

1-1-2005

The Benthic Algal Flora of Demirdöven Dam Reservoir (Erzurum, Turkey)

ERSİN KIVRAK

HASAN GÜRBÜZ

Follow this and additional works at: <https://journals.tubitak.gov.tr/botany>



Part of the [Botany Commons](#)

Recommended Citation

KIVRAK, ERSİN and GÜRBÜZ, HASAN (2005) "The Benthic Algal Flora of Demirdöven Dam Reservoir (Erzurum, Turkey)," *Turkish Journal of Botany*. Vol. 29: No. 1, Article 1. Available at: <https://journals.tubitak.gov.tr/botany/vol29/iss1/1>

This Article is brought to you for free and open access by TÜBİTAK Academic Journals. It has been accepted for inclusion in Turkish Journal of Botany by an authorized editor of TÜBİTAK Academic Journals. For more information, please contact academic.publications@tubitak.gov.tr.

The Benthic Algal Flora of Demirdöven Dam Reservoir (Erzurum, Turkey)

Ersin KIVRAK, Hasan GÜRBÜZ

Atatürk University, K. Karabekir Education Faculty, Department of Biology Education, 25240, Erzurum - TURKEY

Received: 29.01.2004

Accepted: 25.10.2004

Abstract: Seasonal variations in the species composition of the benthic algae of Demirdöven Dam Reservoir were investigated in 2000 and 2001. The benthic algal flora consisted of 174 taxa belonging to the *Bacillariophyta*, *Chlorophyta*, *Cyanophyta* and *Euglenophyta*. In general, *Bacillariophyta* were dominant in terms of species number and abundance during the study period. The ranges of temporal distribution of the benthic algal composition and dominant species differed from each other at all stations.

Key Words: Algae, epipellic, epilithic, seasonal variations, reservoir, Turkey

Demirdöven Baraj Gölünün (Erzurum, Turkey) Bentik Alg Florası

Özet: Demirdöven Baraj Gölünün bentik alglerinin kompozisyonundaki mevsimsel değişimler 2000 ve 2001 yıllarında incelenmiştir. Bentik alg florası *Bacillariophyta*, *Chlorophyta*, *Cyanophyta* ve *Euglenophyta* bölümlerine ait toplam 174 taksondan oluşmuştur. *Bacillariophyta* tür sayısı ve yoğunluk bakımından dominant olmuştur. Örnekleme istasyonlarındaki bentik alglerin kompozisyonunun mevsimsel dağılım oranları ve dominant türlerin birbirinden farklı olduğu bulunmuştur.

Anahtar Sözcükler: Algler, epipelik, epilitik, mevsimsel değişim, baraj gölü, Türkiye

Introduction

Benthic algae are regarded as an important component of lakes, since they make an important contribution to the biological diversity and productivity of the lakes (Moss, 1969; Aktan & Aykulu, 2001). It has been recognised that seasonal changes, composition and production of benthic algae are affected by water chemistry and sediment structure (Round, 1984). There have been some studies on the benthic algae of the lakes, reservoirs and ponds in Turkey (Gönüloğlu, 1985; Altuner & Aykulu, 1987; Yıldız, 1986; Gönüloğlu, 1987; Dere, 1989; Obalı et al., 1989; Şahin, 1998; Elmacı & Obalı, 1998; Altuner & Gürbüz, 1996; Gürbüz, 2000; Çetin et al., 2002; Gürbüz & Kıvrak, 2003).

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

The Study Site

Demirdöven Dam Reservoir (DDR) is located in the north-east of Turkey, 45 km from Erzurum, at latitude $41^{\circ} 21'$ and longitude $40^{\circ} 21'$ (Figure 1). It is surrounded by the Çobandede and Ağmelek mountains to the north and by the agricultural land of the Pasinler plain to the east and south. It was constructed in 1995 for the purposes of irrigation. The maximum storage capacity of the reservoir is $44.5 \times 10^6 \text{ m}^3$ and the area covered by the reservoir is 1.45 km^2 . The average depth is 50 m. The Tımar River carries melted snow water to the reservoir from the mountains. The weather of north-eastern Anatolia, where the DDR is located, can be characterised by a long and very cold winter with heavy snowfalls and a short summer. Therefore, the reservoir surface freezes almost every winter from December to early April.

Sampling Stations:

In order to study the benthic algae of the DDR 3 stations were chosen.

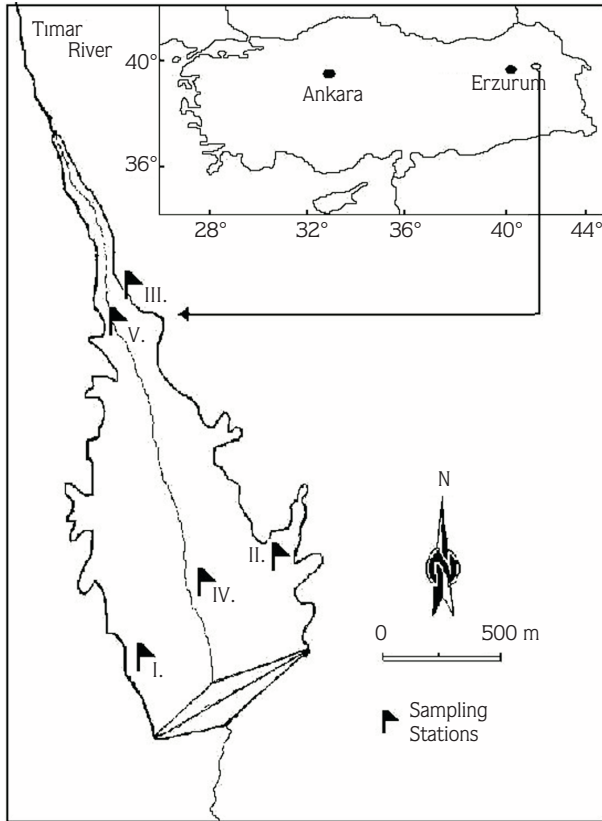


Figure 1. The Demirdöven Dam Reservoir and location of the sampling stations.

Station 1: Located in the west of the reservoir, covered with mud-sand sediment.

Station 2: Located in the east of the reservoir, covered with muddy sediment.

Station 3: Located in the north-west of the reservoir, near the Timar River mouth, covered with muddy sediment.

The physical and chemical properties of the DDR's water were also studied at 2 stations (stations 4 and 5) in the pelagic zone (Figure 1).

Materials and Methods

Samples of the epipellic and epilithic algae were collected monthly from 3 stations in 30-50 cm water depth. Sampling was not performed between December and March, because the reservoir surface was covered with ice and snow.

Water temperature, dissolved oxygen concentrations, pH and conductivity were measured using a Multilap P4 (WTW) in the field at the sampling time. CaCO_3 , HCO_3^- , Ca^{++} , Mg^{++} , SO_4^{2-} , Cl^- , Na^+ and K^+ concentrations were determined by titration in the laboratory (APHA, 1995).

