www.trjfas.org
ISSN 1303-2712
*Turkish Journal of Fisheries and Aquatic Sciences 11: 55-62 (2011)* DOI: 10.4194/trjfas.2011.0108

# The Abundant and Wide-Spread Species of Algae in the Algal Flora of the Lower Euphrates Basin Wetlands

**İlkay Açıkgöz Erkaya[1], Tülay Baykal Özer[2,*], Aydın Akbulut[3], Abel U. Udoh[1], Kazım Yıldız[1]**

[1] Gazi University, Faculty of Education, Department of Biology Education, Ankara, Turkey.
[2] Ahi Evran University, Faculty of Arts and Science, Department of Biology, Kırşehir, Turkey.
[3] Gazi University, Faculty of Arts and Science, Department of Biology, Ankara, Turkey.

* Corresponding Author: Tel.: +90.533 6122068; Fax:-;
E-mail: akbuluta@gazi.edu.tr

Received 28 May 2009
Accepted 04 January 2011

**Abstract**

The research on the algae of the Lower Euphrates Basin of the South East Anatolian Region was done between November 2001 and August 2003 at twenty one stations each, on four different habitats (plankton, epipelon, epifithon, epilithon). Due to the density level of species, Cyanobacteria, Bacillariophyta and Chlorophycophyta were conspicous. A bloom of *Microcystis aeruginosa* was observed in Atatürk and Halfeti Reservoirs in September 2002. In the same period, *Cyclotella ocellata*, in May 2003 *Cyclostephanos dubius*, and in August the same year. It could be said that *Ceratium hirundinella* species were close to bloom level. High density diatoms were found more in plankton. Species such as *Oscillatoria* spp., *Spirogyra* spp. and *Lyngbya* spp. were observed to be more wide-spread than the others. Species such as *Oscillatoria* spp., *Leiblenia epiphytica* and *Phormidium mucicola* increased in abundance in February and September in running waters. Within these months, water temperature in the region ranged between 18-22°C. According to some chemical and biological data, the basin was mesotrophic while some streams with sewage inputs, were observed to have eutrophic characteristics.

*Keywords*: Algae, Lower Euprathes Basin, dominant species.

**Aşağı Fırat Havzası Sulak Alanlarının Alg Florasındaki Bol ve Yaygın Türler**

**Özet**

Güneydoğu Anadolu Bölgesi, Aşağı Fırat Havzası algleri Ekim 2001 ve Ağustos 2003 tarihleri arasında belirlenen 21 istasyonda farklı habitatlardan (plankton, epipelon, epifiton, epiliton) alınan örnekler üzerinde araştırılmıştır. Yoğunluk değerlerine göre Cyanobacteria, Bacillariophyta, Chlorophycophyta sıralaması göze çarpmaktadır. *Microcystis aeruginosa* Eylül 2002'de Atatürk Barajı ve Halfeti Barajı planktonunda aşırı çoğalmıştır. *Cyclotella ocellata* Eylül 2002, *Cyclostephanos dubius* Mayıs 2003'te, *Ceratium hirundinella* ise Ağustos 2003'te aşırı çoğalma derecesine yakın yoğunlukta olduğu söylenebilir. Yoğunluk gösteren diyatomeler daha çok planktonda tespit edilmiştir. Limnothrix, Lyngbya, Oscillatoria, Phormidium, Pseudoanabaena ve Spirogyra türleri diğerlerine göre daha yaygın olmuşlardır. Limnothrix, Phormidium, Pseudoanabaena, Oscillatoria türleri ile *Leiblenia epiphytica* ve *Phormidium mucicola* gibi türlerin bolluk dereceleri akarsularda Eylül ve Şubat aylarında artmıştır. Bu aylarda bölgede su sıcaklığı yaklaşık 18-22°C ölçülmüştür. Kimyasal ve biyolojik verilere bağlı olarak havzanın geneli mezotrofik iken, kanalizasyon girdilerinin olduğu bazı çayların ötrofik karakterli olduğu gözlenmiştir.

*Anahtar Kelimeler*: Aşağı Fırat Havzası, alg, dominant türler.

## Introduction

In addition to irrigation and hydroelectric systems, structures constructed on Tigres and Euphrates Rivers, city/town infrastuctures, agriculture, transportation, industrialization, education, health, settlements, and also tourism, investments in other sectors, have had serious effects on the aquatic ecosystems of the region. The South East Anatolian Project (GAP), a multi-dimensional investment, will bring changes not only to the South East Anatolian Region, but also to the whole of Turkey. Within this context, the investments done in GAP will have very serious effects on the aquatic ecosystems of the area, especially on the dam regions and the running water media.

Algological studies involve, the classification of habitats, identification of floral composition in a habitat, inter-floral relationships, effects of biological, physical and chemical factors within the habitat,

studies of species within a population and the factors controlling algal growth. Most of the studies done so far in our country have centered on ecological evaluations. Increase in algological studies in Turkey started after the 1980s. In this research, along with the identification of the algae of inland waters of Turkey, seasonal variations in densities were examined and some ecological evaluations were made. Because of the conversion of running water systems into lake habitats due to investments done within the GAP, great changes have been recorded in aquatic organisms in the region. With dominant species as the key, algae were identified from different habitats of important dams and running waters (Atatürk Dam, Karkamış Dam, Birecik Dam, Hacıhıdır Dam, Firat River, Goksu River, Cendere Stream, Cam Stream, Caylarbası, Egri Stream, Cakal Stream, Mizar Stream, Karababa Stream, Kalburcu Stream and Abuzer Gaffar Stream) in the area. However, during the identification of the abundant and widespread species in the region, the general characteristics of the Basin and its pollution conditions also, were determined. As a result, lack of previous studies on the freshwater algae of the area, this research serves as a pioneer, an important study in bringing out the dominant algal flora of the region.

