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Benthic Algae (Except Bacillariophyta) and Their Seasonal Variations in Karagöl Lake (Borçka, Artvin-Turkey)

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Abstract: Seasonal variation in the species composition of the benthic algae of Karagöl Lake was investigated from April to October in 2001 and 2002. The benthic algal flora consisted of 38 taxa belonging to the divisions Chlorophyta, Cyanophyta, Euglenophyta, and Chrysophyta. In general, Chlorophyta were dominant in terms of species number and abundance during the study period. The distribution range of the benthic algae composition and dominant species differed from each other at all stations. Benthic algal growth was mostly influenced by water temperature and light.

Key Words: Benthic algae, seasonal variations, Karagöl Lake

Karagöl'ün (Borçka, Artvin-Türkiye) Bacillariophyta Dışındaki Bentik Algleri ve Mevsimsel Değişimi

Özet: Karagöl'ün bentik alglerinin kompozisyonundaki mevsimsel değişimler Nisan-Ekim 2001 ve 2002 yıllarında incelenmiştir. Bentik alg florası Chlorophyta, Cyanophyta, Euglenophyta ve Chrysophyta bölümlerine ait toplam 38 taksondan oluşmuştur. Araştırma süresince Chlorophyta tür sayısı ve yoğunluk bakımından dominant olmuştur. Örnekleme istasyonlarındaki alglerin kompozisyonunun mevsimsel dağılım oranları ve dominant türlerin birbirinden farklı olduğu tesbit edilmiştir. Bu çalışmada, su sıcaklığı ve ışık bentik alglerin gelişmesinde etkili olmuştur.

Anahtar Sözcükler: Bentik algler, mevsimsel değişim, Karagöl

Introduction

The importance of benthic algae in shallow lakes has been reported by many researchers (Wetzel, 1964; Moss, 1969; Khonder & Dokulil, 1988). Investigations on the population dynamics, biomass, and production of benthic algae suggest that they might sometimes exceed total phytoplankton production and, therefore, cannot be neglected when the total primary production of aquatic ecosystems is assessed (Moss, 1969; Khonder & Dokulil, 1988).

Seasonal variation, composition, and production of benthic algae are affected considerably by the physical and chemical properties of water and sediment structure. Benthic algae, which are mostly autotrophic organisms, receive most of their nutrition from dissolved chemicals in water. Thus, many authors think that they should be good indicators of the prevailing conditions in an aquatic environment. As such, algae are widely used as biomonitors to accurately assess eutrophication, pollution, and water quality (Round, 1984; Nather Khan, 1990).

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There is little information on the ecology and composition of benthic algae in high altitude mountain lakes in Turkey (Şahin, 1998, 2000, 2001, 2002; Şahin & Akar, 2005). This is primarily due to their remote location and to logistical problems in reaching them.

The purpose of the present study was to investigate the abundance and species composition of benthic algae, and to examine the physical and chemical properties of the lake water.

Materials and Methods

Karagöl Lake is located at lat 41°52'30" N, long 41°52'40" E at an elevation of approximately 1465 m a.s.l. in a national park in Artvin, Turkey. The lake has a surface area of 10 ha and maximum depth of 7 m. Two streams (Heba and Savgüle streams) enter the lake and outflow is via Çosedinara Stream (Figure 1). The climate

of the region is generally cool and rainy in summer, and cold and snowy in winter (annual means temperature: 14.4 °C; maximum: 42.4 °C; minimum: -5.7 °C; annual precipitation: 708.3 mm) (T.C. Çevre Bakanlığı Devlet Meteoroloji İşleri Genel Müdürlüğü, 2002). Terrestrial vegetation consists of trees, shrubs, and herbs, including *Abies nordmanniana* (Stev.) Mattf., *Picea orientalis* (L.) Link, *Fagus orientalis* Lipsky, *Juglans regia* L., *Rhododendron ungerii* Trautv., *R. caucasicum* Pallas, and *Rubus caucasicus* Focke (Kırsal Çevre ve Ormancılık Sorunlarını Araştırma Derneği, 1994).

