New Records of Euglenophyceae for Turkish Freshwater Algae

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Abstract

Phytoplankton samples were collected from four different water bodies in the Tigris River basin in 2008. Nine Euglenophyceae taxa at specific and infraspecific level are reported for the first time on Turkish freshwater algal flora. New records come from six sampling sites in the study area. These taxa consist of one Euglena Ehrenberg (E. sociabilis), two Strombomonas Deflandre (S. planctonica and S. pascheriana), four Trachelomonas Ehrenberg (T. nigra, T. aspera, T. borodiniana and T. scabra var. labiata) and two Phacus Dujardin (P. inflexus and P. ovalis). Identification keys and general information on the morphology and taxonomy of the species are briefly described in this paper, with original illustrations.

Keywords: Euglenophyceae, new records, freshwater algal flora, Tigris River basin, Turkey.

Özet


Anadah Kelimeler: Euglenophyceae, yeni kayıtlar, tatlısu algal flora, Dicle Nehri havzası, Türkiye.

Introduction

The level of knowledge about the Euglenophyceae of Europe compares well with that from other continents. Studies on euglenoids were performed in the last decade of the 19th century and intensively in the beginning of the 20th century in Europe. From the territory of the present-day Czech Republic there are data on Euglenophyceae reported by Hansgrig (1886). From Germany there are works of Lemmermann (1910, 1913) including data about all groups of algae. A very good study of the genus Trachelomonas from France was done by Deflandre (1926). Later, Conrad and Van Meel (1952) made a major contribution to the euglenophyte flora of Belgium and France. Some of the most important data were elaborated by Skuja (1956), who gave original, very detailed information on all euglenophytes, together with the best iconographic documentation for Sweden. Huber-Pestalozzi (1955) and Sarmach (1983), compiling data on the euglenophytes of almost the whole globe, greatly contributed to the development of research on euglenoids. Popova (1966) and Popova and Safonova (1976) published good monographs on the flora of the Soviet Union. Vetrova (1986) gathered information about colourless and green euglenophytes from Ukrainian continental waters. We can find important data and documentation for Euglena from Poland in Zakryś (1986) and Wolowski (1998); the latter included data on the colourless and green euglenophytes of the Krakow–Czestochowa Upland. Nemeth (1997) studied the euglenophytes of Hungary.

Kusel-Fetzmann (2002) published the results of her long-term observations of the euglenophyte communities of Austria. A large body of data from Slovakia and Poland was elaborated by Wolowski and
Taxonomic and floristic studies of Euglenophyceae in Turkey are still scarce, and, as in many other countries, are usually part of works that include other algal groups. The highly diverse inland waters of Turkey have seen a marked increase in the number of algological studies in recent years. In the check-list of the freshwater algae of Turkey by Aysel (2005), a total of 2030 taxa at specific and infraspecific level were reported, 159 of which were Euglenophyceae. Later, 12 freshwater euglenophytes were recorded for the first time for Turkey by Marascağlıoğlu et al. (2005), Soylu et al. (2007), Sevindik et al. (2010, 2011 and 2015) and Özer et al. (2012), making a total of 171 taxa. This is only 16.19% of the 1056 species of Euglenales reported worldwide (Guiry and Guiry, 2016). The Tigris River is one of the Turkey’s most important rivers but the euglenophytes and other algae of the Tigris River basin is still poorly known (Özer et al., 2012; Varol and Şen, 2014). The aim of this study was to contribute the algal flora of the Tigris River basin, with special attention to Euglenophyceae.

Material and Methods

Study area

The Tigris River originates in the Toros Mountains of Eastern Anatolia. It follows a south-eastern route to Cizre, where it forms the border between Turkey and Syria, and then runs a further 32 km before entering Iraq. Of its ca. 1900 km total length, 523 km (draining 57,614 km²) is within Turkey (Varol et al., 2013). There are three reservoirs in the Turkish part of the basin: Kralkızı Dam (KDR), Dicle Dam (DDR) and Batman Dam (BDR) (Figure 1). The Kralkızı Dam was erected for hydroelectric power generation (HPG), the Dicle Dam for HPG, irrigation and drinking water supply, and the Batman Dam for HPG, irrigation and flood control (Varol, 2013 and 2016).

