TÜBİTAK

Research Article

Turk J Bot
36 (2012) 747-760
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doi:10.3906/bot-1108-16

New records for the freshwater algae of Turkey (Tigris Basin)

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Received: 18.08.2011 ● Accepted: 19.06.2012

Abstract: Samples were collected from different habitats (plankton, epipelon, epiphyton, and epilithon) at 20 stations situated on rivers and dam systems in the Tigris Basin between December 2004 and November 2005. Twenty-five new records were identified for the Turkish freshwater algae. They belong to the following divisions: 3 to Cyanobacteria, 1 to Rhodophya, 1 to Euglenozoa, 2 to Myzozoa, 1 to Ochrophyta, 9 to Chlorophyta, and 8 to Charophyta.

Key words: Algae, new record, freshwater, Dicle Reservoir, South-East Anatolian region

Introduction

Unlike in the past, today freshwater algae research is progressing rapidly in Turkey. However, long-term monitoring of changes in algal diversities and population studies are rarely done. Therefore, 2 different studies were planned in this research to determine the algal flora of the South-East Anatolian region Euphrates and Tigris basins. Recently, since many studies on the diversity and ecology of diatoms have been done (Atıcı & Obalı, 2010; Kıvrak & Uygun, 2012; Solak et al., 2012), new records of algae except Bacillariophyta are greater in number in Turkey (Çelekli et al., 2007; Çevik et al., 2007; Baykal et al., 2009; Sevindik et al., 2010; Sevindik et al., 2011). To date, except in Devegeçidi Reservoir and the Euphrates Basin (Aysel, 2005; Baykal et al., 2009), there have been no records pertaining to the algal flora of the region (Gönülol & Öztürk, 1996; Şen et al., 1997; Aysel, 2005).

Structures such as hydro-electric plants, and agricultural and irrigation systems built on the Tigris River can lead to serious ecological variations. Being the first of its kind in the region, this study is therefore very important in addition to contributing to providing new records of species for the freshwater algae of Turkey. The algae of the region were investigated at 20 sampling stations. The general view of the area and the sampling stations are shown in Figure 1. The names of the stations are indicated in the Table.

Materials and methods

Sampling materials were collected from 20 stations in the Tigris River and its tributaries and from 4 dam reservoirs on the river (Figure 1). For taxonomic analysis, samples were taken using plankton nets of 30 and 55 µm and 2 L fibreglass containers and those

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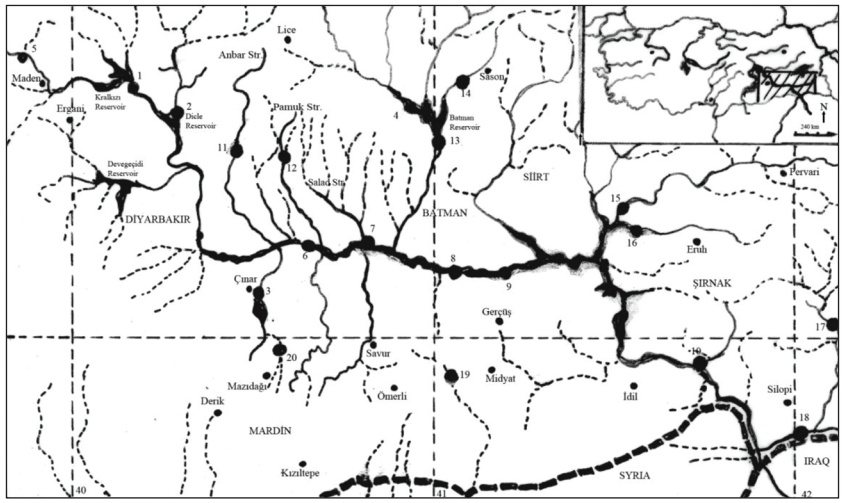


Figure 1. Map showing locations of sampling stations.

Table. Names of the sampling stations.

Station No.	Stations	Station No.	Stations
1	Kralkızı Reservoir	11	Ambar Stream (Diyarbakır)
2	Dicle Reservoir	12	Pamuk Stream (Silvan road)
3	Göksu Reservoir	13	Batman Stream (Malabadi)
4	Batman Reservoir	14	Sason Stream
5	Maden Stream	15	Botan Stream (Siirt)
6	Dicle River (Lower Salad-Bismil)	16	Kezer Stream
7	Dicle River (Upper Salad- Diyarbakır exit)	17	Hezil Stream (Ovaköy-Silopi)
8	Dicle River (Hasankeyf)	18	Hezil Stream (Kapılı-Silopi)
9	Dicle River (Hasankeyf)	19	Beyaz Su (Çatak Stream)
10	Dicle River (Cizre)	20	Karasu (Mazı Mountain)

of epipelic on sediments using a glass rod 0.5-0.8 cm in diameter. Epiphytic and epilithic samples were taken by scratching the surfaces of submerged plants and stones, respectively. All samples were fixed in 4% formaldehyde and organisms were identified on both temporary and permanent slides. Water temperature, pH, conductivity, salinity, and dissolved O_2 were measured in situ, using a YSI model (55/25 FT, 30/25 FT) and Thermo/Orion (210 model) portable probes, respectively. Other physical and chemical analyses were done at the Aquatic Products Laboratory of Fırat University, Elazığ.

Photographs were taken using a Nikon research microscope and are shown in Figures 2-11. Taxonomic identifications were carried out according to the works by Huber-Pestalozzi (1938, 1941, 1950, 1955, 1982, 1983), Bourrelly (1972), Prescott (1975), Korshikov (1987), Komarek and Anagnostidis (1999), John et al. (2002), and Wehr and Sheath (2003). The arrangement of the phyla follows that of AlgaeBase (Guiry, 2012).