Samples were collected during the snow-free period from April to October in 2001 and 2002. The samples were taken on a monthly basis and collected from 3 stations at a depth of 20-30 cm, 50-100 cm offshore. A PVC-pipe 0.8 cm in diameter was used for sampling the surface sediment at stations I and II, and the probes were immediately transported to the laboratory. At each sampling station sediment samples were taken from an area of about 15 cm², and were used for identification and enumeration of all epipellic algae within 2-3 days of collection (Round, 1953). In order to study the epiphytic algae, *Equisetum* spp. were collected from all stations and brought to the laboratory. Epipellic and epiphytic algae were preserved in a 4% formaldehyde solution. All algae were identified on multiple temporary slides.

At the time of sampling, water temperature and pH were measured using a mercury thermometer and a WTW Digi 88 model pH meter. Dissolved oxygen was analysed according to the method of Winkler (Yaramaz, 1988). Other chemical analyses were performed according to the standard methods (APHA, 1995).

The taxonomic identification of algae was carried out according to Prescott (1973), Coesel (1983, 1991), Lenzenweger (1996, 1999), John et al. (2003), and Wotowski and Hindák (2005).

Results and Discussion

Environmental conditions

During the sampling period, water temperature showed large seasonal fluctuation. Mean surface water temperature was 13 °C. Maximum water temperature (21 °C) was measured in June 2001 and minimum (5 °C)

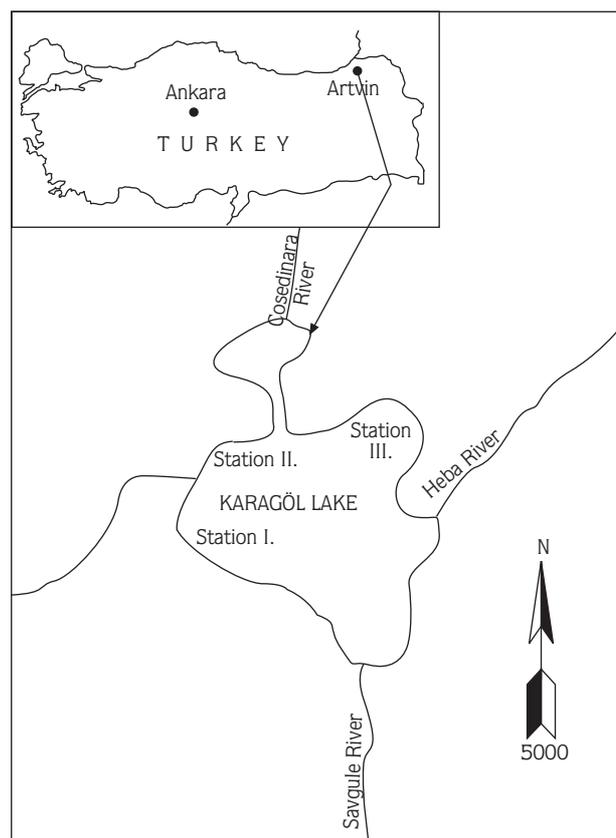


Figure 1. Map of Karagöl Lake.

in April 2002. The pH of Karagöl Lake was relatively constant, ranging from 7.1 to 7.8. Dissolved oxygen was between 8.5 and 12.3 mg l⁻¹. The concentration of Ca⁺⁺ showed seasonal variation and ranged between 8.8 and 19.6 mg l⁻¹. Maximum Mg⁺⁺ concentration was observed in August 2001 (12.2 mg l⁻¹) and minimum (5.2 mg l⁻¹) in July and September 2002. Total hardness ranged between 24 and 89 mg CaCO₃ l⁻¹.

Benthic Algal Flora

The benthic algal flora of Karagöl Lake consisted of epipellic (25 taxa) and epiphytic (19 taxa) algal communities. In all, 38 taxa were recorded; with 22 taxa Chlorophyta was the richest in species composition. Chlorophyta was followed by Cyanophyta (10 taxa), Euglenophyta (4 taxa), and Chrysophyta (2 taxa) at the 3 stations (Table).

Table. List of the epipellic and epiphytic algae in Karagöl Lake.