The epipellic algal samples were collected from sediment using a PVC pipe 0.8 cm in diameter. The samples were placed in glass bottles, and immediately transported to the laboratory. The identification and enumeration of the epipellic algae in these samples were performed according to Round's methods (1953).

Stones and rocks about 10-15 cm in diameter were also collected and transferred to the laboratory for studying the epilithic algae. The epilithic algae were scraped from the surface of the stones and rocks with a brush brush and preserved in a 5% formaldehyde solution. Identification and determination of the abundance of all the epilithic algae were carried out on many temporary slides prepared from the epilithic algae samples.

Samples for diatom analysis were heated gently in a solution of 37% HCl and 6% KMnO_4 to remove organic matter. Clean diatom valves were washed with distilled water and mounted on a slide with Permount. Clean diatom valves were identified at 1000x magnification using an Olympus Vanox research microscope. The relative abundance (%) of each species in the epilithic diatoms was calculated by counting 100 valves per sample.

The main taxonomic references used for identification were Hustedt (1930), Cleve-Euler (1951), Patrick & Reimer (1966, 1975), Prescott (1982), Simonsen & Lange-Bertalot (1978), Findlay & Kling (1979) and Huber-Pestalozzi (1961, 1972, 1982, 1983).

Results

Physical and chemical characteristics

The surface water temperatures varied from 8.8 to 24.6 °C. Dissolved oxygen in the surface water fluctuated between 5.2 and 11.5 mg/l, and the minimum values were recorded throughout the warm period. The pH fluctuated between 7.5 and 8.3 in the surface water. Conductivity values were very low during the study and varied between 65 and 108 mS/cm. Concentrations of CaCO_3 had a seasonal range of 21.5-45.5 mg/l. HCO_3^-

concentrations varied between 22.6 and 46.3 mg/l. Ca^{++} concentrations were measured between 2.4 and 12 mg/l. Mg^{++} concentrations ranged between 2.1 mg/l and 5.2 mg/l. SO_4^{2-} concentrations varied between 2.6 and 10.2 mg/l. Na^+ , K^+ and Cl^- concentrations were relatively low

during the study period (Table 1). Many authors have reported that many lakes, dam reservoirs and ponds in Turkey have slightly alkaline and relatively soft water (Altuner & Gürbüz, 1996; Elmacı and Obalı, 1998; Gürbüz & Kıvrak, 2003).

Table 1. Some physical and chemical parameters of the Demirdöven Dam Reservoir.

Month	Stations	Temp. (°C)	DO (mg/l)	pH	EC (mS/cm)	CaCO_3 (mg/l)	HCO_3^- (mg/l)	Ca^{++} (mg/l)	Mg^{++} (mg/l)	Na^+ (mg/l)	K^+ (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)
22.4.2000	Station IV	12	11.5	8.3	88	32.5	38.3	6.8	3.4	2.7	2.5	0.18	10.2
	Station V	10.6	11.2	8.2	84	28.2	32.5	6.3	2.6	3.1	2.2	0.14	9.4
18.5.2000	Station IV	16.5	10.9	7.8	69	21.5	22.6	6.1	2.1	3.1	2.3	0.12	8.9
	Station V	15	10.8	7.9	66	23.4	25.8	7.3	2.4	2.9	2.5	0.10	9.8
16.6.2000	Station IV	22.2	10.1	8.1	86	25.3	30.5	8.0	2.4	2.5	2.7	0.09	5.5
	Station V	19.6	9.8	8.2	65	32.6	30.5	2.4	2.4	2.6	2.9	0.09	10.1
15.7.2000	Station IV	21.3	7.6	7.6	78	45.5	42.7	10.1	2.4	2.8	2.6	0.07	4.3
	Station V	21.5	7.5	7.8	67	30.1	30.5	8.0	2.4	2.9	2.4	0.06	3.9
16.8.2000	Station IV	24.6	6.3	7.9	68	23.4	25.4	11.5	2.5	3.5	3.1	0.09	7.8
	Station V	24.3	5.2	8.2	65	22.3	24.4	12.0	2.6	2.4	2.8	0.05	4.2
19.9.2000	Station IV	17.1	7.7	7.6	98	41.1	46.3	10.2	3.8	2.4	2.1	0.11	5.1
	Station V	17.5	7.6	7.8	65	26.7	30.5	10.5	3.6	2.1	2.4	0.12	6.1
17.10.2000	Station IV	14.1	7.1	7.5	89	35.6	41.2	7.5	3.4	2.6	2.2	0.11	5.2
	Station V	14.5	6.9	8.2	99	34.2	42.6	6.8	3.4	2.6	2.4	0.12	4.7
13.11.2000	Station IV	9.1	5.8	7.7	81	28.4	32.6	10.3	2.4	3.3	2.3	0.09	10.1
	Station V	9.9	5.7	7.8	84	34.2	39.2	6.8	3.6	3.5	2.2	0.06	7.7
15.4.2001	Station IV	10.2	11.2	8.2	101	32.1	38.3	4.3	2.8	4.2	3.8	0.10	3.6
	Station V	9.8	10.8	8.2	74	27.6	34.5	7.2	3.5	4.2	2.2	0.10	6.1
18.5.2001	Station IV	16	10.9	7.8	74	28.4	35.2	5.1	3.5	4.5	3.4	0.11	5.6
	Station V	15	10.8	7.6	89	25.8	30.5	4.6	2.8	4.4	3.1	0.12	5.6
16.6.2001	Station IV	17.5	9.6	8.1	96	29.9	36.6	3.8	2.4	2.4	3.2	0.19	2.6
	Station V	17.3	10.1	7.8	78	24.3	32.1	4.8	3.4	4.6	3.5	0.11	9.3
13.7.2001	Station IV	22.1	9.3	7.9	83	29.4	34.2	4.2	3.6	4.3	2.6	0.21	3.2
	Station V	21.7	9.4	7.9	108	24.1	30.5	4.1	3.6	4.3	2.7	0.16	5.3
21.8.2001	Station IV	21.8	5.6	8.2	67	28.6	32.5	6.8	2.4	4.7	3.6	0.14	8.3
	Station V	22.3	6.4	8.1	73	32.6	33.6	3.8	2.6	4.4	3.2	0.12	3.4
14.9.2001	Station IV	16.7	7.2	7.8	80	38.1	44.6	5.3	4.3	3.3	2.3	0.08	5.9
	Station V	17.3	6.5	7.8	66	26.2	41.3	3.7	5.2	3.3	2.2	0.06	8.7
12.10.2001	Station IV	14.4	7.1	8	104	25.3	33.2	6.1	4.5	3.5	2.4	0.12	5.9
	Station V	13.8	8.8	8	72	35.1	41.2	4.6	4.6	3.2	2.5	0.12	8.1
11.11.2001	Station IV	9.6	8	7.9	108	26.1	34.2	8.1	2.5	3.5	2.4	0.13	9.2
	Station V	8.8	8.6	8.2	98	34.8	43.2	4.9	3.1	2.4	2.3	0.13	8.4

DO: Dissolved oxygen; EC: Conductivity

Benthic Algal Flora

The benthic algal flora of the DDR consisted of epipellic and epilithic algal communities. A total of 174 taxa were recorded in the benthic algal communities. Most species identified in the study period belonged to the *Bacillariophyta*. A list of the identified taxa is presented in Table 2.

