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New Records for The Turkish Freshwater Algal Flora in Twenty-five River Basins of Turkey, Part II: Chlorophyta, Cyanobacteria, Euglenozoa

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Abstract

Turkish lakes which have different morphometry and hydrology, have a great potential that supports distinct algal diversity as a result of different climate types and geographical variation (latitudinal, longitudinal, and altitudinal gradients). However, the algal flora of Turkey has not been completed, and the number of new taxa has increased due to new studies in Turkey. This study aims to describe new planktonic algal taxa for the Turkish freshwater algal flora. A total of 330 Chlorophyta, 164 Cyanobacteria and 187 Euglenozoa taxa were determined in a study conducted from 2017 to 2019 in 275 lakes of 25 river basins in Turkey. During this study, 116 Chlorophyta, 41 Cyanobacteria, and 81 Euglenozoa new records were found new records for the freshwater algal flora of Turkey.

Introduction

It is thought that due to their small size, high abundance, fast population growth, and long-range dispersal, algae such as other microorganisms are considered as cosmopolitan because they occur in very diverse habitats and distribute globally (Fenchel and Finlay, 2004; Hillebrand, 2004; Graneli and Turner, 2006; Reynolds, 2006). However, recent studies reported that spatial diversity patterns also exist for algae (Ptacnik et al., 2010; Stomp et al., 2011; Wang et al., 2011; Maileht et al., 2013). Some dispersal agents such as a river, air, animals, human are needed for dispersal of algae (Padisák et al., 2016), however, many studies indicated the role of several factors, such as productivity, nutrient and light availability, alkalinity, periodic disturbances, food web structure, colonization processes, dispersal ability among local communities (Tilman et al., 1982; Sommer, 1993; Ricklefs, 1987; Leibold, 1996; Morin and Fox, 2004; Smith et al., 2005; Stomp et al., 2007) for the spatial diversity of algae. Geographical variation (latitudinal, longitudinal, and altitudinal gradients) and lake morphometry have been shown to control these factors and are considered as the major determinant of

phytoplankton diversity (Stomp et al., 2011; Winslow et al., 2015; Borics et al., 2016). Due to the effects of three different types of climate, geographical variation, and different soil types, 23 lake typologies were determined in Turkish lakes (DGWM, 2015a), and these lakes have great potential to support distinct algal diversity.

Although several studies were recorded on phytoplankton composition, diversity, and abundance (Maraşlıoğlu et al., 2005; Sömek et al., 2005; Demir et al., 2014; Sevindik et al., 2017a, Öterler et al., 2018; Çelekli et al., 2020), in recent years, several projects have also been implemented and funded by the Ministry of Agriculture and Forestry, Directorate General of Water Management (DGWM), and General Directorate of State Hydraulic Works (DSİ). This study is also a part of the "Establishment of Reference Monitoring Network in Turkey" project which is supported by DGWM. In this project, 275 lakes in 25 river basins were studied, and a total of 1363 phytoplankton taxa were detected. Among these taxa, 330 Chlorophyta, 164 Cyanobacteria, and 187 Euglenozoa taxa were determined.

A few check-lists were published (Gönülol et al., 1996; Aysel, 2005; Şahin, 2005), and many new records were given for the algal flora of Turkey (Aysel et al., 1993; Öztürk et al., 1995a, 1995b; Şahin 1998, 2000, 2002, 2007, 2009; Şahin and Akar, 2007; Apaydın-Yağcı and Turna, 2002; Atıcı, 2002; Baykal et al., 2009, 2012; Sevindik et al. 2010, 2011, 2015, 2017b; Özer et al., 2012; Akar and Şahin, 2014; Yüce and Ertan, 2014; Varol and Fucikova, 2015; Varol and Şen, 2016; Morkoyunlu and Aktaş, 2020). Therefore, the total number of taxa has increased (Taşkın et al., 2019; Maraşlıoğlu and Gönülol, 2021). Although 6717 Chlorophyta, 4788 Cyanobacteria, and 1513 Euglenozoa taxa were reported in previous studies in the world (Guiry and Guiry, 2021), only 1541 taxa belonging to these three divisions have been listed in Turkey so far (Maraşlıoğlu and Gönülol, 2021).

This study is one of the outcomes of the "Establishment of Reference Monitoring Network in Turkey" project, financially and technically supported by DGWM. In this project, 275 lakes in 25 river basins were studied, and a total of 1363 phytoplankton taxa were detected. It is thought that a total of 238 new records belonging to three divisions (Chlorophyta, Cyanobacteria, Euglenozoa) whose figures and habitats were given in this study will contribute to the studies on freshwater algal flora of Turkey.

Materials and Methods

Study Area

Turkey has 25 river basins (Figure 1), and inland water bodies in these basins consist of 200 natural lakes, 806 reservoirs, and 1000 ponds. Considering the areas of river basins, the annual amount of water produced per unit area is lowest in Akarçay Basin with 64.430 m^3/km^2, while highest in Eastern Karadeniz Basin with 618.850 m^3/km^2 (Foreign Relation Office of DSİ, 2014). However, Lakes Region (Burdur Basin), South Marmara (Susurluk Basin), Lake Van and its surroundings (Lake Van Basin), Lake Tuz, and its surroundings (Konya Basin) were the regions where the natural lakes are gathered (Hoşgören, 1994).

A total of 275 lakes, including reservoirs, were sampled during the study in 25 river basins. The number of studied lakes in the river basins was given in Table 1. These lakes are grouped in 22 lake typologies based on altitude (R), lake depth (D), lake size (A), and geology (J) (DGWM, 2015a), and they are located between the longitudes of 26° 19′ and 43° 54′E and the latitudes of 35° 56′ and 42° 00′N. The altitudes of the sampled lakes vary between sea level (Lake Gala) and 2757 m (Lake Çamlu).

Sampling and Identification

Phytoplankton was sampled three times (spring, summer, and fall) a year during 2017 and 2019 at the one, two, or three monitoring stations in each lake. Station numbers were determined as one for lakes that have a surface area smaller than 50 ha, two for lakes that have a surface area between 50 and 500 ha and, three for lakes that have a surface area higher than 500 ha (DGWM, 2015b). One of the selected stations was determined at the deepest point of the lake. Three depths (surface, middle, and bottom) of the euphotic depth (Secchi disk depth × 2.5) were sampled with a Ruttner water sampler (Hydro-Bios 2 L, 50 cm long) in the lakes, then a subsample was taken from mixed water of the three depths. Plankton net (Hydro-Bios 438001, 50 × 25 cm) with a pore diameter of 50 µm was also used for sampling. Samples were fixed with Lugol's solution. After field sampling, the samples were taken to the laboratories of different universities (Sakarya University, Hitit University, Giresun University, Ankara University, Gaziantep University, İzmir Katip Çelebi University, Trakya University). In these laboratories, phytoplankton samples were firstly prepared for identification and then, phytoplankton enumerations were carried out according to the standard method (Anonymous, 2006). Both compound and inverted microscopes (Olympus BX53, Olympus CKX41, Olympus BX53F (DIC), Olympus BX51, Olympus IX81, Nikon Eclipse Ts2, Leica DM750) were used, since new species were detected both in the identification and enumeration processes according to the literature (Heering, 1914; Geitler, 1925; Desikachary, 1959; Huber-Pestalozzi, 1961, 1962, 1969, 1972, 1983; Philipose, 1967; Compère, 1986; Ettl and Gärtner, 1988; John et al., 2003; Komárek and Anagnostidis, 1999; Dillard, 2000; Komárek and Anagnostidis, 2005; Joosten, 2006; Baker and Fabbro, 2002; Park, 2012; Komárek, 2013). Identified taxa were checked with the checklist of Aysel (2005), Taşkın et al. (2019), and the database of Turkish algae (Maraşlıoğlu and Gönülol, 2021), and then determined as new taxa for Turkish freshwater algal flora. The currently

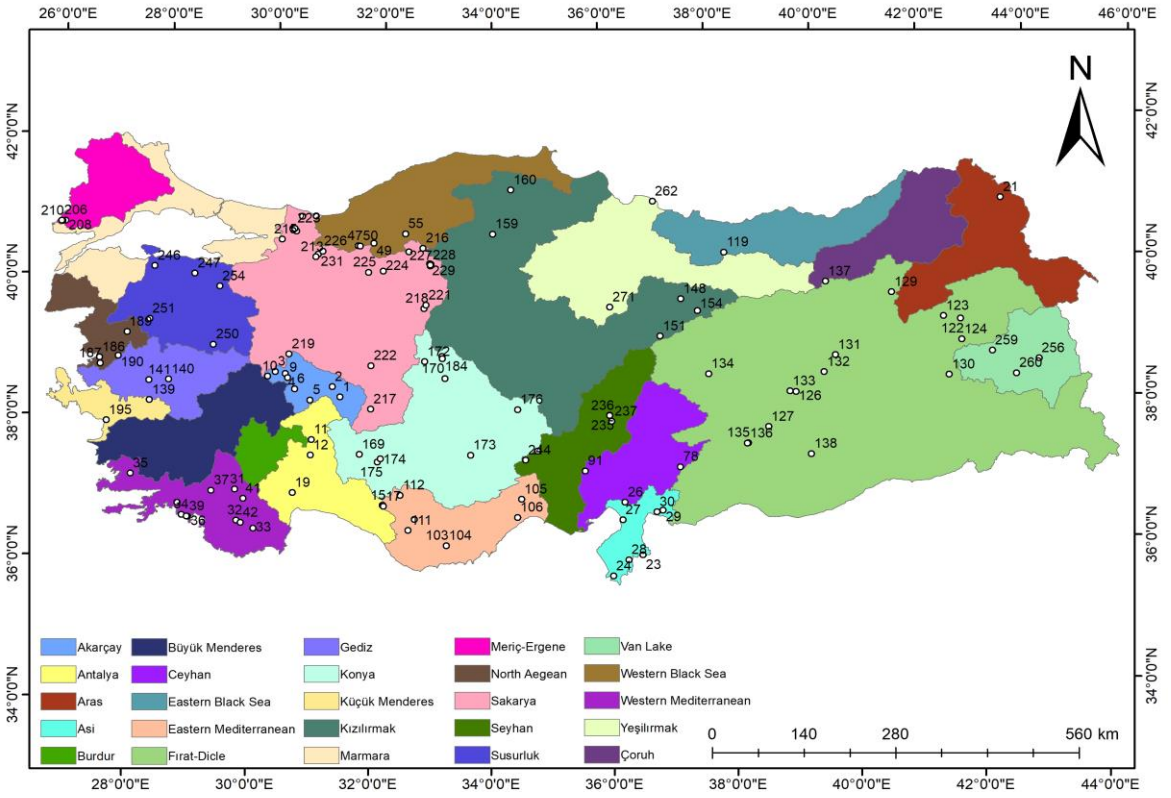

Figure 1. Map of sampling locations and river basins in Turkey.

Akarçay Basin; (1) Akşehir Lake, **(2)** Eber Lake, **(3)** Akdeğirmen Reservoir, **(4)** 26 Ağustos TP Lake, **(5)** Karamık Reeds, **(6)** Ağzıkara Pond, **(9)** Şehit Uz. Çvş. Nurullah Oymak Pond, **(10)** Tazlar Satı Gelin Pond, **Antalya Basin; (11)** Eğirdir Lake, **(12)** Kovada Lake, **(15)** Duruca Lake, **(17)** Küllü Lake, **(19)** Düden Lake, **Aras Basin; (21)** Çıldır Lake, **Asi Basin**; **(23)** Reyhanlı (Yenihisar) Lake, **(24)** Yayladağ Reservoir, **(26)** Karagöl Lake, **(27)** Adsız Lake, **(28)** Yarseli Reservoir, **(29)** Üçpınar Pond, **(30)** Sapkanlı Pond, **Western Mediterranean Basin; 31)** Gölhisar Lake, **(32)** Girdev Lake, **(33)** Avlan Lake, **(34)** Dalaman Wetlands, **(35)** Denizcik Lake, **(36)** Kocagöl Lake, **(37)** Kusuru Lake, **(38)** Köyceğiz Lake, **(39)** Küçükdalyan Lake, **(41)** Yazır Lake, **(42)** Baranda Lake, **Western Black Sea; (47)** Parçayır Lake, **(49)** Dipsiz Lake, **(50)** Gölcük Lake, **(55)** Koca Lake, **Ceyhan Basin; (78)** Kartalkaya Reservoir, **(91)** Zerdali Pond, **Çoruh Basin; (98)** Şavşat Karagöl Lake, **Eastern Mediterranean Basin; (103)** Aygır Lake, **(104)** Uzun Lake, **(105)** Değirmendere Pond, **(106)** Cemilli Çevlik Pond, **(110)** Başyayla Pond, **(111)** Göktepe Pond, **(112)** Bağbaşı Reservoir, **Eastern Black Sea Basin; (119)** Çamlu Lake, **Fırat-Dicle Basin; (122)** Kaz Lake, **(123)** Ahır Lake, **(124)** Haçlı Lake, **(126)** Hazar Lake, **(127)** Karagöl Lake, **(129)** Palandöken Pond, **(130)** Güroymak Reservoir, **(131)** Kalecik Reservoir, **(132)** Kapıaçmaz Pond, **(133)** Dedeyolu Pond, **(134)** Güzelyurt Sulama Pond, **(135)** Hasancık Pond, **(136)** İncesu Pond, **(137)** Otlukbeli Lake, **(138)** Siverek Yeleken Pond, **Gediz Basin; (139)** Gölcük Lake, **(140)** Demirköprü Reservoir, **(141)** Marmara Lake, **Kızılırmak Basin; (148)** Hafik Lake, **(151)** Arı Lake, **(154)** Dipsiz Lake, Lake-1, **(159)** Yeşilgöl 1 Lake, **(160)** Bardakçılı Mevki Lake, **Konya Basin; (169)** Beyşehir Lake, **(170)** Tuz Lake, **(172)** Gök (Kozanlı) Lake, **(173)** Meke Lake (Meke Maarı), **(174)** Gavur Lake, **(175)** Dipsiz Lake, **(176)** Acıgöl Lake 2, **(181)** Düden Lake, **(184)** Küçük Lake, **North Aegean Basin; (186)** Boz Lake, **(187)** Güzelhisar Reservoir, **(189)** Sevişler Reservoir, **(190)** Tepe Lake, **Küçük Menderes Basin; (195)** Gebekirse Lake, **Meriç-Ergene Basin; (206)** Gala Lake, **(208)** Pamuklu Lake, **(210)** Domuz Lake, **Sakarya Basin; (211)** Taşkısığı Lake, **(212)** Akgöl 2 Lake, **(213)** Çubuk Lake, **(214)** Poyrazlar Lake, **(215)** Sapanca Lake, **(216)** Işık Dağı Karagöl Lake, **(217)** Çavuşcu Lake, **(218)** Mogan Lake, **(219)** Üçlerkayası Pond, **(220)** Çubuk Karagöl Lake, **(221)** Eymir Lake, **(222)** Akgöl 1 Lake, **(223)** Küçük Akgöl Lake, **(224)** Avdan Lake, **(225)** Kayuslu Lake, **(226)** Karamurat Lake, **(227)** Cüneyt Sönmez Pond, **(228)** Çılgınlar Pond, **(229)** Yıldırım Evci Pond, **(231)** Sülüklü Lake, **(232)** Çamkoru TP Pond, **(233)** Anagöl Lake, **Seyhan Basin; (235)** Tufanbeyli Demiroluk Pond, **(236)** Adsız Lake, **(237)** Pekmezli-Çatalçam Pond, **(243)** Topacık Pond, **(244)** Hüsniye Pond, **Susurluk Basin; (246)** Manyas Lake, **(247)** Uluabat Lake, **(250)** Gölcük Lake, **(251)** İkizcetepeler Reservoir, **(254)** Nilüfer Reservoir, **Van Lake Basin; (256)** Erçek Lake, **(259)** Aygır Lake, **(260)** Van Lake, **Yeşilırmak Basin; (262)** Akgöl Lake, **(271)** Dipsiz Lake 2

Note:*Maraşlıoğlu *et al.* (2021)

Table 1. Number of studied lakes in 25 river basins

River Basins in Turkey																							
Burdur	Akarçay	Sakarya	Western Black Sea	Eastern Black Sea	Yeşilırmak	Kızılırmak	Meriç-Ergene	Marmara	Antalya	Western	Büyük Menderes	Gediz	North Aegean	Küçük Menderes	Konya	Susurluk	Aras	Çoruh	Fırat-Dicle	Van Lake	Asi	Ceyhan	Eastern Mediterranean	Seyhan
6	10	23	14	7	14	23	5	9	9	13	13	6	5	6	18	9	3	8	17	7	8	18	12	12
Lakes Numbers																								

accepted nomenclature and distribution of taxa have been given according to Guiry and Guiry (2021). The author names were abbreviated according to Brummitt and Powell (1992). Taxa were photographed with imaging systems (LAS v.4.8 program, CellSens Vers. 1.6 program) and a camera (Leica MFC170 HD model, DP73 model, Olympus SC100 model) attached to various microscopes.

Results

A total of 330 Chlorophyta, 187 Euglenozoa, and 164 Cyanobacteria taxa were determined in a study conducted from 2017 to 2019 in 25 river basins of Turkey. 116 Chlorophyta, 81 Euglenozoa, and 41 Cynabacteria taxa were identified as new records for the freshwater algae of Turkey during our study. General information and figures of these taxa were presented in Table 2 and Figure 2-23.

New records were found in 124 of 275 lakes from 25 basins of Turkey. The first three basins with the highest number of lakes recorded new species were Sakarya (22 lakes), Fırat-Dicle (15 lakes) and Western Mediterranean (11 lakes) basins, respectively. The basins with no new records were Burdur, Büyük Menderes and Marmara basins. Western Mediterranean (43 taxa), Fırat-Dicle (41 taxa) and Asi (38 taxa) basins constitute 55.9% of the total new records. The first five lakes with the highest number of new recorded taxa were respectively Girdev Lake (22 taxa) from Western Mediterranean basin, Cüneyt Sönmez Pond (18 taxa) from Sakarya basin, Yarseli Reservoir (16 taxa) from Asi basin, Siverek Yeleken Pond (16 taxa) from Fırat-Dicle basin, and Üçlerkayası Pond (15 taxa) from Sakarya basin.

Discussion

This study reports 238 phytoplankton taxa as new records for the freshwater algal flora of Turkey from the 25 river basins. The diversity of new records presented in this study includes 41 taxa from Cyanobacteria, 81 taxa from Euglenozoa, and 116 taxa from Chlorophyta divisions. The highest genus diversity was seen in Chlorophyta with 57 genera, while the lowest genus diversity was seen in Euglenozoa with 12 genera. Also, 28 genera were identified in Cyanobacteria division.