Results and discussion

A total of 364 algal taxa were identified in the Tigris Basin, with 25 being new records for the Turkish freshwater algal flora.

Phylum: Cyanobacteria

Class: Cyanophyceae

Subclass: Synechococcophycideae

Order: Synechococcales

Family: Chamaesiphonaceae

Genus: *Geitleribactron* Komárek, 1975

1. Species: ***Geitleribactron periphyticum*** Komárek 1975.

(Komarek & Anagnostidis, 1999, pp. 360-361).

Description: Cells solitary or dense, with blue green homogeneous contents, periphytic layers on the substrate, giving a blue-green colour to the latter. Cells straight and cylindrical, rounded at the apex, generally short with colourless mucilaginous pads at the base. Cells 1.3-2.7 µm wide and 4-7 µm long; during reproduction, 1 or 2 new young cells found at the ends (Figure 2).

Found at station 8 in plankton (Epiphytic on *Oedogonium* species).

Phylum: Cyanobacteria

Class: Cyanophyceae

Subclass: Synechococcophycideae

Order: Pseudanabaenales

Family: Pseudanabaenaceae

Genus: *Limnothrix* Meffert, 1987

2. Species: ***Limnothrix redekei*** (van Goor) M.E. Meffert 1988.

(John et al., 2002, p.76).

Basionym: *Oscillatoria redeckei* van Goor

Homotypic Synonym: *Oscillatoria redeckei* van Goor 1918

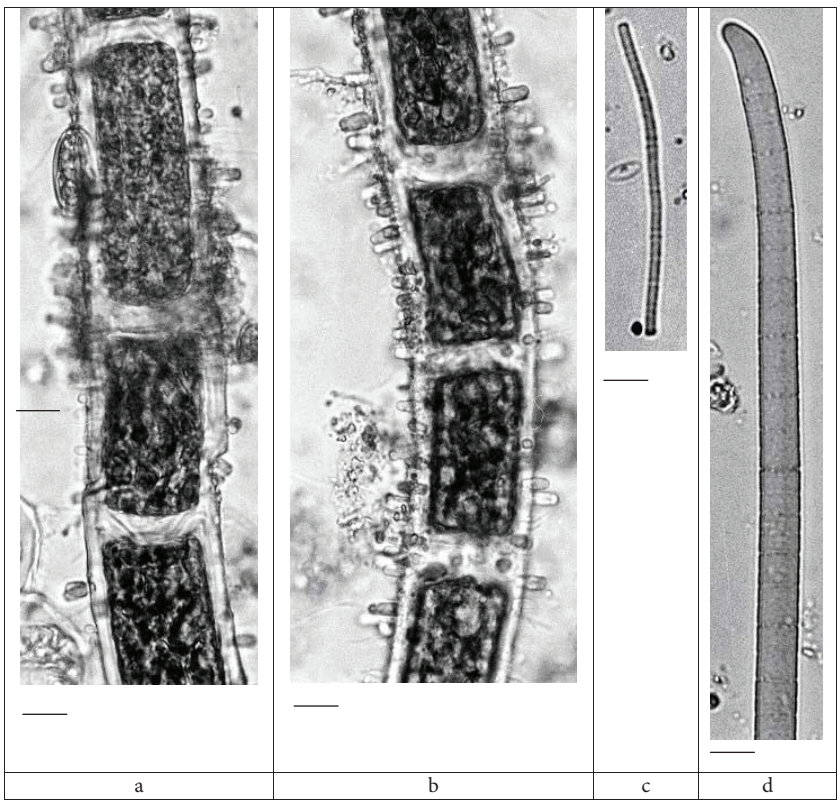


Figure 2. a, b- *Geitleribactron periphyticum*, c- *Limnothrix redekei*, d- *Phormidium okenii* (Scale bars = 10 µm).

Description: Trichome straight, not attenuated at the ends. Cells 1.2-2.1 µm wide, 6.5-8.5 µm long; narrowed at cross walls, appearing rectangular. Gas vacuoles seen on both sides of the cross walls (Figure 2).

Identified at stations 2, 6, 7, 9-11 in plankton, 12 in epiphyton, 1, 3, 4, 7, and 12 in epilithon.

Phylum: Cyanobacteria

Class: Cyanophyceae

Subclass: Oscillatoriophycideae

Order: Oscillatoriales

Family: Phormidiaceae

Genus: *Phormidium* Kützing ex Gomont, 1892

3. Species: *Phormidium okenii* (C.Agardh) Anagnostidis & Komárek 1988.

(Huber-Pestalozzi, 1938, p. 224).

Basionym: *Oscillatoria okenii* C.Agardh

Homotypic Synonyms: *Oscillatoria okenii* C.Agardh 1827

Lyngbya okenii (C.Agardh) Hansgirg 1884.

Heterotypic Synonym: *Oscillatoria okenii* C.Agardh ex Gomont 1892.

Description: Trichome straight, only slightly attenuated and twisted (or curved). Cells 6-8.5 µm wide, 3-3.5 (4.5) µm long, cross walls slightly narrowed, without adjacent granules, end cells weakly conical or round (Figure 2).

Found at station 9 in plankton.

Phylum: Rhodophyta

Class: Florideophyceae

Subclass: Nemaliophycidae

Order: Acrochaetiales

Family: Acrochaetiaceae

Genus: *Audouinella* Bory de Saint-Vincent, 1823

4. Species: *Audouinella hermannii* (Roth) Duby in de Candolle 1830.

(John et al., 2002, p. 128).