Epipellic algae

The epipellic algal flora consisted of 165 taxa belonging to the *Bacillariophyta*, *Chlorophyta*, *Cyanophyta* and *Euglenophyta*. The percentages of the total number of organisms belonging to the *Bacillariophyta*, *Chlorophyta*, *Cyanophyta* and *Euglenophyta* in the epipellic communities were 57%,

Table 2. List of epipellic and epilithic algae in the Demirdöven Dam Reservoir.

Taxa	E*	El*	Taxa	E*	El*
<i>BACILLARIOPHYTA</i>			<i>Diploneis ovalis</i> (Hilse) Cleve	+	+
<i>Centrales</i>			<i>Epithemia adnata</i> (Kütz.) Bréb.	+	+
<i>Aulacoseira distans</i> (Ehrenb.) Simonsen	+	+	<i>E. ocellata</i> (Ehrenb.) Kütz.	+	
<i>Cyclotella kuetzingiana</i> Thwaites	+	+	<i>E. sorex</i> Kütz.	+	+
<i>C. kuetzingiana</i> var. <i>radiosa</i> Fricke	+	+	<i>Eunatia diodon</i> Ehrenb.	+	+
<i>C. ocellata</i> Pant.	+	+	<i>E. exigua</i> (Bréb.) Rabenh.	+	
<i>M. varians</i> C.Agardh	+	+	<i>Eunatia</i> sp.		
<i>Stephanodiscus astrea</i> (Ehrenb.) Grun.	+		<i>Fragilaria vaucheriae</i> (Kütz.) J.B.Petersen	+	+
<i>Pennales</i>			<i>F. ulna</i> (Nitzsch) Lange-Bert.	+	+
<i>Achnanthes lanceolata</i> (Bréb ex Kütz.) Grun.	+	+	<i>Gomphonema acuminatum</i> Ehrenb.	+	+
<i>A. lanceolata</i> var. <i>dubia</i> Grun.	+	+	<i>G. affine</i> Kütz.	+	+
<i>A. minutissima</i> Kütz.	+		<i>G. angustatum</i> (Kütz.) Rabenh.	+	+
<i>Amphora ovalis</i> (Kütz.) Kütz.	+	+	<i>G. constrictum</i> var. <i>capitata</i> (Ehrenb.) Van Heurck	+	+
<i>A. pediculus</i> (Kütz.) Grun. Grun.	+	+	<i>G. gibba</i> J.Wallace	+	+
<i>Asterionella formosa</i> Hassall	+	+	<i>G. olivaceoides</i> Hust.	+	
<i>Caloneis limosa</i> (Kütz.) R.M.Patrick	+		<i>G. olivaceum</i> (Lyngb.) Kütz.	+	+
<i>C. schumanniana</i> (Grun.) Cleve	+		<i>G. parvulum</i> (Kütz.) Kütz.	+	+
<i>C. silicula</i> (Ehrenb.) Cleve	+	+	<i>G. truncatum</i> Ehrenb.	+	+
<i>C. silicula</i> var. <i>turuncatula</i> (Grun.) Cleve	+		<i>Gyrosigma acuminatum</i> (Kütz.) Rabenh.	+	+
<i>C. ventricosa</i> (Ehrenb.) F.Meister	+	+	<i>Hannaea arcus</i> var. <i>arcus</i> (Ehrenb.) in R.M.Patrick & Reimer	+	+
<i>Cocconeis disculus</i> (Schum.) Cleve	+		<i>H. arcus</i> var. <i>amphioxys</i> (Rabenh.) R.M.Patrick	+	+
<i>C. placentula</i> Ehrenb.	+		<i>H. arcus</i> var. <i>linearis</i> Holmboe	+	+
<i>C. placentula</i> var. <i>euglypta</i> (Ehrenb.) Cleve	+	+	<i>Hannaea</i> sp.	+	
<i>Cymatopleura angulata</i> Grev.	+		<i>Hantzschia amphioxys</i> (Ehrenb.) Grun.	+	+
<i>C. elliptica</i> (Bréb.) W.Sm.	+	+	<i>H. virgata</i> (Roper) Grun.	+	
<i>C. solea</i> (Bréb.) W. Sm.	+	+	<i>Meridion circulare</i> (Grev.) C.Agardh	+	+
<i>Cymbella affinis</i> Kütz.	+	+	<i>Navicula capitata</i> Ehrenb.	+	+
<i>C. cistula</i> (Ehrenb.) Kirchner	+	+	<i>N. cryptocephala</i> var. <i>veneta</i> (Kütz.) Rabenh.	+	+
<i>C. cistula</i> var. <i>maculata</i> (Kütz.) Van Heurck			<i>N. cuspidata</i> (Kütz.) Kütz.	+	+
<i>C. cuspidata</i> Kütz.	+		<i>N. dicephala</i> Ehrenb.	+	+
<i>C. cymbiformis</i> C.Agardh	+	+	<i>N. dicephala</i> var. <i>neglecta</i> (Krasske) Hust.	+	
<i>C. lanceolata</i> (C.Agardh) C.Agardh	+	+	<i>N. gracilis</i> Ehrenb.	+	+
<i>C. minuta</i> fo. <i>latens</i> (Krasske) Reimer	+	+	<i>N. graciloides</i> A.Mayer	+	+
<i>C. minuta</i> var. <i>silesiaca</i> (Bleisch ex Rabenh.) Reimer	+	+	<i>N. halophila</i> (Grun.) Cleve	+	+
<i>C. muelleri</i> fo. <i>ventricosa</i> (Temp. & Perag.) Reimer	+		<i>N. laevisissima</i> Kütz.		+
<i>C. naviculiformis</i> (Auersw. ex Heib.) Cleve	+	+	<i>N. mutica</i> Kütz.	+	+
<i>C. sinuata</i> W.Greg.	+	+	<i>N. mutica</i> var. <i>undulata</i> (Hilse) Grun.	+	+
<i>C. tumida</i> (Bréb.) Van Heurck	+	+	<i>N. rhynchocephala</i> Kütz.	+	+
<i>C. turgidula</i> Grun.	+	+	<i>N. salinarum</i> Grun.	+	+
<i>Diatoma anceps</i> (Ehrenb.) Kirchner	+		<i>N. viridula</i> (Kütz.) Ehrenb.	+	+
<i>D. hiemale</i> var. <i>mesodon</i> (Ehrenb.) Grun.	+	+	<i>Neidium affine</i> (Ehrenb.) Pfitzer	+	+
<i>D. vulgare</i> var. <i>grande</i> (W.Sm.) Grun.	+		<i>N. iridis</i> (Ehrenb.) Cleve	+	+
<i>Didymosphenia geminata</i> (Lyngb.) M.Schmidt	+	+	<i>Nitzschia amphibia</i> Grun.	+	+

Table 2. (Continued).