## Materials and Methods

In order to examine the taxonomy and ecological characteristics of algae in the Lower Euphrates of the South East Anatolian Region, eight samplings were done at twenty one stations, each of four habitats (plankton, epipelon, epiphyton, epilithon) between November 2001 and August 2003.

With an oxygen meter and a YSI brand salinity meter, dissolved oxygen and conductivity, salinity and water temperature, were measured *in situ* while the other physico-chemical and water analysis were done by the DSİ XV Regional Management Laboratory in Şanliurfa.

Using a plankton net of 33µm mesh, plankton samples were collected by drawing horizontally on the water surface. For epipelic samples, a glass pipe of 0.8 cm in diameter and 1-1.5 m long, was used on the sediment while epiphytic and epilitic samples were taken by scratching both submerged plants and stones removed from the water, respectively (Round, 1973). These samples were preserved by fixing in 4% formaldehit solution. While diatoms were identified on permanent slides, non-diatoms were examined on temporary slides using a Nikon- Labophot brand light microscope to determine the wide-spread species to evaluate their abundance (Round, 1973). Lackey drop counting method was used in determining the abundance of the identified species (Bakan and Atay, 1988). The names of important dams, running waters, station numbers and their descriptions in the Lower Euphrates Basin are given below:

1. Atatürk Dam (A.D.) - near Dam Body in Bozova
2. Atatürk Dam (A.D.) - Bozova open area
3. Atatürk Dam (A.D.) - in the mid-region of the Dam
4. Atatürk Dam (A.D.) - Adıyaman, a station 1 km to A.D., a dischage point where Adıyaman Province's untreated sewage is emptied.
5. Atatürk Dam (A.D.) - Siverek
6. Atatürk Dam (A.D.) - Caylarbasi, surrounded by large cotton fields
7. Birecik Dam (B.D.) - in Halfeti, on Euphrates River and has 9,400 $hm^3$ water volume with 2.518 GWh annual energy production.
8. Birecik Dam (B.D.) - open area
9. Karkamış Dam (K.D.) - body of water, on Euphrates River, near Syrian border, has 157 $hm^3$ water volume and annual energy production of 652 GWh.
10. Karkamış Dam (K.D.) - at the outflow
11. Hacıhıdır Dam (H.D.) - within the city, on Hacıhıdır stream, with 67.6 $hm^3$ water volume and flowing into A.D.
12. Euphrates River - Karababa underbridge; Total length 2,800 km, (Length within Turkey: 1,263 km); average velocity 959 $m^3$/sn; rate of evaporation high (673 mm), bounded between Şanlıurfa and Diyarbakır provinces.
13. Euphrates River - Birecik
14. Mizar Stream; flows into H.B.G., rearing of cattles and agricultural lands widespread within its surroundings.
15. Göksu River - with average velocity, 7.49 $m^3$/sn, used for irrigation purposes.
16. Kalburcu Stream; joins Euphrates River.
17. Cendere Stream; just after the Historic Cendere Bridge and found within Nemrut Mt. National Park borders, flows into A.D.
18. Cakal Stream; flows into A.D., surrounded with agricultural lands, has an intake of sewage.
19. Eğri Stream; flows into A.D., receives point to point and irregular sewage discharges.
20. Abuzer Gaffar Stream; flows into A.D., characterised as somewhat clean water since it flows through a mountainous area.
21. Cam Stream; flows into A.D.

The distribution of sampling stations and residential areas in the region are given on Figure 1.

Different sources were used for species identification; Komarek and Anagnostidis (1999), Wehr and Sheath (2003), Bourrelly (1972); Huber-Pestalozzi (1982), Korshikov (1987), John *et al*. (2003), Round *et al*. (1990), Sims (1996) and Krammer and Lange–Bertalot (1986, 1988, 1991a, 1991b).

## Results and Discussion

The possession of specific seasonal and geological structures by the region makes it exhibit different ecological characteristics. Activities such as