Basionym: *Conferva hermannii* Roth

Homotypic Synonyms: *Conferva hermannii* Roth 1797.

Chantransia hermannii (Roth) Desvaux 1809.

Chantransia chalybea var. *hermannii* (Roth) Trevisan 1842.

Heterotypic Synonyms: *Audouinella miniata* Bory de Saint-Vincent 1823.

Chantransia violacea Kützing 1845.

Audouinella violacea (Kützing) Hamel 1924.

Rhodochorton violaceum (Kützing) K.M.Drew 1935.

Description: Cylindrical cells with several parietal, ribbon-like chloroplasts and mature forms violet-green colour, 7.5-10 µm wide, and 30-50 µm long. Some of the short lateral branches have ovoid monosporangia, singly or in clusters, 10-12.5 µm wide, up to 30-50 µm long. Some short branch ends have carposporangia. Ends of branches are generally round but sometimes tapering side branches are found (Figures 3 and 4).

Figure 3. a, b- *Audouinella hermannii* (Scale bars = 10 µm).

Figure 4. a, b- *Audouinella hermannii*, c, d- *Euglena spirogyra* var. *abrupte-acuminata* (Scale bars = 10 µm).

Found at stations 2, 15, and 19 in plankton, and at 2 and 19 in epiphyton.

Phylum: Euglenozoa

Class: Euglenophyceae

Order: Euglenales

Family: Euglenaceae

Genus: *Euglena* Ehrenberg, 1830

5. Species: *Euglena spirogyra* var. *abrupte-acuminata* Lemmermann 1913.

(Huber-Pestalozzi, 1955, pp. 101-102).

Description: Cells 20-25 µm wide, up to 137.5 µm long (including tail); longitudinally flattened, with sides nearly parallel; anterior apex slightly narrow, rounded, posterior apex wide, tapering to a short point; pellicle with regularly arranged rows of external bead granules; chloroplasts numerous, disk-shaped, without pyrenoids; rectangular paramylon granules present, one lying anterior to nucleus and another posterior to nucleus; eyespot large and prominent, with motional euglenoid (Figure 4).

Found at station 11 in epilithon.

Phylum: Myzozoa

Class: Dinophyceae

Subclass: Peridiniphycidae

Order: Gonyaulacales

Family: Ceratiaceae

Genus: *Ceratium* F.Schrank, 1793

6. Species: Ceratium hirundinella *f.* austriacum (Zederbauer) Bachmann 1911.

(Huber-Pestalozzi, 1950, pp. 263-268).

Description: Cells broad, 55-58 µm wide, 142-168 µm long; epitheca sharply converging from just above

the transverse furrow, then narrow more gradually to form a long horn (85-87 µm long). Transverse furrow relatively narrow; hypotheca is divided into 3 antapical horns, central horn the longest (approximately 50 µm) and the others are 27-28 µm and 14-16 µm (the given as the figure, apical horn is shown broken). The antapical horns are shorter than the apical horn. The apical horn and antapical horns are in parallel erection, but some antapical horns are extended outward. Epitheca is depressed, conical and slightly flattened compared to the hypotheca (Figure 5).

Figure 5. a- *Ceratium hirundinella* var. *carinthiacum*, b- *Ceratium hirundinella* f. *austriacum* (Scale bars = 10 µm).

Found at stations 1-4, and 7 in plankton.

7. Species: *Ceratium hirundinella* var. *carinthiacum* Zederbauer 1911.

(Huber-Pestalozzi, 1950, pp. 263-268).

Description: Cells 48-60 µm wide, 150-166 (175) µm long; dorsal/apical horn is longer than ventral horns, 80-88 µm long; ventral horns are of different lengths, the longest 45 µm, with the short one protruding (3-5 µm). Apical horn and the longest antapical horn are more or less on the same axis (Figure 5).

Found at stations 2 and 3 in plankton.

Phylum: Ochrophyta

Class: Chrysophyceae

Order: Chromulinales

Family: Dinobryaceae

Genus: *Dinobryon* Ehrenberg, 1834

8. Species: *Dinobryon sociale* var. *stipitatum* (F.Stein) Lemmermann 1903.

(Huber-Pestalozzi, 1941, pp. 226-227; John et al., 2002, p. 226).

Basionym: *Dinobryon stipitatum* F.Stein

Description: Lorica is conically shaped; V-shaped, enlarging towards apex forming a colony. Lorica 37.5 µm long, 7.5 µm wide, broadest at mouth 8-9 µm wide (Figure 6).

Identified at stations 1-3 in plankton.