Taxa	E*	El*	Taxa	E*	El*
<i>N. dissipata</i> (Kütz.) Grun.	+	+	<i>C. lunula</i> (O.F.Müll.) Nitzsch ex Ralfs	+	+
<i>N. fonticola</i> Grun.	+		<i>C. parvulum</i> Näegeli	+	+
<i>N. palea</i> (Kütz.) W.Sm.	+	+	<i>C. ralfsii</i> Bréb. ex Ralfs	+	+
<i>N. paleacea</i> Grun.	+		<i>C. tumidum</i> Johnson	+	+
<i>N. sinuata</i> var. <i>tabellaria</i> (Grun.) Grun.	+	+	<i>Cosmarium denticulatum</i> (Borge) Grönblad	+	+
<i>Pinnularia acrosphaeria</i> (Bréb.) W.Sm.	+	+	<i>C. granatum</i> Bréb.	+	+
<i>P. biceps</i> W. Greg.		+	<i>C. margaritatum</i> (Lund.) Roy & Biss.	+	+
<i>P. borealis</i> Ehrenb.	+	+	<i>C. pyramidatum</i> Bréb.	+	+
<i>P. brebissonii</i> (Kütz.) Rabenh.	+	+	<i>C. subcostatum</i> Nordst.	+	+
<i>P. isostauron</i> (Ehrenb.) Cleve	+		<i>C. vexatum</i> W.West.	+	+
<i>P. mesolepta</i> (Ehrenb.) W.Sm.	+		<i>Cosmarium</i> sp.		+
<i>P. microstauron</i> (Ehrenb.) Cleve	+	+	<i>Staurostrum longiradiatum</i> W.& G.S.West	+	+
<i>P. stomatophora</i> (Grun.) Cleve	+	+	<i>Oedogoniales</i>		
<i>P. viridis</i> (Nitzsch) Ehrenb.	+	+	<i>Bulbochaeta</i> sp.		+
<i>Sellaphora bacillum</i> (Ehrenb.) D.G.Mann	+		<i>Oedogonium</i> sp.		+
<i>S. pupula</i> (Kütz.) Meresch.	+	+	<i>Ulotrichales</i>		
<i>S. pupula</i> var. <i>capitata</i> (Skv. & Meyer) comb.	+		<i>Ulothrix tenerrima</i> Kütz.	+	+
<i>Rhoicosphenia curvata</i> (Kütz.) Grun.	+	+	<i>U. zonata</i> (Weber & D.Mohr) Kütz.		+
<i>Rhopalodia gibba</i> (Ehrenb.) O. Müll.	+	+	<i>Ulothrix</i> sp.	+	+
<i>Stauroneis anceps</i> Ehrenb.	+	+	<i>Volvocales</i>		
<i>S. anceps</i> fo. <i>gracilis</i> Rabenh.	+		<i>Pandorina morum</i> (O.F. Müll.) Bory	+	+
<i>S. phoenicenteron</i> (Nitzsch) Ehrenb.	+		<i>Zygnemales</i>		
<i>S. smithii</i> Grun.	+	+	<i>Spirogyra fuelebornei</i> Schimidle	+	+
<i>Surirella angusta</i> Kütz.	+	+	<i>S. weberi</i> Kütz.	+	+
<i>S. ovata</i> Kütz.	+		<i>Spirogyra</i> sp.	+	
<i>S. robusta</i> Ehrenb.	+	+	CYANOPHYTA		
<i>Synedra demerarae</i> Grun.	+		<i>Chroococcales</i>		
<i>S. parasitica</i> var. <i>subconstricta</i> (Grun.) Hust.	+		<i>Merismopedia elagans</i> A.Braun ex Kütz.	+	+
<i>S. radians</i> Kütz.	+	+	<i>Hormogonales</i>		
<i>S. rumpens</i> Kütz.	+	+	<i>Anabaena aequalis</i> Borge	+	+
<i>S. ulna</i> var. <i>contracta</i> Østrup	+	+	<i>A. affinis</i> Lemmerm.	+	+
CHLOROPHYTA			<i>A. solitaria</i> Brunth.	+	+
<i>Chlorococcales</i>			<i>Oscillatoria limosa</i> (Roth) C.Agardh ex Gomont	+	+
<i>Dictyosphaerium pulchellum</i> H.C.Wood	+	+	<i>O. limnetica</i> Lemmerm.	+	+
<i>Oocystis borgei</i> J.Snow	+	+	<i>O. splendida</i> (Grev.) Gomont	+	+
<i>O. tainoensis</i> Komárek		+	<i>O. tenuis</i> C.Agardh ex Gomont	+	+
<i>Oocystis</i> sp.	+	+	<i>O. tenuis</i> var. <i>natans</i> Gomont	+	+
<i>Pediastrum boryanum</i> (Turpin) Menegh.	+	+	<i>Phormidium formosum</i> (Gomont) Anagn. & Komárek	+	+
<i>P. tetras</i> (Ehrenb.) Ralfs	+	+	<i>Pseudoanabaena</i> sp.	+	+
<i>Scenedesmus acutiformis</i> Schröd.	+	+	<i>Spirulina nordstedtii</i> Gomont	+	+
<i>S. arcuatus</i> (Lemmerm.) Lemmerm.	+	+	EUGLENOPHYTA		
<i>S. disciformis</i> (Chodat) Fott & Komárek	+	+	<i>Euglenales</i>		
<i>S. ecornis</i> (Chodat) Fott & Komárek	+	+	<i>Euglena acus</i> Ehrenb.	+	+
<i>S. linearis</i> Komárek	+	+	<i>E. gracilis</i> G.A.Klebs	+	+
<i>S. obtusiusculus</i> Chodat	+	+	<i>E. polymorpha</i> P.A.Dang.	+	+
<i>S. obtusus</i> fo. <i>alternans</i> (Reinsch.) Comp.	+	+	<i>Euglena</i> sp.	+	+
<i>S. producto-capitatus</i> Schmula	+	+	<i>Euglena</i> sp.	+	+
<i>S. quadricauda</i> (Turpin) Bréb.	+	+	<i>Phacus acuminatus</i> A.Stokes	+	+
<i>Tetraedron minimum</i> (A.Braun) Hansg.	+	+	<i>P. pleuronectes</i> (O.F.Müll.) Dujard.	+	+
<i>Desmidiales</i>			<i>P. spirogyra</i> var. <i>maxima</i> Prescott	+	+
<i>Arthrodesmus triangularis</i> Lagerh.		+	<i>Trachelomonas varians</i> (Lemmerm.) Deflandre	+	
<i>Closterium littorale</i> F. Gay	+	+	<i>T. volvocina</i> Ehrenb.	+	+

