

Epipellic and Epilithic Algae of Küçükgöl Lake (Gümüşhane-Turkey)

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Abstract: The epipellic and epilithic algae of Küçükgöl Lake were studied between June and September 2002. Fifty-five taxa (26 belonging to Bacillariophyta, 23 to Chlorophyta, 3 to Cyanophyta and 3 to Euglenophyta) were determined. *Closterium lunula* var. *biconvexum*, *Cosmarium asphaerosporum* var. *strigosum*, *C. garrolense*, *C. rectangulare*, *Euastrum ansatum* var. *dideltiforme*, *E. denticulatum* and *E. pseudotuddalense* are new records for the algal flora of Turkey.

Key Words: Epipellic algae, Epilithic algae, High mountain lake, Küçükgöl Lake

Küçükgöl'ün (Gümüşhane-Türkiye) Epipelik ve Epilitik Algleri

Özet: Küçükgöl'ün epipelik ve epilitik algleri 2002 yılının Haziran ve Eylül ayları arasında incelenmiştir. Bacillariophyta (26), Chlorophyta (23), Cyanophyta (3) ve Euglenophyta'ya (3) ait olmak üzere toplam 55 takson tesbit edilmiştir. *Closterium lunula* var. *biconvexum*, *Cosmarium asphaerosporum* var. *strigosum*, *C. garrolense*, *C. rectangulare*, *Euastrum ansatum* var. *dideltiforme*, *E. denticulatum* ve *E. pseudotuddalense* Türkiye alg florası için yeni kayıttır.

Anahtar Sözcükler: Epipelik algler, Epilitik algler, Yüksek dağ gölü, Küçükgöl

Introduction

Freshwater lake systems in the high-Arctic are still little investigated and understood. This is mostly due to the remote location of many high-Arctic lakes and to logistical problems in reaching these sites. High-Arctic environments are generally subject to long winters, constant low temperatures, extremes of irradiance and short vegetation periods. Lakes in these regions are often regarded as oligotrophic to ultra-oligotrophic, and are generally characterized by extended ice-cover, low nutrient inputs, low organic carbon content, low diversity of biota communities and low growth rates of biota (1).

A number of lakes, pools and rivers situated in high mountain areas offer good conditions for the development of a rich algal flora because they are largely ecologically intact and remote from the industrial and agricultural centers of Turkey. The first data about the algal flora of high mountain lakes were published by Şahin in Turkey (2-4).

Küçükgöl Lake is located at latitude 40° 44' 30" N, and longitude 39° 42' 00" E at an elevation of approximately 2800 m.a.s.l. in the Artabel Lakes Natural

Park in Gümüşhane (Figure 1). The lake has a surface area of 1.25 km² and a maximum depth of 3 m. The climate of the Artabel Lakes Natural Park is generally hot and dry in summer, cold in winter (seasonal average temperature 16.2 °C, highest temperature 39.5 °C, lowest -8.9 °C and precipitation 39 mm) (5).

The present paper reveals the species composition of epipellic and epilithic algae in Küçükgöl Lake and contributes to the algal flora of Turkey.

Materials and Methods

In order to examine the epipellic and epilithic algal flora of Küçükgöl Lake one station was chosen. The number of sampling stations depended on the size of the lake. Collections were made during the snow-free period from June to September, 2002. The samples were taken on a monthly basis, from 15-30 cm deep and 50-100 cm from the water's edge. Vascular plants and stones were absent from the station in the lake.

Epipellic samples were collected by drawing a glass tube 0.8 cm in diameter across the surface of the

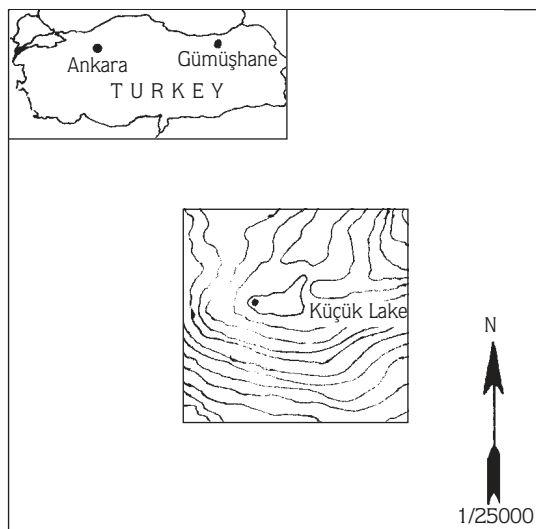


Figure 1. Map of Küçük Lake.

sediment, and epilithic samples were collected at random (6,7). All samples were fixed in 4% formaldehyde.

Permanent slides were prepared after boiling in a 1:1 mixture of concentrated H_2SO_4 and HNO_3 , and the clean diatoms were mounted in Naphrax high optical density mounting medium (6). All algae except for Bacillariophyta were examined on temporary slides.