Phylum: Chlorophyta

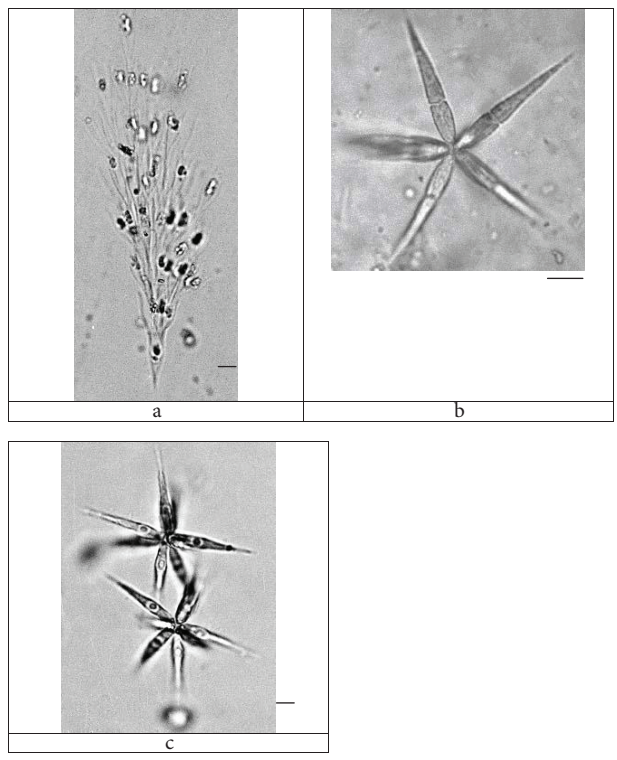


Figure 6. a- *Dinobryon sociale* var. *stipitatum*, b, c- *Actinastrum aciculare* f. *africanum* (Scale bars = 10 µm).

Class: Trebouxiophyceae

Order: Chlorellales

Family: Chlorellaceae

Genus: *Actinastrum* Lagerheim, 1882

9. Species: ***Actinastrum aciculare* f. *africanum*** P. Compère 1976.

(Huber-Pestalozzi, 1983, pp. 744-746).

Description: Coenobial form made of 8 cells, all radiating from a central point. Cells 5-5.5 (6) µm in diameter, 30-40 µm long. From the middle, cells become narrow to end and cylindrical towards centre. Chloroplast with a single pyrenoid, often reaching extremes of cells (Figure 6).

Found at stations 7 and 11 in epipelon.

Phylum: Chlorophyta

Class: Trebouxiophyceae

Order: Chlorellales

Family: Chlorellaceae

Genus: *Micractinium* Fresinius, 1858

10. Species: ***Micractinium quadrisetum*** (Lemmermann) G.M.Smith 1916.

(Korshikov, 1987, pp. 383-384; John et al., 2002, p. 128).

Basionym: *Richteriella quadriseta* Lemmermann 1898.

Homotypic Synonyms: *Richteriella quadriseta* Lemmermann 1898.

Richteriella botryoides var. *quadriseta* (Lemmermann) West.

Description: Coenobia tetrahedral, consisting of a 4-angled central space and 4-celled group, localised at the angles radially, without a mucilage sheath; cells 5.5-7 µm wide, 7-8 µm long, angular ovoid, with bluntly rounded ends and weakly convex, bearing 2-4 spines, about 1-1.5 µm wide, 7-8 µm, up to 48 µm long (Figure 7).

Found at station 3 in plankton.

Phylum: Chlorophyta

Class: Chlorophyceae

Order: Chaetophorales

Family: Aphanochaetaceae

Genus: *Aphanochaete* A.Braun, 1851

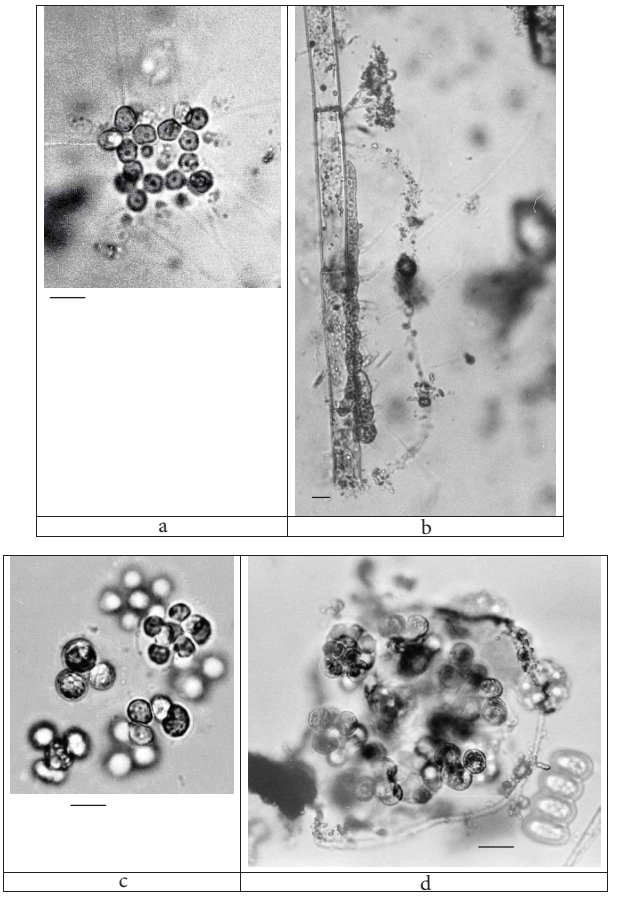


Figure 7. a- *Micractinium quadrisetum*, b- *Aphanochaete repens*, c, d- *Coenocystis planktonica* (Scale bars = 10 µm).

11. Species: ***Aphanochaete repens*** A.Braun 1850.

(Bourrelly, 1972, p. 315; John et al., 2002, p. 434).

Homotypic Synonym: *Herposteiron repens* (A.Braun) Wittrock 1872.

Heterotypic Synonyms: *Aphanochaete confervicola* (Nägeli ex Kützing) Rabenhorst; *Gonatoblaste rostrata* Huber

Description: Filaments linear, partly branched and epiphytic. Cells 7.5 µm wide, 15-16 µm long, each bearing a single (rarely 2) unsheathed bristle; chloroplast parietal with one pyrenoid (Figure 7).

Found on green algae in warm and shallow waters.

Found at stations 2 in epiphyton and 11 in epipelon.