While 75.6% of 41 new records from Cyanobacteria detected in 25 river basins in Turkey are rare species as the distribution area, 24.4 % of them are the species that are widely seen in the world. Although *Anabaena laxa*, *Anathece minutissima*, *A. smithii*, *Aphanocapsa conferta*, *Dolichospermum lemmermannii*, *Microcystis botrys*, *Nostoc caeruleum*, *Nodularia sphaerocarpa*, *Oscillatoria trichoides*, and *Rhabdoderma lineare* species are commonly reported, *Anabaena oblonga*, *A. sphaerica* var. *attenuata*, *Anabaenopsis milleri*, *Aphanizomenon klebahnii*, *Aphanocapsa nubila*, *Arthrospira platensis* var. *non-constricta*, *Aphanothece atrocrustacea*, *A. comasii*, *A. floccosa*, *Chroococcus lithophilus*, *C. mipitanensis*, *Coelosphaerium aerugineum*, *Gloeothece subtilis*, *Leptolyngbya ectocarpi*, *Limnospira fusiformis*, *Oscillatoria chlorina* f. *perchlorina*, *Pannus spumosus*, *Phormidium schultzii Planktolyngbya microspira*, *Planktothrix isothrix*, *Pulvinularia suecica*, *Romeria gracilis*, *Snowella litoralis*, *S. fennica*, *Synechocystis parvula*, *Woronichinia botrys*, and *W. karelica* taxa are rarely reported in worldwide. Also, no distributional records were found in algaebase about the distribution areas of *Aphanocapsa planctonica*, *Merismopedia hyalina*, *Anabaenopsis rippkae*, and *Dolichospermum fallax* species (Guiry and Guiry, 2021). Among the new record species in Cyanobacteria, the ones with common distribution are generally seen in the Sakarya Basin, while those with rare distribution areas were mostly detected in Fırat-Dicle and Western Mediterranean basins.

A great majority of 81 new records from Euglenozoa detected in 25 river basins in Turkey are rare species in the world. However, *Euglena velata*, *Euglenaria anabaena*, *Phacus carinatus*, and *P. caudatus* are common species in the world (Guiry and Guiry, 2021). Most of the new records detected from Euglenozoa group were tolerant taxa as water quality indicators (Phillips et al., 2010). Among the new records in Euglenozoa, species with rare distribution areas were mostly found in Sakarya and Fırat-Dicle basins, while such a predominant basin could not be detected for common species.

While 78,4 % of 116 new records from Chlorophyta detected in 25 basins in Turkey are rare species, 21.6 % of them are the species that are widely seen in the world. *Acanthosphaera zachariasii, Ankistrodesmus stipitatus, Aulacomonas submarina, Characium angustum, Chlamydomonas anglica, C. nivalis, Chlorella chlorelloides, Chlorolobion lunulatum, Desmodesmus abundans* var. *brevicauda, Dicellula geminata, Dictyosphaerium subsolitarium, Didymocystis inermis, Didymogenes palatina, Kirchneriella major, Monoraphidium obtusum, M. pseudobraunii, Planktococcomyxa lacustris, Palmococcus reniformis, Paulschulzia pseudovolvox, Pediastrum ovatum, P. simplex* var. *clathratum, Pseudopediastrum subgranulatum, Quadrigula chodatii, Q. sabulosa,* and *Willea crucifera* taxa are commonly distributed in the word. However, the remaining 91 new records from Chlorophyta were identified as rare taxa (Guiry and Guiry, 2021). In this study, among the new record species from Chlorophyta, the Sakarya Basin was the main area where taxa with both common and rare distribution areas were most frequently found. In Chlorophyta, the rare distribution area consist of species belonging to the genus *Carteria*, while the common distribution area consist of species belonging to the genera *Monoraphidium*, *Quadrigula*, and *Willea*.

The fact that Western Mediterranean (43 taxa), Fırat-Dicle (41 taxa) and Asi (38 taxa) are the basins with the most new records may be due to the wetlands in

Table 2. List of phytoplankton taxa identified as new records in 25 basins of Turkey.

Abbreviations; For Basin(s); AK: Akarçay, AN: Antalya, AR: Aras, AS: Asi, WM: Western Mediterranean, EM: Eastern Mediterranean, WB: Western Black Sea, EB: Eastern Black Sea, KM: Küçük Menderes, CE: Ceyhan, CO: Çoruh, FD: Fırat Dicle, GE: Gediz, KI: Kızılırmak, KO: Konya, NA: North Aegean, ME: Meriç-Ergene, SA: Sakarya, SE: Seyhan, SU: Susurluk, VL: Van Lake, YE: Yeşilırmak. **For Habitat;** Fre: Freshwater, Mar: Marine, Bra: Brackish, Ter: Terrestrial**.** Bold numbers indicated lake names in the legend of Figure 1.

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake Number*	Distribution in the World**
CYANOBACTERIA						
Anabaena laxa Braun	—	4.5-5.0	Fre	SA	**217**	Common
Anabaena oblonga De Wild.	—	4.5-5.0	Fre	FD	**131**	Rare
Anabaena sphaerica var. *attenuata* Bharadwaja	—	3.2-5.2	Fre	FD	**131**	Rare
Anabaenopsis milleri Woron.	—	3.7-10.9 × 3.6-8	Fre	YE	**262**	Rare
Anabaenopsis rippkae Komárek	—	4.5-6	Fre	FD	**126**	Rare
Anathece minutissima (West) Komárek, Kastovsky & Jezberová	*Microcystis minutissima*	1.5 x 0.8	Fre	SA	**213**	Common
				FD	**126**	
Anathece smithii (Komárk.-Legn. & Cronberg) Komárek, Kastovsky & Jezberová	*Aphanothece smithii*	3 x 1.3	Fre	SA	**219**	Common
Aphanizomenon klebahnii Elenkin	—	3.9-8.3 × 3.6-4.9	Fre	GE	**139, 140**	Rare
				NA	**187, 189, 190**	
				SU	**250, 251, 254**	
				CE	**78, 91**	
Aphanocapsa conferta (West & G.S.West) Komárk.-Legn. & Cronberg	*Aphanocapsa elachista* var. *conferta*	1.5–2.0 dia	Fre	FD	**138**	Common
Aphanocapsa nubila Komárek & Kling	*Microcystis pulverea* var. *racemiformis*	1.0-2.0 dia	Fre	FD	**124**	Rare
Aphanocapsa planctonica (G.M.Sm.) Komárek & Anagn.	*Microcystis pulverea* f. *planctonica*	2.0-3.0 dia	Fre	SA	**227**	Rare
Aphanothece atrocrustacea Skuja	—	2-4 x 1.5-2	Fre	WM	**32**	Rare
Aphanothece comasii Komárk.-Legn.& Tavera	—	1.8-3.0 dia	Fre	WM	**32, 33**	Rare
Aphanothece floccosa (Zalessky) Cronberg & Komárek	*Microcystis floccosa*	3-4 x 1-2	Fre	WM	**37**	
Arthrospira platensis var. *non-constricta* (Banerji) Desikachary	*Spirulina platensis* var. *non-constricta*	2-3.5	Fre	AK	**2**	Rare
Chroococcus mipitanensis (Wolsz.) Geitler	*Chroococcus turgidus* var. *mipitanensis*	1.7-2.5	Fre	WM	**32**	Rare
Chroococcus lithophilus Erceg.	*Gloeocapsa lithophila*	3-5 dia	Fre	WM	**33**	Rare
Coelosphaerium aerugineum Lemmerm.	—	2.2-3.5 dia	Fre, Bra	FD	**137**	Rare
Dolichospermum fallax (Komárek & Komárk.-Legn.) Wacklin, Hoffm. & Komárek	*Anabaena fallax*	5.2–6.0	Fre	FD	**131**	Rare
Dolichospermum lemmermannii (Richt.) Wacklin, Hoffm. & Komárek	*Anabaena lemmermannii*	6.3 x 5	Fre	AR	**21**	Common
Gloeothece subtilis Skuja	—	1.5 x 0.7	Fre	AS	**29**	Rare
Leptolyngbya ectocarpi (Gomont) Anagn. & Komárek	*Phormidium ectocarpi*	2.0 x 1.6	Fre, Mar	KO	**170, 181**	Rare
Limnospira fusiformis (Woron.) Nowicka-Krawczyk, Mühlsteinová & Haue	*Spirulina fusiformis*	4–5	Fre	SA	**214**	Rare
Merismopedia hyalina (Ehrenb.) Kütz.	*Gonium hyalinum*	2–3 dia	Fre, Bra	WM	**33**	Rare
				SA	**214**	
Microcystis botrys Teiling	—	6–7 dia	Fre	NA	**190**	Common
Nodularia sphaerocarpa Bornet & Flahault	*Nodularia harveyana* var. *sphaerocarpa*	5-7 x 3.4-6	Fre	SA	**222**	Common
Nostoc caeruleum Lyngb.	—	5-7 dia	Fre	KO	**169, 172, 174, 176**	Common
				AN	**11, 12, 15**	
Oscillatoria chlorina f. *perchlorina* (Lauterborn) Elenkin	*Oscillatoria chlorina* var. *perchlorina*	4-8 x 3.5-4	Fre	FD	**133**	Rare
Oscillatoria trichoides Szafer	—	5 x 1-1.5	Fre	AK	**5**	Common
Pannus spumosus Hickel	—	1-1.5 dia	Fre, Mar	SA	**226**	Rare
				VL	**259**	
Phormidium schultzii (Lemmerm.) Anagn. & Komárek	*Oscillatoria schultzii*	3.3 dia	Fre	FD	**127**	Rare

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Planktolyngbya microspira Komárek & Cronberg	—	1.5–2 x 1.0	Fre	KM	**195**	Rare
Planktothrix isothrix (Skuja) Komárek & Komárk.	*Oscillatoria agardhii* var. *isothrix*	1.2-2.5 x 4-6	Fre	YE	**271**	Rare
				AK	**2, 3**	
				VL	**256**	
					260	
Pulvinularia suecica Borzì	—	3.2–6.9 x 3.0–6.4	Fre	SA	**216**	Rare
				FD	**127**	
Romeria gracilis (Koczw.) Koczw.	*Raciborskia gracilis*	4.0 x 1.3	Fre	WM	**33**	Rare
Rhabdoderma lineare Schmidle & Lauterborn	*Rhabdoderma lineare* var. *spirale*	6 x 2	Fre	KO	**176**	Common
				SA	**211**	
				AK	**2**	
Snowella fennica Komárek & Komárk.-Legn.	—	3.5 x 2.0	Fre	AK	**5**	Rare
Snowella litoralis (Häyrén) Komárek & Hindák	*Gomphosphaeria litoralis*	2-3(-4) dia	Fre	WM	**33, 37**	Rare
Synechocystis parvula Perfiliev	—	0.7-0.9 dia	Fre, Mar	SA	**213**	Rare
Woronichinia botrys (Skuja) Komárek & Hindák	*Gomphosphaeria botrys*	5.5 x 4.5	Fre	SA	**224**	Rare
Woronichinia karelica Komárek & Komárk.-Legn.	—	3.2 x 1.7	Fre	AK	**5**	Rare
				FD	**124**	
EUGLENOZOA						
Anisonema prosgeobium Skuja	—	30 x 20	Fre	WM	**32, 34, 35, 36, 37, 42**	Rare
Astasia cylindrica From.	—	18 x 10	Fre	FD	**138**	Rare
Astasia thiophila Hub.-Pest.	—	22 x 8	Fre	FD	**129**	Rare
Euglena antefossa Johnson	—	175 x 20	Fre	AS	**29**	Rare
				WM	**31**	
Euglena gracilis var. *urophora* Chadef. & Provasoli	—	70 x 14	Fre	SA	**219**	Rare
Euglena mainxii Deflandre	*Euglena reticulata*	33 x 13	Fre	AS	**28**	Rare
Euglena rostrata Ehrenb.	—	45 x 10	Fre	SA	**233**	Rare
Euglena sacculiformis Schiller	—	30 x 14	Fre	AK	**1**	Rare
Euglena velata G.A. Klebs	—	96 x 25	Fre	AN	**12**	Common
				KI	**159, 160**	
				KO	**169, 172, 174, 175**	
				SE	**235, 236, 237, 243, 244**	
Euglenaria anabaena (Mainx) Karnkowska & E.W.Linton	*Euglena anabaena*	42 x 18	Fre	AS	**28**	Common
				FD	**135, 138**	
Euglenopsis vacuolata (Skuja) Popova	*Astasia vacuolata*	35 x 13	Fre	FD	**138**	Rare
Lepocinclis conica (P.Allorge & Lefèvre) Zakryś & Lukom.	*Lepocinclis ovum* var. *conica*	18 x 13	Fre	SA	**213**	Rare
Lepocinclis fusiformis var. *amphirhynchus* Nygaard	—	19 x 13	Fre	SA	**232**	Rare
Lepocinclis lobata Conrad	—	27 x 25	Fre	WM	**36**	Rare
Lepocinclis nayalii Conrad	—	44 x 24	Fre	AS	**28**	Rare
Lepocinclis ovum var. *angustatum* (Deflandre) Conrad	*Lepocinclis bütschli* var. *angustata*	32 x 17	Fre	WM	**32**	Rare
Lepocinclis ovum var. *dimidio-minor* (Deflandre) Conrad	—	28 x 15	Fre	AS	**29**	Rare
Lepocinclis teres f. *parvula* Conrad	—	23 x 16	Fre	AK	**1**	Rare
Lepocinclis texta var. *mammillata* (Da Cunha) Conrad	—	35 x 21	Fre	SA	**213, 219, 227**	Rare
				WM	**42**	

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Menoidium semilunare var. *regulare* Wermel	—	29 x 11	Fre	AS	**29**	Rare
Monomorphina aenigmatica (Drezep.) Nudel. & Triemer	*Phacus striatus*	36 x 9	Fre	KI	**160**	Rare
Petalomonas applanata Skuja	—	27.5 × 28	Fre	FD	**123**	Rare
Phacus agilis var. *inversus* Bourr.	—	14 x 10	Fre	SA	**233**	Rare
Phacus applanatus Pochm.	—	40 x 18	Fre	AK	**2**	Rare
				KO	**174**	
Phacus carinatus Skvortsov	—	35 x 27	Fre	FD	**135**	Common
Phacus caudatus Hübner	*Phacus ovalis*	50 x 27	Fre	AN	**19**	Common
				AS	**23, 28**	
				NA	**186**	
				GE	**141**	
				KO	**170**	
				WM	**33**	
				WB	**49**	
				SU	**247**	
				ME	**206, 208, 210**	
Phacus circumflexus Pochm.	—	70 x 30	Fre	WM	**42**	Rare
Phacus dangeardii Lemmerm.	—	16 x 9	Fre	SA	**225**	Rare
				WM	**32**	
Phacus formosus Pochm.	—	30 x 17	Fre	SA	**223**	Rare
Phacus minutus (Playfair) Pochm.	*Phacus pleuronectes* var. *minutus*	28 x 25	Fre	SA	**212**	Rare
Phacus swirenkoi Skvortsov	—	28 x 19	Fre	EM	**106**	Rare
Phacus tortuosus Y.V.Roll	—	29 x 23	Fre	WM	**41**	Rare
Strombomonas borystehniensis (Y.V.Roll) T.G.Popova	*Trachelomonas borystehniensis*	33 x 24	Fre	SU	**247**	Rare
Strombomonas acuminata var. *amphora* (Playfair) Deflandre	—	42 x 21	Fre	AS	**28**	Rare
Strombomonas acuminata var. *deflandreana* Conrad	—	28 x 15	Fre	FD	**136**	Rare
				SA	**219**	
Strombomonas inconstans (N.Carter) Deflandre	—	20 x 10	Fre	SA	**216**	Rare
Strombomonas lanceolata (Playfair) Deflandre	*Trachelomonas lanceolata*	31 x 20	Fre	AS	**28**	Rare
				FD	**136**	
Strombomonas napiformis (Playfair) Deflandre	*Trachelomonas napiformis*	40 x 20	Fre	WM	**33**	Rare
Strombomonas praeliaris var. *nana* (Palmer) Deflandre	—	23 x 13	Fre	FD	**135**	Rare
Strombomonas rotunda f. *hortobagyi* Hub.-Pest.	—	35 x 18	Fre	AS	**29**	Rare
Strombomonas subcurvata var. *africana* Bourr. & Gayr.	—	22 x 14	Fre	WM	**31**	Rare
Strombomonas treubii (Wolosz.) Deflandre	*Trachelomonas treubii*	22 x 12	Fre	AK	**3**	Rare
Strombomonas urceolata (A.Stokes) Deflandre	*Trachelomonas urceolata*	41 x 21	Fre	FD	**136**	Rare
Strombomonas aspera (Skvortsov) Deflandre	*Trachelomonas rhombus*	25 x 11	Fre	SA	**233**	Rare
Trachelomonas abrupta f. *angustata* Deflandre	—	30 x 15	Fre	FD	**138**	Rare
Trachelomonas amphora Svirenko	—	20 x 12	Fre	KO	**174**	Rare
Trachelomonas anulifera Hub.-Pest.	—	13 x 12	Fre	SA	**219**	Rare
Trachelomonas bacillifera f. *sparsispina* Deflandre	—	26 x 22	Fre	FD	**133**	Rare
Trachelomonas chodati Skvortsov	—	18 x 10	Fre	FD	**134**	Rare
				SA	**227**	
Trachelomonas columba Palmer	—	27 x 26	Fre	KO	**170, 173**	Rare