Sampling and Identification

Figure 1 shows the seven phytoplankton sampling sites. Three were in the river, one in KDR, one in DDR and one in BDR. Samples were taken at monthly intervals between May 2008 and October 2008. The samples were collected with a plankton net (55 µm mesh) and examined with a light microscope (Olympus BX51). Photographs were taken using Olympus DP71 digital camera. Taxa were identified according to Starmach (1983) and Karnkowska-Ishikawa et al. (2013). Identified taxa were checked against the checklist of Aysel (2005) and the database of Turkish algae (Gönülol, 2016), and determined as new taxa for Turkish freshwater algal flora. The current accepted nomenclature has been checked with AlgaeBase (Guiry and Guiry, 2016).

Results

Nine Euglenophyceae taxa new for the freshwater algae of Turkey were identified. These taxa consist of one Euglena Ehrenberg (E. sociabilis), two Strombomonas Deflandre (S. planctonica and S. pascheriana), four Trachelomonas Ehrenberg (T. nigra, T. aspera, T. borodiniana and T. scabra var. labiata) and two Phacus Dujardin (P. inflexus and P. ovalis). New records come from six sites (B-1, D-1, K-1, T-1, T-2 and T-3). Identification keys and general information on the morphology and taxonomy of Euglenophyceae species and genera presented in this paper are given below.

Class: Euglenophyceae
Order: Euglenales
Family: Euglenaceae
Genus: Euglena Ehrenberg
Genus: Strombomonas Deflandre
Genus: Trachelomonas Ehrenberg
Family: Phacaceae
Genus: Phacus Dujardin

Key to Genera:

1a. Cells naked without lorica.............................................2
1b. Cells enclosed in lorica.............................................3

2a. Cells flexible, with pronounced euglenoid movement, elongate, sometimes twisted, with one emergent flagellum, chloroplasts with variously developed pyrenoids, paramylon bodies from small grains to large rod-shaped.............................................Euglena
2b. Cells rigid, leaf-shaped, flattened, may be twisted, usually with large ring-shaped or discoid paramylon bodies and with variously developed posterior cauda..........................................................Phacus

3a. Cells enclosed in lorica tapering anteriorly, with neck which is only extension of lorica.....................................Strombomonas
3b. Cells enclosed by external lorica except apical pore, usually with collar or surrounded by thickening, through which emerges the flagellum, lorica variously ornamented ..................................................................Trachelomonas

Genus: Euglena Ehrenberg
Euglena sociabilis P.A.Dangeard

References: Karnkowska-Ishikawa et al. (2013; page 619, figure 1a-d), Starmach (1983; page 70, figures 90 and 91)
**Description:** Cells spindle-shaped; 15–27 µm wide, 62–87 µm long; rounded at anterior end, gradually tapering to posterior and passing into short tail-piece; pellicle very delicate, spirally striated; chloroplasts ca. 10 per cell, very deeply lobed, up to centre of cell, each with double-sheathed pyrenoids (Figure 2a).

**Specimens studied:** This species was collected at site T–1 (Bismil; 37° 50' N - 40° 39' E, 538 m a.s.l.) of the Tigris River in May 2008.

**Distribution:** Britain (Wolowski et al., 2011), Romania (Caraus, 2012), Brazil (Alves-da-Silva and Menezes, 2010), South Africa (Oberholster et al., 2010), Southeastern United States (Wolowski et al., 2013), India (Ratha et al., 2006), New South Wales and Queensland (Day et al., 1995).

**Genus:** Strombomonas Deflandre

**Key to species of Strombomonas:**

1a. Lorica usually with variously developed extension……………………………………………2

1b. Lorica without extension or sometimes with short one …………………………………………..3

2. Lorica ovoid or pyriform with straight or rarely curved extension…………………S. planctonica

3. Lorica broadly cylindrical in outline ……………………4

4. Lorica longitudinally ovoid, irregularly granulate…………………………..S. pascheriana

**Strombomonas planctonica** (Wołoszyńska) Popova

**Basionym:** Trachelomonas affinis var. planctonica Wołoszyńska

**Synonym:** T. affinis var. planctonica Wołoszyńska

**References:** Starmach (1983; page 260, figure 569)

**Description:** Lorica egg-shaped or pyriform, 18–32 µm wide, 27–50 µm long, gradually narrowed at anterior end into neck; at posterior end passing into conical, straight or slightly curved extension; wall rough, brown (Figure 2b).