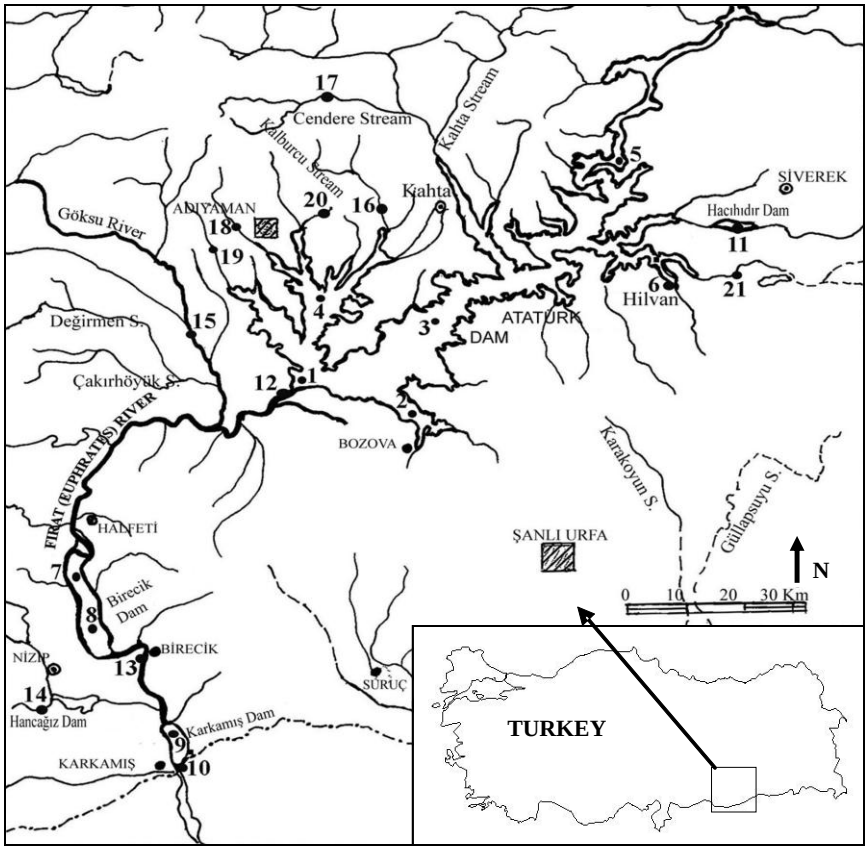


**Figure 1.** Map of sampling stations.

cattle-rearing, industrialization, domestic, irrigation and agricultural wastes discharge have all affected the aquatic ecosystems negatively. When the structure of the ecosystem was considered, it was observed that the sampling stations had similar characteristics, thereby making it possible to divide the region into three sections (I, II, III). This division was based, not only on habitat and similarities in water qualities, but also on the composition of algal species and their abundance. According to these, Section I: Atatürk Dam and the Euphrates River, the flowing portion with some stations **(**1-5, 12, 14-15); Section II: Euphrates River within the border of Turkey with Syria up to Halfeti region with stations (9-10, 7-8, 13) and Section III: covering Hacıhıdır Dam and the other small streams that feed the east and the western parts of Atatürk Dam having stations (16-21, 6, 11). Species of algae showed differences in diversity and abundance according to section. The dominant species observed in the algal flora of the region were generally found in each of the habitats. Also, the degrees of abundance of organisms observed were high.

While some species observed were less widespread but with high densities, other species were less in abundance but more widespread.

In spite of the general widespread and dominace of members of Bacillariophyta in phytoplankton, species of other classes were widespread and dominant in the other habitats, too.

Both, dams and running water surface temperatures measured in summer and late autumns varied between 17–27°C (average 23°C), with pH ranging between 7.4–8.1 throughout the research period. The lowest oxygen concentration was 6.1 mg $L^{-1}$, with temperature (27°C) recorded in Hacıhıdır Dam with the highest 11 mg $L^{-1}$, with temperature (20°C) recorded in Karkamış Dam. Average dissolved suspended substances (D.S.S.): Atatürk Dam: 225 mg $L^{-1}$, Birecik Dam: 236 mg $L^{-1}$, Karkamış Dam: 240 mg $L^{-1}$, Hacıhıdır Dam: 195 mg $L^{-1}$, and in Euphrates River: 241 mg $L^{-1}$ with the highest being in Mizar Stream (average 334 mg $L^{-1)}$. The avarage value for the other running waters was 233 mg $L^{-1}$, with 406 mg $L^{-1}$ being the EC value. Throughout the study, the minimum nitrogen concentration was 1.1 mg $L^{-1}$ recorded in Karkamış Dam and the highest value: 29.6 mg $L^{-1}$ in Eğriçay, the latter being a point-discharge area. Orto phosphate concentrations were measured between 0.01 mg $L^{-1}$ and 0.30 mg $L^{-1}$, with the maximum value recorded in Egricay.

A total of 60 taxa were identified as abundant and widespread species in the region. While organisms' abundance was evaluated according to densities on slides, widespread species was based on their availability in all the stations. Abundant and widespread species observed in the region according to habitats are given on Table 1.