Taxa	1	2	Taxa	1	2
Chlorophyta			<i>Micrasterias rotata</i> (Greville) Ralfs ex Ralfs		+
Chlorophyceae			<i>Zygnemales</i>		
<i>Chlorococcales</i>			<i>Spirogyra</i> sp.		+
<i>Ankistrodesmus falcatus</i> (Chodat) Chodat	+		Chrysophyta		
<i>Oocystis</i> sp.		+	Chrysophyceae		
<i>Scenedesmus armatus</i> (Chod.) G.M.Smith	+	+	<i>Chrysomonadales</i>		
<i>Ulotrichales</i>			<i>Dinobryon</i> sp.		+
<i>Ulothrix cylindrica</i> Prescott		+	<i>Synura</i> sp.		+
<i>Chaetophorales</i>			Cyanophyta		
<i>Stigeoclonium flagelliferum</i> Kütz.		+	Cyanophyceae		
Oedogoniophyceae			<i>Chroococcales</i>		
<i>Oedogoniales</i>			<i>Merismopedia elegans</i> A.Braun	+	
<i>Bulbochaete</i> sp.		+	<i>Hormogonales</i>		
<i>Oedogonium</i> sp. 1		+	<i>Anabaena</i> sp.	+	
<i>Oedogonium</i> sp. 2		+	<i>Oscillatoria formosa</i> Bory.	+	
Bryopsidophyceae			<i>O. limnetica</i> Lemmerman	+	+
<i>Cladophorales</i>			<i>O. limosa</i> (C.Agardh) Gomont	+	
<i>Cladophora</i> sp.	+	+	<i>O. princeps</i> Vaucher		+
Conjugatophyceae			<i>O. sancta</i> (Kützing) Gomont	+	
<i>Desmidiiales</i>			<i>O. subbrevis</i> Schmidle	+	+
<i>Closterium costatum</i> Corda ex Ralfs	+		<i>O. tenuis</i> (C.Agardh) Gomont	+	
<i>Cl. ehrenbergi</i> Menegh. ex Ralfs	+		<i>Rivularia</i> sp.	+	+
<i>C. littorale</i> Gay.	+		Euglenophyta		
<i>C. striolatum</i> Ehrenb. ex Ralfs	+		Euglenophyceae		
<i>Cosmarium difficile</i> Lütkemüller	+		<i>Euglenales</i>		
<i>C. impressulum</i> Elfving		+	<i>Euglena oxyuris</i> Schmarda	+	+
<i>C. leave</i> Rabenhorst var. <i>leave</i>	+		<i>Phacus circulatus</i> (Pochmann)	+	
<i>C. regnellii</i> Wille var. <i>pseudoregnellii</i> (Messik.)			<i>Trachelomonas hispida</i> (Perty) Stein	+	
Krieger & Gerloff	+		<i>T. volvocina</i> Ehrenberg	+	
<i>C. subcrenatum</i> Hantzsch	+		1: Epipellic. 2: Epiphytic.		
<i>C. subundulatum</i> Wille		+			
<i>Euastrum insulare</i> (Witrock) J.Roy	+				

Chlorophyta was predominant and comprised 57.89% of all recorded taxa. Cyanophyta represented 26.31% of all recorded taxa, whereas Euglenophyta species (10.52%) and Chrysophyta (5.26%) made up only an insignificant part.

During the study period the greatest number epipellic algae cells (7971 cells/cm²) at station I was recorded in August 2001 and the lowest (1028 cells/cm²) was recorded in April 2002 (Figure 2). At station II, the highest number of epipellic algae cells (5397 cells/cm²) was recorded in May 2001 and the lowest (1028 cells/cm²) was recorded in April 2002 (Figure 2). The epipellic algae showed similar seasonal variation in 2001 and 2002; however, the range of distribution of the epipellic algal composition and dominant species differed from each other at all stations. A greater abundance of epipellic algae was recorded at station I than at station II throughout the study. Additionally, photographs of some species are shown in Figure 3.

Members of the Desmidiaceae were the most commonly encountered unicellular Chlorophyta. *Euastrum insulare*, for example, reached its greatest abundance (3598 cells/cm²) at station I in August 2001. The same pattern was exhibited by *Closterium striolatum* (1285 cells/cm²) at station II in July 2001. *Cosmarium regnellii* var. *pseudoregnellii* (length: 15 µm; width: 10 µm; isthmus: 3 µm) is a new record for Turkey (Şahin, 2005). Many authors have reported that water alkalinity is one of the main factors affecting the occurrence of desmid species (Brook, 1981; Ruzicka, 1981; Lenzenweger, 1996). Desmids prefer primarily acidic and pH-circumneutral

waters; however, Fehér (2003) reported that many desmid species were found in alkaline lakes and wetlands in southern Hungary. Desmid species were also reported to be abundant and common in many alkaline lakes in Turkey (Gönüloğlu & Obalı, 1986; Gönüloğlu & Çomak, 1993; Şahin, 1998).