Phylum: Chlorophyta

Class: Chlorophyceae

Order: Sphaeropleales

Family: Radiococcaceae

Genus: *Coenocystis* Korshikov, 1953.

12. Species: ***Coenocystis planktonica*** Korshikov 1953.

(Korshikov, 1987, pp. 307-308; John et al., 2002, p. 343).

Synonym: *Coenochloris korshikovii* Hindak.

Description: In colonies 4 or 8 cells localised near the centre. Cells globose or ovoid, (8) 9-11 µm wide, with smooth and thin walls. There is 1 parietal, thickened at the apex, indistinct pyrenoid (Figure 7).

Found at stations 2, 3, 6, and 9 in plankton, and at 11 in epiphyton.

Phylum: Chlorophyta

Class: Chlorophyceae

Order: Sphaeropleales

Family: Scenedesmaceae

Genus: *Coelastrum* Nägeli, 1849.

13. Species: ***Coelastrum verrucosum*** (Reinsch) Reinsch 1878.

(Huber-Pestalozzi, 1983, pp. 730-731; John et al., 2002, p. 342).

Basionym: *Sphaerastrum verrucosum* Reinsch.

Homotypic Synonym: *Sphaerastrum verrucosum* Reinsch.

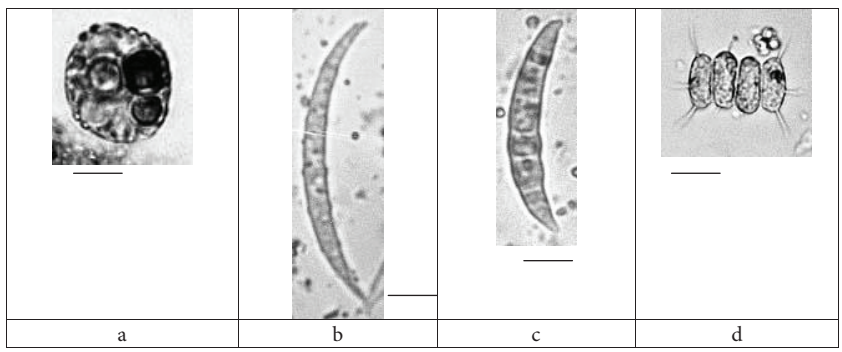
Heterotypic Synonym: *Coelastrum morus* West & G.S.West 1896.

Description: Coenobia spherical, 8-16 celled, up to 20-27 µm diameter. Cells 7-14 µm wide, spherical with 6-12 pointed protuberances, connecting with neighbouring cells (Figure 8).

Found at stations 8 in plankton, and at 2 and 15 in epiphyton.

Phylum: Chlorophyta

Class: Chlorophyceae



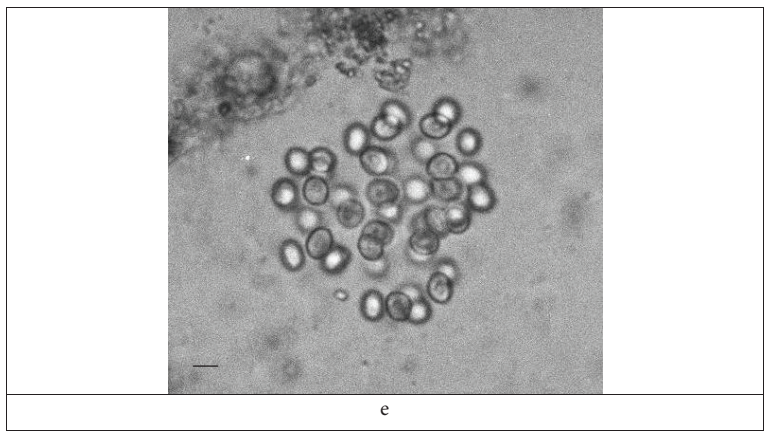


Figure 8. a- *Coelastrum verrucosum*, b, c- *Monoraphidium fontinale*, d- *Scenedesmus flavescens*, e- *Sphaerobotrys fluviatilis* (Scale bars = 10 µm).

Order: Sphaeropleales

Family: Selenastraceae

Genus: *Monoraphidium* Komárková-Legnerová, 1969.

14. Species: ***Monoraphidium fontinale*** Hindák 1980.

(Huber-Pestalozzi, 1983, p. 632).

Description: Cells solitary, 5-5.5 µm wide, 42-57.5 µm long, spindle-oblong, nearly straight to curved. Chloroplast trough-shaped, no pyrenoid. 4 or 8 autospores per cell (Figure 8).

Found at station 3 in plankton.

Phylum: Chlorophyta

Class: Chlorophyceae

Order: Sphaeropleales

Family: Scenedesmaceae

Genus: *Scenedesmus* Meyen, 1829.

15. Species: ***Scenedesmus flavescens*** Chodat 1913.

(John et al., 2002, p. 393).

Heterotypic Synonym: *Scenedesmus tenuispina* Chodat 1913.

Description: Coenobia of (2-) 4 linearly arranged cells. Cells 5-5.5 µm wide, 12-13 µm long, slightly cylindrical to ovoid with rounded ends. Marginal cells bear 2 short equatorial spines on sides and longer spines on the polar ends. Inner cells are straight and carry 1 or 2 spines each at both ends (Figure 8).

Found at stations 1, 5, 9, 11, and 12 in epiphyton.

Phylum: Chlorophyta

Class: Chlorophyceae

Order: Chlorophyceae incertae sedis

Family: Chlorophyceae familia incertae sedis

Genus: *Sphaerobotrys* Butcher, 1932.