**Table 1**. The distribution of abundant and widespread species according to habitat and stations

| | Plankton | Epiphytic | Epilitic | Epipelic |
|---|---|---|---|---|
| BACILLARIOPHYTA | | | | |
| *Cyclotella ocellata* Pantocsek | 1, 2, 3, 6, 8 | | | |
| *Melosira varians* Agardh | 19 | | | |
| *Cyclostephanos dubius* (Hustedt) Round | 3, 2, 8, 12 | | | |
| *Achnanthidium minutisimum* (Kützing) Czarnecki | 12 | 13 | 13, 16 | 16, 18, 21 |
| *Cymbella affinis* Kützing | 9 | 15 | 12, 15, 16 | 19 |
| *C. caespitosa* (Kützing) Brun | | 13, 19 | 14 | 13 |
| *C. lanceolata* (Ehrenberg) Kirchner | 3, 18 | | | |
| *Encyonema minutum* (Hilse) D.G.Mann | 9 | 9, 14 | 15 | |
| *Reimeria sinuata* (Gregory) Kocioleck&Stoermer | 9 | | | |
| *Gomphonema augur* Ehren**b**erg | 4, 12 | | | 20 |
| *G. olivaceum* (Hornemann) Brébisson | 4, 12 | | 12, 17 | |
| *Pinnularia* sp. | 9 | | | |
| *Denticula elegans* Kützing | 9 | | | |
| *Epithemia* sorex Kützing | 9 | 13, 15, 16, 20 | 9, 12, 13, 17 | |
| *Nitzschia fonticola* (Grunow) Grunow | 20 | | | 19 |
| *Surirella ovalis* Brébisson | 4 | | | |
| *Asterionella formosa* Hassall | 2, 3 | | | |
| *Ulnaria ulna* (Nitzsch) Compere | 9 | | | 17, 18 |
| *Ulnaria acus* (Kützing) Aboul | 2, 3 | | | |
| CYANOBACTERIA | | | | |
| *Microcystis aeruginosa* (Kützing) Kützing | 1, 2, 3, 4, 7, 6, 20 | | | |
| *M. floss-aquae* (Wittrock) Kirchner | 6, 21 | | | |
| *Merismopedia elegans* A.Braun ex Kützing | | | | 15, 18 |
| *M. glauca* (Ehrenberg) Kützing | | | | 15, 18 |
| *Phormidium formosum* (Bory de Saint-Vincent) Anagnostidis & Komárek | 20 | | | 9, 12, 13, 14, 18, 21 |
| *Phormidium limosum* (Dillwyn) P.C.Silva | 12, 18,20 | 4, 12, 13,15, 17, 20 | 1,8, 4 | 5, 9, 11,12, 13, 14,15, 19, 21 |
| *Phormidium mucicola* Huber-Pestalozzi &Naumann | | | 4, 6, 10, 20 | 2, 3, 13, 15 |
| *Pseudanabaena limnetica* (Lemmermann) Komárek | 5, 18, | 3, 4, 12, 13, 15 17, 19 | 2, 8, 9, 14 | 11, 12, 13, 21 |
| *Limnothrix planctonica* (Woloszynska) Meffert | 5, 12, 18, 20 | 15, 12 | 14, 8, 9 | 9, 15, 19, |
| *Oscillatoria* sp. | 6, 9,10 | 1, 2, 4, 8, 14 | 1, 6, 13 | 3, 6, 10, 12, 14, 15, 18, 21 |
| *Leiblenia epiphytica* (Hieronymus) Compere | | | 6, 12 | 12, 18 |
| *Leptolyngbya lagerheimii* (Gomont) Anagnostidis&Komarek | 17 | 9 | | |
| *Lyngbya* sp.1 | | 9, 10 | 8, 9, 10, 14 | 3, 6, 13 |
| *Lyngbya* sp. 2 | | 9, 10 | 8, 10 | 3, 6 |
| *Calothrix fusca* (Kützing) Bornet & Flahault | | | 1, 2, 10 | |
| *Pelogloea bacillifera* Lauterborn | 4, 6, 14, 19 | 13 | | |
| CHLOROPHYCOPHYTA | | | | |
| *Hormidiopsis crenulata* (Kützing) Heering | 21 | 13 | | |
| *Cladophora glomerata* (L.) Kützing | 4 | | | |
| *Oedogonium* spp. (2 species) | 8 | | | |
| STREPTOPHYCOPHYTA | | | | |
| *Zygogonium africanum* Bourrelly | 7, 8 | | | |
| *Zygogonium ericetorum* Kützing | 12, 16, 20, 19 | 12 | | |
| *Mougeotia genuflexa* (Dillwyn) C.A. Agardh | 14 | 19 | 12 | |
| *Spirogyra fluviatilis* Hisle | | 19 | | |
| *S. majuscula* Kützing | 14 | 7 | | 14 |
| *S. mirabilis* (Hassall) Kützing | 7 | | 8 | 14, 18 |
| *S. rhizobrachialis* Jao | | 12 | | |
| *S. subsalsa* Kützing | 16, 18 | | | 7, 8 |
| *Spirogyra* spp. (4 species) | 9, 12, 18, 20, 21 | 16 | 7, 8 | 18, 2 |
| *S. varians* (Hassall) Kuetzing | 7 | | | 14 |
| *Zygnema pectinatum* (Vaucher) C. Agardh | 9, 20 | 12 | | |
| *Cosmarium reniforme* (Ralfs) W.Archer | | | 20, 21 | |
| *Cosmarium* sp. | | 12 | 4 | 15 |
| *C. wembaerense* Schmidle | | | | 15 |
| DİNOFLAGELLATA | | | | |
| *Ceratium hirundinella* (O. F. Müller.) Dujardin | 2, 3 | | | |
| *Peridinium cinctum* (O.F.Müller) Ehrenberg | 2, 3 | | | |
| EUGLENOZOA | | | | |
| *Euglena polymorpha* P.A.Dangeard | 13 | | | |
| RHODOPHYCOPHYTA | | | | |
| *Batrachospermum turfosum* Bory de Saint-Vincent | 12, 13 | | | |

* indicates station number.

*Cyclostephanos dubius* and *Cyclotella ocellata* showed a significant widespread in the region with the former having a wide distribution property in Turkey. It is found mostly in the littoral part of lakes and also in non-stagnant waters (Czarnecki and Blinn, 1978; Krammer and Lange-Bertalot, 1991a). Foged (1982) had defined this species as oligohaline–alcaliphilous. It reached its highest density in the summer months in Dams. *Ulnaria acus* was the other abundant species widespread in some stations (Table 1). De Seve (1993) had identified *U. acus* as an oligohalobien taxon that grows in a medium with less than 5% salinity, while Rijstenbil *et al.* (1993) had found *U. ulna* in a medium with 5.2% salinity. But according to Miemi (1982), this species grows in a medium below 2% salinity and cannot grow in a high salinity medium. Also, Van Dam and Mertens (1993) had accepted *U. ulna* as an indicator for eutrophic lakes.

When the general distribution of non-Bacillariophyta in the three sections of the region was considered, members of Chroococcales were identified under Mizar Bridge. *Merismopedia glauca* and *M. elegans* were widespread in all the sections of the region.