Oscillatoria was the most commonly observed Cyanophyta genus. The occurrence of members of the blue-green algae, especially *Oscillatoria limnetica* (1799 cells/cm² at station I) and *O. sancta* (1028 cells/cm² at station II) in summer and autumn was notable, thus supporting Round's (1984) view that the blue-green algae *Anabaena* and *Oscillatoria* grow better and are more common in the summer months. In addition, members of Cyanophyta are known to be abundant in eutrophic waters and on sediments polluted with organic matter (Round, 1984).

Euglenophyta was represented by species of *Euglena*, *Phacus*, and *Trachelomonas*. The existence of Euglenophyta in the lake water is proof that the water is rich with organic substances (Palmer, 1980).

Among the epiphytic algal flora, filamentous Chlorophyta were represented by members of the genera *Bulbochaete*, *Cladophora*, *Oedogonium* and *Spirogyra*, which were sterile and could not be identified. The other identified algae of the epiphytic algal flora were unimportant at all of the stations.

One important aspect of the benthic algal distribution in Karagöl Lake was intermixing with phytoplankton. Members of the Chrysophyta (*Dinobryon* and *Synura*), for example, were found in the epipellic community in Karagöl Lake. *Dinobryon* and *Synura* species were reported to be planktonic organisms (Hutchinson, 1967). We can say that the presence of benthic algae species together with those of phytoplankton may have been the result of wind affecting the water surface in shallow lakes.

Müller (1994) reported that algal biomass and growth were positively correlated with light intensity and water temperature. The growth of benthic algae in Karagöl Lake supports this finding, because the density of benthic algae was low in early spring, when water temperature was low. Higher temperatures supported the growth and density of benthic algae in Karagöl Lake, which were at their highest levels in May and August (Figure 2).

In conclusion, snow, light, and water temperature were important factors in regulating the growth of

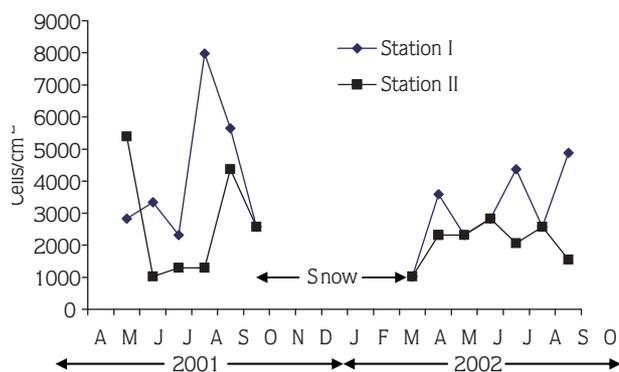


Figure 2. Seasonal variation in total benthic algae in Karagöl Lake.

