorded for the first time for the desmid flora of Turkey.

Keywords: Karagöl Lake, new record, desmids, Turkey.

Karagöl-Sahara Milli Parkı'ndaki (Şavşat-Artvin/Türkiye) Karagöl'den Yeni Desmid Kayıtları

Özet

Karagöl'ün (Şavşat, Artvin) bentik alg florası Ekim 2008 ile Eylül 2010 tarihleri arasında incelenmiştir. *Actinotaenium diplosporum* var. *americanum*, *Cosmarium pseudoexiguum*, *Gonatozygon kinahanii*, *Staurastrum boreale* var. *quadriradiatum*, *S. hantzschii* ve *Staurodesmus dejectus* var. *apiculatus* Türkiye'nin desmid florası için ilk kez kaydedilmiştir.

Anahtar Kelimeler: Karagöl, yeni kayıt, desmid, Türkiye.

Introduction

Desmids are typically freshwater and very attractive algae characteristic of acidic and nutrient-poor aquatic ecosystems. The roles of desmids are contributing to the food supply of aquatic animals, primary producers in the aquatic environment and indicators of trophic status and pollution since they have a low tolerance for inorganic salts. Desmids have attracted the attention of microscopists because they exhibit great diversity in their external morphology as well as show remarkably complex cell symmetry making them of great natural beauty and aesthetic appeal (Kadiri, 2002).

Turkey is rather unique among the European countries in that it still contains rich freshwater areas. Ertan and Morkoyunlu (1998) pointed out that Turkey has 906.118 ha of lakes, 18.000 ha of dam lakes and a water network 145.000 km long. A number of lakes, pools and rivers are situated in high mountain areas, offering good conditions for the development of a rich desmid flora because they are largely ecologically intact and remote from the industrial and agricultural centers of Turkey. In particular, there are a number of high mountain lakes in the Eastern Black Sea region of Turkey.

Among numerous floristic papers from European countries there is relatively little information about Turkish desmids. Due to a shortage of limnologists, a lot of water bodies and difficulties of transport. Nevertheless a few check-lists were published including the results of the studies of freshwater algal flora of Turkey at different times (Aysel, 2005; Gönülol *et al.*, 1996; Şahin, 2005). In addition, new records are given for the freshwater algal flora of Turkey in various dates (Atıcı, 2002; Baykal *et al.*, 2009; Ongun-Sevindik *et al.*, 2010, 2011; Öztürk *et al.*, 1995a, 1995b; Şahin, 1998, 2000, 2002, 2005, 2007a, 2007b, 2009).

The aim of the present study was to make a contribution to the desmids flora of Turkey. Therefore

six new records were described in this paper.

Materials and Methods

Study Area

Karagöl Lake is located between the longitudes of 42°29'10.28" E and latitudes of 41°18'32.47" N in Karagöl-Sahara National Park in Artvin (Şavşat), Turkey (Figure 1). The lake has a surface area of 6 ha and depth of 33 m. It is 1630 m above sea level.

The climate of the region is generally cool and rainy in summer and cold and snowy in winter (annual means temperature 9.8^{0}C, annual precipitation 737.9 mm) (DMİGM, 2001). Karagöl-Sahara National Park is most famous for its high amount of endemic plant and animal species. Terrestrial vegetation is composed of trees, shrubs and herbs, including genera *Abies*, *Astragalus*, *Campanula*, *Fagus*, *Geranium*, *Picea*, *Pinus*, *Ranunculus*, *Trifolium*, *Veronica* and *Vicia* (Eminağaoğlu and Anşin, 2004). *Equisetum ramosissimum*, *Polygonum amphibium* and *Myriophyllum spicatum* in the littoral zone of the lake are also available. *Tetraogallus caspius*, *Vipera kaznakovi* and *Ursus arctos* are also among the animals found in the Karagöl-Sahara National Park (Anonym, 2002).