**Specimens studied:** This species was collected at site T–1 (Bismil; 37° 50' N - 40° 39' E, 538 m a.s.l.) in September 2008.

**Distribution:** Romania (Caraus, 2012), Brazil (Alves-da-Silva and Menezes, 2010), Israel (Barinova and Tavassi, 2009), New Jersey (Conforti, 2009) and Russian Far East (Medvedeva and Nikulina, 2014).

**Strombomonas pascheriana** (Skvortzow) Deflandre

**Basionym:** Trachelomonas pascheriana Skvortzow

**Synonym:** T. pascheriana Skvortzow

**References:** Starmach (1983; page 242, figure 517)

**Description:** Lorica elongate-ovoid, 37–40 µm long, 18.5–23 µm wide; walls thick, dark brown, irregularly granulate and punctate; chloroplasts 6–10 (Figure 2c).

**Specimens studied:** This species was collected at site T–3 (Cizre; 37° 19' N - 42° 11' E, 371 m a.s.l.) of the Tigris River in October 2008.

**Distribution:** China (Skvortzow, 1925).

**Genus:** Trachelomonas Ehrenberg

**Key to species of Trachelomonas:**
1a. Lorica elliptic ................................................. 2
1b. Lorica obovoid or irregularly elliptic .................. 3
1c. Lorica oval .................................................... 4
2a. Lorica without collar, apical pore surrounded by several large verrucae.............. T. nigra
2b. Lorica with well developed collar................. T. aspera

3. Wall rough, slightly conical at posterior end ......................................................... T. borodiniana

4. Lorica oval, usually covered by particles of exogenous material.................... T. scabra var. labiata

Trachelomonas nigra Svirenko

References: Starmach (1983; page 329, figures 751, 751a)

Description: Lorica broadly ovoid, 23–23.5 µm long, 19–19.5 µm wide, dark brown or black, wall punctate, covered with small single verrucae or short spines, especially at posterior end, apical pore surrounded by several large verrucae (Figure 2d).

Specimens studied: This species was collected at site B–1 (38° 11′ N - 41° 09′ E, 652 m a.s.l.) of the Batman Dam Reservoir in October 2008.

Distribution: Israel (Stupina et al., 2000), Czech Republic (Hindak et al., 2006) and Bulgaria (Dimitrova et al., 2014).

Trachelomonas aspera A.M. Cunha

References: Starmach (1983; page 347, figure 832)

Description: Lorica elliptic, 20–25 µm long, ca. 15 µm wide, light brown, covered with irregular tubercles; collar well developed, cylindrical with smooth edges; flagellum 2–3 times longer than lorica; stigma large; chloroplasts 10 in each cell, plate-shaped with pyrenoids (Figure 2e).

Specimens studied: This species was collected at site T–3 (Cizre; 37° 19′ N - 42° 11′ E, 371 m a.s.l.) of the Tigris River in August 2008.

Distribution: Brazil (Alves-da-Silva and Menezes, 2010) and Israel (Barinova and Tavassi, 2009).

Trachelomonas borodiniana Svirenko

References: Starmach (1983; page 329, figure 749)

Description: Lorica obovoid, 23–28 µm long, 13–15–(22) µm wide, slightly widened at anterior part, slightly conical at posterior end; apical pore without collar, surrounded by thickening; wall rough, plate-shaped (Figure 2f).

Specimens studied: This species was collected at site T–3 (Cizre; 37° 19′ N - 42° 11′ E, 371 m a.s.l.) of the Dicle Dam Reservoir in August 2008.

Distribution: Taiwan (Shao, 2009).