(*) E: Epipellic El: Epilithic

27%, 11% and 5%, respectively. The *Bacillariophyta* were dominant in terms of species number and abundance during the study period. However, members of the *Cyanophyta*, especially *Anabaena aequalis* Borge and *Oscillatoria limnetica* Lemmerm., became dominant only at station II with a rapid increase in late summer and early autumn. *N. rhynchocephala* Kütz., *N. salinarum* Grun., *Cocconeis placentula* var. *euglypta* (Ehrenb.) Cleve and *Pinnularia borealis* Ehrenb. (*Bacillariophyta*) were dominant at all stations. *Hannaea arcus* (Ehrenb.) R.M.Patrick *Cymbella minuta* fo. *latens* (Krasske) Reimer and *Achnanthes lanceolata* (Bréb.) Grun. were dominant only at station I. *Nitzschia palea* (Kütz.) W. Sm. was abundant, and *Amphora ovalis* (Kütz.) Kütz., *Fragilaria ulna* (Nitzsch) Lange-Bert. *Oscillatoria limnetica* and *O. limosa* (Roth) C.Agardh ex Gomont were subdominant species at station II. *Cosmarium margaritatum* (Lund.) Roy & Biss., *Staurastrum longiradiatum* W.&G.S.West, *Closterium lunula* (O.F.Müll.) Nitzsch ex Ralfs, *C. parvulum* Näegeli, *Euglena polymorpha* P.A.Dang., *E. gracilis* G.A.Klebs and *Phacus acuminatus* A.Stokes were abundant at stations II and III.

The epipellic algae exhibited similar seasonal variations in 2000 and 2001; however, the ranges of distribution of the epipellic algal composition and dominant species differed from each other at all stations. A higher abundance of epipellic algae was recorded at stations II and III than at station I throughout the study.

During the spring, numbers of the epipellic algae were very low at station I, and members of the *Bacillariophyta* constituted almost 80% of the epipellic algal community in both years. *Hannaea arcus*, *Achnanthes lanceolata*, *Cocconeis placentula* Ehrenb., *Navicula rhynchocephala*, *N. salinarum* and *Fragilaria ulna* were dominant at station I. The composition and growth of the epipellic algae were similar at stations II and III during the spring. At these stations, the epipellic algae were mainly dominated by the *Bacillariophyta*; members of the *Chlorophyta* and *Cyanophyta* were found in very low numbers, and members of the *Euglenophyta* occurred rarely at that time. The dominant species were *Amphora ovalis* (only in 2001), *Navicula rhynchocephala*, *N. salinarum*, *Nitzschia palea*, *Pinnularia borealis*, *Cosmarium margaritatum*, *Closterium parvulum*, *C. lunula*, *Oscillatoria limosa*, *Phormidium formosum* (Gomont) Anagn. & Komárek (only in 2000), *Anabaena solitaria* Brunth. and *A. aequalis* (only in 2001). A result of long winter conditions, the

spring peak of the epipellic algae was recorded in June 2000 and June 2001 (Figure 2).

During the summer (July and August) of 2000, while notable decreases in the total counts of epipellic algae were observed, there was a more gradual change in the abundance of the epipellic algae at the same time in 2001. The *Bacillariophyta* were dominant at station I, with 80% of the total individual counts of the epipellic algae. No changes in the numbers of members of the *Chlorophyta* and *Cyanophyta* were observed at station I in this period on comparing with the spring period. Whilst members of the *Bacillariophyta* decreased in number at stations II and III in summer, there were notable increases in the counts of the *Cyanophyta* and *Euglenophyta* members in summer. *Anabaena aequalis* (*Cyanophyta*) showed a rapid increase, especially in 2001, and reached about 3790 individuals per cm². Thus, the *Cyanophyta* became dominant together with the *Bacillariophyta* at these stations. Almost all of the species dominating in spring were also dominant in summer at all stations (Figure 2).

The maximum number of epipellic algae was recorded in September of both years, followed by a steady decline to the end of the year. Members of the *Bacillariophyta* were found at higher numbers than the *Chlorophyta* and *Cyanophyta* at station I. *Anabaena aequalis*, *Oscillatoria limosa* (only in 2000) and *O. limnetica* (*Cyanophyta*) (only in 2001) grew rapidly in late summer and autumn at stations II and III. In particular, *Anabaena aequalis* increased very rapidly at station II in 2001 and appeared as a mat on the sediment surface. Some 15380 individuals per cm² of this species were found at station II and constituted the majority of the epipellic community. The sediment of station III was mostly dominated by members of the *Bacillariophyta* and *Cyanophyta*. *Euglena polymorpha*, *E. gracilis* and *Phacus acuminatus* (*Euglenophyta*) were widespread at stations II and III in the summer and autumn, but they were observed rarely at station I (Figure 2).

Epilithic Algae

The epilithic algal flora was mainly dominated by diatoms at all stations, and the dominating species in the epilithic algal flora differed from each other at all stations. *Cocconeis placentula* var. *euglypta*, *Navicula rhynchocephala* and *N. salinarum* were the most abundant species at all stations. *Achnanthes lanceolata*, *Hannaea arcus* var. *amphioxys* (Rabenh.) Patrick, *Cymbella minuta*

