ГОДИШНИК НА СОФИЙСКИЯ УНИВЕРСИТЕТ „СВ. КЛИМЕНТ ОХРИДСКИ“

БИОЛОГИЧЕСКИ ФАКУЛТЕТ
Книга 2 – Ботаника

Том 107, 2023

ANNUAL OF SOFIA UNIVERSITY “ST. KLIMENT OHRIDSKI”

FACULTY OF BIOLOGY
Book 2 – Botany

Volume 107, 2023

https://doi.org/10.60066/GSU.BIOFAC.Bot.107.17-56

FIRST DATA ON THE SUMMER PHYTOPLANKTON COMPOSITION OF 21 MICRORESERVOIRS IN BULGARIA AND THEIR FLORISTIC SIMILARITY

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Abstract. The present paper provides first detailed data on the phytoplankton species composition collected during two summer campaigns (2019 and 2021) from 21 Bulgarian microreservoirs (<100 ha). By conventional light microscopy (LM) 414 algae from seven phyla were identified, among which Chlorophyta were the taxonomically richest group (143 taxa). The recorded high algal biodiversity corresponded to the average species contribution of 36 taxa per site. It was associated with a significant variability between the phytoplankton composition in different microreservoirs: the total number of species ranged from 9 to 97. The dominant/co-dominant and sub-dominant phytoplankton composition comprised 46 algae from six phyla, most of which were cyanoprokaryotes (26 species, out of which 17 dominated in 12 microreservoirs and 11 sub-dominated in seven microreservoirs). The floristic similarity estimated through Sørensen’s Correlation Index (SCI) was quite low (0-43%) corresponding to the high number of species (256, or 61%) found in a single waterbody. We strongly believe that the obtained results will stimulate further investigations of such small waterbodies as unexplored genetic reservoirs of algae.

Keywords: cyanobacteria, cyanoprokaryotes, drone, green algae, Sørensen’s correlation index

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INTRODUCTION

Bulgaria is a country well-known for its significant contribution to the biodiversity of the Balkan Peninsula, considered as a hot-spot of the European biodiversity (Griffits et al. 2004). The algal diversity, despite not thoroughly studied, has been recognized as notable, comprising more than 5,500 taxa (Stoyneva 2014). Most of these algae have been found in the wetlands, the number of which exceeds 10,000 (Michev & Stoyneva 2007). In a more than a century, the largest and most significant of them have been sampled with different regularity (Michev & Stoyneva 2007, Stoyneva et al. 2017, Descy et al. 2018). However, much less phycological attention has been paid to the shallow small waterbodies (<100 ha), which serve as microreservoirs for irrigation, as fish-breeding ponds or as sport-fishing recreational sites, and are of great importance for the local people, especially in the lowlands, plains and kettles with small summer precipitation (Michev & Stoyneva 2007). In addition, it has to be noted that many of these waterbodies serve as resting, nesting or over-wintering places for waterfowl and currently are of nature conservational interest (Michev & Stoyneva 2007). The number of such waterbodies in the country exceeds 2484 and the vulnerability of their water quality has been stressed (Michev & Stoyneva 2007). Therefore, considering the ongoing climatic global change combined with anthropogenically speeded-up eutrophication, which result in increasing threats from harmful algal blooms (*e.g.*, Delpla et al. 2009, Whitehead et al. 2009, Ahmed et al. 2020, Meerhoff et al. 2022, WHO 2022, Zeppernick et al. 2023), we decided to investigate 21 microreservoirs in the country, which have never been studied in relation to phytoplankton.

The work was done in the frames of three complementary projects, oriented towards harmful algal blooms in relation to public health and national security in the country, during which the summer phytoplankton of 43 different waterbodies has been studied (Stoyneva-Gärtner et al. 2023). Some data on their general diversity with details on the main toxin producers, as well as on their quantitative structure, have been published in a set of papers (Stoyneva-Gärtner et al. 2019, 2021, 2022, 2023; Radkova et al. 2020; Stefanova et al. 2020; Uzunov et al. 2021a, b).

The present paper provides the first detailed data on the species composition of the summer phytoplankton of 21 small waterbodies from different parts of the country, selected according to their vulnerability, significant local importance and lack of previous algological studies. The only exception is the reservoir Mechka, from which ten cyanoprokaryotes were published in 2022 (Dochin 2022). Although based on single samplings, our results demonstrate the great biodiversity of the phytoplankton in all these waterbodies with strong variability from site to site and low floristic similarity of the studied microreservoirs. We strongly believe that the obtained results will stimulate further investigations of such small waterbodies as unexplored genetic reservoirs of algae.

MATERIALS AND METHODS

Sampling sites

The paper is based on phytoplankton samples from 21 selected microreservoirs in Bulgaria collected during two summer campaigns in August 2019 and August 2021 (**Table 1**). In regard to the sampling periods, we would like to recall that there was no sampling campaign in the year 2020 because of the travelling restrictions during Covid-19 pandemics (Stoyneva-Gärtner et al. 2021, 2023).

