Cryptogamie, Algol., 2003, 24 (4): 341-353

Biodiversity of benthic algal communities in some high mountain lakes of the Turkish Eastern Black Sea Region

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(Received 4 June 2003, accepted 16 July 2003)

Abstract — This paper summarizes the results of long-term research concerning the algal biodiversity of some mountain lakes in the Eastern Black Sea region of Turkey. The algal flora is comprised of 182 taxa from four divisions: Cyanophyta (24), Bacillariophyta (80), Chlorophyta (76) and Euglenophyta (2). The taxonomic composition of the algal flora has been analysed. Differences between the communities of the studied lakes are described and rare taxa are noted. The algal flora of the mountain lakes in the Eastern Black Sea region is more diverse than those of other lakes studied in Turkey.

Algae / biodiversity / East Black Sea Region / mountain lakes / Turkey

Résumé — Biodiversité des communautés algales de quelques lacs de haute montagne dans la région orientale de la Mer Noire en Turquie. Ce travail présente les résultats d'une recherche de longue durée sur la diversité algale de quelques lacs de haute montagne dans la région orientale de la Mer Noire en Turquie. La flore algale observée comprend 182 taxons appartenant à quatre divisions : Cyanophytes (24), Diatomophytes (80), Chlorophytes (76) et Euglénophytes (2). La composition taxinomique de cette flore algale des divers lacs est décrite et les taxons rares sont notés. La flore algale de ces lacs de haute montagne est la plus diversifiée des flores algales lacustres étudiées jusqu'à ce jour en Turquie.

Algues / biodiversité / lacs de montagne / région orientale de la Mer Noire / Turquie

INTRODUCTION

Given the continual increase of pollution pressure on aquatic biota, it is increasingly urgent to study intact, natural ecosystems prior to their disturbance (Medvedeva, 2001). Some mountain lakes of the Eastern Black Sea region of Turkey are ideal examples of natural systems unaffected by anthropogenic pollution. These lakes are largely ecologically intact and remote from the industrial and agricultural centres of the region. As such, they present unparalleled opportunities for research into fully functional, unperturbed aquatic ecosystems in the Eastern Black Sea region of Turkey.

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Although high mountain lakes have attracted the interest of limnologists for some time (e.g. Lukavský, 1994; Banderas-Tarabay, 1997; Tolotti, 2001; and Medvedeva, 2001), the algal flora in Turkey has been largely ignored due to a shortage of limnologists, few large water bodies, deficiencies in the selection of study sites and sampling methods, and the limited availability of specialized literature.

The author began researching the algae of the mountain lakes in 1996. Prior to this, no algal research had been undertaken in the area (Şahin, 1998a, 2000a, 2001, 2002a). The present paper combines the earlier data sets and provides a broad overview of algal biodiversity in the mountain lakes.

MATERIALS AND METHODS

The studied lakes are located on the Çakırgöl, Haldizen and Kızılkaya mountains in the Eastern Black sea region of Turkey (Fig. 1). Hydrological characteristics are given in Tab. 1. For all lakes, the bottom is composed of pebbles and is a little muddy.

The climate of the region is temperate, with cool summers and mild winters (seasonal average temperature 15.5° C, precipitation 80.5 mm). Terrestrial vegetation is composed of trees, shrubs and herbs, including *Picea orientalis, Fagus orientalis, Ranunculus caucasicus, Pinus silvestris, Rhododendron* sp. (Anonym, 1999).