Water temperature and pH were measured in situ using a mercury thermometer and a WTW Digi 88 model pH meter respectively. Dissolved oxygen concentration was measured according to the method described by Winkler (8).

Taxonomic identifications were made according to Dillard (9-12), Krammer and Lange-Bertalot (13-16), Lenzenweger (17-20), Patrick and Reimer (21,22) and Prescott (23). The main species of the flora were photographed using an Olympus BH-2 research microscope. All dimensions are given in micrometers and the following abbreviations are used: L: Cell length, W: Cell width, I: Breadth of isthmus.

Results

Environmental conditions

The water temperature varied from 6 to 15 °C (mean 10.5 °C). Low temperatures generally prevailed in June, and the highest temperature was in August. pH fluctuated

between 6.5 and 7.1 (mean 6.8), indicating a circumneutral character. Dissolved oxygen levels fluctuated between 9.7 and 12 mg/l.

Algal flora

A total of 55 species and varieties of algae were recorded from Küçükgöl Lake. As expected, Bacillariophyta and Chlorophyta were predominant. Comprising 47.2% and 41.8% of all recorded taxa, respectively. Cyanophyta (5.5%) and Euglenophyta (5.5%) make up an insignificant part of all taxa. A list of taxa is given in the Table. Bacillariophyta is cited according to the systematic classification of Krammer-Lange-Bertalot (13-16).

Epipellic algal flora

A total of 46 taxa were recorded from the epipellic community, of which 24 belong to Bacillariophyta, 20 to Chlorophyta and 2 to Euglenophyta. Cyanophyta was not represented in the epipellic community of Küçükgöl Lake (Table).

Pinnularia appendiculata was the most abundant, followed by *Aulacoseira italica* and *Surirella robusta* in the epipellic community. Other common epipellic diatoms included *Eunotia valida*, *Pinnularia maior* and *Stauroneis anceps*.

Chlorophyta was represented by members of the desmidiates in the epipellic community. *Micrasterias denticulata* was the most abundant, followed by *Euastrum obesum* and *E. oblongum* among the desmidiates. Euglenophyta was only represented by 2 species, which are unidentified.

Epilithic algal flora

A total of 25 taxa were recorded from the epilithic community, of which 14 belonged to Bacillariophyta, 8 to Chlorophyta and 3 to Cyanophyta. Euglenophyta was not represented in the epilithic community (Table).

Tabellaria flocculosa was the most abundant, followed by *Aulacoseira italica* and *Stauroneis anceps* in the epilithic community. Other common epipellic diatoms included *Surirella robusta*.

Filamentous Chlorophyta were represented by 2 species, Bulbochaete and Oedogonium, which were sterile and could not be identified. The most common unicellular Chlorophyta was *Euastrum obesum*. Cyanophyta was represented by 2 genera, including *Oscillatoria* and *Spirulina*.

Table. List of the epipellic and epilithic algae of Küçükgöl Lake.

		1	2
Divisio	Bacillariophyceae		
Classis	Centrobacillariophyceae		
Ordo	Centrales		
	<i>Aulacoseira italica</i> (Ehrenberg) Simonsen (Figure 2,a)	+	+
Classis	Pennatibacillariophyceae		
Ordo	Pennales		
	<i>Amphora ovalis</i> var. <i>pediculus</i> Kützing	+	
	<i>Cymbella amphicephala</i> Naegeli (Figure 2,b)	+	+
	<i>C. cistula</i> (Hemprich) Grun.	+	
	<i>C. minuta</i> Hilse ex. Rabh. (Figure 2,c)	+	
	<i>Eunotia alpina</i> (Naegali) Hustedt	+	
	<i>E. arcus</i> Ehrenberg	+	
	<i>E. gracilis</i> (Ehrenberg) Rabh.	+	
	<i>E. praerupta</i> Ehrenberg	+	+
	<i>E. pseudopectinalis</i> (Kütz.) Rabh. (Figure 2,d)	+	
	<i>E. valida</i> Hustedt (Figure 2,e)	+	
	<i>Frustulia vulgaris</i> (Thwaites) De Toni (Figure 2,f)	+	+
	<i>Gomphonema gracile</i> Ehrenberg (Figure 2,g)	+	
	<i>G. olivaceum</i> var. <i>calcareum</i> (Cleve) Cleve (Figure 2,h)	+	
	<i>Navicula bacillum</i> Ehrenberg	+	
	<i>N. minima</i> Grunow (Figure 2,i)	+	
	<i>Neidium alpinum</i> Hustedt (Figure 2,j)	+	
	<i>Pinnularia appendiculata</i> (C. Agardh) Cleve	+	+
	<i>P. borealis</i> Ehrenberg	+	+
	<i>P. gibba</i> Ehrenberg (Figure 2,k)	+	+
	<i>P. maior</i> (Kützing) Rabenhorst	+	+
	<i>P. interrupta</i> W. Smith (Figure 2,l)	+	+
	<i>Stauroneis anceps</i> Ehrenberg (Figure 2,m)	+	+
	<i>Surirella robusta</i> Ehrenberg (Figure 2,n)	+	+
	<i>S. tenera</i> Gregory	+	
	<i>Tabellaria flocculosa</i> (Roth) Kützing (Figure 2,o,p)	+	+
Divisio	Chlorophyta		
Classis	Chlorophyceae		
Ordo	Chlorococcales		
	<i>Pediastrum</i> sp.	+	
Classis	Oedogoniophyceae		
Ordo	Oedogoniales		
	<i>Bulbochaete</i> sp.	+	
	<i>Oedogonium</i> sp.	+	
Classis	Conjugatophyceae		
Ordo	Desmidiiales		
	<i>Actinotaenium cucurbita</i> (Bréb.) Teiling (Figure 3,a)	+	
	<i>Closterium lunula</i> (O.F. Müll.) Nitzsch ex Ralfs	+	