In order to examine benthic algal flora of Karagöl Lake, three stations were chosen. The number of sampling stations depended on the size of the lake. The first station is at the north-west of the lake. There are small stones and vascular plants which are *Equisetum ramosissimum*, *Polygonum amphibium* and *Myriophyllum spicatum*. The second station is situated at east of the lake where sediment, stones and vascular plants are located. The third station is at the south-west of the lake. In this station there are only vascular plants. Samples were collected during the snow-free period from October 2008 and September 2010. The samples were taken on a monthly basis. Epipelic samples (from station II) were collected by drawing a glass tube across the suface of the sediment, epilithic (from stations I, II) and epiphytic (from all stations) samples were collected at random (Round, 1953; Sladeckova, 1962). All samples were

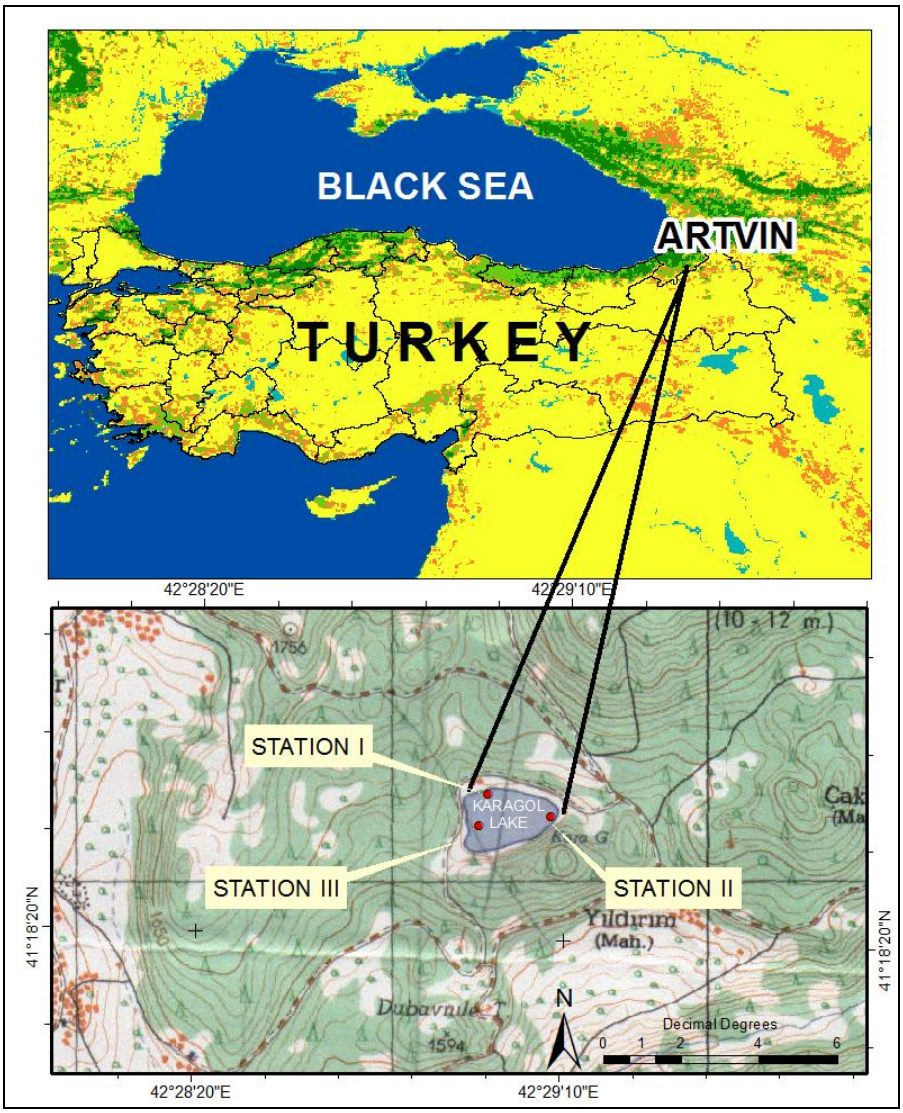

Figure 1. Map of the Karagöl Lake.

fixed in 4% formaldehyde. Samples were examined in temporary slides and under a Leica DM 2500 light microscope (magnification x400). Identification of algae were made according to Coesel and Meesters (2007), Dillard (1991), Lenzenweger (1996, 1997), John *et al*. (2003). Taxa were photographed with a camera attached to a Leica DM 2500 light microscope.