*Phormidium formosum, P. limosum, Pseudoanabaena limnetica, Limnothrix planctonica* were abundant and widespread in sections II and III but rare in phytoplankton. While these species and some of *Oscillatoria* species were abundant in section I (especially under Karababa Bridge–Euphrates and Göksu Rivers in epiphytic flora), it was rare and in little quantity in Atatürk Dam phytoplankton. These species show better growth in stagnant and anaerobic waters (Prescott, 1975) and is used as water pollution indicator species (Şahin, 2002). Also, water temperature and effect of light had enhanced the growth of some *Oscillatoria* species in the region. As a result of the increase in eutrophication in Turkey, these species are found in abundance and widespread.

*Lyngbya* species was abundant and widespread in sections II and III of the region. In section I, *Lyngbya* was observed to be abundant and widespread especailly in Atatürk Dam, the epilitic flora of the coastal region of Adıyaman and both in the epilitic and the epiphytic flora of Karababa-underbridge (Euphrates).

When the dominance of species in their media was considered, the first was Cyanobacteria, followed by Bacillariophyta and Chlorophycophyta. Generally, Cyanobacteria show better development in shallow media rich in P and N, a pH of 7.0 and above, with summer temperatures varying between 25–30°C (Prescott, 1975). Apart from summer temperatures at the study stations, high temperature and rich organic materials in a medium in autums too, are also the necessary conditions for the growth of diatoms and blue-green algae.

Filamentous forms were dominant within Chlorophycophyta, especially in section I with *Cladophora, Oedogonium* and *Scenedesmus* species. In section II *Hormidiopsis crenulata and Stigeoclonium* species and in section III, with *Pediastrum* and *Scenedesmus*. However, species of *Spirogyra* within Streptophycophyta were abundant and widespread in all the sections but very few in Hacıhıdır Dam and none was observed at Çaylarbaşı.

*Cladophora* is a typical species of hard water (Prescott, 1975). *Cladophora glomerata,* which grows better in lakes, coastal regions of stagnant portions of running waters and on stone surfaces (Bellis and McLarty, 1967; Dodds and Gudder, 1992; Wehr and Sheath, 2003) was observed in Atatürk Dam (station 4), Mizar underbridge, Göksu River, Çakal Stream, A.Gaffar Stream plankton and widespread in epilitic flora in Temmuz 2002 and dense in Atatürk Dam (station 4)

Species of *Oedogonium* were found in Atatürk Dam at stations (1-2, 4-5) in section I and II (station 8). Generally, these species grow better in alkaline systems (Stevenson *et al*., 1996). Since it is rare to find *Oedogonium* species with its reproductive structures, it is therefore difficult to identify it through vegetative structures. As a result of this, *Oedogonium* is recorded on the genus level. This species shows a wide distribution in Turkish freshwaters – Altınapa, Suat Uğurlu Dams, Karamık, Uzungöl, Dağbaşı, Tortum lakes with Samsun-İncesu, Kılıçözü Streams and in freshwaters around Trabzon area (Yıldız, 1986; Yazıcı and Gönülol, 1994; Gönülol and Obalı, 1986; Şahin, 1998; Şahin, 2001; Altuner and Aykulu, 1987; Gönülol and Arslan, 1992; Baykal *et al*., 2001; Şahin, 1993).

Species of *Pediastrum* were more widespread in section III in the region while those of *Cosmarium* were widespread but observed in little quantities in the three sections. *Pediastrum* and *Cosmarium* species are more of oligotrophic characteristics while *P. boryanum* (Turpin) Meneghini and *P. duplex* Meyen have mesotrophic properties (Jyothi *et al*., 1992). Members of Desmidiaceae were widespread but few in numbers in the region. Species of Desmidiaceae are oligotrophic organisms (Hutchinson, 1967). Species of *Scenedesmus* were abundant and widespread in all the sections but more frequent in section III of the region. These species prefer eutrophic media (Jyothi *et al*., 1992).

*Zygogonium ericetorum* was observed mostly in lake coasts and in shallow waters in this study. However, this cosmopolitan species shows better growth in mainly acidic and low nutrients media (John *et al*., 2003).

The species of Mougeotia are able to grow in a wide range of environments from eutrophic to oligotrophic and across a range of pH levels, but they are rarely dominant under natural conditions (Graham *et al*., 1996). Members of *Mougeotia* genera were observed mostly in floating masses and on less illuminated coastal regions, mingled with other algae. *M. genuflexa* was abundant in Karababa underbridge,

Egricay epiphytic and epilitic flora in October 2001 in the region.

Also, more of *Spirogyra* species were observed than Streptophycophyta, but in section I of Atatürk Dam (stations 1-5), abundant and widespread in section II with Birecik Dam (stations 7–8); very few in Hacıhıdır Dam in section III and none was found in Çaylarbaşı. Species of *Zygnema* were observed in abundance and widespread in section I of Euphrates River (Karababa) and also abundant and widespread in Karkamış Dam (station 9) of section II. *Zygnema pectinatum;* Rare in lakes, found in masses in running waters at where vegetation is high (Prescott, 1975). It was widespread in epihytic especially in Karababa (Firat) underbridge algal flora in April 2002 and was from time to time, found in Karkamış Dam plankton. It was also identified in Altınapa Dam Lake, Dağbaşı and in Karamık lakes (Yıldız, 1986; Şahin, 2001; Gönülol and Obalı, 1986). *Zygnema* species by ratio was observed more in abundance in this region.