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Trachelomonas curta var. *minima* Tell & Zalocar	—	15 x 15	Fre	AS	**23**	Rare
Trachelomonas dangeardii var. *glabra* (Playfair) Deflandre	*Trachelomonas armata* var. *glabra*	27 x 20	Fre	WM	**32**	Rare
Trachelomonas globularis var. *boyeri* (Palmer) Conrad	—	22 x 21	Fre	SA	**227**	Rare
Trachelomonas grandis Kam.P.Singh	—	18 x 16	Fre	FD	**123**	Rare
Trachelomonas granulosa var. *subglobosa* Playfair	—	27 x 23	Fre	SA	**231**	Rare
Trachelomonas hexangulata var. *hexagona* (Oye) Hub.-Pest.	*Trachelomonas hexagona*	26 x 23	Fre	AS	**27**	Rare
Trachelomonas heduma Conrad	—	21 x 18	Fre	SA	**233**	Rare
Trachelomonas horrida Palmer	—	30 x 24	Fre	SE	**236**	Rare
Trachelomonas kelloggii var. *nana* Balech	—	53 x 50	Fre	WM	**41**	Rare
Trachelomonas komarowii Skvortsov	—	18 x 17	Fre	FD	**123**	Rare
Trachelomonas lismorensis var. *inermis* Playfair	—	20 x 16	Fre	FD	**137**	Rare
Trachelomonas perlata Deflandre	—	13 x 11	Fre	SA	**219**	Rare
Trachelomonas pseudofelix Deflandre	—	13 x 12	Fre	SA	**225, 232**	Rare
Trachelomonas oblonga var. *australica* Playfair	*Trachelomonas planctonica* var. *australica*	11 x 10	Fre	SA	**232**	Rare
Trachelomonas obovata var. *klebsiana* Deflandre	*Trachelomonas obovata* f. *klebsiana*	26 x 18	Fre	AK AS FD SA	**10** **24** **124, 133** **219**	Rare
Trachelomonas orenburgika var. *ornata* Skvortsov	—	17 x 14	Fre	FD	**129**	Rare
Trachelomonas stokesiana f. *meandrina* (Conrad) T.G.Popova	*Trachelomonas rugulosa* f. *meandrina*	18 x 17	Fre	SA	**233**	Rare
Trachelomonas rugulosa var. *obliqua* Bourr.	—	18 x 17	Fre	FD	**134**	Rare
Trachelomonas scabra var. *coberensis* Deflandre	—	14 x 13	Fre	SA	**227**	Rare
Trachelomonas scabra var. *ovata* f. *minör* Playfair	—	22 x 16	Fre	FD	**138**	Rare
Trachelomonas sydneyensis var. *minima* Playfair	—	26 x 19	Fre	SA	**216**	Rare
Trachelomonas sydneyensis var. *obesa* Playfair	—	28 x 22	Fre	SA	**224**	Rare
Trachelomonas tuberculata Middelh.	—	10 x 10	Fre	AS	**23**	Rare
Trachelomonas varians f. *globosa* Deflandre	—	16 x 16	Fre	FD	**130**	Rare
Trachelomonas verrucosa f. *irregularis* Deflandre	—	14 x 14	Fre	AS FD SA	**26** **138** **219**	Rare
Trachelomonas verrucosa f. *sparseornata* Deflandre	—	19 x 19	Fre	AK FD	**3** **129**	Rare
Trachelomonas verrucosa var. *macrotuberculata* Grand.	—	24 x 23	Fre	SA	**227**	Rare
Trachelomonas verrucosa var. *spirogyra* (Bal.) Hub.-Pest.	*Trachelomonas spirogyra*	13 x 12	Fre	SA	**219, 227**	Rare
Trachelomonas volvocina var. *derephora* Conrad	*Trachelomonas derephora*	16 x 15	Fre	FD	**137**	Rare
Trachelomonas volvocinopsis var. *khannae* (Skvor.) Bourr.	—	29 x 29	Fre	AS	**27**	Rare
Trachelomonas zorensis Deflandre	—	22 x 16	Fre	AS	**29**	Rare
CHLOROPHYTA						
Acanthosphaera zachariasii Lemmerm.	*Acanthosphaera tenuispina*	8-15 dia	Fre	AS	**24**	Common
Ankistrodesmus stipitatus Komárk.-Legn.	*Ankistrodesmus falcatus* var. *stipitatus*	30–45 x 3–6	Fre	FD	**129**	Common
Aulacomonas submarina Skuja	—	6 x 2	Fre, Mar	SA	**229, 231**	Common
Carteria agloeformis Nygaard	—	10–45 dia	Fre	FD	**138**	Rare
Carteria fritschii H.Takeda	—	6-16 dia	Fre	FD	**133, 138**	Rare
Carteria huberi Christen	—	18-26 x 10-16	Fre, Mar	SA	**227**	Rare

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Carteria lohammari Skuja	—	14-18 x 8-10	Fre	FD	**138**	Rare
Carteria inversa (Korshikov) Bourr.	*Carteria crucifera* var. *inversa*	22-30 x 16-24	Fre	FD	**127, 138**	Rare
				AS	**27**	
Carteria sphaerica Hub.-Pest.	—	13-14 x 9	Fre	SA	**216**	Rare
Carteria stellifera Nygaard	—	8-14 x 10-12	Fre	FD	**130**	Rare
Characium angustum Braun	*Characium apiculatum*	70-170 x 2.5-6	Fre	AK	**4**	Common
Chlamydomonas anglica (G.S. West) Pascher	—	14-20 x 9-13	Fre	SA	**222**	Common
Chlamydomonas bichlora Pascher & Jahoda	—	13-18 x 5-7	Fre	AS	**26**	Rare
				SA	**224**	
Chlamydomonas confinis Skuja	—	13-19 x 9-14	Fre	FD	**137**	Rare
Chlamydomonas conocylindrus Pascher	—	12-17 x 9-12	Fre	SA	**222**	Rare
Chlamydomonas crassa Christen	*Chloromonas crassa*	10-17 x 11-16	Fre	AN	**19**	Rare
Chlamydomonas elegans G.S. West	—	12-14 x 7-10	Fre	SA	**224**	Rare
Chlamydomonas gloeophila Skuja	—	14-17 x 4-6	Fre	AK	**2**	Rare
Chlamydomonas granulosa Skvortsov	—	22 x 12	Fre	WM	**42**	Rare
Chlamydomonas incerta Pascher	*Chlamydomonas incerta* var. *macropyrenoidosa*	27 dia	Fre	SA	**213, 215, 218, 219, 225, 233**	Rare
				AK	**1, 2, 3, 4, 5, 10**	
				FD	**135, 138**	
Chlamydomonas incisa Korshikov	—	24-34 × 10-22	Fre	SA	**231**	Rare
				AK	**3**	
				FD	**136**	
Chlamydomonas klinobasis Skuja	*Chlamydomonadopsis klinorostris*	13-17 x 10-17	Fre	AS	**24**	Rare
Chlamydomonas lapponica Skuja	—	8-10 x 22	Fre	KO	**175**	Rare
Chlamydomonas macroplastida Lund	—	15-25 x 8-17	Fre, Ter	SA	**215**	Rare
				AK	**2**	
Chlamydomonas macropyrenoidosa Skuja	—	12-15 x 8-10	Fre	WM	**33**	Rare
Chlamydomonas metapyrenigera Skuja	—	15-23 x 5-10	Fre	FD	**124, 130**	Rare
Chlamydomonas microsphaerella Pascher & Jahoda	—	12-14 x 6-8	Fre	SA	**220, 229**	Rare
				AK	**2**	
				FD	**130**	
Chlamydomonas nivalis (F.A.Bauer) Wille	*Protococcus nivalis*	12 x 6	Fre, Ter	SA	**215**	Common
				AS	**24**	
Chlamydomonas penium Pascher	—	10-15 x 5-10	Fre	AS	**26**	Rare
Chlamydomonas pulvinata Vischer	—	12-16 x 6-8	Fre	AK	**5**	Rare
Chlamydomonas rhopaloides Korshikov	—	11-13 x 5-8	Fre	SA	**229**	Rare
Chlamydomonas rotifera Gerloff	—	12-16 x 10-12	Fre	WM	**39**	Rare
Chlamydomonas simplex Pascher	—	11-14 x 7-10	Fre	FD	**134**	Rare
Chlamydomonas skujae Pascher	—	5.5-7 x 6-8	Fre	AS	**28**	Rare
Chlamydomonas tremulans Skuja	—	6.5-11.5 x 4-8.5	Fre	WM	**32**	Rare
Chlamydomonas truncata Pascher & Jahoda	—	10-14 x 6-9	Fre	WM	**38**	Rare
Chlamydomonas upsaliensis Skuja	—	10-20 x 11-17	Fre	SA	**215, 225**	Rare
				WM	**32, 42**	
Chlorella chlorelloides (Naumann) C.Bock, Krienitz & Pröschold	*Dictyosphaerium chlorelloides*	3-7 x 2-6	Fre	SU	**246**	Common
				ME	**210**	

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Chlorolobion lunulatum Hindák	*Keratococcus lunulatus*	10 x 2-4	Fre, Ter	AS	**29, 30**	Common
Chloromonas vernalis (Skuja) Nakada	*Chloromonas tapeta* var. *vernalis*	15-25 x 11-24	Fre	SA AK FD	**223** **5** **135**	Rare
Chloromonas vesterbottnica (Skuja) Gerloff & H.Ettl	*Chlamydomonas vesterbottnica*	20-23 x 11-18	Fre	WM	**32**	Rare
Chloromonas westiana (Pascher) Gerloff & Ettl	*Chlamydomonas westiana*	12-14 x 10-12	Fre	AS	**26**	Rare
Coccomonas platyformis Jane	—	12-20 x 16-20	Fre	SA	**229**	Rare
Coenococcus planctonicus Korshikov	*Eutetramorus planctonicus*	5.5-6 dia	Fre	FD AS	**134** **28**	Rare
Desmatractum indutum (Geitler) Pascher	*Calyptobactron indutum*	3-5 x 7-10	Fre	AK AS	**6** **23**	Rare
Desmodesmus abundans var. *brevicauda* (G.M. Sm.) Taskin & Alp	*Scenedesmus subspicatus* var. *brevicauda*	5-7 x 2-3	Fre	EM	**103, 104, 105, 106, 110**	Common
Dicellula geminata (Printz) Korshikov	*Dicellula planctonica*	10-12 x 6-7	Fre	WM AK	**31, 32, 35, 41, 42** **3**	Common
Dictyosphaerium subsolitarium Goor	—	1.5-3 dia	Fre, Mar	SA AK FD	**225, 227, 228, 232** **10** **138**	Common
*Didymocystis inermis (*Fott) Fott	*Scenedesmus inermis*	8-13 x 3-6	Fre	SA AK	**232** **10**	Common
Didymogenes palatina Schmidle	—	6-11 x 1.3-3.7	Fre	AS	**28**	Common
Eutetramorus tetrasporus Komárek	*Coenococcus tetrasporus*	2-3.8 dia	Fre	FD	**127, 130**	Rare
Franceia javanica (C.Bernard) Hortob.	*Chodatella javanica*	4-8 x 3.5-5	Fre	SA	**218**	Rare
Gloeomonas tecta (Skuja) H.Ettl & O.Ettl	*Chlamydomonas tecta*	20-32 x 13-27	Fre	SA	**219**	Rare
Golenkinia brevispina Korshikov	—	11-17 dia	Fre	SA	**220**	Rare
Golenkinia maxima Tiffany & Ahlstrom	—	17- 22 dia	Fre	SA AS	**213** **28**	Rare
Golenkinia viridis (Frenzel) Printz	*Phythelios viridis*	10-12 dia	Fre	WM SA AK	**32** **214, 219** **2, 3, 9**	Rare
Hafniomonas montana (Geitler) Ettl & Moestrup	*Pyramimonas montana*	12-15 x 10-12	Fre	SA	**224, 225, 226**	Rare
Hafniomonas reticulata (Korshikov) Ettl & Moestrup	*Pyramimonas reticulata*	10-12 x 6-9	Fre	SA	**227**	Rare
Hyalogonium elongatum Matv.	—	4-10 x 20-80	Fre	AK	**2**	Rare
Ixipapillifera sacculiformis (Korshikov) Nakada	*Chlamydomonas sacculiformis*	17-24 x 8-14	Fre, Mar	SA	**224**	Rare
Kirchneriella major C.Bernard	*Pseudokirchneriella major*	12-20 x 2.5-6	Fre	WB EM	**47, 50** **103, 104, 110, 111, 112**	Common
Micractinium elongatum (H.J. Carter) Hegew. & Schnepf	*Conococcus elongatus*	6-7 dia	Fre	SA AK	**229** **9**	Rare
Microglena coccifera (Gorosch.) Demchenko, Mikhailyuk & Proschold	*Chlamydomonas coccifera* var. *mesopyrenigera*	22-24 x 19-23	Fre	AS	**27**	Rare
Microspora amoena var. *gracilis* (Wille) De Toni	*Microspora elegans*	6-8 dia	Fre	KO	**172**	Rare
Monoraphidium obtusum (Korshikov) Komárk.-Legn.	*Choricystis obtusa*	32-64 x 4.5- 5	Fre	SA	**223**	Common
Monoraphidium pseudobraunii (Belcher & Swale) Heynig	*Ankistrodesmus pseudobraunii*	10-25 x 1.5-2.5	Fre	SA FD	**219** **129**	Common

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Mucidosphaerium sphagnale (Hindak) C.Bock, Proschold & Krienitz	*Dictyosphaerium sphagnale*	20 dia	Fre	FD	**131**	Rare
Oocystis tainoensis Komárek	—	3.5-9.5 x 2-4.8	Fre	KO	**184**	Rare
Palmococcus hercynicus (H. Heynig) I. Kostikov, T. Darienko, A. Lukesová, & L. Hoffm.	*Coenocystis hercynica*	10-11 x 8-9	Fre, Ter	FD	**137**	Rare
				SA	**216**	
Palmococcus reniformis (Korshikov) I.Kostikov, T.Darienko, A.Lukesová & L.Hoffm.	*Coenocystis reniformis*	10-12.8 x 6-7	Fre	SA	**227**	Common
Papenfussiomonas cordata (Pascher & Jahoda) Desikachary	*Dunaliella cordata*	8-10 x 12-14	Fre	WM	**31**	Rare
Paulschulzia pseudovolvox (P.Schultz) Skuja	*Schulziella pseudovolvox*	40-350 dia	Fre	SA	**224**	Common
Paulschulzia tenera (Korshikov) J.W.G.Lund	*Tetraspora tenera*	6-13 dia	Fre	EB	**119**	Rare
Pediastrum orbitale Komárek	—	7-9 x 9.5-11	Fre	FD	**129**	Rare
Pediastrum ovatum (Ehrenb.) Braun	*Pediastrum simplex* var. *ovatum*	16-57 x 6-38	Fre	SA	**227**	Common
Pediastrum simplex var. *clathratum* Schröt.	—	16-57 x 6-38	Fre	AN	**11**	Common
Phacotus glaber Pochm.	—	40-71 dia	Fre	SA	**231**	Rare
Phyllariochloris caeca (Pascher) Pascher & Jahoda	*Phyllariomonas caeca*	12-14 x 18-26	Fre	FD	**122**	Rare
Planktococcomyxa lacustris (Chodat) Kostikov, Darienko, Lukesová & Hoffm.	*Coccomyxa lacustris*	6.7-8.3 x 2.4-3.5	Fre	FD	**127**	Common
Platymonas cordiformis Korshikov	—	16-23 x 14-20	Fre	WM	**32, 41**	Rare
Podohedriella falcata (Düringer) Hindák	*Podohedra falcata*	30-68 x 1.5-2.5	Fre	KO	**174**	Rare
Pseudodidymocystis fina (Komárek) Hegew. & Deason	*Choricystis fina*	4.3-7 x 1.6-2.8	Fre	SA	**214**	Rare
				FD	**126, 129, 135, 136, 138**	
				AS	**24, 28, 29**	
Pseudopediastrum subgranulatum (Racib.) Lenarczyk	*Pediastrum subgranulatum*	5.5-28.5 x 5-25	Fre	KI	**151**	Common
Pteromonas rugosa Skvortsov	—	12-25 x 10-13	Fre	WM	**42**	Rare
Pyramimonas delicatula B.M.Griffiths	—	12-15 dia	Fre, Mar	WM	**32**	Rare
Pyramimonas inconstans Hodgetts	—	7.5-10 x 10-15	Fre, Mar	SA	**216, 227**	Rare
Pyramimonas splendidissima Pascher	—	5-7 x 10-12	Fre	SA	**216**	Rare
Quadrigula chodatii (Tanner-Füll.) G.M.Sm.	*Gregiochloris chodatii*	30-80 x 3.5-7	Fre	SA	**227**	Common
Quadrigula sabulosa Hindák	—	21 x 1.7-2.3	Fre	FD	**130**	Common
Radiococcus bavaricus (Skuja) Komárek	*Coenochloris bavarica*	6-15 dia	Fre	FD	**129**	Rare
Rayssiella hemisphaerica Edelst. & Prescott	—	15-20 x 6- 10	Fre	WM	**32**	Rare
Scenedesmus aldavei E.H.Hegewald	—	4.4-8.6 x 1.9-4.8	Fre	SA	**212, 216**	Rare
Scenedesmus calyptratus Comas	—	7.4-9.6 x 2-4	Fre	WM	**32, 42**	Rare
				SA	**211, 214, 215, 224, 227, 232**	
				FD	**130, 132, 133, 136**	
				AS	**26**	
Scenedesmus formidolosus Hortob.	—	13.5-16.8 x 4.2	Fre	FD	**138**	Rare
Scenedesmus fusiformis Menegh.	—	13-16 x 3.6-4.5	Fre	WM	**32, 42**	Rare
Scenedesmus gutwinskii var. *bacsensis* Uherk.	—	5.2-13 x 2-4.5	Fre	WM	**32, 33**	Rare
Scenedesmus opoliensis var. *bicaudatus* Hortob.	—	10-21 x 2.7-6.5	Fre	AK	**2, 3**	Rare
Scenedesmus protuberans f. *danubianus* Hortob.	—	11.2-34 x 3.5-7	Fre	AS	**28**	Rare
Scenedesmus protuberans var. *minor* Ley	—	15-30 x 5-9	Fre	AS	**28**	Rare
Scenedesmus pseudoquadricauda Hortob.	—	15-16.5 x 5.4-6.5	Fre	WM	**32**	Rare
Scenedesmus similagineus Hortob.	—	7.5-20 x 4-8	Fre	WM	**32, 41**	Rare
Scenedesmus tibiscensis Uherk.	—	7.5-13 x 3.5-4.5	Fre	KI	**151, 154**	Rare

Table 2. *Continued*

Taxa	Synonym(s)	Dimensions (cell) length x weight or diameter (µm)	Habitat	Basin(s) in Turkey	Lake number*	Distribution in the World**
Schroederia ecsediensis Hortob.	—	15-20 x 1.5-4	Fre	FD	**130**	Rare
Siderocystopsis punctifera (Boloch.) Hegew. & Schnepf	*Siderocystopsis fusca*	6-20 x 4-18	Fre	KO	**175**	Rare
				AS	**28**	
Sorastrum spinulosum Nägeli	*Sorastrum cornutum*	8-20 x 6-18	Fre	AN	**17**	Rare
Sphaerellopsis agloë Pascher	—	5.5-7 x 9-11	Fre	SA	**227**	Rare
Tetraëdron minimum f. *apiculatum* (Reinsch) De Toni	*Polyedrium minimum* f. *apiculata*	6-20 x 5-8	Fre	AS	**23**	Rare
Tetraëdron octaedricum (Reinsch) Hansg.	*Polyedrium octaedricum*	32-47 dia	Fre	FD	**136**	Rare
Tetraëdron octaedricum var. *spinosum* (Reinsch) West & G.S.West	*Polyedrium octaedricum* f. *spinosum*	38 x 47	Fre	WM	**32**	Rare
Tetraëdron trigonum f. *minus-obtusum* (Reinsch) De Toni	—	14-16	Fre	AS	**28**	Rare
Tetraëdron trigonum var. *longispinum* Philipose	—	8-18 x 3-8	Fre	SA	**227**	Rare
Trochiscia granulata (Reinsch) Hansg.	*Acanthococcus granulatus*	8-23 dia	Fre	WB	**49, 55**	Rare
Tetraselmis arnoldii (Proshk.-Lavr.) R.E.Norris, Hori & Chihara	*Platymonas arnoldii*	12-15 x 9.6-12.5	Fre	KO	**174, 181, 184**	Rare
				AN	**12**	
Tetraselmis elliptica (G.M. Sm.) R.E.Norris, Hori & Chihara	*Platymonas elliptica*	7-8 x 4-5	Fre	WM	**36, 42**	Rare
				SA	**221, 222, 227**	
				AK	**5**	
Volvox rousseletii G.S.West	—	16 x 8	Fre	SA	**219**	Rare
Willea crucifera (Wolle) D.M.John, M.J.Wynne & P.M.Tsarenko	*Crucigeniella crucifera*	5-9 x 3-5	Fre	KI	**148**	Common
				WM	**32**	
				SA	**219**	
				CO	**98**	
				FD	**130, 131, 135, 138**	
				AS	**28, 29**	