At the time of sampling, surface water temperature, pH, conductivity and dissolved oxygen concentration were measured using in situ with portable measuring instruments. On return to the laboratory, concentrations of Ca^{++}, Mg^{++}, K^{+}, Cl^{-}, SiO_2, PO_4^{3-}–P, NO_2^{-}-N, NO_3^{-}-N, NH_4^{+}-N and total hardness were measured with WTW S12 Model photometer.

Identified taxa were checked with the checklistof Aysel (2005); Gönülol *et al*. (1996) and Şahin (2005) determined as new taxa for Turkish algal flora. Taxonomy of algae was controlled with Guiry and Guiry (2013).

Results

Environmental Conditions

The water temperature of the Karagöl Lake ranged from 1,1 °C (at station II, in March 2009) to 25,4 °C (at sation III, in July 2010) (mean 14,4 °C) during the sampling period. pH values varied between 6,87 and 9,22 (mean 7,79). Accordingly, the lake water was slightly alkaline. Dissolved oxygen concentrations were measured between 6,58 mg/L (at station III, in July 2010) and 12,42 mg/L (at station III, in December 2008). Other hydrological characteristics of the lake water are given in Table 1.

Annotated List of Species

A total of 6 new records desmid taxa of 5 genera belonging to 2 families were identified from epipelic, epilithic and epiphytic samples. All genera belonged to placoderm desmids.

Divisio: Charophyta
Classis: Conjugatophyceae
Ordo: Desmidiales
Familia: Gonatozygaceae
Genus: *Gonatozygon* de Bary, 1858
G. kinahanii (W.Archer) Rabenhorst, 1868 (Figure 2a) Coesel, F.M. and Meesters, K. (2007) p. 28, pl. 5, figs: 1-2 John, D.M., Whitton, B.A. and Brook, A.J. (2003) p. 529, pl. 128, fig. N Lenzenweger, R. (1996) p. 16, pl. 1, fig: 1

Cells 12.5 µm breadth, 275 µm length. Cell 22 times longer than wide. Cell elongate cylindrical and straight. Apices of the cell truncate; walls smooth; chloroplast an axile ribbon with a series of 10 pyrenoids.
Habitat: Epilithic.
Station: 1
Familia: Desmidiaceae
Genus: *Actinotaenium* (Nägeli) Teiling, 1954
A. diplosporum var. *americanum* (West & West) Teiling,1954 (Figure 2b)
Coesel, F.M. and Meesters, K. (2007) p. 61, pl. 30, figs: 1-2
Dillard, E.G. (1991) p. 16, pl. 1 fig. 9
Cells 27,4µm breadth, 62,2 µm length.
Cells somewhat ellipsoid. Lateral sides slightly converging toward the apex. Sinus narrower and sharper marked. Chloroplast asteroid.
Habitat: Epipelic, epilithic, epiphytic.
Stations: 1, 2, 3
Genus: *Cosmarium* Corda ex Ralfs, 1848
C. pseudoexiguum Raciborski, 1885 (Figure 2c)
Coesel, F.M. and Meesters, K. (2007) p.134, pl. 67, figs: 12-13

Cells 8,8 µm breadth, 17 µm length, isthmus 2,9 µm. Cells much longer than broad, in outline rectangular with rounded angles. Sinus deep, linear and closed for the greater part. Cell wall smooth.
Habitat: Epiphytic.
Station: 3
Genus: *Staurastrum* Meyen ex Ralfs, 1848
S. boreale var. *quadriradiatum* Korshikov, 1941 (Figure 2d1,2)
Coesel, F.M. and Meesters, K. (2007) p. 177, pl. 104,