Table. (Continued).

		1	2
	<i>Cl. lunula</i> var. <i>biconvexum</i> Schmidle	+	+
	<i>Cl. pseudolunula</i> Borge (Figure 3,b)	+	
	<i>Cl. rostratum</i> Ehrenb. ex Ralfs (Figure 3,c)	+	+
	<i>Cl. sp.</i>	+	
	<i>Cosmarium asphaerosporum</i> var. <i>strigosum</i> Nordst. in Wittr. et Nordst.	+	
	<i>C. botrytis</i> Menegh. ex Ralfs (Figure 3,d)	+	+
	<i>C. garrolense</i> Roy et Biss.	+	
	<i>C. rectangulare</i> Grunow	+	
	<i>C. regnelli</i> Wille	+	
	<i>C. sp.</i>	+	
	<i>Euastrum ansatum</i> var. <i>dideltiforme</i> Duce. (Figure 3,e)	+	
	<i>E. denticulatum</i> Gay.	+	
	<i>E. obesum</i> Joshua	+	
	<i>E. oblongum</i> (Grev.) Ralfs (Figure 3,f)	+	
	<i>E. pseudotuddalense</i> Messik.	+	
	<i>Micrasterias denticulata</i> Bréb. ex Ralfs (Figure 3,g)	+	
	<i>Staurastrum dispar</i> Bréb.	+	+
	<i>S. punctulatum</i> Bréb. ex Ralfs (Figure 3h)	+	+
Divisio	Cyanophyta		
Classis	Cyanophyceae		
Ordo	Hormogonales <i>Oscillatoria formosa</i> Bory	+	
	<i>O. limosa</i> (Roth.) C. A. Agardh	+	
	<i>Spirulina</i> sp. (Figure 3,i)	+	
Divisio	Euglenophyta		
Classis	Euglenophyceae		
Ordo	Euglenales		
	<i>Euglena</i> spp. (2 species) (Figure 3,j,k)	+	
	<i>Trachelomonas</i> sp. (Figure 3,l)	+	

1: Epipellic, 2: Epilithic.

Closterium lunula var. *biconvexum* Schmidle (L: 540 µm, W: 110 µm), *Cosmarium asphaerosporum* var. *strigosum* Nordst. in Wittr. et Nordst. (L: 10 µm, W: 7.5-8 µm, l: 2.5-3 µm), *C. garrolense* Roy et Biss. (L: 33 µm, W: 22 µm, l: 5 µm), *C. rectangulare* Grunow (L: 50 µm, W: 36.6 µm, l: 11.6 µm), *Euastrum denticulatum* Gay. (L: 30 µm, W: 26 µm, l: 8 µm) and *E. pseudotuddalense* Messik. (L: 18-20 µm, W: 15-17.5 µm, l: 5-7.5 µm) are new records for the algal flora of Turkey.

Discussion

The algal flora of Küçükgöl Lake shows great similarity with the algal flora of Aygır and Balıklı (2), Dağbaşı (3) and Yedigöller (4) lakes. Diatoms and desmids were predominant in the epipellic and epilithic communities of these lakes. Cremer (1) and Lenzenweger (20) reported that diatoms and desmids are the most abundant algal groups in high-Arctic and alpine lakes.



Figure 2. a. *Aulacoseira italica*, b. *Cymbella amphicephala*, c. *C. minuta*, d. *Eunotia pseudopectinalis*, e. *E. valida*, f. *Frustulia vurgalis*, g. *Gomphonema gracile*, h. *G. olivaceum* var. *calcarea*, i. *Navicula minima*, j. *Neidium alpinum*, k. *Pinnularia gibba*, l. *P. interrupta*, m. *Stauroneis anceps*, n. *Surirella robusta*, o. *Tabellaria flocculosa*, p. Girdle view of *T. flocculosa* (Scale bar: 10 μ m).