Note:*Maraşlıoğlu *et al.* (2021)

****Distribution has been evaluated according to AlgaeBase (Guiry and Guiry, 2021)

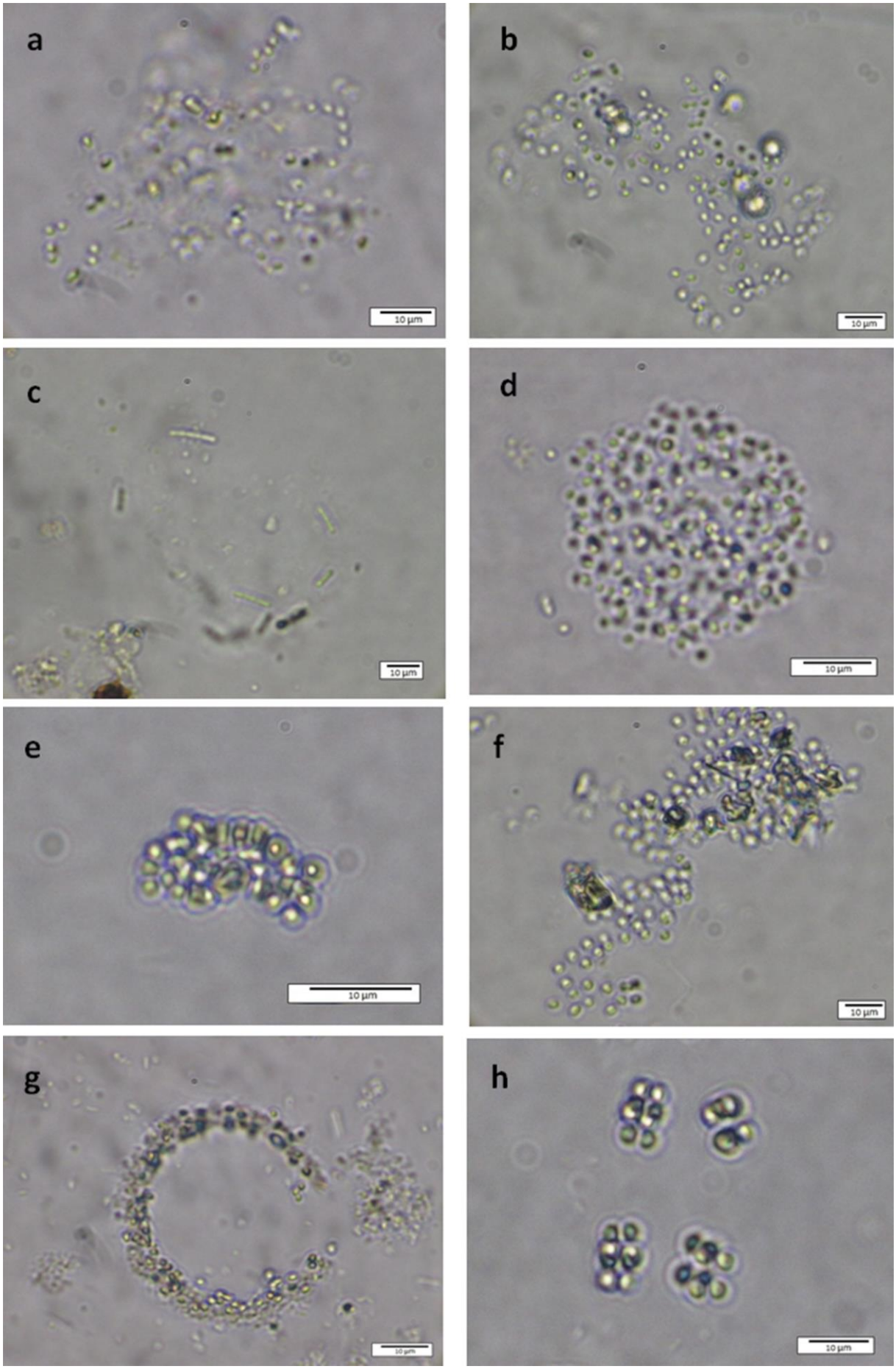

Figure 2. Cyanobacteria; **a)** *Anathece minutissima*, **b)** *Anathece smithii*, **c)** *Rhabdoderma lineare*, **d)** *Aphanocapsa conferta*, **e)** *Aphanocapsa nubila*, **f)** *Aphanocapsa planctonica*, **g)** *Pannus spumosus*, **h)** *Merismopedia hyalina*, (Scale 10 µm).

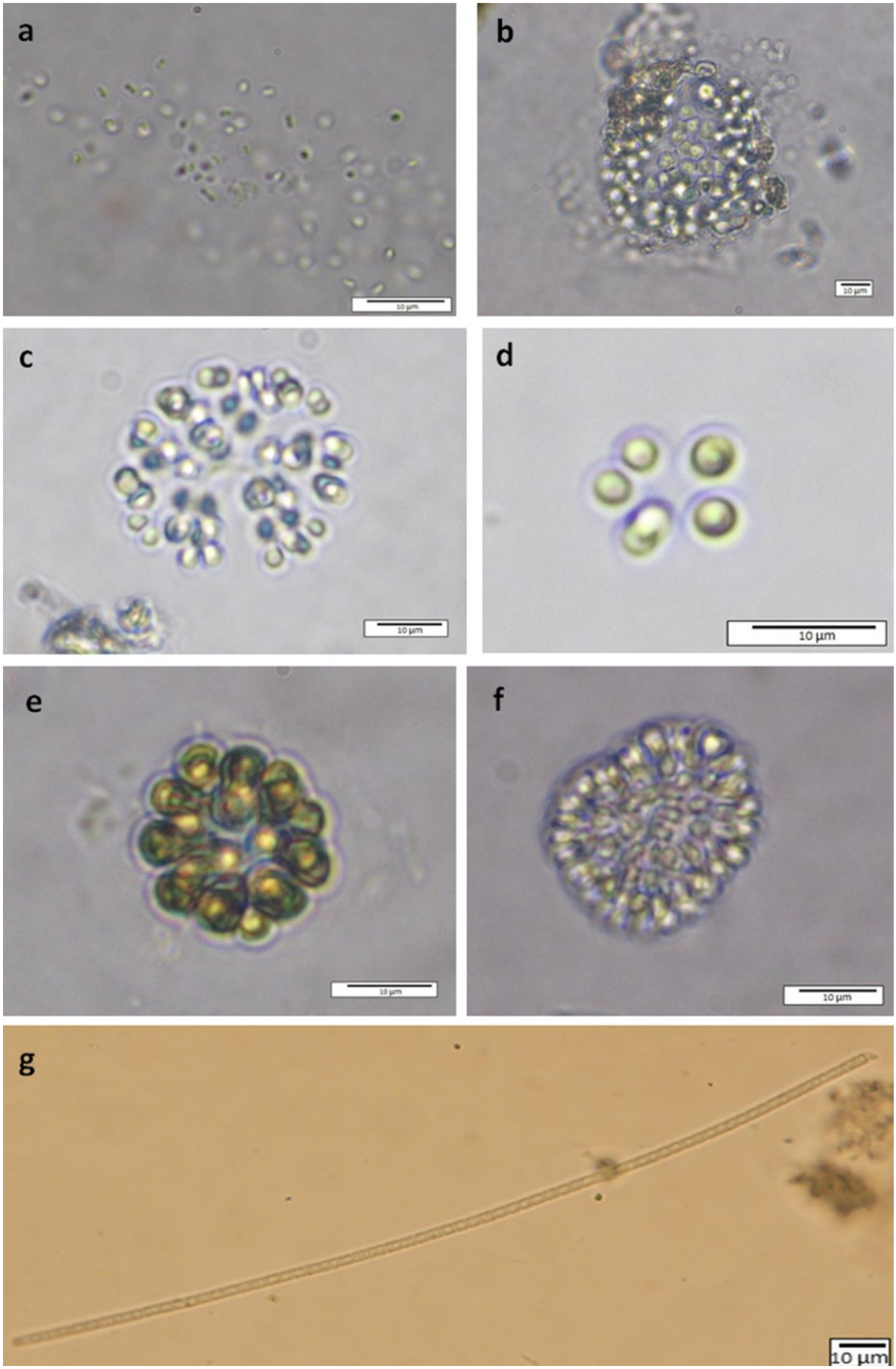

Figure 3. Cyanobacteria; **a)** *Synechocystis parvula*, **b)** *Coelosphaerium aerugineum*, **c)** *Snowella fennica*, **d)** *Snowella litoralis*, **e)** *Woronichinia botrys*, **f)** *Woronichinia karelica*, **g)** *Leptolyngbya ectocarpi*, (Scale 10 µm).

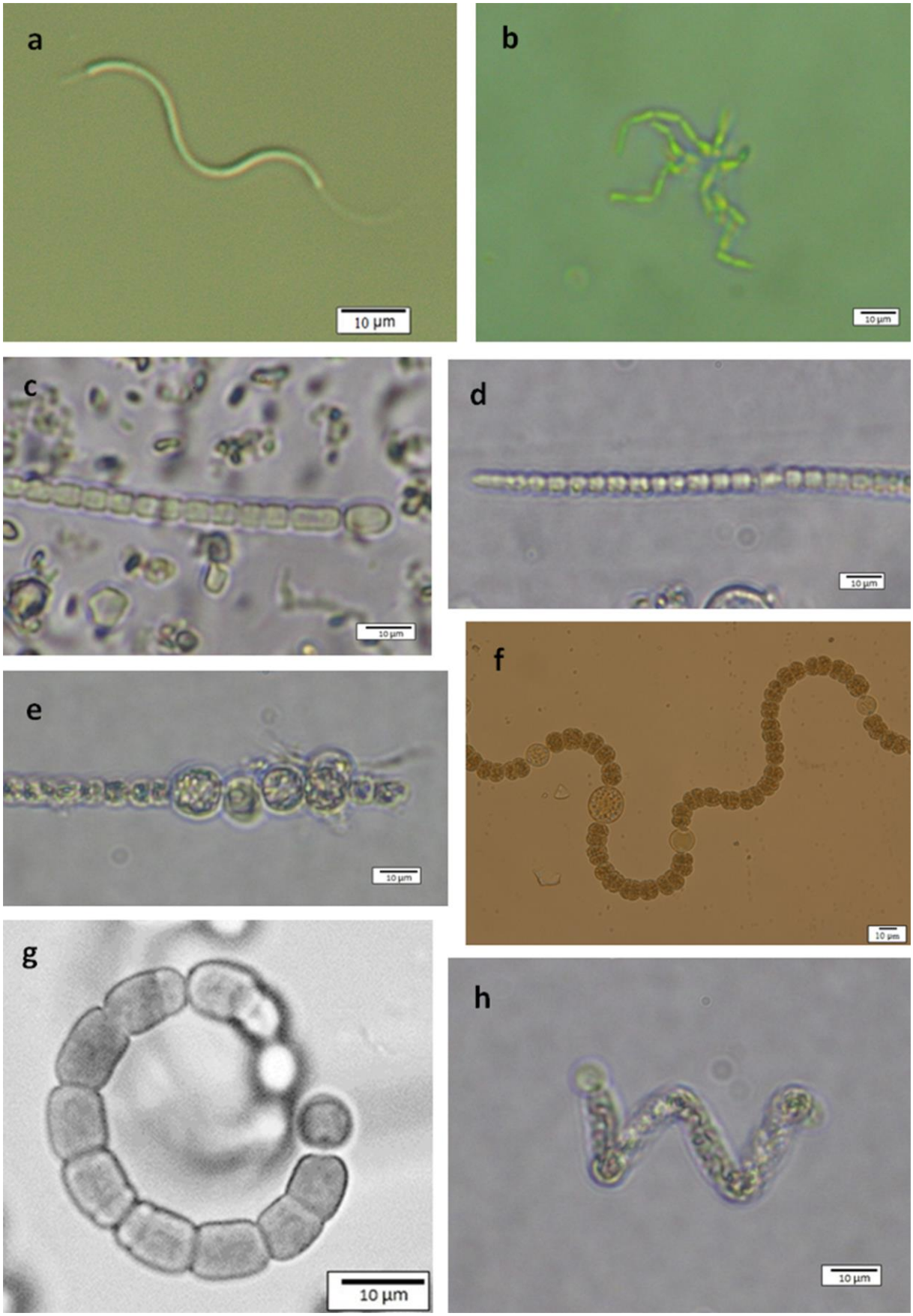

Figure 4. Cyanobacteria; **a)** *Planktolyngbya microspira,* **b)** *Romeria gracilis,* **c)** *Anabaena laxa*, **d)** *Anabaena oblonga,* **e)** *Anabaena sphaerica* var. *attenuata*, **f)** *Nostoc caeruleum*, **g)** *Anabaenopsis milleri,* **h)** *Anabaenopsis rippkae*, (Scale 10 µm).

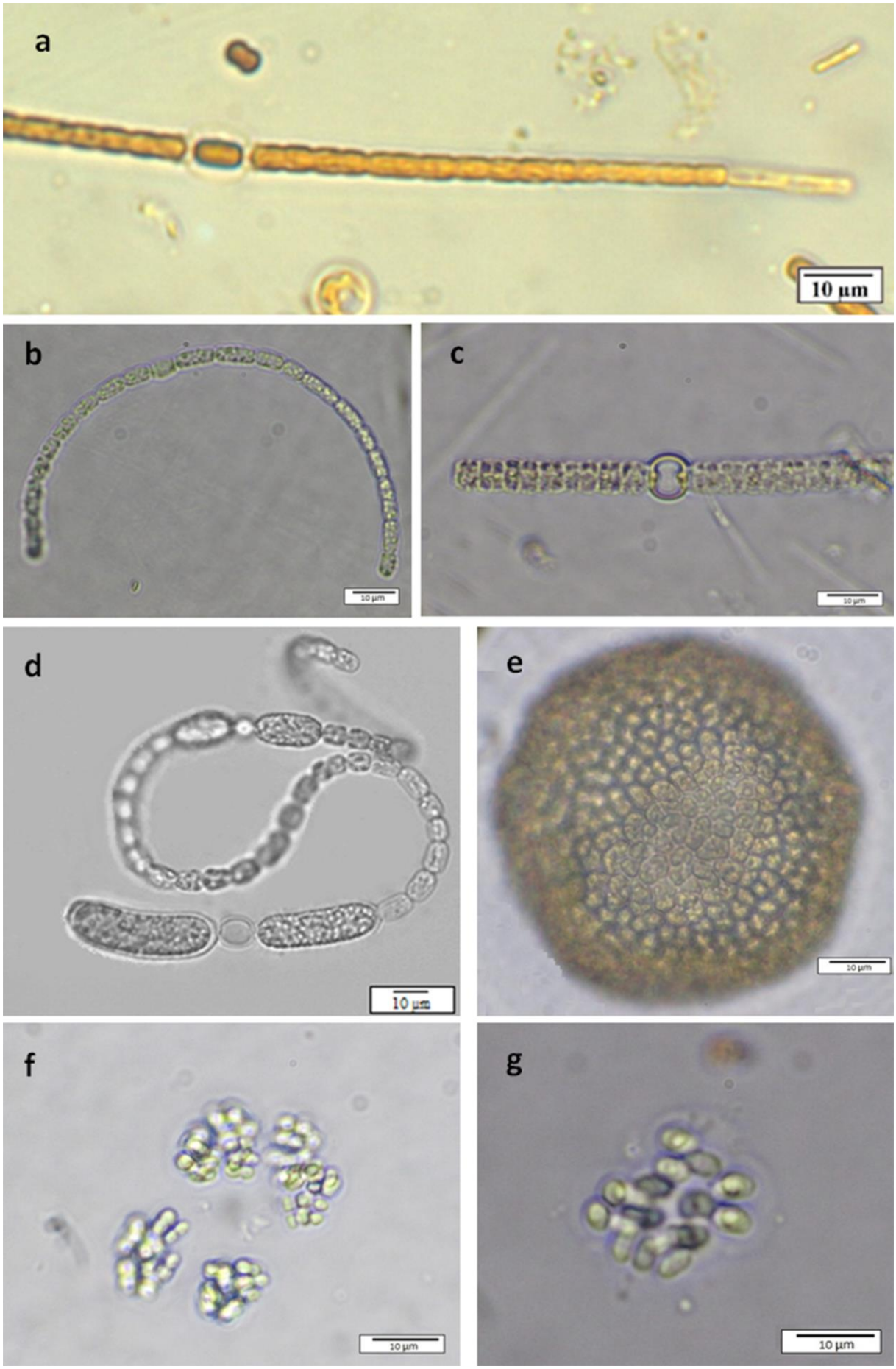

Figure 5. Cyanobacteria; **a)** *Aphanizomenon klebahnii*, **b)** *Dolichospermum fallax*, **c)** *Nodularia sphaerocarpa,* **d)** *Dolichospermum lemmermannii*, **e)** *Pulvinularia suecica*, **f)** *Aphanothece atrocrustacea,* **g)** *Aphanothece comasii*, (Scale 10 µm).