Table 1. Hydrological characteristics of Karagöl Lake

Parameters	Station I			Station II			Station III		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Temp. (°C)	1.20	24.80	14.42	1.10	23.90	14.30	1.20	25.40	14.66
DO(mg/L)	6.73	11.20	9.10	6.90	12.35	9.11	6.58	12.42	8.98
pH	6.90	9.22	7.78	6.94	9.17	7.77	6.87	8.91	7.82
EC (µS/cm)	57.70	119.90	107.18	66.90	123.60	106.10	73.00	140.20	111.84
TDS(mg/L)	28.00	59.00	52.63	33.00	60.00	52.26	36.00	69.00	54.94
$CaCO_3$ (mg/L)	30.00	86.00	61.42	28.00	88.00	57.32	21.00	89.00	57.16
NH_4^{+}-N (mg/L)	0.01	0.32	0.05	0.01	0.07	0.03	0.01	0.13	0.04
NO_3^{-}-N (mg/L)	0.10	0.80	0.31	0.10	1.40	0.42	0.10	1.00	0.30
NO_2^{-}-N (mg/L)	0.01	0.02	0.015	0.01	0.03	0.017	0.01	0.03	0.015
PO_4^{3-}- P (mg/L)	0.01	0.19	0.05	0.01	0.20	0.04	0.01	0.16	0.05
SiO_2 (mg/L)	0.50	6.70	3.62	0.50	8.10	3.61	0.50	5.90	3.17
Ca^{2+} (mg/L)	12.00	35.00	24.68	11.00	36.00	22.95	8.00	36.00	22.84

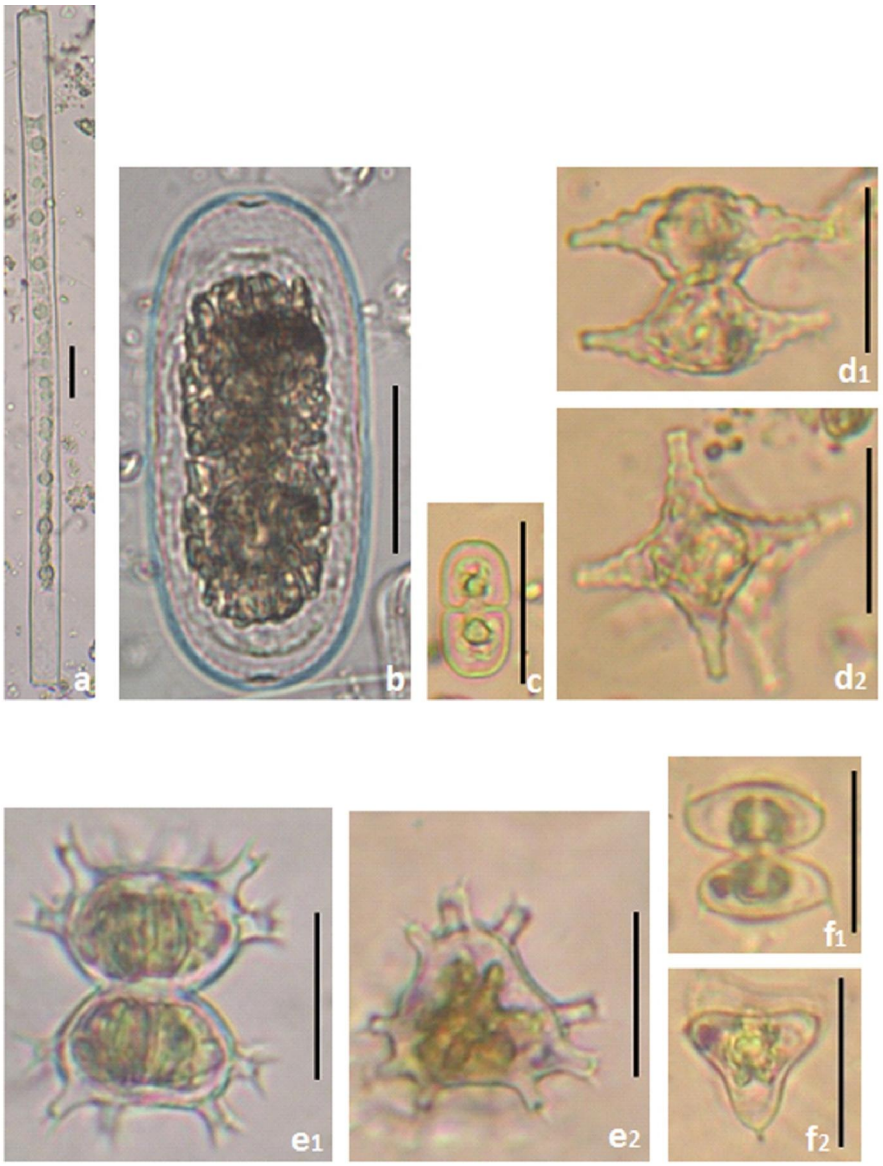

Figure 2. a. *Gonatozygon kinahanii*, b. *Actinotaeniumdiplosporum* var. *americanum*, c. *Cosmarium pseudoexiguum*, d1,2. *Staurastrum boreale* var. *quadriradiatum*, e1,2. *S. hantzschii*, f1,2. *Staurodesmus dejectus* var. *apiculatus* (Scale 20 μm)