The algal flora of Küçükgöl Lake is characterized by a high proportion (71%) of cosmopolitan and alpine (22%) elements, comprising about 93% of all taxa. The remaining species (7%) are elements of Arctic-alpine flora, *Cosmarium garrolense*, *Eunotia alpinum*, *Neidium alpinum* and *Tabellaria flocculosa* (1, 24). Coesel (25) reported that *Closterium rostratum* was on the red list in The Netherlands.

One of the author's (Şahin) began researching the algae of the high mountain lakes in 1996, since when 32 desmid species have been added to the list of Turkey's freshwater algae (26-29). The fact that 32 species found in high mountain lakes have not been registered in Turkey may be due to 2 factors:

1-A number of lakes, pools and rivers situated in high mountain areas offer good conditions for the

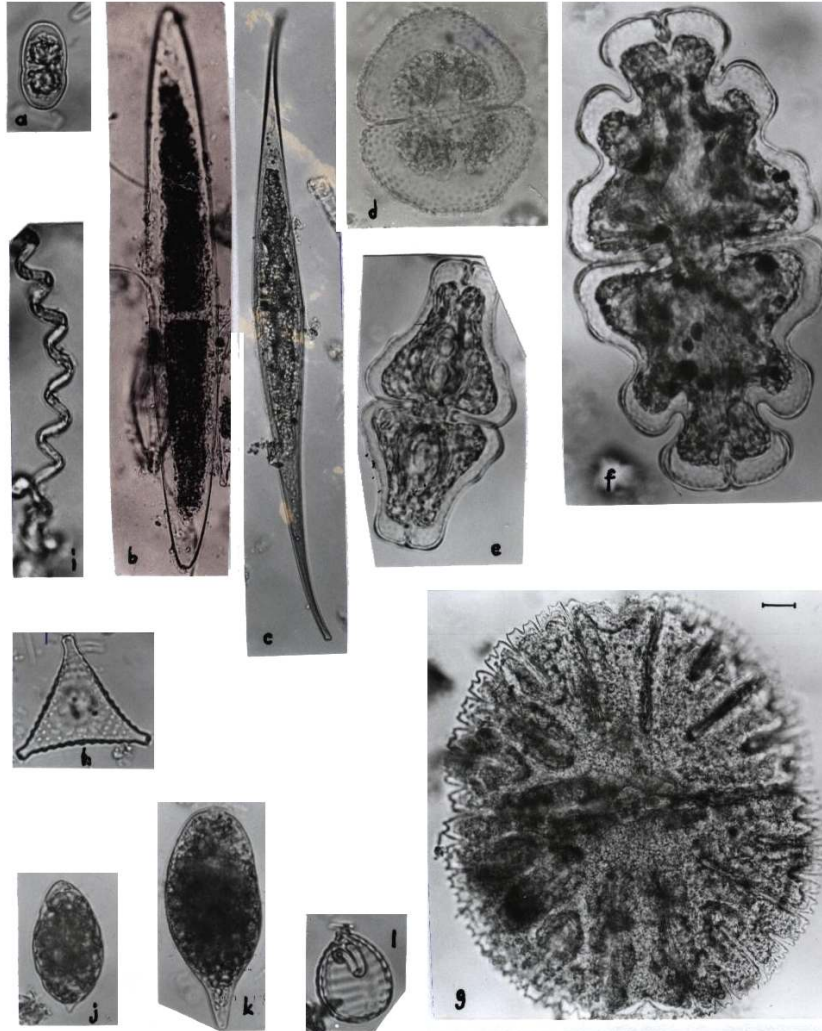


Figure 3. a. *Actinotaenium cucurbita*, b. *Closterium pseudolunula*, c. *C. rostratum*, d. *Cosmarium bortyitis*, e. *Euastrum ansatum* var. *dideltiforme*, f. *E. oblongum*, g. *Micrasterias denticulata*, h. *Staurastrum puntulatum*, i. *Spirulina* sp., j. *Euglena* sp. (1), k. *E. sp.* (2), l. *Trachelomonas* sp. (Scale bar: 10 µm).

development of a rich algal (especially desmid) flora because they are largely ecologically intact and remote from the industrial and agricultural centers of Turkey.

2- Few studies on benthic algae of high mountain lakes have been carried out or published in Turkey.

These 2 factors suggest that by increasing the number of phycofloristic studies in the northern and higher regions of Turkey the number of recorded algae species could be increased.

The taxa found in Küçükgöl Lake mainly reflect the trophic state of the lake. Küçükgöl Lake has an oligotrophic character. This was observed in the taxa. However, to be more precise it will be necessary to conduct a thorough physical and chemical analysis of the lake water.

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