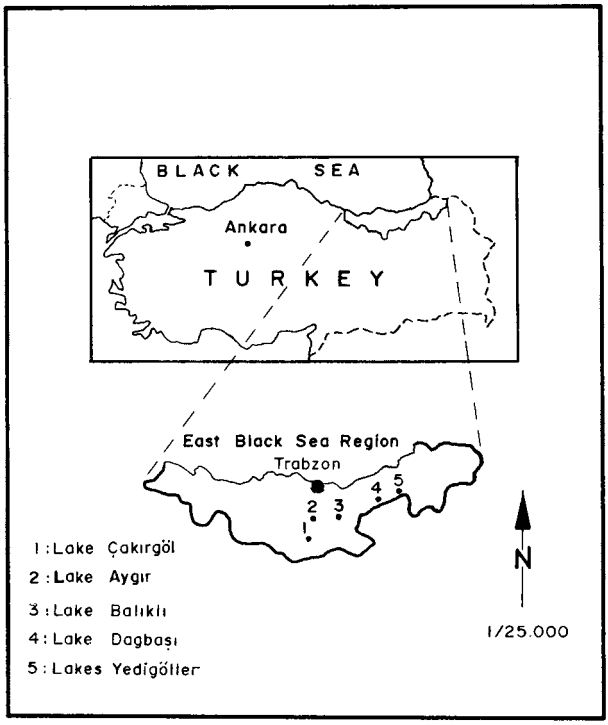

Fig 1. Map of the studied region.

Table 1. Hydrological characteristics of the mountain lakes.

Lake characteristics	*Çakırgöl Lake*	*Aygır Lake*	*Balıklı Lake*	*Dağbaşı Lake*	*Yedigöller Lakes*
Location	40º-41´ N 39º-40´ E	50º-52´ N 36º-38´ E	50º-52´ N 36º-38´ E	40º 37¹ 30¹¹ N 40º 45¹ 00¹¹ E	40º 52¹ 32¹¹ N 40º 37¹ 30¹¹ E
Size (m)	250 × 200	350 × 175	350 × 175	225 × 200	75 × 50-250 × 175
Depth (m)	15	8	8	10	0.2-8
Elevation (ma.s.l.)	2 533	2 700	2 600	2 721	3 100-3 142
T (ºC)	4-15	4.5-16.5	4.5-16.5	11-16	9-25
PH	7.1-7.2	7.0-7.1	7.0-7.1	7.1-7.2	6.9-7.5
DO (mg/l)	9.5-12	9.5-12	9.5-12	9.5-11	8.1-11.2

Collections were made during snow-free periods from June to September in 1996-2001. The number of sampling stations per watercourse depended on the size of the lakes. Samples were taken on a monthly basis and were collected from stations of 20-30 cm depth, 50-100 cm offshore. Vascular plants were absent at all stations. In total, 308 samples of epipelic and epilithic algae were collected and processed. Epipelic samples were collected by drawing a glass tube across the surface of the sediment, epilithic samples were collected at random. All samples were fixed in 4 % formalin. For diatom identification, permanent slides were prepared by boiling the sample in a 1:1 mixture of concentrated H_2SO_4 and HNO_3, then mounting the cleaned diatoms in Naphrax high optical density medium. Samples were examined under a Nikon light microscope (Round, 1953; Sládecková, 1962). Algae other than diatoms were examined using temporary slide preparations. Taxonomic identifications were made according to Bourrelly & Couté (1982), Dillard (1990, 1991a, 1991b, 1993), Förster (1982), Gontcharov (1998), Hartley *et al.* (1997), Hoek *et al.* (1997), Hustedt (1930), Lenzenweger (1997), Lind & Brook (1980), Ling & Tyler (1986), Patrick & Reimer (1966, 1975), Prescott (1973), and Scott & Prescott (1961). Algal species lists were compiled using the classification scheme proposed by Hartley *et al.* (1997) and Hoek *et al.* (1997). Full author names are in Tab. 6. To evaluate richness and diversity among algal communities of the different lakes, Shannon-Weaver's species diversity index (H) was used (Shannon & Weaver, 1949). All waterbodies studied are listed in the legend to Tab. 6.

At the time of sampling, water temperature and pH were measured by mercury thermometer and WTW Digi 88 model pH meter. Dissolved oxygen concentration was measured according to the method of Winkler (Yaramaz, 1988).

RESULTS

Floristic composition

The algal flora of the lakes includes 182 taxa from four divisions and 56 genera (Tab. 2).

The Bacillariophyta (diatoms), with 80 taxa, displayed the greatest diversity and comprised almost half of the total. The most common diatoms were

Table 2. Systematic composition of the algal flora of the mountain lakes.