16. Species: ***Sphaerobotrys fluviatilis*** Butcher 1932.

(Bourrelly, 1972, p. 206; John et al., 2002, p. 402).

Description: Cells attached to remains of mother cell walls enclosed within a thin mucilaginous envelope and about 5.5 µm wide, 6.5-7 µm long; slightly disc or pear-shaped, ventral view round, arranged in oblique rows; chloroplast parietal with a single pyrenoid (Figure 8).

Found at station 3 in plankton and epiphyton.

Phylum: Chlorophyta

Class: Trebouxiophyceae

Order: Chlorellales

Family: Chlorellaceae

Genus: *Geminella* Turpin, 1828.

17. Species: ***Geminella interrupta*** (Turpin) Lagerheim 1883.

(Bourrelly, 1972, p. 246; John et al., 2002, p. 440).

Basionym: *Hormospora interrupta* Turpin.

Homotypic Synonym: *Hormospora interrupta* Turpin.

Description: Filament free-floating, unbranched. Cells in pairs or single, some enclosed in mucilaginous sheath, and of equal distant from one another. Cells 5-6 µm wide, 8-12 µm long, cylindrical or rounded; chloroplast filling at least two-thirds of cell, parietal, with one or a pair of pyrenoids (Figure 9, redrawn from original photo).

Found at station 3 in plankton.

Phylum: Charophyta

Class: Klebsormidiophyceae

Order: Klebsormidiales

Family: Klebsormidiaceae

Genus: *Klebsormidium*

18. Species: ***Klebsormidium crenulatum*** (Kützing) Lokhorst in Lokhorst & Star 1985.

(John et al., 2002, pp. 447-448).

Basionym: *Hormidium crenulatum* Kützing 1845

Homotypic Synonym: *Ulothrix crenulata* Kützing (Kützing) 1849.

Chlorhormidium crenulatum (Kützing) Komaromy 1976.

Klebshormidium crenulatum (Kützing) H. Ettl *et* G. Gartner 1995.

Description: Filaments long, cells 9-20 µm wide (including mucilage sheath), 0.5 times longer than wide or equal, cylindrical barrel-shaped. Cell walls

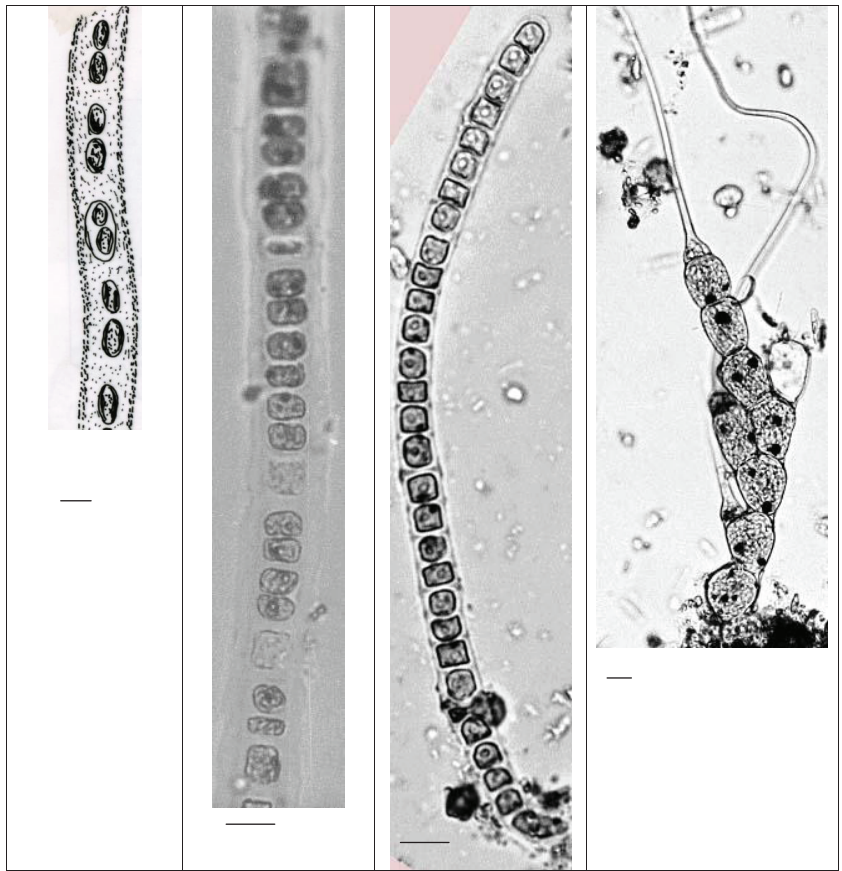


Figure 9. a- *Geminella interrupta*, b, c- *Klebsormidium crenulatum*, d- *Coleochaete pulvinata* (Scale bars = 10 µm).

thin and smooth, some filaments markedly thickened, stratified, H-shaped segments occasionally present. Chloroplasts plate or girdle-shaped, covering almost 80% of cell circumference (sometimes covering completely), with 1, rarely 2, or 3 prominent pyrenoids (Figure 9).

Found at stations 4 in plankton and epiphyton and 13 in epiphelon.

Phylum: Charophyta

Class: Coleochaetophyceae

Order: Coleochaetales

Family: Coleochaetaceae

Genus: *Coleochaete* Brébisson, 1844.

19. Species: ***Coleochaete pulvinata*** A.Braun in Kützing 1849.

(Bourrelly, 1972, p. 326; John et al., 2002, p. 471).

Description: Filament forming hemispherical, cushion-like growths (2-3 mm across) of irregularly branched erect filaments radiating from a common centre. Cells 18-24 µm wide, up to 70 µm long, irregularly cylindrical, typically bearing bristles (Figure 9).