*Spirogyra*, *Zygnema* and *Oedogonium* species are found in Meram Stream, Porsuk Stream, Karasu River (Altuner and Gürbüz, 1990) and also in streams and rivers around Trabzon in Turkey. It has been reported that *Spirogyra* and *Cladophora* species are abundant in Seyhan River (Kandemir *et al*., 1994).

*Ceratium hirundinella* and *Peridinium cinctum* as members of Dinoflagellata, were abundant and widespread organisms. *Ceratium hirundinella* was abundant and widespread in both sections I and II. This species is a characteristic of mesotrophic lake organisms (Cirik *et al*., 1991).

Species of *Euglena* are known to show good development in polluted waters with abundant organic substances (Round, 1957). These species are found in abundance in Manisa - Marmara and Bafra Balık Lakes (Cirik-Altındağ, 1984; Gönülol and Çomak, 1993). In our research, *E. polymorpha* was identified only once in plankton bloom at Birecik-underbridge (Euphrates).

During the studies in the Lower Euphrates Basin, it was observed that members of Cyanobacteria and Bacillariophyta recorded more algal blooms in warm seasons. Among these, *Microcystis aeruginosa*, in September 2002 Atatürk Dam (stations 1, 2 and 3); Birecik Dam (station 7) and in Çaylarbaşı phytoplankton in November 2002. Also, *Cyclotella ocellata* (Sept. 2002) in Atatürk Dam (stations 1, 2 and 3); November 2002 Atatürk Dam (station 3) May 2003, Birecik Dam (station 8); *Cyclostephanos dubius;* in November 2002 in Atatürk Dam (station 3), in May 2003 Atatürk Dam (stations 2 and 3) and in Birecik Dam (station 8) phytoplankton, algal blooms were observed. *M. aeruginosa* species was observed to have had blooms from place to place in several freshwater media. For instance, in Mogan, Karamık lakes, Kurtboğazı and in the phytoplankton of Suat Uğurlu Dams, this situation occured a few times (Obalı, 1984; Gönülol and Obalı, 1986; Aykulu and Obalı, 1981; Yazıcı and Gönülol, 1994). However, in this study, *Cymbella* spp. and *U. ulna* were observed in high abundance in the phytoplankton of several stations in November 2002. *Ceratium hirundinella*, caused a bloom in Atatürk Dam in May 2003. Another bloom by the same species was recorded in Suat Uğurlu Dam (Yazıcı and Gönülol, 1994).

Species of *Cyclotella* are normally used as oligotrophic lakes indicators (Round, 1973). However, in our country, mesotrophic lakes such as Çamlıdere, Çubuk-I, Hafik, Karamuk, Keban, Tercan Dams with Aksu, Kızılırmak, Meram, Porsuk (Baykal, 2006; Gönülol and Aykulu, 1984; Kılınç, 1998; Şen *et al*., 1994; Çetin and Şen, 1998; Altuner and Aykulu, 1987; Ertan and Morkoyunlu, 1998; Yıldız and Özkıran, 1991; Yıldız, 1984, 1987) and in some freshwaters with eutrophic characteristics, *Cyclotella ocellata* and *C. meneghiniana* are the dominant species among planktonic algae. Also, *Pinnularia* species identified as oligotrophic (Round, 1960) and *Epithemia* spp. known to show good growth in nitrogen-limited media (Stevenson *et al*., 1996) recorded significant growths in Karkamış Dam.

In terms of algal growth, two stations were conspicuous in this study, one of which was, Mizar Stream with intensive cattle rearing activities with few species of *Limnothrix, Lyngbya, Oscillatoria, Phormidium, Pseudoanabaena* and *Spirogyra* observed as widespread. But when there was much influx of allactonic that made the station anoxide, *Pelogloea bacillifera* from Cyanobacteria became abdundant and widespread. Also, *Enteromorpha intestinalis* (Linnaeus) Nees species used as eutrophication indicator and grows well especially in waters rich in organic (canalization) and agricultural wastes (Lund and Lund, 1995), was observed en masse only at this station plankton. The other station was Cendere Stream, with clean water and a very high velocity. In this water, species of *Merismopedia glauca, Lyngbya* spp., *Spirulina major* Kützing ex Gomont, *Prasiola velutina* (Lyngbye) Wille, *Cladophora fracta* (O.F.Müller ex Vahl) Kützing, *Zygogonium ericetorum* and *Spirogyra varians* were observed in small quantities. This also shows that, velocity and nutrient salts serve as factors that limit the growth of algal flora in rivers. Throughout the research, it was observed that dissolved oxygen, temperature, electrical conductivity and nitrate concentration had significant effects on algal development. There was a significant negative relationship between dissolved oxygen and temperature in the waters: dams (r=-0.73) and for running waters (r=-0.70). In the same form, a powerful relationship was established between the values of EC and DSS (Dissolved Suspended Substance) concentrations in Atatürk Dam (r=0.93) and the other dams (average r=0.96); Euphrates River (r=0.98) and the other running waters (average r=0.92).

Generally, all the sections in the region showed

more of mesotrophic lakes characteristics. With increase recorded at some stations with increasing temperature, oxygen and salt concentrations, it was observed that stations such as Karababa (Euphrates) and Birecik (Euphrates) which are near city centers with sewage from the latter, had characteristics nearer to eutrophic conditions.

## Acknowledgement

The study was supported by TUBITAK Project No. TBAG-2046 (101047)

## References

Altuner, Z. and Aykulu, G. 1987. A study on the epipelic algal flora of Lake Tortum. İstanbul University, Su Ürünleri Dergisi, 1(1): 120–138.