For most of the studied microreservoirs, except Hadzhidimovo, Byalata Prust-Mezek and Yunets, data on location, morphometry, usage, etc. are available in the Database of the Inventory of Bulgarian wetlands (IBW - Michev & Stoyneva 2007)

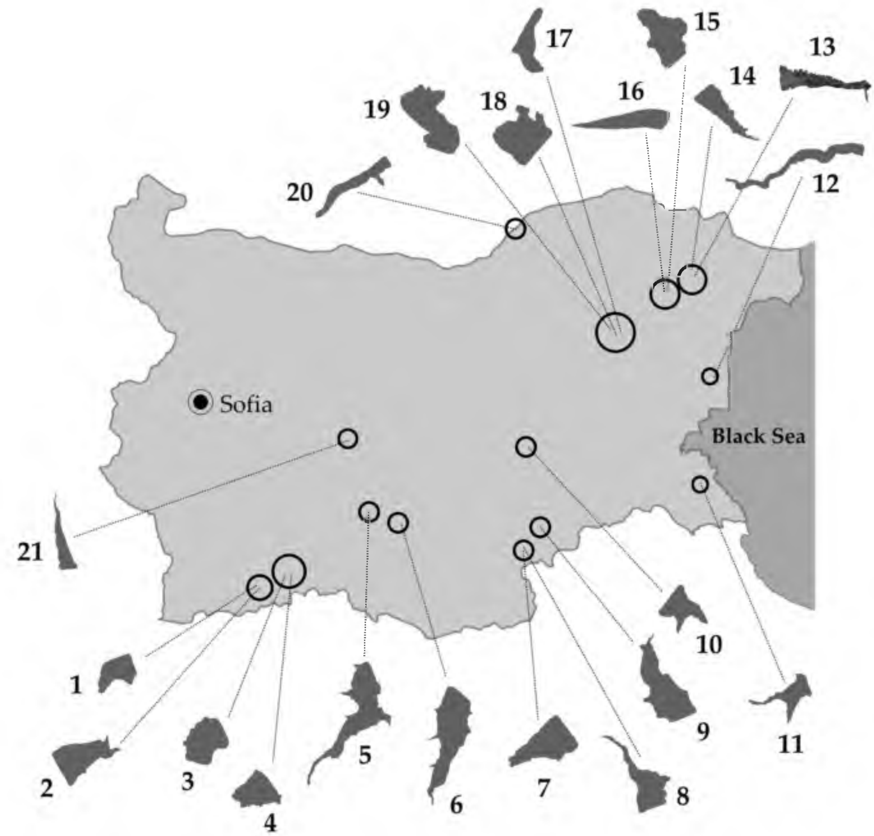


Fig. 1. Map of Bulgaria with location of the studied waterbodies. The waterbodies are represented by numbers that follow Table 1 (modified after Google Earth and Ginkgo maps).

Table 1. Sampling sites in Bulgarian waterbodies and their environmental parameters during summer sampling campaigns in years 2019 and 2021. Legend: WBN – name of the waterbody, IBW – identification number in Inventory of Bulgarian Wetlands (Michev & Stoyneva 2007), Abbr – abbreviation of the name, Alt – altitude above the sea level [m], WT – water temperature [° C], CN - conductivity [S m^{-1}], TDS – total dissolve solids [µg L^{-1}], DO – oxygen concentration [mg L^{-1}], TP - total phosphorus [µg L^{-1}], TN – total nitrogen [mg L^{-1}].