Found at stations 1 in epilithon and at 2 and 12 in epiphyton.

Phylum: Charophyta

Class: Zygnematophyceae

Order: Zygnematales

Family: Zygnemataceae

Genus: *Mougeotia* C.Agardh, 1824.

20. Species: ***Mougeotia abnormis*** Kisselev 1927.

(Prescott, 1975, p. 299; John et al., 2002, p. 483).

Heterotypic Synonym: *Mougeotia floridana* Transeau 1934.

Description: Cells 18-20 µm wide, 90-120-(135) µm long; chloroplast filling the length of a cell with 6-8 pyrenoids. Zygospores in a triangular tube, triangular-ovoid with concave walls 25 µm wide, 38 µm long; median wall smooth (Figure 10).

Found at stations 2 in epiphyton and at 7 in plankton, epiphyton, and epilithon.

21. Species: ***Mougeotia genuflexa*** (Dillwyn) C.Agardh 1824.

(Prescott, 1975, p. 301; John et al., 2002, p. 487).

Basionym: *Conferva genuflexa* Dillwyn

Homotypic Synonym: *Conferva genuflexa* Dillwyn.

Heterotypic Synonym: *Mesocarpus pleurocarpus* De Bary 1858.

Description: Cells 23-28.5 µm wide, 60-125 µm long. Chloroplasts broad, ribbon-like, almost covering complete cell circumference, with 6-8 pyrenoids usually in irregular series; conjugation lateral, zygospores formed in conjugation tube, quadrate-ovoid (Figure 10).

Found at stations 1 in epiphyton and 20 in plankton.

Phylum: Charophyta

Class: Zygnematophyceae

Order: Zygnematales

Family: Zygnemataceae

Genus: *Spirogyra* Link, 1820.

22. Species: ***Spirogyra rhizobrachialis*** Jao 1936.

(Prescott, 1975, p.320).

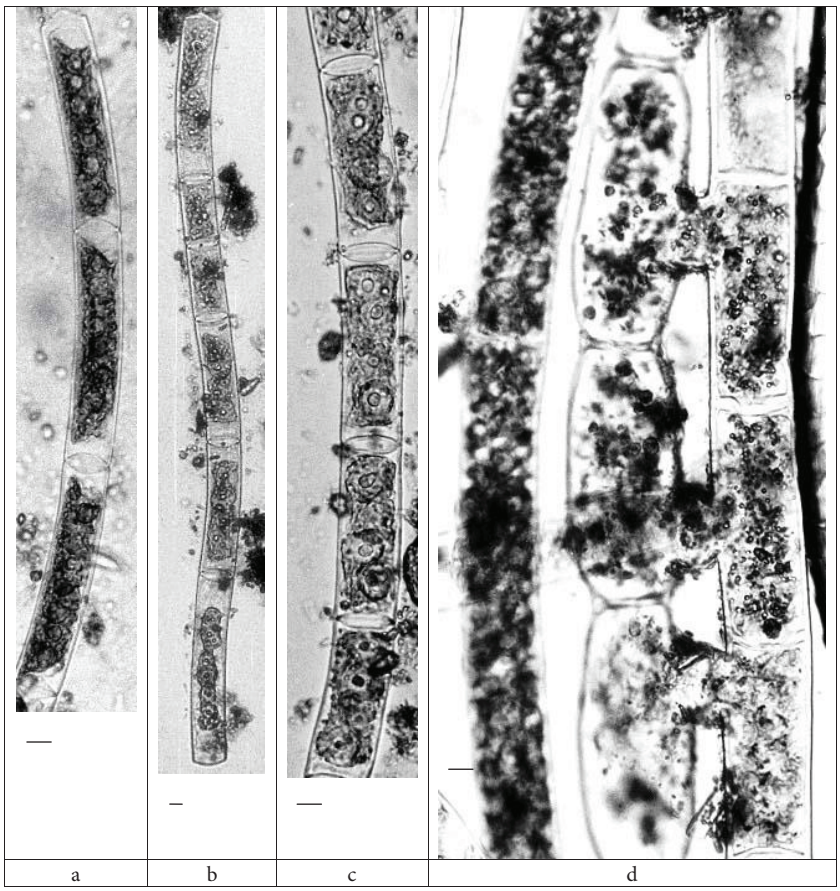


Figure 10. a- *Mougeotia abnormis*, b, c- *Mougeotia genuflexa*, d- *Spirogyra rhizobrachialis* (Scale bars = 10 µm).

Description: Cells 37.5-50 µm wide, 240-312.5 µm long, with plain end walls. Chloroplasts crenate and deeply toothed on the margins, broad, 2.5-3.5 (4.5) turns. Fertile cells cylindrical and sterile ones frequently forming tubes that develop highly branched rhizoidal processes at their ends. Zygospores ellipsoidal, brown, 42.5-72.5 µm wide, 90-95 µm long (Figure 10).

Found at stations 11 and 17 in plankton, and at 7, 14, and 16 in epilithon.

Phylum: Charophyta

Class: Zygnematophyceae

Order: Zygnematales

Family: Zygnemataceae

Genus: *Zygogonium* Kützing, 1843.

23. Species: *Zygogonium ericetorum* Kützing 1843.

(Bourrelly, 1972, p. 378; Prescott, 1975, p. 329; John et al., 2002, p. 510).

Heterotypic Synonym: *Zygnema ericetorum* (Kützing) Hansgirg 1886.