Altuner, Z. and Gürbüz, H. 1990. A study on the epilithic and the epiphytic algae of the (Fırat) Karasu River, X. National of the Biology Congress, Erzurum: 193-203.

Aykulu, G. and Obalı, O. 1981. Phytoplankton biomass in Kurtboğazı Dam Lake. Comm. de la Fac. Sci. d'Ank., 24: 29-45.

Bakan, N. and Atay, D. 1988. Göllerde Fitoplankton Populasyonları ve Kantitatif Analiz Metodları (Spesific Subject). A.Ü. Fen Bil. Enst., Ankara, 608 pp.

Baykal, T., Udoh, U.A. and Yıldız, K. 2001. The algal flora and seasonal variations of species abundance in Kılıçözü stream (Kırşehir) Turkey. 7th International Phycological Congress, Thessaloniki, Greece.

Baykal, T. 2006. The diatoms of Çamlıdere Dam Reservoir. Istanbul University Journal of Fisheries, 20(21): 45-62.

Bellis, V.J. and McLarty, D.A. 1967. Ecology of *Cladophora glomerata* (L.) Kütz in Southern Ontario. Journal of Phycology, 3: 57–63.

Bourrelly, P. 1972. Les Algues D 'eau Douce Tome I:Les Algues Vertes E'ditions. France: N. Boubee & Cie 3, Place Saint-Andre-Des-Arts. Paris, 572 pp.

Cirik-Altındağ, S. 1984. Phytoplankton of the Manisa-Marmara Lake II-Euglenophyta. Doğa Bilim Dergisi, 7(3): 460-468.

Cirik, S., Cirik, Ş. and Benli, H.A. 1991. Water flora of Beyşehir Lake and seasonal changes. Ege University Faculty of Fisheries, Su Ürünleri Dergisi, 8(31–32): 155–174.

Çetin, A.K. and Şen, B. 1998. Diatoms (Bacillariophyta) in the phytoplankton of Keban Reservoir and their seasonal variations. Tr. J. Botany, 22: 25-33.

Czarnecki, D.B. and Blinn, D.W. 1978. Diatoms of the Colorado River in Grand Canyon National Park and Vicinity. (Diatoms of Southwestern USA II). Bibliotheca Phycologia 38. J. Cramer. 181 pp.

De Sève, M.A. 1993. Diatom bloom in the tidal freshwater zone of a turbid and shallow eustuary, Rupert bay (James bay, Canada). Hydrobiologia, 269/279: 225-233.

Dodds, W.K. and Gudder, D.A. 1992. The Ecology of Cladophora. Journal of Phycology, 28: 415–427.

Ertan, Ö.O. and Morkoyunlu, A. 1998. The algae flora of Aksu Stream (Isparta-Turkey). Tr J. of Botany, 22: 239-255.

Foged, N. 1982. Diatoms in Bornholm, Denmark. J. Cramer, Germany, 174 pp.

Gönülol, A. and Aykulu, G. 1984. Studies on the algal flora of the Çubuk–I Dam Lake I. Seasonal changes of phytoplankton composition and density. Doğa Bilim Dergisi, A2, 8(3): 330–342.

Gönülol, A. and Obalı, O. 1986. Phytoplankton of Karamık lake (Afyon) Turkey. Commun. Fac. Sci. Univ. Ank., C(4): 105–128.

Gönülol, A. and Arslan, N. 1992. Studies on the algal flora of the İncesu Stream, Samsun-Turkey. Doğa, T. J. of Botany, 16: 311-334.

Gönülol, A. and Çomak, Ö. 1993. Floristic studies on the phytoplankton of Bafra Balık Gölleri (Balık Gölü, Uzun Göl) Bafra-Turkey, II-Euglenophyta. Doğa-Tr. J. Botany, 17: 163-169.

Graham, J.M., Arancibia-Avila, P. and Graham, L.E. 1996. Physiological ecology of a species of the filamentous gren alga Mougeotia under acidic condiditon; Light and temperature effects on photosynthesis and respiration. Limnol.Oceonogr., 41(2): 233-262.

Huber–Pestalozzi, G. 1982. Das Phytoplankton Des Süβwassers 8. Teil Conjugatophyceae, Zygnematales and Desmidiales. E. Schweizerbartsche Verlagsbuchhandlung, Germany, 542 pp.

Hutchinson, G.E. 1967. A Treatise on Limnology, Vol.:2 Introduction to Lake Biology and The Limnoplankton. Department of Yale University, New York, 1115 pp

Jyothi, B., Sudhakar, G. and Venkateswarlu, V. 1992. Chlorophycean blooms and their ecological aspects. Intern. J. Environmental Studies, 40(2-3): 151-164.

John, D.M., Whitton, B.A. and Brook, A.J. 2003. The Freshwater Algal Flora of the British Isles: An identification guide to freshwater and terrestrial algae. The Natural History Museum and The British Phycological Society, Cambridge University Press, Cambridge, 702 pp.

Kandemir, Ç.F., Göksu, M.Z.L. and Sarıhan, E. 1994. Planctonic algae and seasonal changes of Seyhan River (which in the part of Adana city border). XII. National Biology Congress, Edirne: 189-194.

Kılınç, S. 1998. A study in the seasonal variation of phytoplankton in Hafik Lake (Sivas, Turkey) Tr. J. of Botany, 22: 35-41.

Komárek J. and Anagnostidis, K. 1999. Cyanoprokaryota. In: H. Ettl, G. Gardner, H. Heynig and D. Mollenheuer, (Eds.), 1: Chroococcales. Süsswasserflora von Mitteleurope, Gustav Fischer, Jena: 225–236.