Division	*Number of genera*	*Number of taxa*
Cyanophyta	8	24
Bacillariophyta	24	80
Chlorophyta	22	76
Euglenophyta	2	2
Total	56	182

Cymbella affinis, C. cistula, C. minuta, Fragilaria arcus, Pinnularia maior, Surirella splendida and *S. tenera*. The second most diverse division was the Chlorophyta (green algae), with 76 taxa, but these were not as abundant as the diatoms. Desmids were also very common. The Cyanophyta was the next most diverse division with 24 taxa, the most common being *Oscillatoria amoena, O. limosa* and *O. subbrevis*. Species of the Euglenophyta were encountered in only low numbers and the Chrysophyta, Dinophyta and Cryptophyta were absent.

Algal communities

The algal flora of the Çakırgöl lake included 36 taxa from three divisions (Tab. 3) (Şahin, 1998a). The most common diatoms were *Surirella splendida, Pinnularia maior* and *Cymbella cistula*, while the main green alga was *Cosmarium subcostatum* var. *minus*. Members of the Cyanophyta were present but rare (Tab. 6).

The flora of the Aygır lake included 47 taxa, while that of Balıklı lake included 71 taxa from four divisions (Tab. 3) (Şahin, 2000a). In both lakes, diatoms were the most numerous, followed by the green algae. Desmids were also diverse and numerous (Tab. 6).

The algal flora of Dağbaşı lake included 96 taxa from four divisions (Tab. 3) (Şahin, 2001), the most diverse and abundant were diatoms and desmids. Diatoms prevailed both in epipelic and epilithic communities. Desmids were also plentiful (Tab. 6).

The Yedigöller lakes consist of seven variously-sized lakes on the Kızılkaya mountain. The algae found in these lakes included 87 taxa from four divisions (Tab 3) (Şahin, 2002a). The diatom taxa composition of the Yedigöller lakes was almost the same in the Dağbaşı lake. Desmids were also highly diverse and abundance, with 28 taxa (Tab. 6).

Table 3. Systematic composition of the algae in the mountain lakes (Dash = Zero).

Lakes	*Cyanophyta*	*Bacillariophyta*	*Chlorophyta*	*Euglenophyta*	*Total*
Çakırgöl Lake	3/8.33 %	23/63.88 %	10/27.77 %	–	36/100 %
Aygır Lake	4/8.51 %	25/53.19 %	17/36.17 %	1/2.12 %	47/100 %
Balıklı Lake	7/9.85 %	34/47.88 %	29/40.84 %	1/1.40 %	71/100 %
Dağbaşı Lake	15/15.62 %	51/53.12 %	28/29.16 %	2/2.08 %	96/100 %
Yedigöller Lakes	11/12.64 %	42/48.27 %	33/37.93 %	1/1.14 %	87/100 %

Common species

There were some 30 (16.48 %) common taxa (Tab. 4) in the lakes, found in more than 50 % of the lakes. These were mainly diatoms, plus 8 Chlorophyta and 4 Cyanophyta. All of these taxa occupied an epiphytic or epilithic habitat and preferred slightly alkaline conditions. Most of these taxa are widely distributed throughout the world.

Diversity evaluation

The changes in species diversity of the algal communities in the mountain lakes were analysed using Shannon-Weaver's species diversity index (H).

The lowest value was obtained in the Çakırgöl lake (Tab. 5). Higher species richness, with higher species diversity value, occurred in the Dağbaşı lake (Tab. 5). However, uniformity of environmental conditions in these lakes results in impoverishment and constancy of species composition.

Table 4. Common taxa in the mountain lakes.