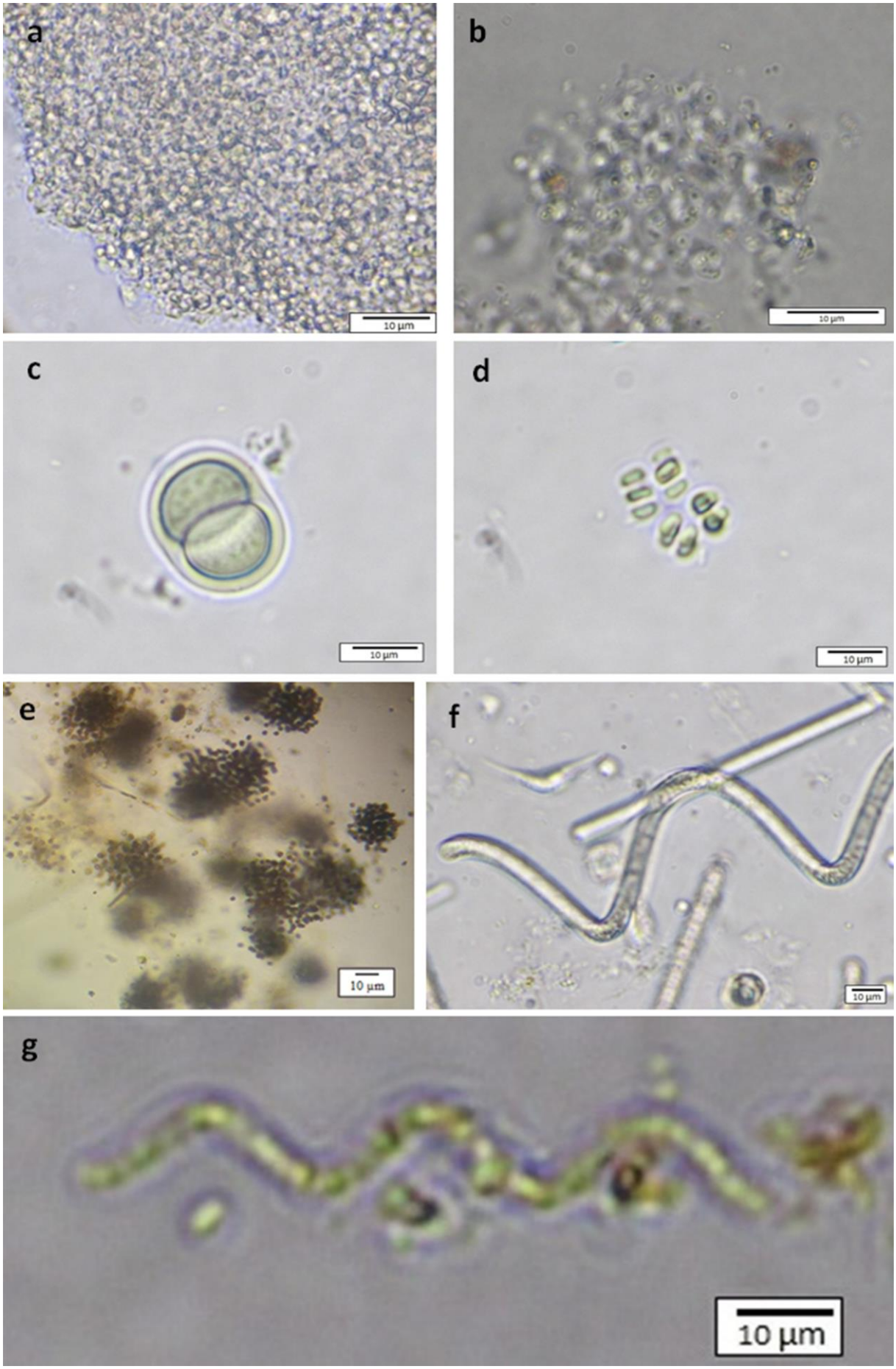

Figure 6. Cyanobacteria; **a)** *Aphanothece floccosa*, **b)** *Gloeothece subtilis*, **c)** *Chroococcus lithophilus*, **d)** *Chroococcus mipitanensis*, **e)** *Microcystis botrys*, **f)** *Arthrospira platensis* var. *non-constricta*, **g)** *Limnospira fusiformis*, (Scale 10 µm).

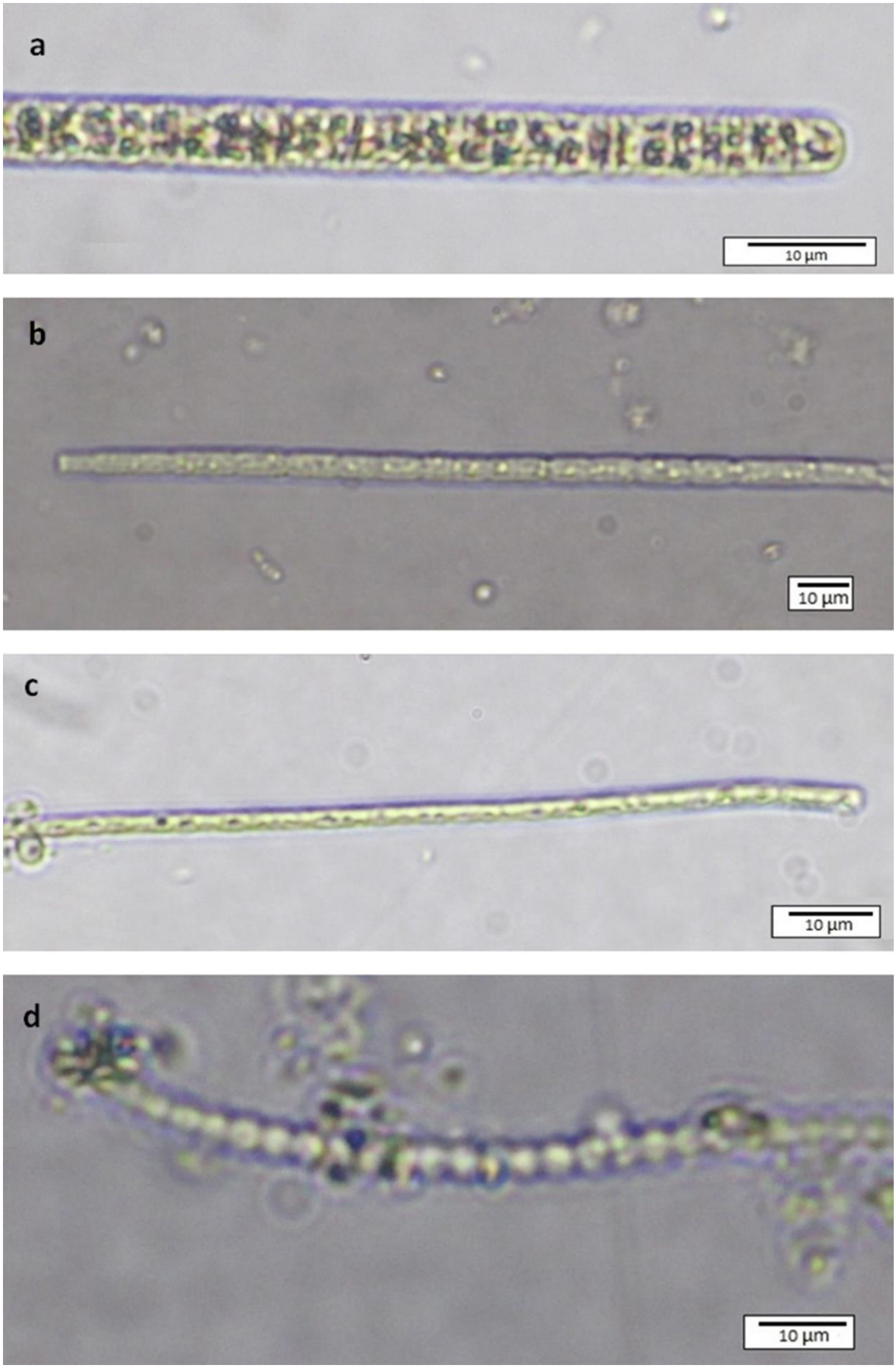

Figure 7. Cyanobacteria; **a)** *Planktothrix isothrix,* **b)** *Oscillatoria chlorina* f. *perchlorina*, **c)** *Oscillatoria trichoides*, **d)** *Phormidium schultzii*, (Scale 10 µm).

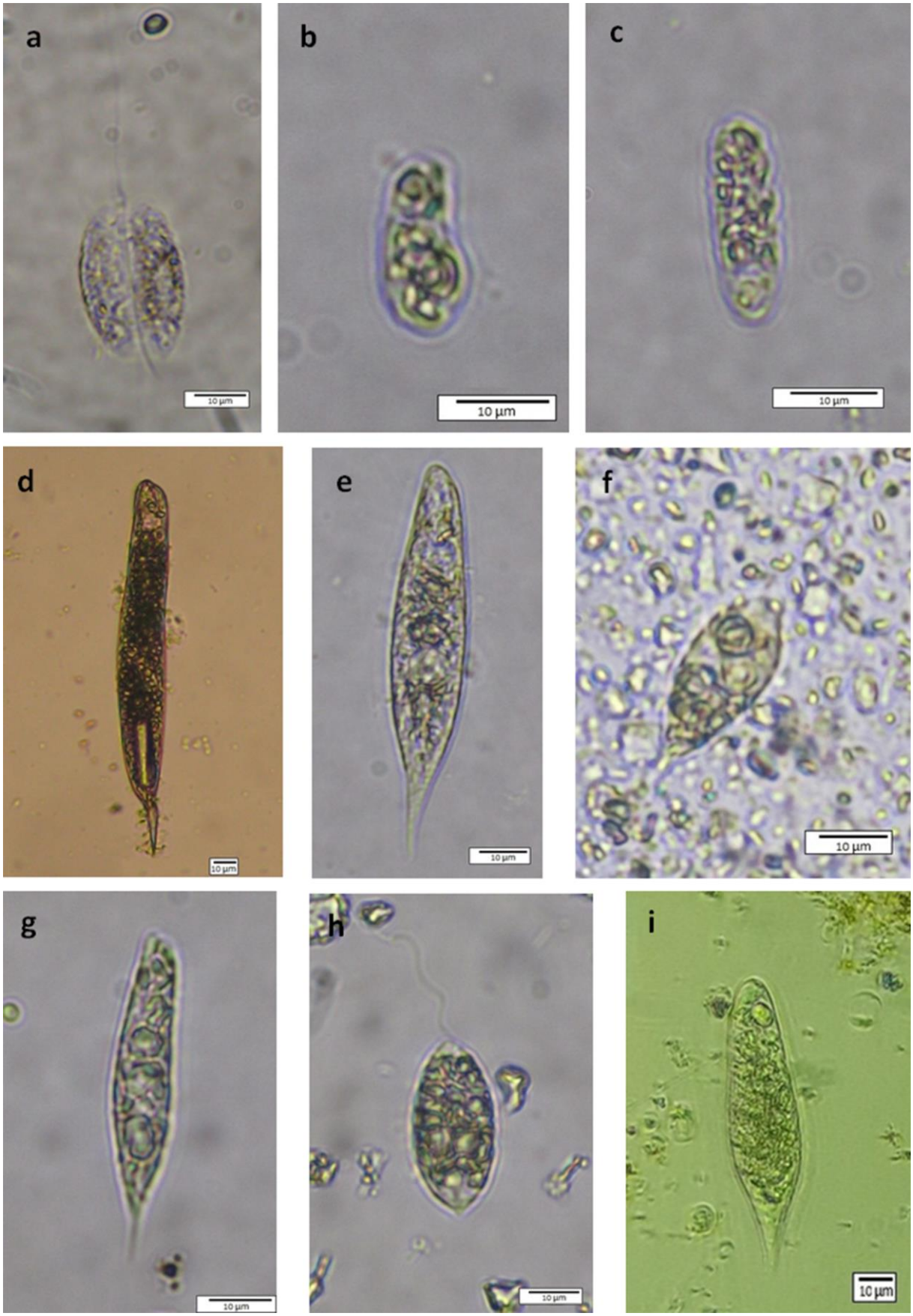

Figure 8. Euglenozoa; **a)** *Anisonema prosgeobium*, **b)** *Astasia cylindrica*, **c)** *Astasia thiophila*, **d)** *Euglena antefossa*, **e)** *Euglena gracilis* var. *urophora*, **f)** *Euglena mainxii*, **g)** *Euglena rostrata*, **h)** *Euglena sacculiformis*, **i)** *Euglena velata*, (Scale 10 µm).

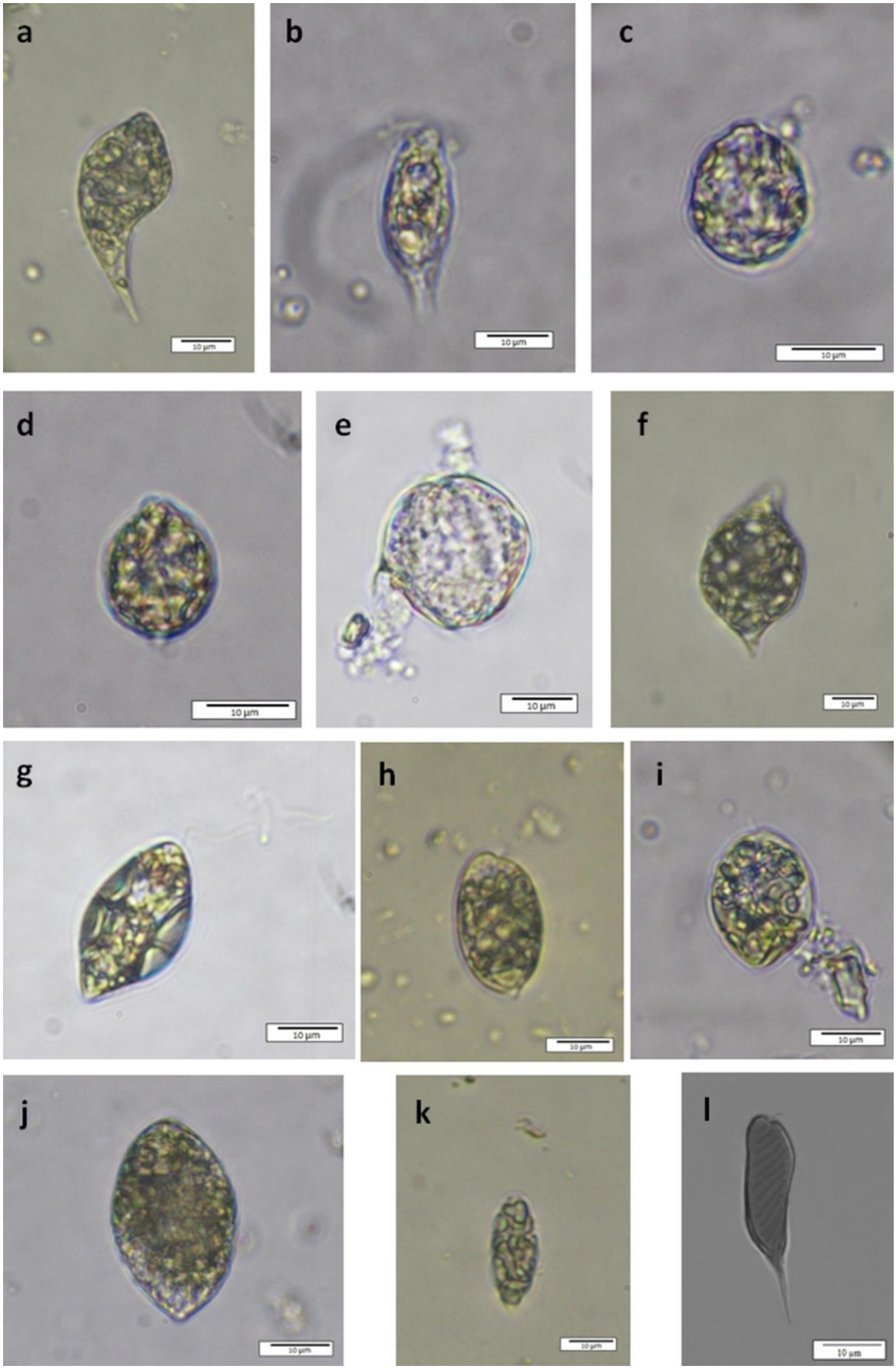

Figure 9. Euglenozoa; **a)** *Euglenaria anabaena*, **b)** *Euglenopsis vacuolata*, **c)** *Lepocinclis conica*, **d)** *Lepocinclis fusiformis* var. *amphirhynchus*, **e)** *Lepocinclis lobata*, **f)** *Lepocinclis nayalii*, **g)** *Lepocinclis ovum* var. *angustatum*, **h)** *Lepocinclis ovum* var. *dimidio-minor*, **i)** *Lepocinclis teres* f. *parvula*, **j)** *Lepocinclis texta* var. *mammillata*, **k)** *Menoidium semilunare* var. *regulare*, **l)** *Monomorphina aenigmatica*, (Scale 10 µm).

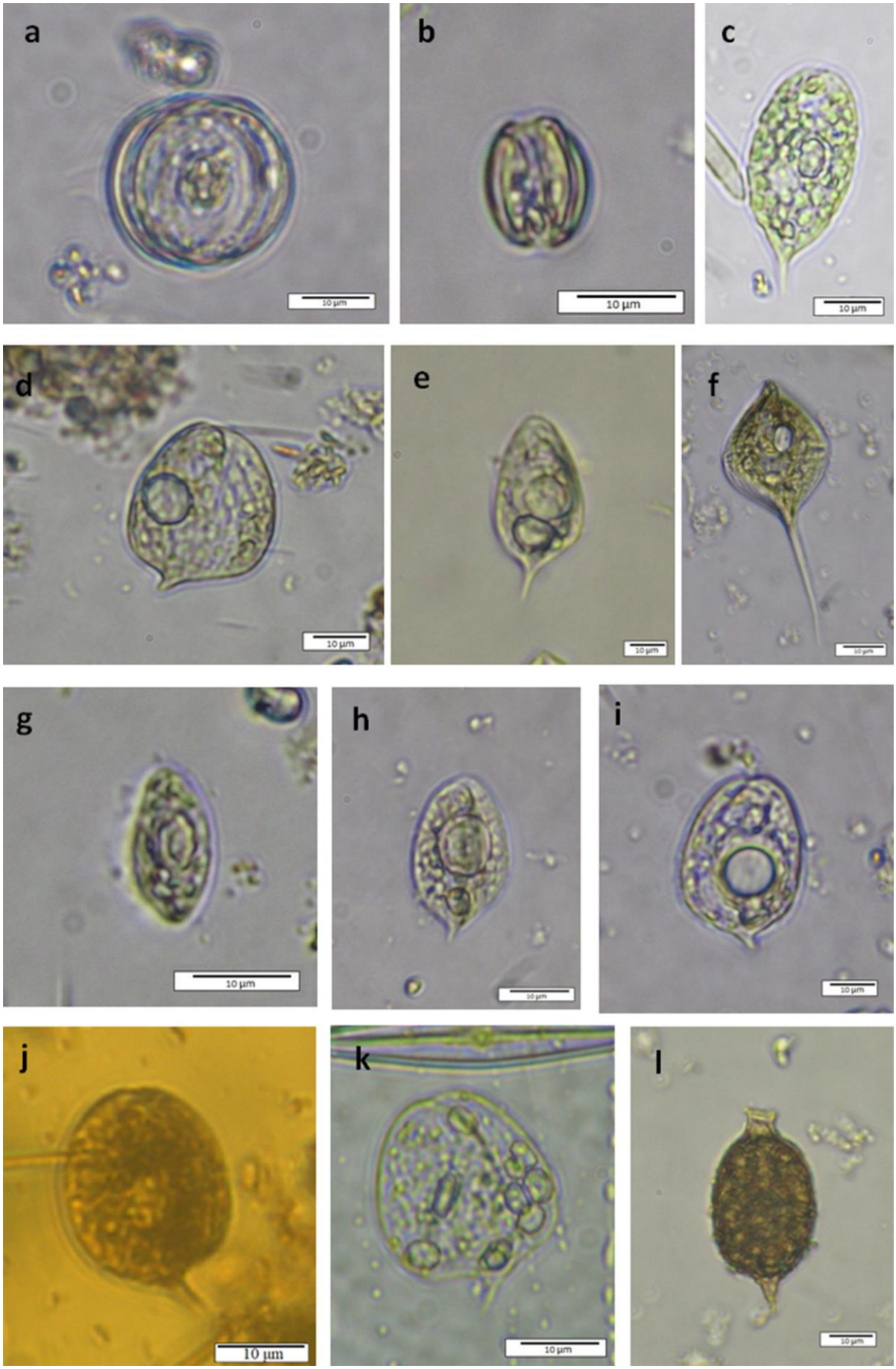

Figure 10. Euglenozoa; **a)** *Petalomonas applanata*, **b)** *Phacus agilis* var. *inversus*, **c)** *Phacus applanatus*, **d)** *Phacus carinatus*, **e)** *Phacus caudatus*, **f)** *Phacus circumflexus*, **g)** *Phacus dangeardii*, **h)** *Phacus formosus*, **i)** *Phacus minutus*, **j)** *Phacus swirenkoi*, **k)** *Phacus tortuosus*, **l)** *Strombomonas acuminata* var. *amphora*, (Scale 10 µm).