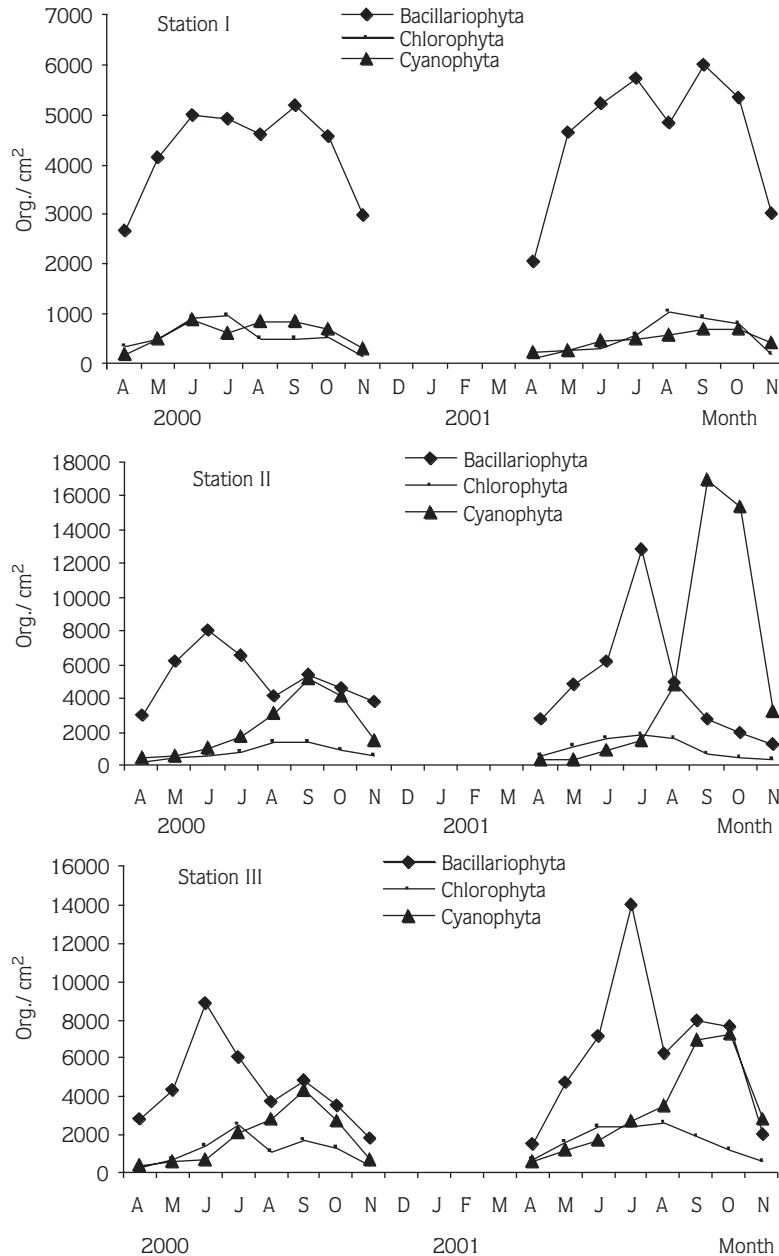


Figure 2. Seasonal changes in density of algal groups in the Demirdöven Dam Reservoir.

fo. latens, *Cymbella minuta* var. *silesiaca* (Bleisch ex Rabenh.) Reimer, *Epithemia adnata* (Kütz.) Bréb. and *Gomphonema olivaceum* (Lyngb.) Kütz. were common at stations I and III. *Gomphonema parvulum* (Kütz.) Kütz., *Epithemia adnata*, *Epithemia sorex* Kütz. and *Nitzschia palea* were dominant at station II.

In the epilithic flora, while members of the *Chlorophyta* were abundant throughout the study period,

members of the *Cyanophyta* and *Euglenophyta* were abundant only at stations II and III in the summer and autumn. *Cosmarium margaritatum*, *Closterium parvulum*, *Oedogonium* sp., *Ulothrix zonata* (Weber & D.Mohr) Kütz., *Staurastrum longiradiatum*, *Anabaena aequalis*, *Oscillatoria limosa*, *Euglena gracilis*, *E. polymorpha* and *Trachelomanas volvocina* Ehrenb. were abundant Table 3.

Table 3. Mean relative abundance of epilithic diatom taxa in the Demirdöven Dam Reservoir.

Taxa	Station I	Station II	Station III	Taxa	Station I	Station II	Station III
<i>Centrales</i>				<i>Cyprasigma acuminatum</i>	0.63	0.75	0.69
<i>Aulacoseria distans</i>	0.25	0.69	0.25	<i>Hannaea arcus</i>	5.56	1.56	4.31
<i>Cyclotella kützingiana</i>	0.94	1.31	1.44	<i>Hannaea arcus</i> var. <i>amphioxys</i>	4.06	1	2.31
<i>C. kützingiana</i> var. <i>radiosa</i>	0.56	0	0.44	<i>Hannaea arcus</i> var. <i>linearis</i>	1.81	0.56	0.63
<i>Cyclotella ocellata</i>	2.06	1.94	2.44	<i>Hantzschia amphioxys</i>	0.81	0.63	0.56
<i>Meloseria varians</i>	1.81	0.94	1.13	<i>Meridion circulare</i>	0.13	0.69	0.31
<i>Pennales</i>				<i>Navicula capitata</i>	0.63	0.25	0.25
<i>Achnanthes lanceolata</i>	4.94	0.94	3	<i>Navicula cryptocephala</i> var. <i>veneta</i>	1.88	2.88	1.44
<i>Achnanthes lanceolata</i> var. <i>dubia</i>	0	0.25	0	<i>Navicula cuspidata</i>	0.44	0	0.63
<i>Amphora ovalis</i>	1.13	0	1.25	<i>Navicula dicephala</i>	0	1.31	0
<i>Amphora ovalis</i> var. <i>pediculus</i>	0.5	2.5	0.31	<i>Navicula gastrum</i>	0.44	0.75	0.56
<i>Asterionella formosa</i>	0.25	0	0	<i>Navicula gracilis</i>	0.88	1.44	0.31
<i>Caloneis silicula</i>	0.69	0.5	0.38	<i>Navicula graciloides</i>	0.31	0	0.56
<i>Caloneis ventricosa</i>	0.31	0.5	0.19	<i>Navicula halophila</i>	0.69	0.81	0.38
<i>Cocconis placentula</i> var. <i>euglypta</i>	4.13	3.81	5.19	<i>Navicula leavissima</i>	0	0.38	0
<i>Cymatopleura elliptica</i>	0.25	0.69	0.19	<i>Navicula mutica</i>	1.19	1.19	0
<i>Cymatopleura solea</i>	0.69	0.38	0.38	<i>Navicula mutica</i> var. <i>undulata</i>	1.5	0.75	1.38
<i>Cymbella affinis</i>	1.44	1.75	2.19	<i>Navicula rhyncocephala</i>	3.94	8	7.19
<i>Cymbella cistula</i>	1.25	1.94	2.56	<i>Navicula salinarum</i>	3.44	5.94	4.88
<i>Cymbella cistula</i> var. <i>maculata</i>	0	0	0.5	<i>Navicula viridula</i>	0.75	0	0.75
<i>Cymbella cymiformis</i>	1.25	1.63	1.38	<i>Neidium affine</i>	0.31	0	0.38
<i>Cymbella lanceolata</i>	1.06	2.06	1.63	<i>Neidium iridis</i>	0.19	0	0
<i>Cymbella minuta</i> fo. <i>latens</i>	5.94	2.88	3.44	<i>Nitzschia amphibia</i>	0.88	1.31	0.94
<i>Cymbella minuta</i> var. <i>silesiaca</i>	6.13	2.44	4.38	<i>Nitzschia dissipata</i>	2.19	1.56	2.13
<i>Cymbella naviculiformis</i>	0.69	0.56	0.25	<i>Nitzschia palea</i>	0.44	4.75	2.5
<i>Cymbella sinuata</i>	0.69	0	0.5	<i>Nitzschia sinuata</i> var. <i>tabellaria</i>	0.75	0.56	0.19
<i>Cymbella tumida</i>	0.94	0.88	1.5	<i>Pinnularia acrosphaeria</i>	0.19	0.31	0.25
<i>Diatoma heimale</i> var. <i>mesodon</i>	0.31	0.31	0.5	<i>Pinnularia biceps</i>	0	0	0.25
<i>Didymosphenia geminata</i>	0.5	0.38	0.38	<i>Pinnularia borealis</i>	1.38	1.19	0.56
<i>Diploneis ovalis</i>	0.19	0.19	0.38	<i>Pinnularia brebissoni</i>	0	0	0.25
<i>Epithemia adnata</i>	3	4.63	3.88	<i>Pinnularia microstauron</i>	0	0.81	0
<i>Epithemia sorex</i>	1.94	3.31	2	<i>Pinnularia stamotophora</i>	0.19	0.31	0.19
<i>Eunatia diadon</i>	0.13	0.38	0.31	<i>Pinnularia viridis</i>	0.81	0.69	0.75
<i>Eunatia</i> sp.	0.13	0	0	<i>Rhicosphenia curvata</i>	0.56	0.75	0.19
<i>Fragilaria vaucheriae</i>	1.25	0.81	1	<i>Rhopalodia gibba</i>	0.44	0.56	0.56
<i>Fragilaria ulna</i>	3.5	1.88	3.25	<i>Sellaphora pupula</i>	1.25	1.19	0.88
<i>Gomphonema acuminatum</i>	1.19	1.25	1.44	<i>Stauroneis anceps</i>	0.75	0.75	0.38
<i>Gomphonema affine</i>	0.31	1	0.19	<i>Stauroneis smithii</i>	0.31	0	0.19
<i>Gomphonema angustatum</i>	1.5	2.25	1.75	<i>Suirella angustata</i>	0.81	0.88	1.13
<i>Gomphonema consrictum</i> var. <i>capitata</i>	0.5	0	0	<i>Surirella robusta</i>	0.25	0	0
<i>Gomphonema gibba</i>	1.06	0	0.81	<i>Synedra radians</i>	0.63	0	0.44
<i>Gomphonema olivaceum</i>	3.88	2.19	4.06	<i>Synedra rumpens</i>	0	0.44	0.25
<i>Gomphonema parvulum</i>	0.56	6.06	4.19	<i>Synedra ulna</i> var. <i>consricta</i>	0	1.13	0
<i>Gomphonema turuncatum</i>	0.81	0.75	0.5				