Amphora pediculus	*Hantzschia amphioxys*
Caloneis silicula	*Navicula cryptocephala*
Cymbella affinis	*N. radiosa*
C. amphicephala var. *intermedia*	*N. rhynchocephala*
C. cistula	*Pinnularia borealis*
C. minuta	*P. maior*
Diatoma anceps	*Surirella splendida*
D. vulgaris var. *brevis*	*S. tenera*
Didymosphenia geminata	*Cosmarium botrytis*
Epithemia argus	*C. subcostatum* var. *minus*
Fragilaria arcus	*Pediastrum boryanum*
F. arcus var. *amphioxys*	*Penium margaritaceum* var. *margaritaceum*
F. ulna	*Pleurataenium trabecula* var. *trabecula*
Gomphonema acuminatum	*Staurastrum punctulatum*
Gyrosigma acuminatum	*Merismopedia elegans*

Table 5. Values of Shannon-Weaver's species diversity index (H) for each lake studied.

Lakes	*H*
Çakırgöl Lake	0.838
Aygır Lake	0.987
Balıklı Lake	1.007
Dağbaşı Lake	1.110
Yedigöller Lakes	1.091

Rare species

Rare species were noted from virtually every division, including the Bacillariophyta: *Tabellaria flocculosa* and *T. flocculosa* var. *asterionelloides*; Chlorophyta: *Actinotaenium cruciferum, A. cucurbita, Cosmarium costatum, C. galeritum, C. norimbergense, C. novae-semliae, C. speciosum, C. variolatum, Euastrum binale* var. *gutwinskii, E. luetkemuelleri* var. *carniolicum, E. luetkemuelleri* var. *floridanum, E. obesum, E. oblongum, E. verrucosum* var. *alatum, E. verrucosum* var. *rhomboideum, Micrasterias americana, M. denticulata, M. rotata, Netrium digitus, Spondylosium planum, Staurastrum dispar* and *S. pilosum*. All of these taxa were new records for Turkey and detailed descriptions are included in Şahin (1998b, 2000b, 2002b). In addition, members of the genera *Actinotaenium, Micrasterias, Netrium* and *Spondylosium* were observed for the first time in Turkey. For the Cyanophyta, *Aphanocapca rivularis* was a rare taxon.

Table 6. List and distribution of taxa in the mountain lakes.

Taxa	*Lake number*
Cyanophyta	
Anabaena inaequalis (Kütz.) Born. *et* Flah.	4
A. flos-aquae (Lyngb.) Bréb. *ex* Born. *et* Flah.	4
Anabaena spp.	4, 5
Aphanocapsa rivularis (Carm.) Rabenhorst	5
Chroococcus dispersus var. *minor* G. M. Smith	2
Chroococcus sp.	3
Lyngbya aerugineo-caerulea (Kütz.) Gom.	5
Merismopedia elegans A. Braun	3, 4, 5
M. glauca (Ehr.) Näg.	3, 4
Merismopedia spp.	1, 3
Microcystis aeruginosa Kütz.	2, 4
Microcystis sp.	2
Nostoc spp.	4, 5
Oscillatoria amoena (Kütz.) Gom.	2, 4, 5
O. formosa Bory *ex* Gom.	1, 2, 3, 4, 5
O. limnetica Lemmermann	1
O. limosa C. A. Agardh *ex* Gom.	3, 4, 5
O. princeps Vaucher *ex* Gom.	5
O. sancta (Kütz.) Gom.	5
O. subbrevis Schmidle	4, 5
O. tenuis C.A. Agardh *ex* Gom.	4
Bacillariophyta	
Achnanthes minutissima Kütz.	5
Amphora pediculus (Kütz.) Grunow	1, 3, 5
Aulacosira italica (Ehrenb.) Simonsen	2, 3, 4
Caloneis silicula (Ehrenb.) Cleve	1, 4, 5

Table 6. List and distribution of taxa in the mountain lakes *(suite)*.