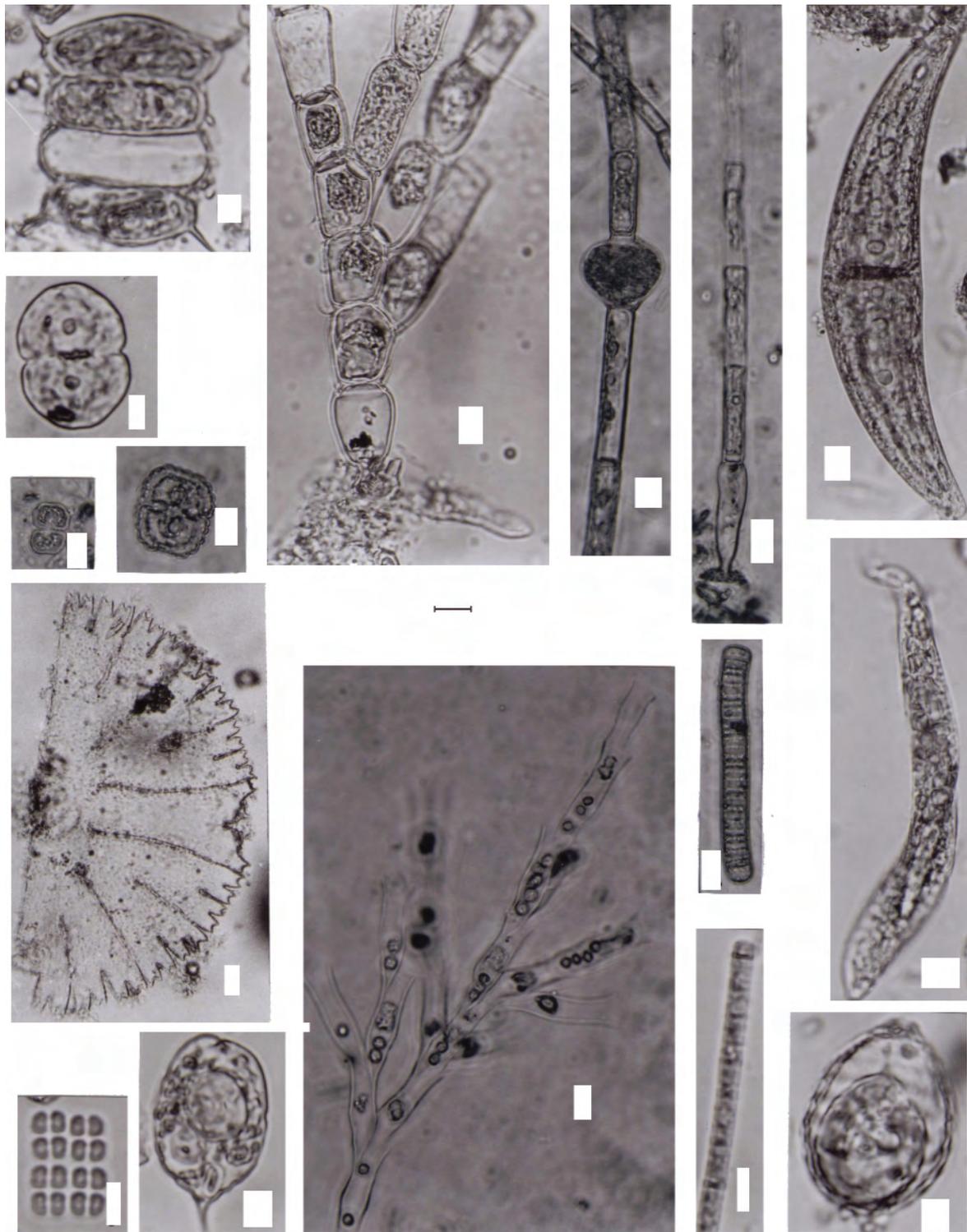


Figure 3. *Scenedesmus armatus* (Chod.) G.M.Smith (a), *Bulbochaete* sp. (b), *Oedogonium* sp. 1 (c), *O.* sp. 2 (d), *Closterium ehrenbergi* Menegh. ex Ralfs (e), *C. leave* Rabenh. var. *leave* (f), *C. regnelli* var. *pseudoregnellii* (Messik.) Krieger & Gerloff (g), *C. subcrenatum* Hantzsch (h), *Micrasterias rotata* (Grev.) Ralfs ex Ralfs (i), *Dinobryon* sp. (j), *Merismopedia elegans* A.Braun (k), *Oscillatoria limosa* (Roth.) Cl. Agardh (l), *O. subbrevis* Schmidle (m), *Euglena oxyuris* Schmarda (n), *Phacus orbicularis* Hübner (o). Scale: 10 μ m.

benthic algae. It was determined that Karagöl Lake is mesotrophic in character, due to its morphology, the physical and chemical properties of its water, and the presence of algal flora.