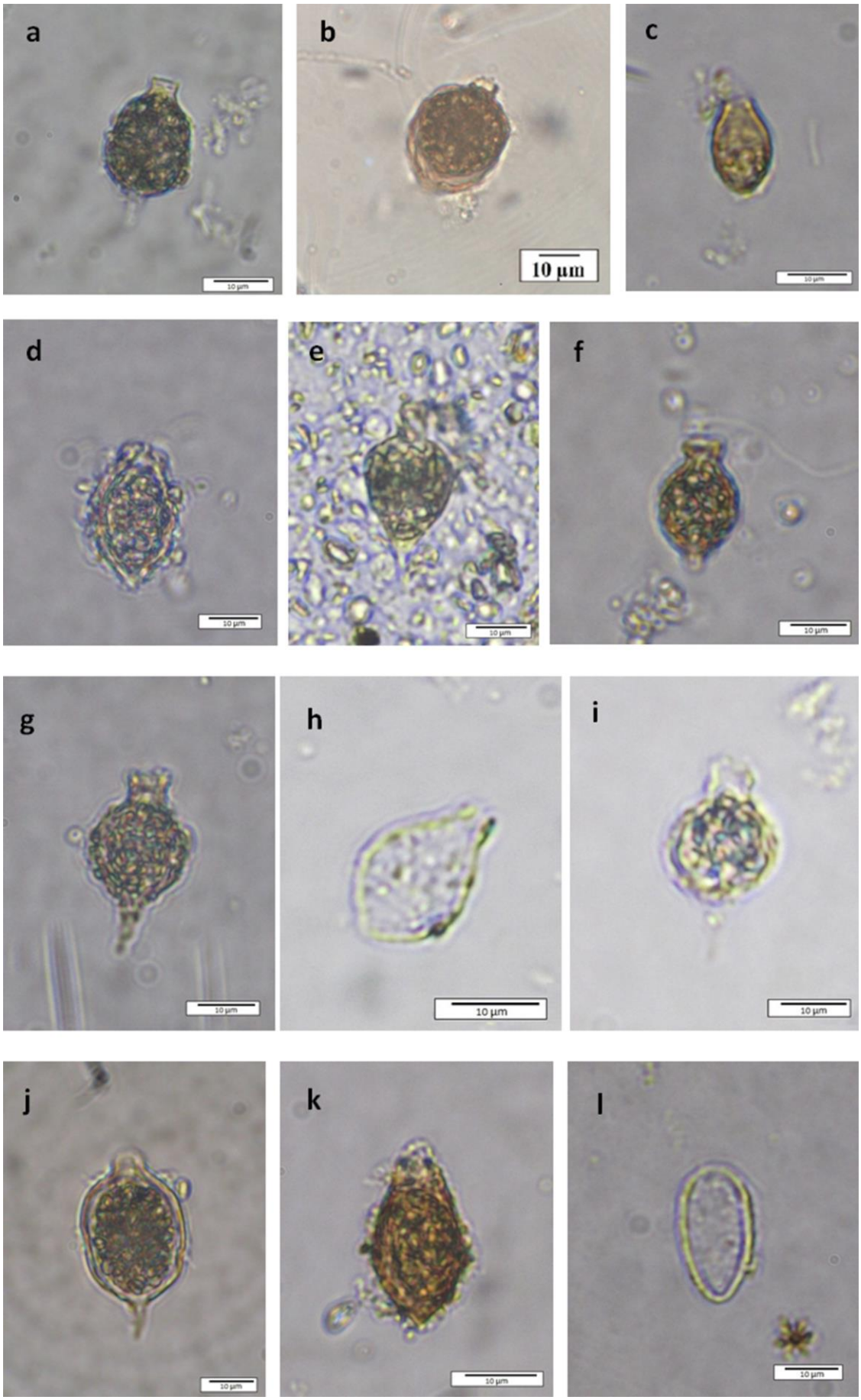

Figure 11. Euglenozoa; **a)** *Strombomonas acuminata* var. *deflandreana*, **b)** *Strombomonas borystehniensis*, **c**) *Strombomonas inconstans*, **d)** *Strombomonas lanceolata*, **e)** *Strombomonas napiformis*, **f)** *Strombomonas praeliaris* var. *nana*, **g)** *Strombomonas rotunda* f. *hortobagyi*, **h)** *Strombomonas subcurvata* var. *africana*, **i)** *Strombomonas treubii*, **j)** *Strombomonas urceolata*, **k)** *Strombomonas aspera*, **l)** *Trachelomonas abrupta* f. *angustata*, (Scale 10 µm).

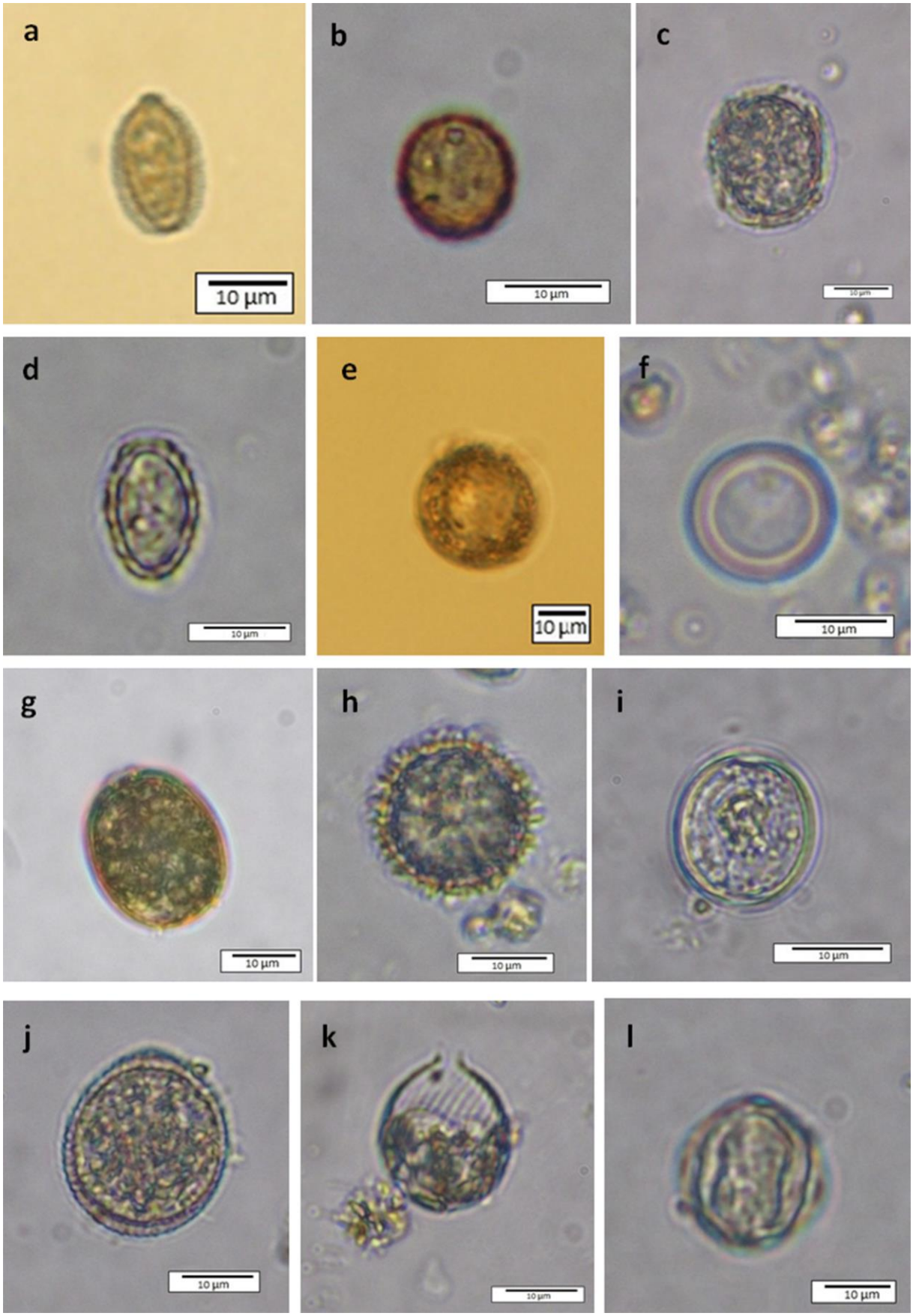

Figure 12. Euglenozoa; **a)** *Trachelomonas amphora*, **b)** *Trachelomonas anulifera*, **c)** *Trachelomonas bacillifera* f. *sparsispina*, **d)** *Trachelomonas chodati*, **e)** *Trachelomonas columba*, **f)** *Trachelomonas curta* var. *minima*, **g)** *Trachelomonas dangeardii* var. *glabra*, **h)** *Trachelomonas globularis* var. *boyeri*, **i)** *Trachelomonas grandis*, **j)** *Trachelomonas granulosa* var. *subglobosa*, **k)** *Trachelomonas heduma*, **l)** *Trachelomonas hexangulata* var. *hexagona*, (Scale 10 µm)

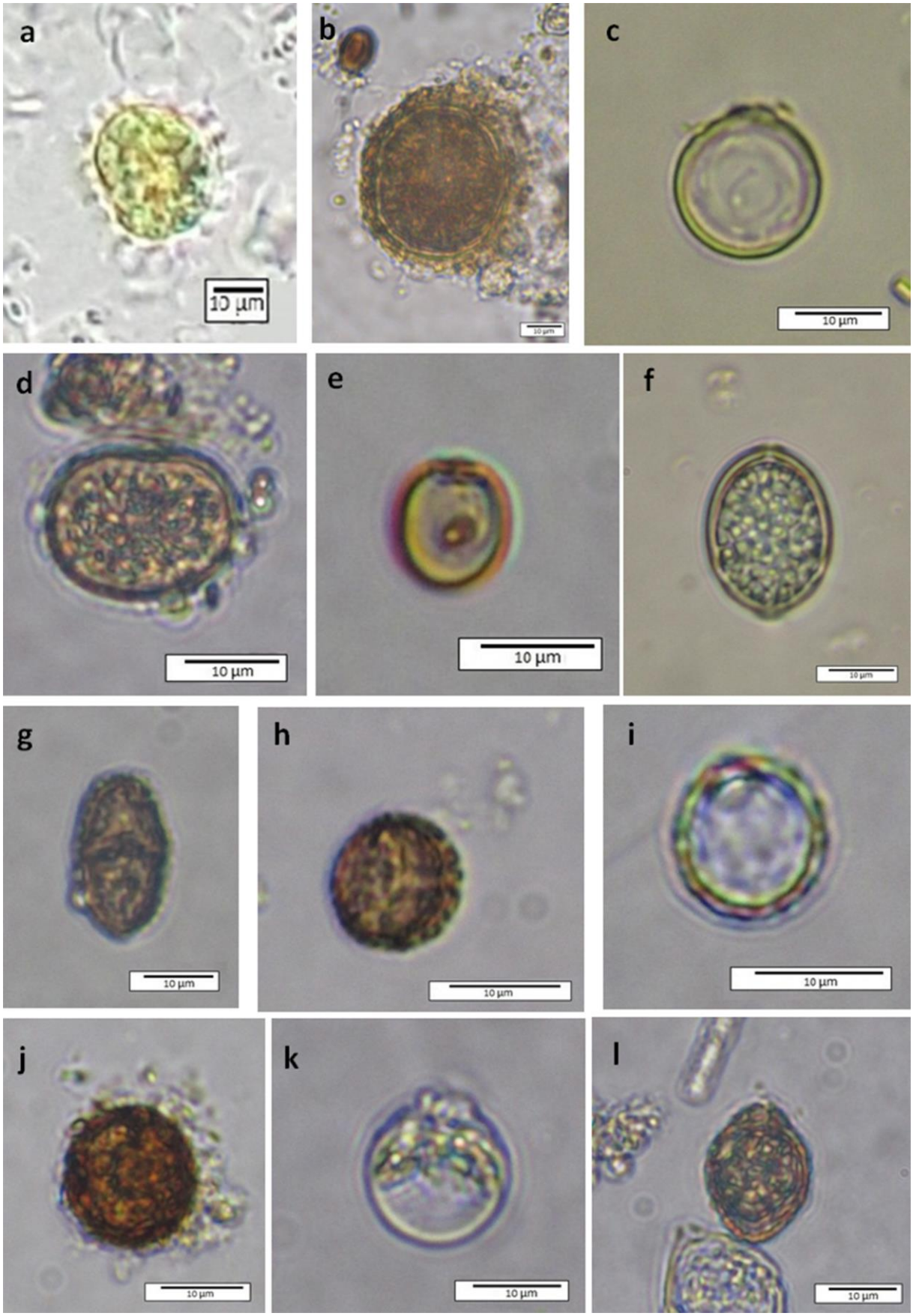

Figure 13. Euglenozoa; **a)** *Trachelomonas horrida*, **b)** *Trachelomonas kelloggii* var. *nana*, **c)** *Trachelomonas komarowii*, **d)** *Trachelomonas lismorensis* var. *inermis*, **e)** *Trachelomonas oblonga* var. *australica*, **f)** *Trachelomonas obovata* var. *klebsiana*, **g)** *Trachelomonas orenburgika* var. *ornata*, **h)** *Trachelomonas perlata*, **i)** *Trachelomonas pseudofelix*, **j)** *Trachelomonas stokesiana* f. *meandrina*, **k)** *Trachelomonas rugulosa* var. *obliqua*, **l)** *Trachelomonas scabra* var. *ovata* f. *minör*, (Scale 10 µm).

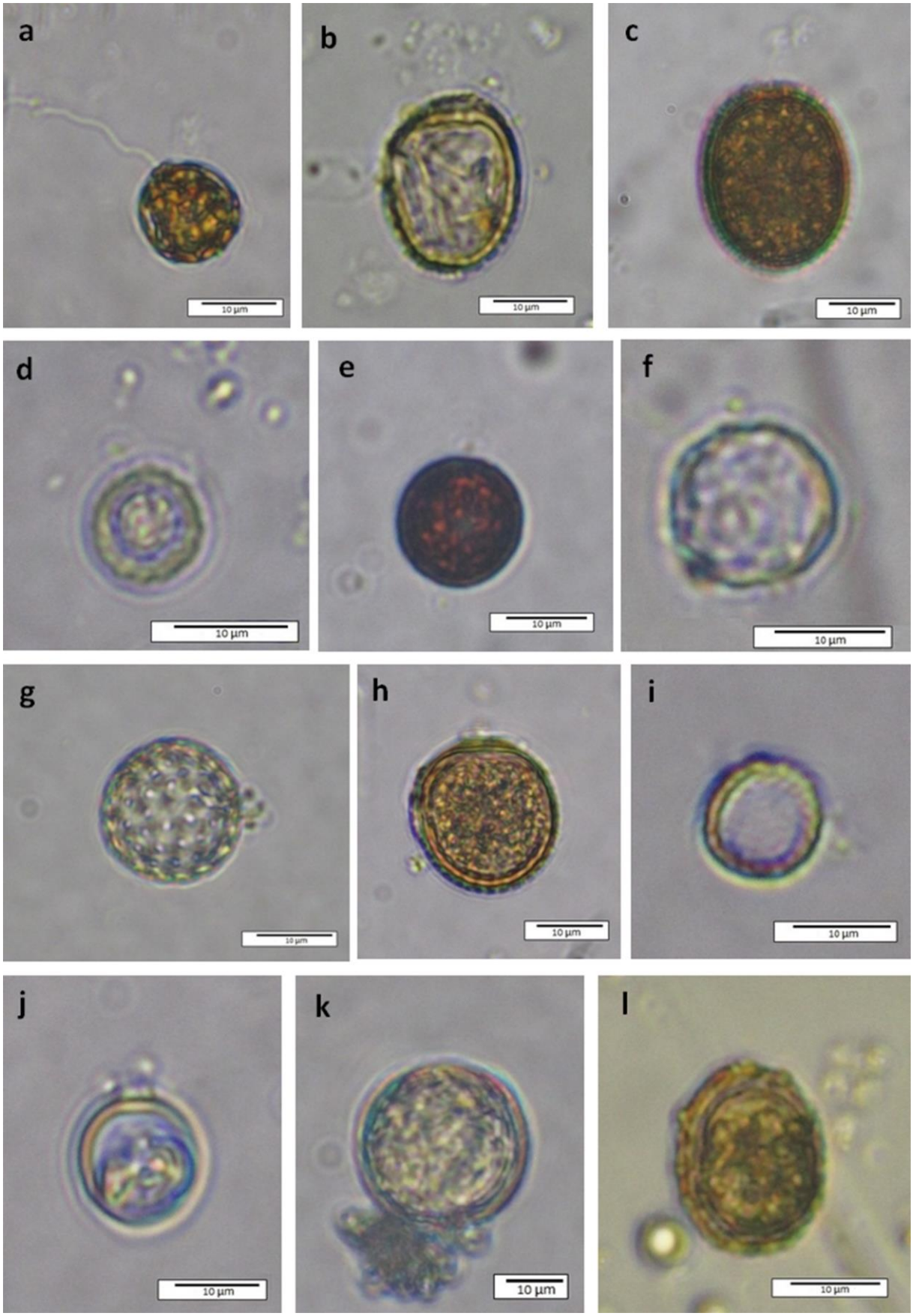

Figure 14. Euglenozoa; **a)** *Trachelomonas scabra* var. *coberensis*, **b)** *Trachelomonas sydneyensis* var. *minima*, **c)** *Trachelomonas sydneyensis* var. *obesa*, **d)** *Trachelomonas tuberculata*, **e)** *Trachelomonas varians* f. *globosa*, **f)** *Trachelomonas verrucosa* f. *irregularis*, **g)** *Trachelomonas verrucosa* f. *sparseornata*, **h)** *Trachelomonas verrucosa* var. *macrotuberculata*, **i)** *Trachelomonas verrucosa* var. *spirogyra*, **j)** *Trachelomonas volvocina* var. *derephora*, **k)** *Trachelomonas volvocinopsis* var. *khannae*, **l)** *Trachelomonas zorensis*, (Scale 10 µm).