Discussion

Members of the *Bacillariophyta* dominated in the benthic algal flora of other lakes and reservoirs in Turkey and they were also dominant in that of the DDR, followed by the *Cyanophyta* and *Chlorophyta*. Similarly, species of *Cyanophyta* were subdominant in Tortum Lake (Altuner and Aykulu, 1987) and *Chlorophyta* were subdominant in Palandöken (Gürbüz, 2000) and 23 Temmuz Ponds (Gürbüz & Kivrak, 2001), Tercan (Altuner & Gürbüz, 1996) and Çubuk-I Dam Lakes (Gönüloğlu, 1985).

The composition of the epipelagic algal flora is affected by a complex of factors, of which the chemical properties of the overlying water is the dominant one, interacting with the chemical and physical nature of the sediment and with the degree of water movement (Round, 1984). Seasonal variations and the composition of the epipelagic algal flora of the DDR were observed to differ from each other at all stations. These results could be attributed to different environmental conditions such as the chemical and physical nature of the sediment at the stations. Whilst the *Bacillariophyta* were dominant at station I throughout the study period, they were dominant together with the *Cyanophyta* at stations II and III during the summer and autumn. *Navicula rhynchocephala*, *N. salinarum*, *Cocconeis placentula* and *Pinnularia borealis* were dominant at all stations. *Navicula* Bory species are known to be especially tolerant to changing environmental conditions (Nather Khan, 1990), which explains why they have been shown to be dominant in the epipelagic algal flora of many lakes and reservoirs in Turkey (Gönüloğlu, 1985; Elmalı & Obalı, 1998; Çetin et al., 2002; Gürbüz & Kivrak, 2003). *Hannaea arcus*, *Cymbella minuta* fo. *latens* and *Achnanthes lanceolata* were dominant only at station I with mud-sandy sediment.

Round (1960) reported that species of *Amphora* Ehrenb., *Caloneis* Cleve, *Cocconeis* Ehrenb., *Cymbella* C.Agardh, *Cymatopleura* W.Sm., *Epithemia* Bréb., *Navicula*, *Nitzschia* Hassall and *Rhopalodia* O.Müll. were common in calcareous and slightly alkaline water. The diatoms that grow well in calcareous and slightly alkaline water were also dominant in the benthic algal flora of the DDR. The results of chemical analyses of the reservoir water showed that it is slightly alkaline (Table 1). Diatoms growing in calcareous and alkaline water were also dominant in the benthic algal flora on the sediments of ponds, lakes and reservoirs in Turkey (Gönüloğlu, 1985,

1987; Elmalı & Obalı, 1998; Gürbüz & Kivrak, 2003).

Members of the *Cyanophyta* were subdominant at stations II and III, whereas they were not important at station I. *Anabaena aequalis*, *Oscillatoria limnetica* and *O. limosa* were recorded in high numbers in the DDR during the summer and early autumn. Round (1984) reported that these species grow in eutrophic water and on organically polluted sediments in summer and autumn. The dominance of *Nitzschia palea*, *Anabaena* Bory and *Oscillatoria* Vaucher species suggested that the sediments of these stations are very rich in organic matter.

Cosmarium margaritatum, *Staurastrum longiradiatum*, *Closterium lunula* and *C. parvulum* were found in low abundance on the sediments. *Staurastrum* Meyen species are known to be planktonic organisms, and *Staurastrum longiradiatum* may be transferred from the pelagic zone to sediments when common in reservoir waters during the summer.

Euglena polymorpha, *E. gracilis* and *Phacus acuminatus* were abundant at stations II and III in the summer and autumn. Round (1984) stated that members of the *Euglenophyta* were abundant in eutrophic water and on sediments polluted with organic matter.