References

- APHA (1995). *Standard Methods for Examination of Water and Wastewater*. Washington: American Public Health Association.
- Brook AJ (1981). *The Biology of Desmids*. Oxford: Blackwell Sci Pub.
- Coesel PFM (1983). *De Desmidiaceen van Nederland deel 2. Fam. Closteriaceae*. Utrecht: Stichting Uitgeverij KNNV,
- Coesel PFM (1991). *De Desmidiaceen van Nederland deel 4. Fam. Desmidiaceae (2)*. Utrecht: Stichting Uitgeverij KNNV.
- Fehér G (2003). The desmid flora of some alkaline lakes and wetlands in Southern Hungary. *Biologia* 58: 671-683.
- Gönülol A & Obalı O (1986). Phytoplankton of Karamık Lake (Afyon), Turkey. *Commun Fac Sci Univ Ank Ser C* 4:105-128.
- Gönülol A & Çomak Ö (1993). Bafra Balık Gölleri (Balık Gölü, Uzun Göl) fitoplanktonu üzerinde floristik araştırmalar III-Chlorophyta. *Doğa- Tr J of Botany* 17: 227-236.
- Hutchinson GE (1967). *A Treatise on Limnology II. Introduction to Lake Biology and the Limnoplankton*. New York: Wiley Intersci Pub.
- John DM, Whitton BA & Brook AJ (2003). *The Freshwater Algal Flora of the British Isles, An Identification Guide to Freshwater and Terrestrial Algae*. Cambridge: Cambridge University Press.
- Khonder M & Dokulil M (1988). Seasonality, biomass and primary productivity of epipellic algae in a shallow lake (Neusiedlersee, Austria). *Acta Hydrochim Hydrobiol* 16: 499-515.
- Kırsal Çevre ve Ormancılık Sorunlarını Araştırma Derneği (1994). *Borçka (Artvin) Camili-Karagöl Orman ekosistemleri koruma ve geliştirme olanaklarının araştırılması*. Ankara.
- Lenzenweger R (1996). *Desmidiaceenflora von Österreich, teil 2*. Stuttgart: J Cramer.
- Lenzenweger R (1999). *Desmidiaceenflora von Österreich, teil 3*. Stuttgart: J Cramer.
- Moss B (1969). Algae of two Somersetshire pools: Standing crops of phytoplankton and epipellic algae as measured by cell numbers and chlorophyll-a. *J Phycol* 5: 158-168.
- Müller U (1994). Seasonal development of epiphytic algae on *Phragmites australis* (Cav.) Trin. ex Sten. in a eutrophic lake. *Arch Hydrobiol* 129: 273-292.
- Nather Khan ISA (1990). Assessment of water pollution using diatom community structure and species distribution- A case study in a tropical river basin. *Int Revue ges Hydrobiol* 75: 317-338.
- Palmer CM (1980). *Algae and Water Pollution*. New York: Castle House Pub Ltd.
- Prescott GW (1973). *Algae of the Western Great Lake Area*. Dubuque, Iowa: Brown Comp Pub.
- Round FE (1953). An investigation of two benthic algal communities in Malham Tarn Yorkshire. *Journal of Ecology* 41: 97-174.
- Round FE (1984). *The Ecology of Algae*. Cambridge: Cambridge University Press.
- Ruzicka J (1981). *Die Desmidiaceen Mitteleuropas 1-2*. Stuttgart: E Schweizerbart.
- Şahin B (1998). A study on the benthic algae of Uzungöl (Trabzon). *Turk J Bot* 22: 171-189.
- Şahin B (2000). Algal flora of Lakes Aygır and Balıklı (Trabzon, Turkey). *Turk J Bot* 24: 35-45.
- Şahin B (2001). Epipellic and epilithic algae of Dağbaşı Lake (Rize-Turkey). *Turk J Bot* 25: 187-194.
- Şahin B (2002). Epipellic and epilithic algae of the Yedigöller Lakes (Erzurum-Turkey). *Turk J Biol* 26: 221-228.
- Şahin B & Akar B (2005). Epipellic and epilithic algae of Küçükgöl Lake (Gümüşhane-Turkey). *Turk J Biol* 29: 57-63.
- Şahin B (2005). A preliminary checklist of desmids of Turkey. *Cryptogamie Algol* 26: 399-415.
- T.C. Çevre Bakanlığı Devlet Meteoroloji İşleri Genel Müdürlüğü (2002). *Rasat Bilgisi*. No: 6936.
- Wetzel GW (1964). A comparative study of the primary productivity of higher aquatic plants, periphyton, and phytoplankton in a large, shallow lake. *Int Revue ges Hydrobiol* 49: 1-61.
- Wotowski K & Hindák F (2005). *Atlas of Euglenophyta*. VEDA Pub. House of the Slovak Academy of Science.
- Yaramaz Ö (1988). *Su kalitesi*. İzmir: Ege Üniv Su Ürün. Yüksek Okulu.

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