Taxa	*Lake number*
C. silicula var. *gibberula* (Kütz.) Grun.	1
C. silicula var. *truncatula* (Grun.) May.	4
Cymbella affinis Kütz.	1, 2, 4, 5
C. amphicephala var. *intermedia* A. Cl.	1, 4, 5
C. cistula (Hempr.) Grun.	1, 2, 3, 4, 5
C. cymbiformis Ag.	5
C. helvetica Kütz.	2, 3, 5
C. lata Grun.	4
C. minuta Hilse *ex* Rabh.	1, 2, 3, 4, 5
C. tumida (Bréb.) van Heurck	1, 3
Diatoma anceps (Ehrenb.) Grun.	1, 2, 3, 4
D. vulgaris var. *brevis* Grun.	1, 4, 5
Didymosphenia geminata (Lyngb.) M. Schmidt	2, 3, 4, 5
Diploneis elliptica (Kütz.) Cleve	4, 5
D. puella (Schumann) Cleve	4
Epithemia argus (Ehrenb.) Kütz.	2, 3, 4, 5
Eunotia diodon Ehrenb.	4, 5
E. gracilis (Ehrenb.) Rabenh.	1, 4
E. minor (Kütz.) Rabenh.	2, 3, 4
E. monodon var. *maior* (W. Smith) Hust.	5
E. praerupta Ehrenb.	4
E. praerupta var. *inflata* Grun.	4
E. robusta Ralfs	4
E. tenella (Grun.) Hust.	4
E. valida Hust.	4, 5
Frustulia vulgaris (Thwaites) De Toni	5
Fragilaria arcus (Ehrenb.) Patr. var. *arcus*	1, 2, 3, 4, 5
F. arcus var. *amphioxys* (Rabh.) Patr.	3, 4, 5
F. arcus var. *linearis* (Holmboe) R. Ross	3, 4
Fragilaria parasitica W. Smith.	1
F. ulna (Nitzsch.) Ehrenb.	3, 4, 5
Gomphonema acuminatum Ehrenb.	1, 4
G. acuminatum var. *clavus* (Bréb.) Grun.	2, 3
G. constrictun Ehrenb.	2, 3, 4
G. olivaceum (Lyngb.) Kütz. var. *olivaceum*	4, 5
G. olivaceum var. *calcareaum* (Cleve) Cleve	5
G. olivaceoides Hust.	2, 3, 5
G. parvulum Kütz.	1
G. truncatum var. *capitatum* (Ehrenb.) Patr.	4
Gyrosigma acuminatum (Kütz.) Rabh.	2, 3, 4, 5
Hantzschia amphioxys (Ehrenb.) Grun.	2, 3, 4, 5

Table 6. List and distribution of taxa in the mountain lakes *(suite)*.

Taxa	*Lake number*
Melosira varians Ag.	5
Meridion circulare Ag. var. *circulare*	5
M. circulare var. *constrictum* (Ralfs) Van Heurck	4, 5
Navicula cryptocephala Kütz.	1, 2, 3, 4
N. cryptocephala var. *intermedia* Grun.	4
N. cryptocephala var. *veneta* (Kütz.) Grun.	5
N. radiosa Kütz. var. *radiosa*	2, 3, 4, 5
N. radiosa var. *parva* Wallace	4
N. rhynchocephala Kütz.	1, 4, 5
Neidium iridis var. *amphigomphus* (Ehrenb.) Van Heurck	5
N. temperei Reimer	4
Nitzschia thermalis Kütz.	4
Pinnularia abaujensis var. *linearis* (Hust.) Patr.	4
P. borealis Ehrenb.	3, 4, 5
P. braunii (Grun.) Cleve	3
P. gibba W. Sm.	2
P. maior (Kütz.) Cleve	1, 2, 3, 4, 5
P. mesolepta Ehrenb.	1, 3
P. interrupta W. Smith	3
P. viridis (Nitzsch.) Ehrenb.	1, 5
P. viridis var. *sudetica* Hust.	5
Pinnularia sp.	2
Stauroneis acuta W. Smith	5
S. anceps Ehrenb.	3, 4
Surirella angusta Kütz.	2, 3, 4
S. brebissonii var. *kuetzingii* Krammer *et* Lange-Bertalot	2, 3
S. capronii Bréb.	3, 4
S. linearis W. Smith	1
S. ovalis Bréb.	4
S. robusta Ehr.	4, 5
S. splendida (Ehrenb.) Van Heurck	1, 2, 3, 4, 5
S. spiralis Kütz.	4, 5
S. tenera Gregory	1, 2, 3, 4, 5
Tabellaria flocculosa (Roth) Kütz.	2, 3
T. flocculosa var. *asterionelloides* Grun.	3, 5
Chlorophyta	
Actinotaenium cucurbita (Bréb.) Teilling	5
A. cruciferum (De Bary) Teilling	4
Ankistrodesmus falcatus (Corda) Ralfs	4
Bulbochaete sp.	2, 4
Closterium dianae Ehrenb. *ex* Ralfs	5

Table 6. List and distribution of taxa in the mountain lakes *(suite)*.