Trachelomonas scabra var. labiata (Teiling) Huber-

Pestalozzi

Basionym: Trachelomonas labiata Teiling

Synonym: T. labiata Teiling, T. uniformis Skvortzow

References: Starmach (1983; page 347, figure 827)

Description: Lorica oval, granulate, brownish; 16.2–18.5 µm wide, 20.0–22.2–25.0 µm long, anterior end slightly narrowed, with short, not well developed, irregular neck; posterior end slightly narrowed into short extension ca. 1.8 µm long; chloroplast disc-shaped, ca. 3 µm in diameter, with pyrenoids (Figure 2g).

Specimens studied: This species was collected at site T–1 (Bismil; 37° 50′ N - 40° 39′ E, 538 m a.s.l.) of the Tigris River in September 2008 and site K–1 (38° 21′ N - 39° 52′ E, 790 m, a.s.l.) of the Kralkızı Dam Reservoir in August 2008.

Distribution: New South Wales and Victoria (Day et al., 1995), Poland (Poniewozik, 2009), Czech Republic (Kocarkova et al., 2004) and Singapore (Pham et al., 2011).

Genus: Phacus Dujardin

Key to species of Phacus:
1. Cells oval in outline................................................. 2
   2a. Cells strongly S-shaped with short projection at posterior end.......................... P. inflexus
   2b. Cells longitudinally oval with long projection........................................... P. ovalis

Phacus inflexus (I.Kisselev) Pochmann

Basionym: Euglena inflexa I.Kisselev

Synonym: E. inflexa I.Kisselev, Phacus inflexus var. minor Bourrelly & Manguin

References: Starmach (1983; page 156, figure 274)

Description: Cells flattened, strongly S-shaped, almost folded in two; 20–31 µm long, 7.5–11 wide µm wide, incised at anterior end, with blunt short extension at posterior end; pellicle striated from right to left side; 1–2 paramylon bodies various in size (Figure 2h).

Specimens studied: This species was collected at site T–3 (Cizre; 37° 19′ N - 42° 11′ E, 371 m a.s.l.) of the
Tigris River in July 2008.

**Distribution:** Romania (Caraus, 2012), Spain (Alvárez-Cobelas, 1984), Mexico (Valadez et al., 2010), Brazil (Alves-da-Silva and Menezes, 2010), Sierra Leone (Alfinito, 2011), China (Hu and Wei, 2006) and Taiwan (Shao, 2009).

**Phacus ovalis** (Woronichin) Popova

**Basionym:** Phacus longicauda var. ovalis Woronichin

**Synonym:** P. longicauda var. ovalis Woronichin

**References:** Starmach (1983; page 192, figure 388)

**Description:** Cells longitudinally oval, 87–102 µm long, 42–46 µm wide, narrowed at posterior end into long appendix ca. 31–33 µm long; periplast longitudinally striated, paramylon grains ring-shaped, one large located in cell centre, smaller located in lower part of cell; chloroplasts small, without pyrenoids (Figure 2i).

**Specimens studied:** This species was collected at site T–2 (Hasankeyf; 37º 42’ N - 41º 24’ E, 471 m a.s.l.) of the Tigris River in October 2008.

**Distribution:** Russian Far East (Medvedeva and Nikulina, 2014), Ukraine (Bilous et al., 2012) and Taiwan (Shao, 2009).

**Discussion**

This study reports nine taxa of euglenoids as new records for the freshwater algal flora of Turkey from the Tigris River basin. Most of the taxa found in the basin are well known, and only *Strombomonas pascheriana*, *Trachelomonas aspera* and *T. borodiniana* are rarely reported worldwide (Starmach, 1983; Guiry and Guiry, 2016). All taxa occurred together with other algae such as diatoms (*Navicula*, *Gomphonema*, *Nitzschia*) and chlorococcal green algae. We found that the euglenophyte populations developed very well together with diatoms in almost all the studied samples.

The high number of euglenoids in the water bodies indicates organic pollution (Fjerdingstad, 1964; Sladecek and Perman, 1977; Starmach, 1983; Wołowski, 1998; Wołowski, 2011). Abundant development of euglenoids is also known to indicate high water temperature (Wołowski et al., 2013; Duangjan and Wolowski, 2013; Duangjan et al., 2014). Therefore, knowledge of the euglenophyte flora can be useful in assessment of water quality. This study is offered as a contribution toward determining Euglenophyceae from Turkey.

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References