Description: Filaments simple or rarely branched. Cells 25-27.5 µm wide, 50-53 µm long, cylindrical, or slightly constricted at the crosswalls, usually with purple cell sap. Has 2 pillow-shaped chloroplasts knotted in the middle, each with a central pyrenoid (Figure 11).

Found at station 7 in epiphyton.

Phylum: Charophyta

Class: Zygnematophyceae

Order: Zygnematales

Family: Desmidiaceae

Genus: *Cosmarium* Corda ex Ralfs, 1848.

24. Species: *Cosmarium subtumidum* Nordstedt 1889.

(Huber-Pestalozzi, 1982, p. 277).

Heterotypic Synonym: **Cosmarium subtumidum** var. **minor** J.Sampaio 1922.

Description: Cells 14.5-22.5 µm wide, 18-27.5 µm long, about 1-2 times as long as wide (L/W:1.2-1.24), with a deep sinus, linearly and closed until the end of an extension. Half cells rounded, trapezoidal with broadly rounded basal angles and lateral margins. Convex, not straight, apex broad and flat, trimmed or slightly convex. In apical view elliptic oblong, slightly swollen on the sides, circular in lateral view. Walls with fine pores in half cells. Centre and at the apex somewhat thickened. Chromotophores half monocentric with a pyrenoid in each half-cell (Figure 11).

Found at stations 1, 2, and 7 in epiphyton.

25. Species*: Cosmarium subtumidum* var. *minutum* (Willi Krieger) Willi Krieger & Gerloff 1965.

(Huber-Pestalozzi, 1982, p. 278).

Heterotypic Synonym: *Cosmarium subtumidum* f. *minus* Cedergren 1938.

Description: Cells are very small, but relatively long, 10.5-13 µm wide and 15-17 µm long (L/W: 1.25), resembling 2 joined spheres; apical view

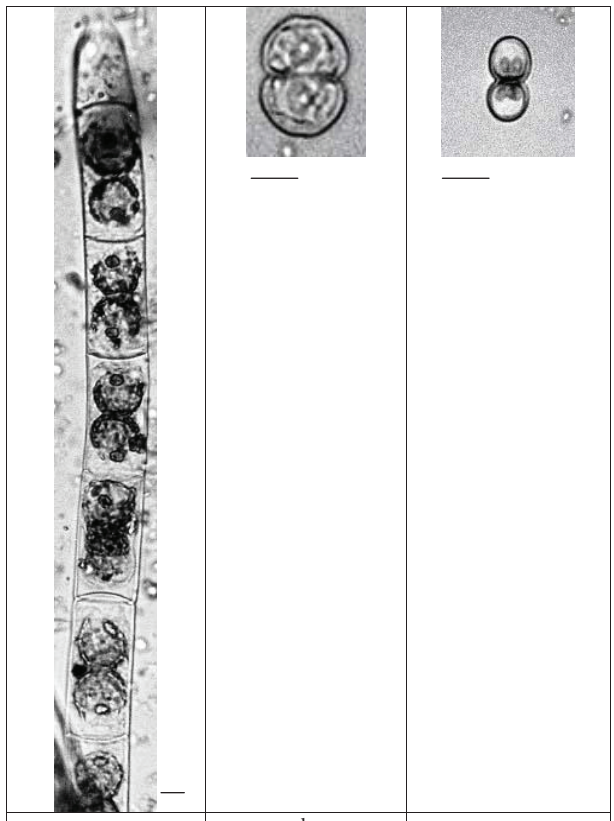


Figure 11. a- *Zygogonium ericetorum*, b- *Cosmarium subtumidum*, c- *Cosmarium subtumidum* var. *minutum* (Scale bars = 10 µm).

swollen. Chromatophores monocentric, furcoid with a central pyrenoid-like structure in every half-cell (Figure 11).

Found at stations 1 and 12 in plankton, at 7 in epiphyton, and at 1, 2, and 3 in epilithon.

Generally, eutrophic species are found in Turkish freshwaters. However, Tortum Lake (Altuner & Aykulu, 1987), Aygır and Balıklıgöl lakes (Şahin, 2000), and Yedigöller (Şahin, 2002) are oligotrophic, while Hazar Lake is in a state of transition from oligotrophic to mesotrophic (Şen, 1988). Dam reservoirs are said to have more mesotrophic characteristics (Baykal et al., 2009; Açıkgöz et al., 2011).

The surface temperature values of running waters and dam reservoirs recorded in the region were 6.2-31.7 °C (average 16.6 °C), pH was 6.8-9.2 (average 7.8), and dissolved oxygen was 3.5-13.9 (average 9.2) mg L^{-1}. Among the changing physical and chemical properties, temperature, light transmission, and nutrients had more effects on algal growth. Filamentous species such as *Klebsormidium crenulatum*, *Audouinella hermannii*, *Mougeotia genuflexa*, and *Spirogyra rhizobrachialis* were identified in Batman, Botan-Beyazsu, Karasu, and Hezil streams, respectively. Most of the other species were identified in more plankton and epipelon in the reservoirs on the Tigris River and its main tributary. Species identified were generally observed to be widespread and sometimes rare in mesotrophic and eutrophic media in European and American waters (John et al., 2002; Wehr & Sheath, 2003).

Conclusion

In recent years, multifaceted studies about algae have been conducted in Turkey. However, systematic studies that require long and exhausting investigations have started to decline. This study is considered a critical contribution toward determining the algal flora of Turkey.

Acknowledgements

This study was supported within project no. TBAG–2436 101T047 by the Basic Sciences Research Grant Committees of the Scientific and Technological Research Council of Turkey (TÜBİTAK).

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