Diatoms known as attached organisms, such as species of *Hannaea* R.M.Patrick, *Cymbella*, *Cocconeis*, *Epithemia*, *Gomphonema* C.Agardh and *Synedra* Ehrenb. were abundant in the epilithic algal community. Members of the *Chlorophyta* (especially *Oedogonium* sp. and *Ulothrix zonata*), *Cyanophyta* and *Euglenophyta* were abundant during the summer and autumn. The abundant species in the epilithic community of the DDR are similar to those of Çubuk-I Dam and Bayındır Dam Lakes (Gönüloğlu, 1985; 1987), Akşehir Lake (Elmalı & Obalı, 1998) and Kuzgun Dam Reservoir (Gürbüz & Kivrak, 2003). Round (1984) reported that filamentous algae and *Cymbella*, *Cocconeis*, *Epithemia*, *Gomphonema* and *Synedra* species were the most abundant organisms of the epilithic habitat.

The diatom taxa, thriving well in slightly alkaline water, became dominant in the benthic algal flora of the DDR. Seasonal variations and the growth of benthic algae were affected by environmental factors, especially water temperature. The abundance of benthic algae in the DDR was very low in early spring and late autumn (when water temperature is low) and high during the late spring, summer and early autumn.

References

- Aktan Y & Aykulu G (2001). İznik Gölü'nün kıyı bölgesi sedimanları üzerinde yaşayan alg toplulukları. *Istanbul Üniv. Su Ürünleri Dergisi* 12: 31-48.
- Altuner Z & Aykulu G (1987). Tortum Gölü epipelik alg florası üzerinde bir araştırma. *Istanbul Üniv Su Ürünleri Dergisi* 1(1): 120-132.
- Altuner Z & Gürbüz H (1996). Tercan Baraj Gölü bentik alg florası üzerinde bir araştırma. *Tr J of Botany* 20: 41-51.
- APHA (1995). Standard methods for the examination of water and wastewater. Washington: American Public Health Association.
- Cleve-Euler A (1951). Die Diatomeen Van Schweden und Finnland. Almquist und Stocholm: Wikselle Bok tryckeri Ab.
- Çetin AK, Sen B & Yıldırım V (2002). Seasonal variations of epipellic diatoms in Gölbaşı Lake with relation to physical-chemical variables. *Fresenius Environmental Bulletin* 11(6): 306-311.
- Dere Ş (1989). Beytepe ve Alap Göletlerindeki bazı bentik diyatome cins ve türlerinin mevsimsel dağılımı. *Doğa TU Biyoloji Dergisi* 13: 1-7.
- Elmacı A & Obalı O (1998). Akşehir Gölü kıyı bölgesi alg florası. *Tr J of Biology* 22: 81-78.
- Findlay DL & Kling HJ (1979). A species list and dicitorial reference to the phytoplankton of central and Northern Canada, part I., II. Fisheries and Marine Service Manuscripts Report No: 1503, Winnipeg; Canada.
- Gönülol A (1985). Çubuk-I Baraj Gölü üzerinde araştırmalar. II. Kıyı alglerinin kompozisyonu ve mevsimsel değişimi. *Doğa Bilim Dergisi A₂(9)*: 253-268.
- Gönülol A (1987). Studies on the benthic algae of Bayındır Dam Lake. *Tr J of Botany* 11: 38-55.
- Gürbüz H (2000). Palandöken Göleti bentik alg florası üzerinde kalitatif ve kantitatif bir araştırma. *Tr J of Biology* 24: 31-48.
- Gürbüz H & Kıvrak E (2001). Erzurum, 23 Temmuz Göleti bentik alg florası üzerinde bir araştırma. *Istanbul Üniv Su Ürünleri Dergisi* 12: 73-91.
- Gürbüz H & Kıvrak E (2003). Seasonal variations of benthic algae of Kuzgun Dam Reservoir and their relationship to environmental factors. *Fresenius Environmental Bulletin* 12(9): 1025-1032.
- Huber-Pestalozzi G (1961). Das Phytoplankton des Süßwassers, Systematik und Biologie, Teil 5, Thienemann, A., Chlorophyceae (Grünalgen), Ordnung Volvocales. Stuttgart: E. Schweizerbarth'sche Verlagsbuchhandlung (Nägele u. Obermiller).
- Huber-Pestalozzi G (1972). Das Phytoplankton des Süßwassers, Systematik und Biologie, Teil 6, Fott, V.B., Chlorophyceae (Grünalgen), Ordnung Tetraporales. Stuttgart: E. Schweizerbarth'sche Verlagsbuchhandlung (Nägele u. Obermiller).
- Huber-Pestalozzi G. (1982). Das Phytoplankton des Süßwassers, Systematik und Biologie, Teil 8: Förster V.K., Conjugatophyceae (Grünalgen), Ordnung Zygnematales und Desmidiates. Stuttgart: E. Schweizerbarth'sche Verlagsbuchhandlung (Nägele u. Obermiller).
- Huber-Pestalozzi G (1983). Das Phytoplankton des Süßwassers, Systematik und Biologie, Teil 7: Komárek, J und B. Fott., Chlorophyceae (Grünalgen), Ordnung Chlorococcales Stuttgart: E. Schweizerbarth'sche Verlagsbuchhandlung (Nägele u. Obermiller).
- Hustedt F (1930). *Bacillariophyta*. Helf 10 in Pasches, Die Süßwasser Flora Mitteleuropas. Germany: Gustav Fischer Pub.
- 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.
- 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.
- Obalı O, Gönülol A & Dere Ş (1989). Algal flora in the littoral zone of Lake Mogan. *Ondokuz Mayıs Üniv Fen Dergisi* 1: 33-53.
- Patrick R & Reimer CW (1966). The Diatoms of the United States. Vol. I: *Fragilariaceae, Eunotiaceae, Achnantheaceae, Naviculaceae*. Philadelphia: The Academy of National Science of Philadelphia.
- Patrick R & Reimer CW (1975). The Diatoms of the United States. Vol. II: *Entomoneidaceae, Cymbellaceae, Gomphonemaceae, Epithemiaceae*. Philadelphia: The Academy of National Science of Philadelphia.
- Prescott GW (1982) Algae of the Western Great Lake Area. Germany, Koengstein: Otto Koeltz Science Pub.
- Round FE (1953). An investigation of two benthic algal communities in Malham Tarn, Yorkshire. *J Ecol* 41: 174-197.
- Round FE (1960). The epipellic algal flora of some Finnish Lakes. *Arch Hydrobiol* 57(1/2): 161-178.
- Round FE (1984). The Ecology of Algae. Cambridge: Cambridge University Press.
- Simonsen R & Lange-Bertalot H. (1978). A taxonomic revision of the *Nitzschia lanceolata* Grunow, Germany: J. Grammer Publisher.
- Şahin B (1998). A study on the benthic algae of Uzungöl (Trabzon). *Tr J of Botany* 22: 171-189.
- Yıldız K (1986). Altınapa Baraj Gölü alg toplulukları üzerinde araştırmalar. II. Sedimanlar üzerinde yaşayan alg topluluğu. *Doğa TU Biyoloji Dergisi* 10: 547-554.