Korshikov, O.A. 1987. The Fresh Water Algae of the Ukrainian SSR. V. Sub-Class Protococcineae Vacuolales and Protococcales. Bishen Singh Mahendra Pal Singh and Koeltz Scientific Books, Dehra Dun, 412 pp.

Krammer, K. and Lange–Bertalot, H. 1986. Süβwasserflora von Mitteleuropa, Bacillariophyceae Band 2/1,1. Teil: Naviculaceae. Gustav Fischer Verlag, Stuttgart, 876 pp.

Krammer, K. and Lange–Bertalot, H. 1988. Süβwasserflora von Mitteleuropa, Bacillariophyceae Band 2/2, 2. Teil: Bacillariaceae, Epithemiaceae, Surirellaceae. Gustav Fischer Verlag, Stuttgart, 596 pp.

Krammer, K. and Lange–Bertalot, H. 1991a. Süβwasserflora von Mitteleuropa, Bacillariophyceae Band 2/3, 3. Teil: Centrales, Fragilariaceae. Gustav Fischer Verlag, Stuttgart, 576 pp.

Krammer, K. and Lange–Bertalot, H. 1991b. Süβwassers von Mitteleuropa, Bacillariophyceae Band 2/4, 4. Teil: Achnanthaceae. Kritische Ergönzungen zu Navicula (Lineolatatae) und Gomphonema Gesamtliteraturverzeichnis, Gustav Fischer Verlag, Stuttgart, 437 pp.

Lund, H.C. and Lund, W.G.J. 1995. Freshwater Algae their Microscopic World Explored. Biopress Ltd, Bristol, 360 pp.

Miemi, A. 1982. Dynamics of Phytoplankton in the Brackiswater Inlet Pojoviken, Southern Coast of Finland. Hydrobiologia, 86: 33-39.

Obalı, O. 1984. Mogan gölü fitoplanktonunun mevsimsel değişimi. Doğa Bilim Dergisi, 8(1): 91–104.

Prescott, G.W. 1975. Algae of the Western Great Lakes Area. W.M.C. Brown Company Publishers, Michigan, 977 pp.

Rijstenbil, J.W., Bakker, C., Jackson, R.H., Merks, A.G.A. and de Visscher, P.R.M. 1993. Spatial and temporal variation in community composition and photosynthetic characteristics of phytoplankton in the upper Westerschelde Eustuary (Belgium, SW Netherlands). Hydrobiologia, 269/270: 263-273.

Round, F.E. 1960. The epipelic algal flora of some Finnish Lakes. Arch Hydrobiol, 57(1/2): 161-178.

Round, F.E. 1973. The Biology of the Algae, 2nd edition, Edward Arnold Publishers, London, 278 pp.

Round, F.E. 1957. Studies on bottom-living algae in some lakes of the English Lake District, J. Ecol., 45: 343–360.

Round, F.E., Crawford, R.M. and Mann, D.G. 1990. The Diatoms. Biology, Morphology of the Genera. Cambridge University Press, U.K., 747 pp.

Sims, P.A. 1996. Atlas of British Diatoms. Biopress Ltd. Dorchester, U.K., 601 pp.

Stevenson, R.J., Bothwell, M.L. and Lowe, R.L. 1996. Algal Ecology Freshwater Benthic Ecosystems. America. Academic Press, San Diego, 753 pp.

Şahin, B. 1993. The freshwater benthic algae except Bacillariophyta around Trabzon. Doğa Tr. J. of Botany, 17: 103-107.

Şahin, B. 1998. A study on the benthic algae of Uzungöl (Trabzon). Tr. J. of Botany, 22: 171–189.

Şahin, B. 2001. Epipelic and Epilithic Alge of Dağbaşı Lake (Rize-Turkey). Tr. J. of Biology, 25: 187-194.

Şahin, B. 2002. Epipelic and epilithic algae of the Yedigöller lakes (Erzurum–Turkey), Tr. J. of Biology, 26: 221–228.

Şen, B., Yıldız, K., Akbulut, A. and Atıcı, T. 1994. Planktonic Bacillariophyta of Karamuk Lake (Afyon) and appraise of its water quality. XII. Ulusal Biyoloji Kongresi, Edirne.

van Dam, H. and Mertens, A. 1993. Long-term changes of diatoms and chemistry in headwater streams polluted by atmospheric deposition of sulphur and nitrogen compounds, Freshw. Biol., 34: 579–600.

Wehr, J.D. and Sheath, R.G. 2003. Freshwater Algae of North America: Ecology and Classification. Academic Press, San Diego, CA., 918 pp.

Yazıcı, N. and Gönülol, A. 1994. Suat Uğurlu Baraj Gölü (Çarşamba–Samsun–Türkiye) Fitoplanktonu Üzerinde Floristik ve Ekolojik Bir Araştırma, Ege Üniversitesi Su Ürünleri Dergisi, 11(42–43): 71–93.

Yıldız, K. 1984. Algae Communities of Meram Stream I-Phytoplankton community. Bulletin of Science, Faculty of Science–Arts, University of Selçuk, 3: 213-217.

Yıldız, K. 1986. Algal communities of Altınapa Dam Lake Part II: Algae Living on sediments. Doğa Bilim Dergisi, 10(3): 547–554.

Yıldız, K. 1987. Diatoms of the Porsuk River, Turkey. Doğa TU J. Biol., 11(3): 162-182.

Yıldız, K. and Özkıran, Ü. 1991. Diatoms of the Kızılırmak River. Doğa Tr. J. of Botany, 1: 166-188.