Taxa	*Lake number*
Cl. littorale Gay	3, 4
Cl. lunula var. *intermedium* Gutwinski	5
Cl. lunula var. *massartii* (Wildeman) Krieger	5
Cl. parvulum Näg. var. *parvulum*	4
Cl. pritchardianum Archer	5
Cl. ralfsii Bréb. *ex* Ralfs var. *ralfsii*	3
Cl. rostratum Ehrenb. *ex* Ralfs var. *rostratum*	5
Cl. striolatum Ehrenb. *ex* Ralfs	5
Closterium sp.	2, 3, 5
Cosmarium bioculatum Bréb. *ex* Ralfs	5
C. blyttii Wille var. *blyttii*	3, 4
C. blyttii var. *hoffii* Boergesen	5
C. botrytis Menegh. *ex* Ralfs	3, 4, 5
C. costatum Nordst.	5
C. dentiferum Corda *ex* Nordst.	3
C. exiguum var. *subrectangulum* West *et* G.S. West	5
C. galeritum Nordst.	5
C. laeve Rabenh.	4, 5
C. mansangense W. & G.S. West	4
C. margaritiferum Menegh. *ex* Ralfs	5
C. novae-semliae Wille	5
C. norimbergense Reinsch	5
C. pseudoholmii Borge	2
C. punctulatum Bréb. var. *punctulatum*	2
C. speciosum Lund	5
C. subcostatum Nordst. var. *subcostatum*	4
C. subcostatum var. *minus* (W. et G.S. West) Försten	1, 3, 4, 5
C. subspeciosum var. *validus* Nordst.	5
C. transitorium (Heimerl) Ducellier	5
C. turpinii Bréb.	5
C. variolatum (De Bary) Teilling	4
C. vexatum West	5
Cylindrocyctis brebissonii (Ralfs) De Bary	4, 5
Euastrum ansatum Ehr. *ex* Ralfs var. *ansatum*	3
E. binale var. *gutwinskii* (Sch) Krieger	4
E. luetkemuelleri var. *carniolicum* (Lütk.) Krieger	4
E. luetkemuelleri var. *floridanum* Scott et Groenblad	4
E. obesum Joshua	4
E. oblongum Ralfs	2, 3, 5
E. pinnatum Ralfs	2
E. verrucosum var. *alatum* Wolle	5

Table 6. List and distribution of taxa in the mountain lakes *(suite)*.

Taxa	*Lake number*
E. verrucosum Ehrenb. *ex* Ralfs var. *rhomboideum* Lund	2
Mougeotia sp.	2, 3
Micrasterias americana (Ehrenb.) Ralfs	2
M. denticulata Bréb. *ex* Ralfs	2, 3
M. rotata (Grev.) Ralfs	3
Microspora sp.	4
Netrium digitus (Bréb.) Itzigs. et Rothe	5, 3
Oedogonium fennicum (Tiff.) Tiffany	4
Oedogonium sp.	1, 3, 4
Pediastrum boryanum (Turp.) Menegh.	1, 2, 3, 4, 5
P. duplex Meyen	3
P. integrum var. *scutum* Raciborski	3, 5
P. muticum Kütz.	2
Pediastrum sp.	3
Penium margaritaceum (Ehrenb.) Bréb. *ex* Ralfs var. *margaritaceum*	1, 3, 5
P. polymorphum (Perty) Perty	4
Pleurotaenium trabecula (Ehrenb.) *ex* & Näg. var. *trabecula*	2, 3, 4, 5
P. minutum (Ralfs) Delp. var. *minutum*	3
Roya obtusa (Bréb.) West *et* G.S. West	5
Scenedesmus sp.	1
Staurastrum dispar Bréb.	5
S. pilosum (Näg.) Arch.	3, 4
S. polytrichum (Petry) Bréb.	3
S. punctulatum Bréb.	1, 2, 3, 4, 5
Spondylosium planum (Wolle) West *et* G.S. West	3
Spirogyra weberi Kütz.	4
Spirogyra sp.	1, 2, 3
Ulothrix variabilis Kütz.	4, 5
Ulothrix sp.	4
Zygnema sp.	3, 4, 5
Euglenophyta	
Euglena sp.	2, 4, 5
Phacus agilis Skuja	4