figs: 13-17
Cells 31,1 μm breadth, 23,7 μm length. Cells broader than long, deeply constricted. Sinus widely open. Semicell cup-shaped, the apical angles produced to form rather short to moderately long, slightly divergent processes tipped by short spines. Cell wall furnished with granules. Semicells in apical view 4 radiate.
Habitat: Epilithic, epiphytic.
Stations: 2, 3.

S. hantzschii Reinsch, 1866 (Figure 2e1,2)
Lenzenweger, R. (1997) p. 93, pl. 41, figs: 9-10
Cells 22,22 μm breadth, 27,40 μm length. Cells 1,2 longer than broad, not including processes; median constriction shallow, sinus open; semicells elliptical in outline, lateral margins convex, with processes short, jagged, concave margins between processes, cell wall smooth; chloroplast with a pyrenoid by semicell; apical circular, with nine denticulate processes, concave edges between the processes.
Habitat: Epiphytic.
Station: 3
Genus: *Staurodesmus*Teiling, 1948
S. dejectus var. *apiculatus* (Brébisson) Croasdale, 1957 (Figure 2f1,2)
Coesel, F.M. and Meesters, K. (2007) p. 161, pl. 88, figs: 20-25
John, D.M., Whitton, B.A. and Brook, A.J. (2003) p. 579, pl. 141, fig: S
Lenzenweger, R. (1997) p. 26, pl. 22, figs: 8,9,11
Cells 16,2 μm breadth, 17,7 μm length. Cells are almost as broad as long. Cells triradiate, sinus widely open and rounded internally, isthmus slightly elongate, 5,1 μm wide; semicells cup-shaped, apex slightly convex and small, vertically directed spines.
Habitat: Epiphytic.
Station: 3

Discussion

On the basis of the results of the phsico-chemical analyses and determined algae (e.g. Ochrophyta, Charophyta, Chlorophyta, Cyanobacteria, Euglenozoa and Myzozoa) it is concluded that the Karagöl Lake has mesotrophic character.

The occurence of acidophilic desmids, including *Gonatozygon kinahanii*, *Staurastrum hantzschii* and *Staurodesmus dejectus. apiculatus*, in slightly alkaline water is remarkable (Coesel, 2007; John *et al*., 2003; Lenzenweger 1997).

The same situation was observed in many water bodies in Turkey and Europe (Atıcı, 2002; Baykal *et al*., 2009; Feher, 2003; Ongun-Sevindik *et al*.,2010, 2011; Öztürk *et al.*, 1995a, 1995b; Kostkeviciene *et al*., 2003; Şahin and Akar, 2007, Şahin, 1998, 2000, 2002, 2005, 2007, 2009). In addition, according to the ranges of conductivity, composition and concentrations of ions and biogenic elements, as recorded in this study, these desmids appear to be well-adapted to mesotrophic habitat.

Other desmids (e.g. *Actinotaenium diplosporum* var. *americanum*, *Cosmarium pseudoexiguum* and *Staurastrum boreale. quadriradiatum*) are known as inhabitants of mesotrophic water bodies of Europe (Coesel, 2007).

It is noteworthy that several parameters of physico-chemical analysis such as pH, conductivity, dissolved O_2, total hardness, PO_4^{3-}-P, NO_2^--N, NO_3^--N and NH_4^+-N, have a low variability in the investigated stations and this may have been a contributing factor to the development of a diverse desmid community.

It is generally acknowledged that Cosmarium and Staurastrum are the most significant desmids in the northern flora (Getzen, 1985). In this study, these genera are represented with 3 species.

In conclusion, we can say that by increasing the number of studies the number of desmids will rise.

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