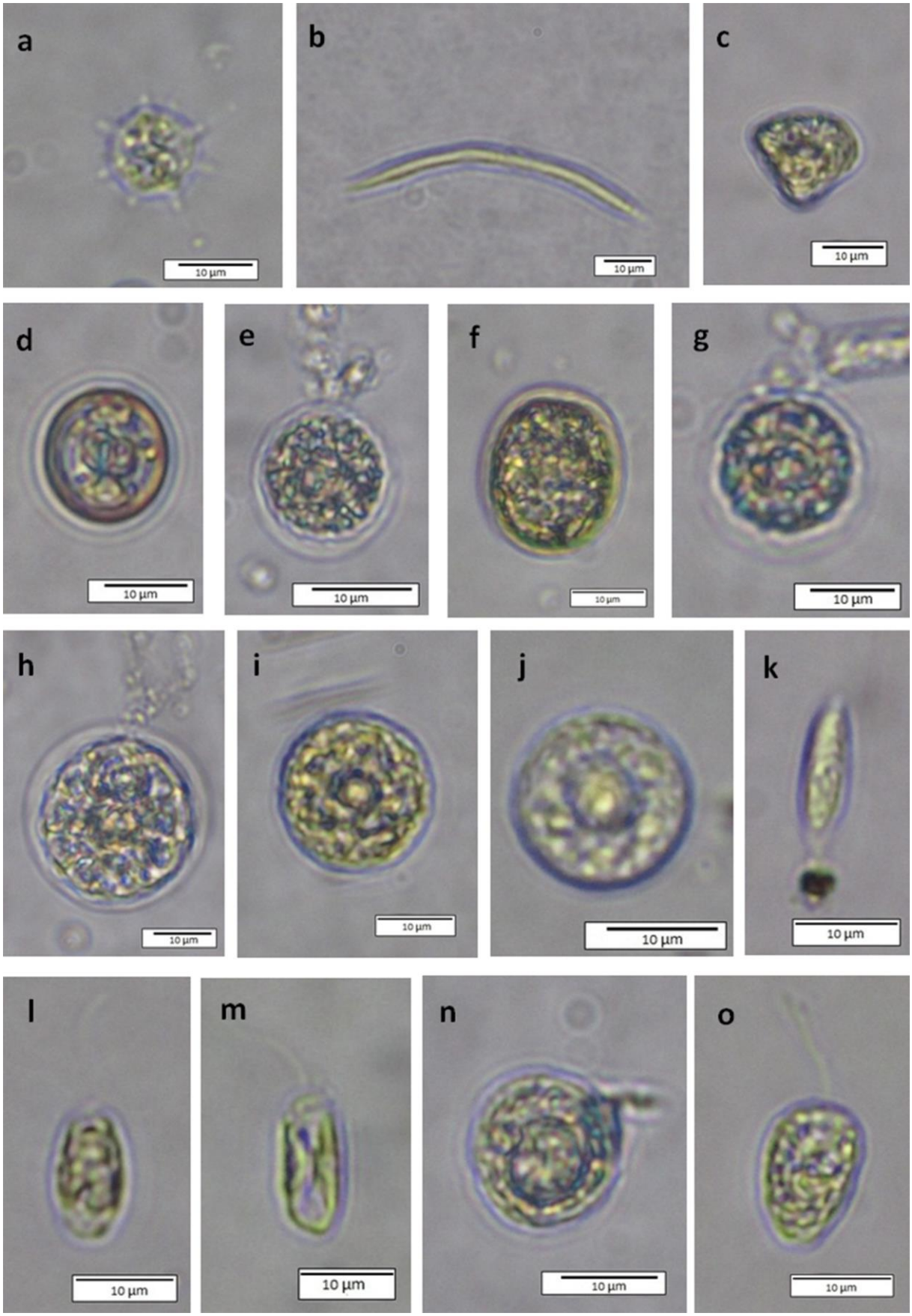

Figure 15. Chlorophyta; **a)** *Acanthosphaera zachariasii,* **b)** *Ankistrodesmus stipitatus,* **c)** *Aulacomonas submarina,* **d)** *Carteria agloeformis*, **e)** *Carteria fritschii,* **f)** *Carteria huberi,* **g)** *Carteria inversa,* **h)** *Carteria lohammari,* **i)** *Carteria sphaerica,* **j)** *Carteria stellifera,* **k)** *Characium angustum,* **l)** *Chlamydomonas anglica,* **m)** *Chlamydomonas bichlora,* **n)** *Chlamydomonas confinis,* **o)** *Chlamydomonas conocylindrus*, (Scale 10 µm).

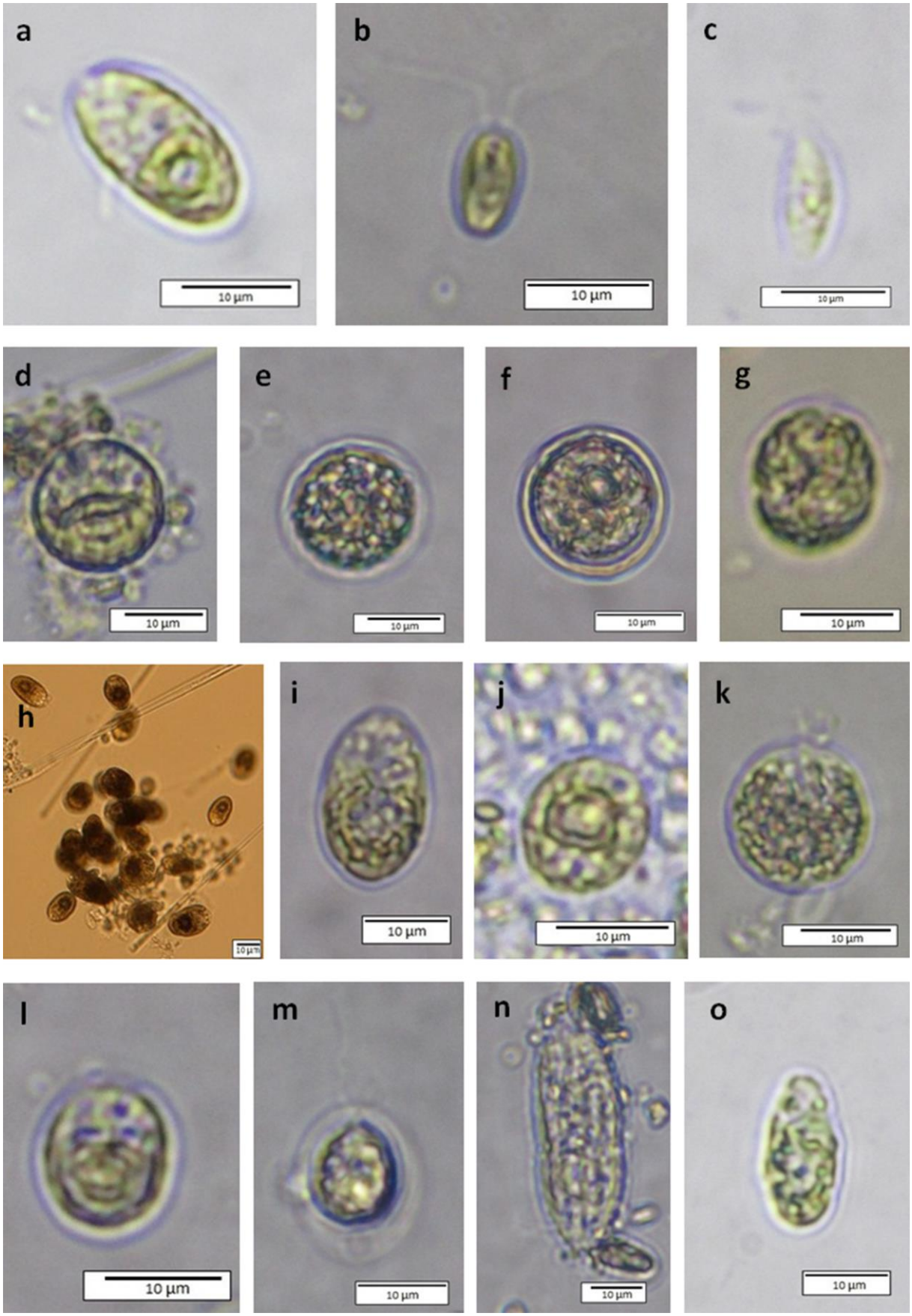

Figure 16. Chlorophyta; **a)** *Chlamydomonas crassa,* **b)** *Chlamydomonas elegans,* **c)** *Chlamydomonas gloeophila*, **d)** *Chlamydomonas granulosa,* **e)** *Chlamydomonas incerta,* **f)** *Chlamydomonas incisa,* **g)** *Chlamydomonas klinobasis,* **h)** *Chlamydomonas lapponica,* **i)** *Chlamydomonas macroplastida,* **j)** *Chlamydomonas macropyrenoidosa,* **k)** *Chlamydomonas metapyrenigera,* **l)** *Chlamydomonas microsphaerella,* **m)** *Chlamydomonas nivalis,* **n)** *Chlamydomonas penium,* **o)** *Chlamydomonas pulvinata*, (Scale 10 µm).

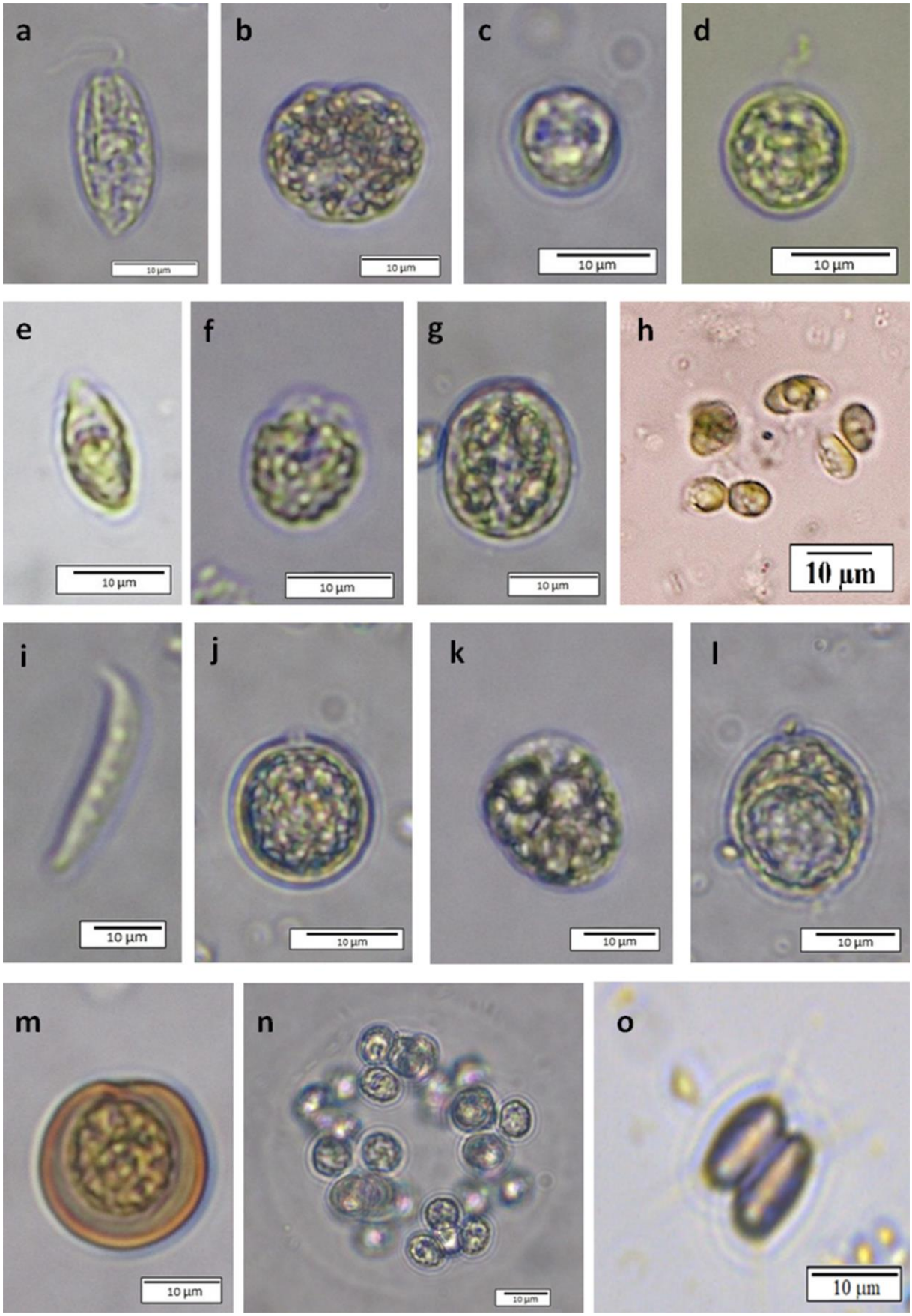

Figure 17. Chlorophyta; **a)** *Chlamydomonas rhopaloides,* **b)** *Chlamydomonas rotifera,* **c)** *Chlamydomonas simplex,* **d)** *Chlamydomonas skujae,* **e)** *Chlamydomonas tremulans,* **f)** *Chlamydomonas truncata,* **g)** *Chlamydomonas upsaliensis,* **h)** *Chlorella chlorelloides*, **i)** *Chlorolobion lunulatum,* **j)** *Chloromonas vernalis,* **k)** *Chloromonas vesterbottnica,* **l)** *Chloromonas westiana,* **m)** *Coccomonas platyformis,* **n)** *Coenococcus planctonicus,* **o)** *Desmodesmus abundans* var. *brevicauda,* (Scale 10 µm).

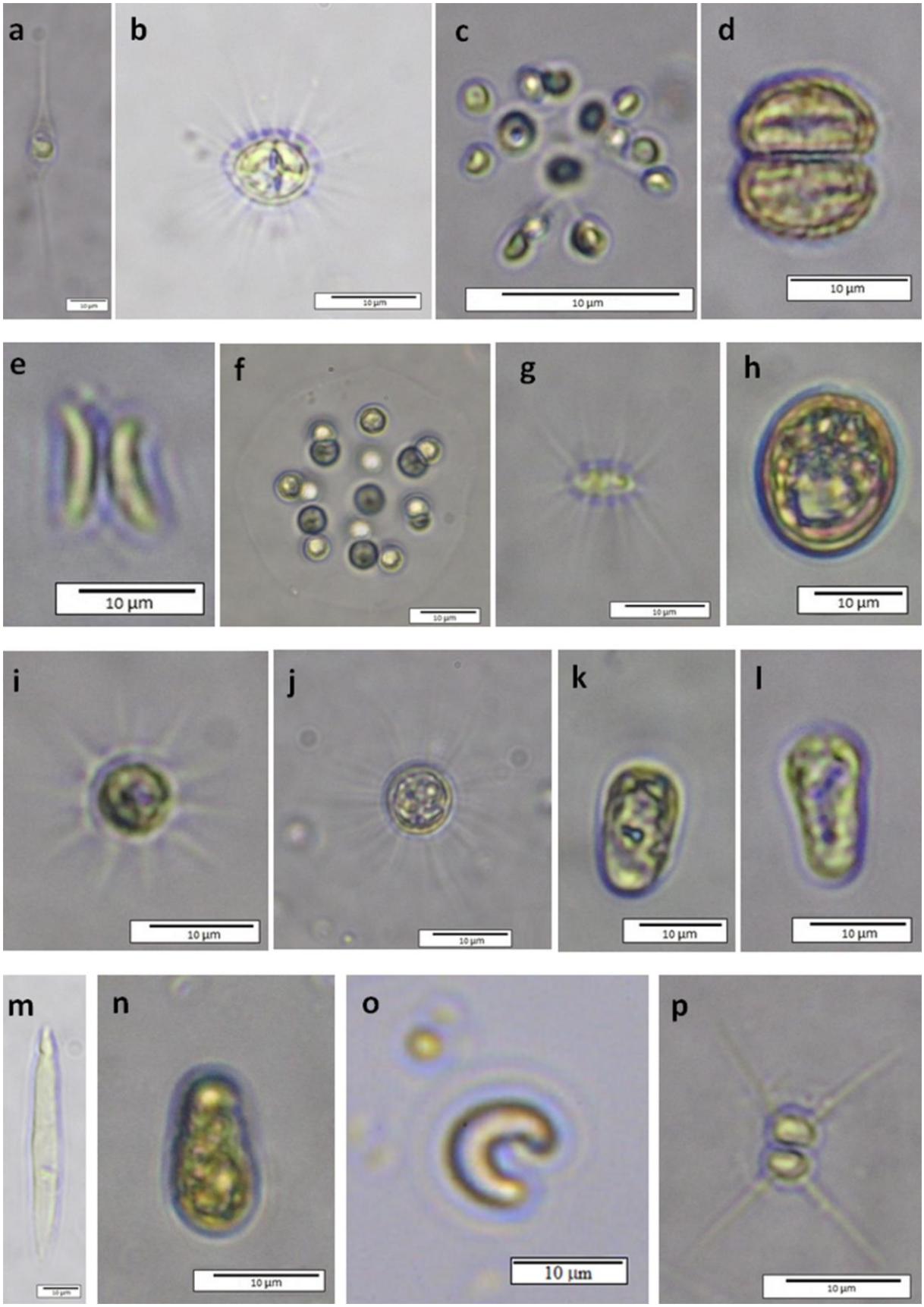

Figure 18. Chlorophyta; **a)** *Desmatractum indutum* **b)** *Dicellula geminata,* **c)** *Dictyosphaerium subsolitarium,* **d)** *Didymocystis inermis,* **e)** *Didymogenes palatina,* **f)** *Eutetramorus tetrasporus,* **g)** *Franceia javanica,* **h)** *Gloeomonas tecta,* **i)** *Golenkinia brevispina,* **j)** *Golenkinia maxima,* **k)** *Hafniomonas montana,* **l)** *Hafniomonas reticulata*, **m)** *Hyalogonium elangatum,* **n)** *Ixipapillifera sacculiformis,* **o)** *Kirchneriella major,* **p)** *Micractinium elongatum,* (Scale 10 µm).

Figure 19. Chlorophyta; **a)** *Microglena coccifera,* **b)** *Microspora amoena* var. *gracilis,* **c)** *Monoraphidium obtusum,* **d)** *Monoraphidium pseudobraunii,* **e)** *Mucidosphaerium sphagnale,* **f)** *Oocystis tainoensis,* **g)** *Palmococcus hercynicus,* **h)** *Palmococcus reniformis,* **i)** *Papenfussiomonas cordata,* **j)** *Paulschulzia pseudovolvox*, (Scale 10 µm).