1 = Çakırgöl Lake, 2 = Aygır Lake, 3 = Balıklı Lake, 4 = Dağbaşı Lake, 5 = Yedigöller Lakes.

DISCUSSION

The present study documents 185 taxa from four divisions for the benthic algal flora of the Turkish lakes. Each of the lakes had a similar floristic composition, which probably reflects the uniformity of their environmental conditions. More than 70 % of the taxa collected belong to eight families, with the best represented the *Fragilariaceae* (Bacillariophyta) and *Desmidiaceae* (Chlorophyta). The results are therefore similar to descriptive data for the Sikhote-Alin reserve, Russia, given by Medvedeva (2001). The *Fragilariaceae*, *Closteriaceae*, *Eunotiaceae* and *Achnanthaceae* are typically northern algal families and their species composition reflects the holoarctic characteristics of northern hemisphere floras. As a whole, the taxonomic composition found in the present study is typical of temperate zones of Eurasia. Furthermore, a high number of single-species families and few-species genera is typical of most northern floras (Getzen, 1985). In the present study, single-species families comprised 45.8 % of the total number of families. Single-species and few-species (2-5 taxa) genera comprised 73.5 % of the total number of genera.

The most abundant genera were *Cosmarium*, *Eunotia* and *Surirella*. The uniqueness of the range of genera found in the Turkish lakes is best exemplified by the desmids. It is generally acknowledged that *Cosmarium* and *Staurastrum* are the most significant desmids in the northern flora (Getzen, 1985), and Medvedeva has suggested that a prevalence of *Cosmarium* is characteristic for the arctic flora, while *Staurastrum* is characteristic of more southerly floras. The prevalence of *Closterium* in the algal flora of the Turkish lakes is therefore evidence of its uniqueness. Almost half of the desmids found in the lakes represented new records for Turkey, which may be due to the unusual physiographic features of the basin that result in an unusual climate in an otherwise tropical and semiarid region, or alternatively the many new records may simply reflect how few studies on benthic algae have been undertaken or published in Turkey. It is clear that further studies are necessary to fully document the flora.

While Chrysophyta, Dinophyta and Xanthophyta were represented by a few taxa in the benthic communities in the Sikhote-Alin biosphere reserve in Russia (Medvedeva, 2001), Adamello-Brenta Regional Park in Italy (Tolotti, 2001) and Lake El sol in Mexico (Banderas-Tarabay, 1997), these groups of algae were not encountered in the Eastern Black Sea Region of Turkey. They may, however, be abundant in the plankton (which was not sampled) and not in the benthic communities.

The general taxonomic composition of the algal communities recorded in the lakes of the Eastern Black Sea Region is largely in accordance with that reported for oligotrophic high mountain or sub-arctic lakes of the northern hemisphere (Banderas-Tarabay, 1997; Tolotti, 2001; Medvedeva, 2001). Since there are no data on the benthic algal flora of the high-mountain lakes in other regions of Turkey, it is not possible to compare the flora of these regions with that of studied lakes.

The present study documents the taxonomic structure and richness of the algal flora of some mountain lakes in the Eastern Black Sea region. The waters of these lakes are a prime example of a natural system unaffected by pollution. We can therefore regard algal assemblages of the lakes (as described herein) as 'models' that will be of great value in providing baseline data for future monitoring and for assessing the effects of anthropogenic pollution.

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