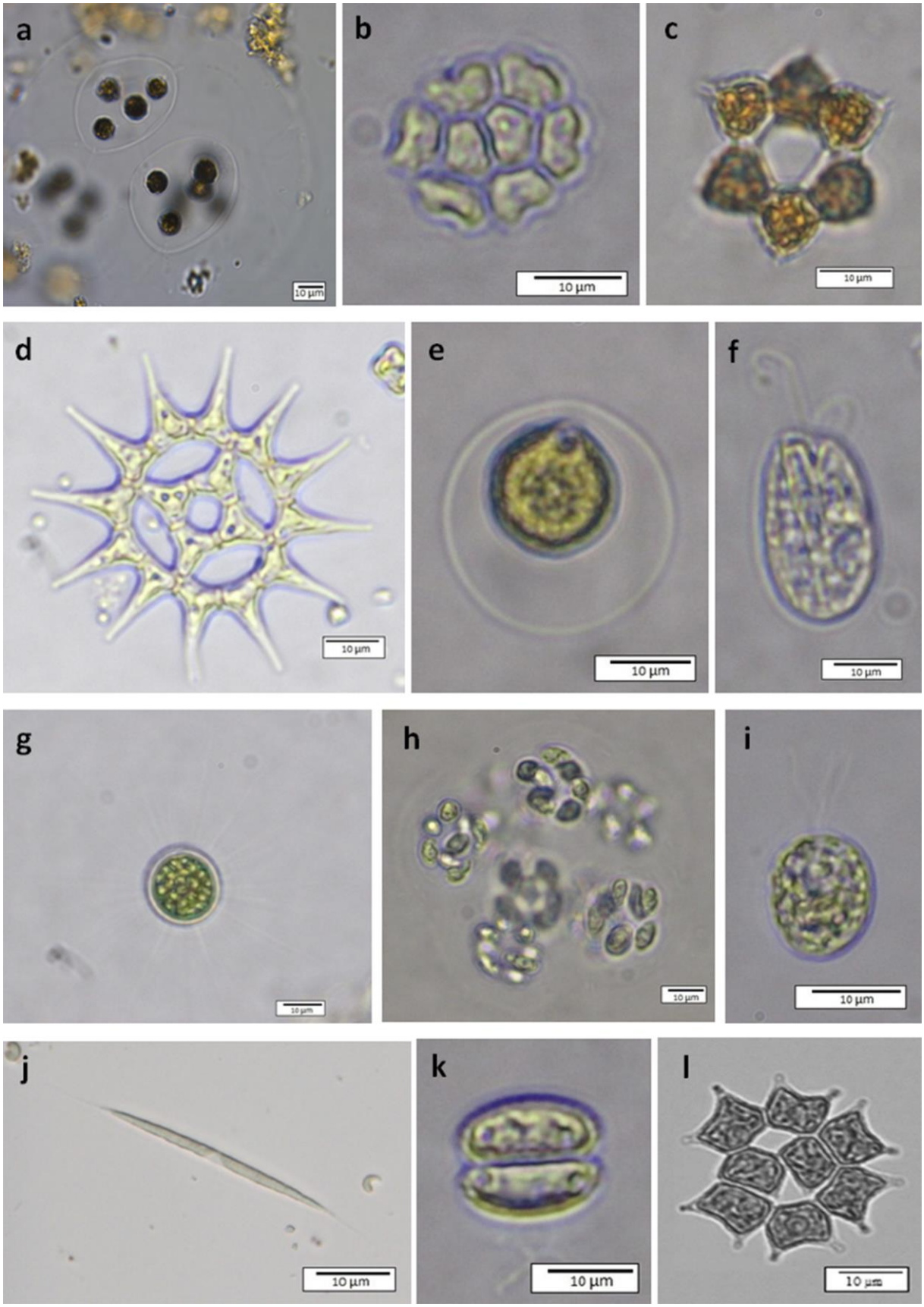

Figure 20. Chlorophyta; **a)** *Paulschulzia tenera*, **b)** *Pediastrum orbitale,* **c)** *Pediastrum ovatum,* **d)** *Pediastrum simplex* var. *clathratum,* **e)** *Phacotus glaber*, **f)** *Phyllariochloris caeca,* **g)** *Golenkinia viridis,* **h)** *Planktococcomyxa lacustris,* **i)** *Platymonas cordiformis,* **j)** *Podohedriella falcata,* **k)** *Pseudodidymocystis fina,* **l)** *Pseudopediastrum subgranulatum,* (Scale 10 µm).

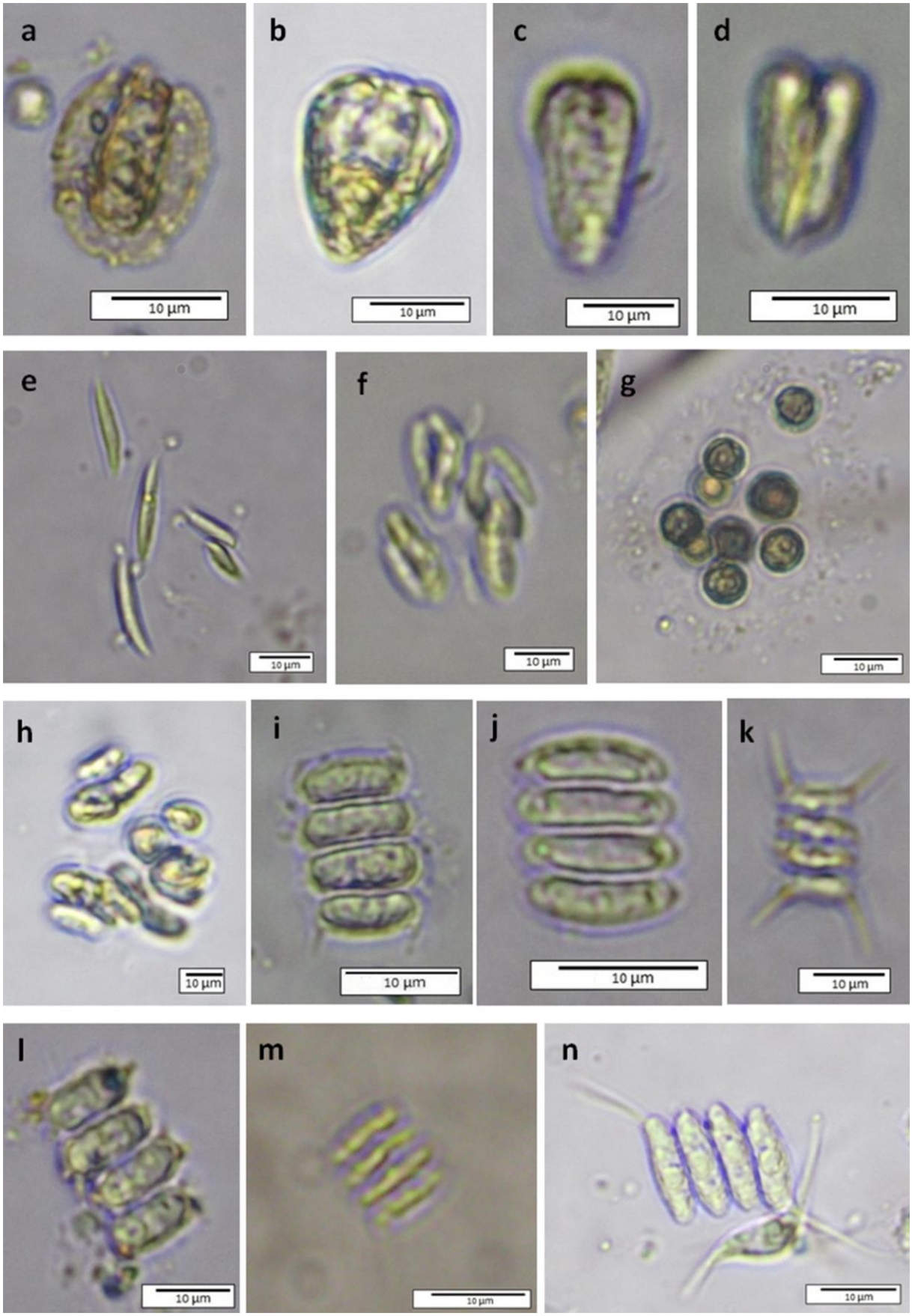

Figure 21. Chlorophyta; **a)** *Pteromonas rugosa,* **b)** *Pyramimonas delicatula,* **c)** *Pyramimonas inconstans,* **d)** *Pyramimonas splendidissima,* **e)** *Quadrigula chodatii,* **f)** *Quadrigula sabulosa,* **g)** *Radiococcus bavaricus,* **h)** *Rayssiella hemisphaerica,* **i)** *Scenedesmus aldavei,* **j)** *Scenedesmus calyptratus,* **k)** *Scenedesmus formidolosus*, **l)** *Scenedesmus fusiformis,* **m)** *Scenedesmus gutwinskii* var. *bacsensis,* **n)** *Scenedesmus opoliensis* var. *bicaudatus,* (Scale 10 µm).

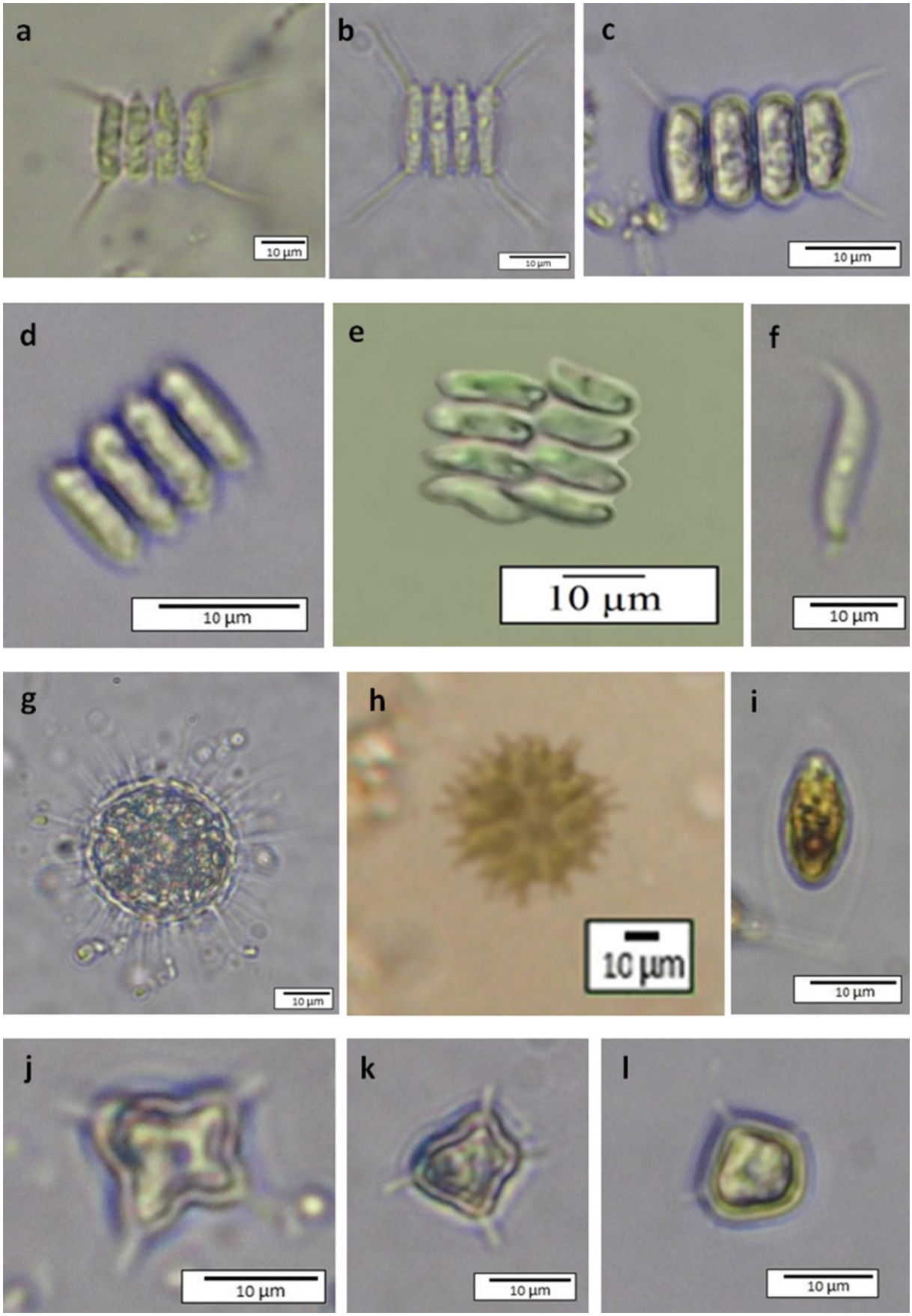

Figure 22. Chlorophyta; **a)** *Scenedesmus protuberans* var. *minor,* **b)** *Scenedesmus protuberans* f. *danubianus,* **c)** *Scenedesmus pseudoquadricauda,* **d)** *Scenedesmus similagineus,* **e)** *Scenedesmus tibiscensis,* **f)** *Schroederia ecsediensis,* **g)** *Siderocystopsis punctifera,* **h)** *Sorastrum spinulosum,* **i)** *Sphaerellopsis agloë,* **j)** *Tetraëdron minimum* f. *apiculatum,* **k)** *Tetraëdron octaedricum,* **l)** *Tetraëdron octaedricum* var. *spinosum,* (Scale 10 µm).

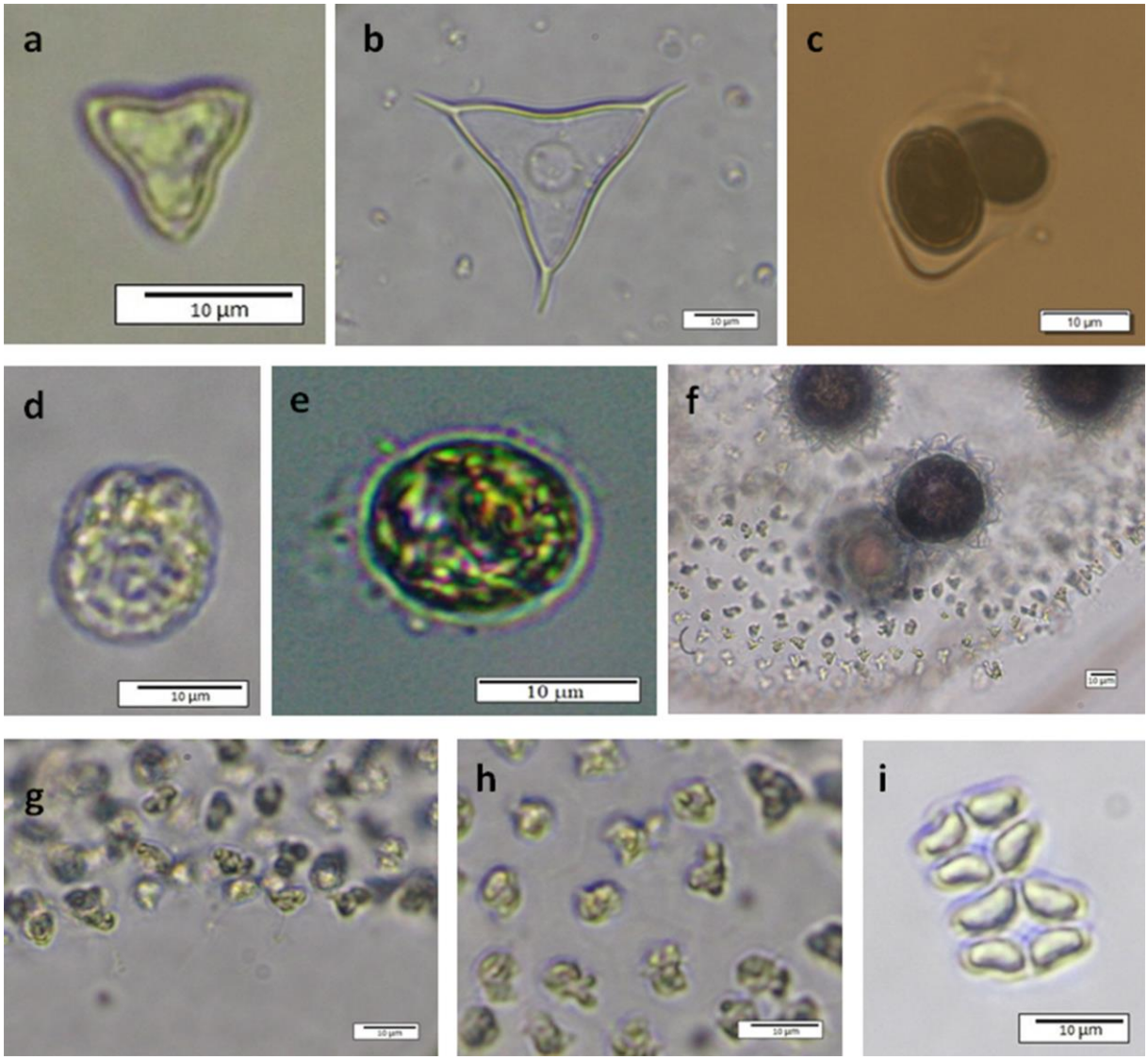

Figure 23. Chlorophyta; **a)** *Tetraëdron trigonum* f. *minus-obtusum,* **b)** *Tetraëdron trigonum* var. *longispinum,* **c)** *Tetraselmis arnoldii,* **d)** *Tetraselmis elliptica,* **e)** *Trochiscia granulata,* **f-g-h)** *Volvox rousseletii,* **i)** *Willea crucifera*, (Scale 10 µm).

these basins are wilderness with extreme climatic conditions. When we analyze the relationship between the number of lakes sampled in 25 basins and the number of new records, it is seen that the most remarkable basins are Asi, Western Mediterranean, Kızılırmak and Ceyhan. Although the number of studied lakes (13 and 8, respectively) in the Western Mediterranean and Asi basins was low, the number of new records (43 and 38, respectively) were found to be quite high compared to other basins. The number of studied lakes is high in Kızılırmak, Ceyhan, Western Black Sea, Yeşilırmak, and Büyük Menderes basins, but hardly any of new records have been detected. This indicates that the lake areas in these basins that we have sampled are not wilderness.

In all three divisions, it was observed that tolerant species are more dominant in the basins among the species with rare and common distribution areas. This shows that the water quality level of the water resources in the basins is not very good. The fact that the majority of both tolerant and sensitive species in all three divisions were detected in the Sakarya and Fırat-Dicle basins shows that the biodiversity is relatively high in both basins.

Conclusion

The Establishment of Reference Monitoring Network in Turkey Project, which is coordinated by the Ministry of Agriculture and Forestry, is the most comprehensive research project on the ecology of wetlands in Turkey in recent years. 1363 phytoplankton species and sub-species are determined from the 275 lakes. 238 taxa of them in three divisions are new records for the algal flora of Turkey. The present study includes the new records from the three main algal divisions, expected to contribute to the Algal database of Turkey (http://turkiyealgleri.hitit.edu.tr) edited by Maraşlıoğlu and Gönülol (2021) and to the Turkey Algae list published by Taşkın et al. (2019).

Ethical Statement

Not applicable

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Author Contribution

First Author: Conceptualization, Writing-review, editing, Data Curation, Formal Analysis, Investigation, Methodology, Visualization

Second Author: Data Curation, Formal Analysis, Investigation, Methodology, Visualization

Third Author: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Visualization

Fourth Author: Data Curation, Formal Analysis, Investigation, Methodology, Visualization

Fifth Author: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Visualization

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Conflict of Interest

The author(s) declare that they have no known competing financial or non-financial, professional, or personal conflicts that could have appeared to influence the work reported in this paper.

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