	WBN and IBW	Abbr	Year	Alt	Latitude	Longitude	WT	pH	CN	TDS	DO	TP	TN
1	Hadzhidimovo	Hd	2021	156	41°29.8933'	23°50.1890'	29.1	9.5	300	192	17.00	0.1	0.1
2	Dubnitsa (IBW3698)	Db	2021	600	41°33.8500'	23°50.7500'	25.2	9.6	246	159	9.21	0.1	0.1
3	Ablanitsa (IBW6013)	Ab	2021	682	41°32.8594'	23°55.5869'	27.2	8.8	242	157	8.54	1.0	0.5
4	Satovcha 2 (IBW1197)	Sv	2021	1017	41°36.8222'	23°58.1446'	27.4	8.70	272	176	9.00	0.5	0.1
5	Chetiridesette Izvora (IBW1523)	CI	2021	246	42°00.5510'	24°56.2819'	28.7	7.5	402	263	8.66	1.0	0.5
6	Mechka (IBW1584)	Mc	2021	319	41°55.8970'	25°06.1595'	27.1	9.0	241	154	8.50	1.5	1.0
7	Byalata Prust-Mezek	BP	2021	167	41°45.1080'	26°05.2403'	29.7	8.5	291	188	9.37	2.0	1.0
8	Birgo (Shtit)	Br	2021	215	41°49.7743'	26°22.1889'	27.3	8.0	594	385	8.75	1.5	1.8
9	Studena (Fishera) (IBW2421)	Sd	2021	282	41°54.2136'	26°24.5964'	29.3	9.0	652	423	3.35	1.0	0.3
10	Mogila (Kaynaka) (IBW2626)	Mg	2021	166	42°29.8310'	26°36.1043'	29.2	9.5	682	442	15.75	4.0	1.0
11	Hadzhi Yani (Lozenets) (IBW2893)	HY	2021	12	42°12.0333'	27°47.3000'	26.1	7.5	751	488	8.42	1.5	0.8
12	Yunets	Yn	2021	79	42°55.6700'	27°45.3074'	27.4	8.5	965	765	11.00	2.5	1.8
13	Plachidol 2 (IBW5073)	Plc	2019	220	43°33.3504'	27°52.6338'	24.6	9.0	1225	793	9.13	0.2	0.4
14	Yazovir Malka Smolnitsa (IBW3107)	MS	2019	211	43°36.2606'	27°44.5367'	25.2	9.1	755	490	7.05	0.6	0.6
15	Preselka (IBW3078)	Pr	2019	281	43°25.3767'	27°16.6214'	24.1	9.0	138	282	10.05	0.6	2.8
16	Izvornik 2 (IBW3082)	Iz	2019	255	43°27.3838'	27°21.1110'	24.5	9.4	389	253	13.26	9.0	4.8
17	Fisek (IBW2674)	Fs	2019	182	43°18.8453'	26°44.3765'	27.2	8.7	690	397	7.52	0.2	0.1
18	Shumensko Ezero (IBW2754)	SE	2019	152	43°14.8140'	26°57.5675'	25.2	8.5	471	445	6.32	0.2	0.5
19	Kriva Reka (IBW3071)	KR	2019	133	43°22.6573'	27°10.9807'	23.7	8.4	662	428	6.24	1.0	9.0
20	Nikolovo (IBW3176)	Nk	2021	89	43°50.9768'	26°05.1796'	26.0	9.8	2156	1400	11.88	11	2.0
21	Duvanli (IBW1483)	Dv	2019	250	42°23.1851'	24°43.1000'	26.3	8.8	4050	291	7.09	0.1	0.3

and, therefore, their identification numbers are provided in **Table 1**. We would like to note, that after our visit the unidentified waterbody near to village Vulkosel ("Vodoem do Vulkosel" in Bulgarian language), provided by IBW number 6013, has to be renamed as reservoir of Ablanitsa ("Yazovir Ablanitsa" in Bulgarian language), used mainly for local irrigation.

Aquameter AM-200 and Aquaprobe AP-2000 from Aquaread water monitoring instruments, 2012 Aquaread Ltd were used to prove the geographical coordinates and altitude, as well as for the *in situ* measurements of the physical and chemical water parameters (water temperature, pH, water hardness expressed by total dissolved solids, oxygen concentration, chlorophyll *a* and conductivity). The *ex situ* measurements of the total nitrogen (TN) and total phosphorus (TP) were done using Aqualytic AL410 Photometer from AQUALYTIC®, Dortmund, Germany - **Table 1**.

Regarding the sampling sites, it has to be boldly underlined that they were selected according to the identification of algal blooms as one of the main targets of the projects, and, therefore, the collection of water from inflatable boats was preceded by drone observations Methodological details and advantages of drone application have been provided in a set of our papers (Stoyneva-Gärtner et al. 2019, 2021, 2022, 2023; Radkova et al. 2020; Stefanova et al. 2020; Uzunov et al. 2021a, b; Valskys et al. 2022), but for the completeness of the methods description here, we recall that two types of drones (each supplied by a photo camera) have been used: DJI Mavic Pro, Model: M1P GL200A (SZ DJI Technology Co., LTD, Shenzhen, China) in 2018 and DJI Mavic 2 Enterprise Dual Pro (DJI Technolo-gy Co, LTD, Shenzhen, China) in 2019, 2021, which can measure the surface water temperature.

Algal identification and counting by light microscopy

At each site, a surface water sample (0.5-1.5 L) was collected for algal determination and counting by light microscopy (LM). These samples were immediately fixed with 2-4% formalin and transported in a dark box to the lab, where they were sedimented to 30 ml for at least 48 hours (Stoyneva-Gärtner et al. 2019, 2021, 2022, 2023; Radkova et al. 2020; Uzunov et al. 2021a, b). The taxonomic LM work was performed twice: 1) almost immediately after the collection on a Motic BA microscope with a Moticam 2000 camera, supported by Motic Images 2 Plus software program; 2) some months later, all samples were processed in a repetitive and comparative way on a Motic B1 microscopes supplied by a Moticam 2.0 mp camera with Motic Images 3 Plus software program. To ensure the consistency of LM data, the identification and counting was done by one and the same person (MPSG) (Stoyneva-Gärtner et al. 2023).

The algal identification was done on non-permanent slides under magnification 100x with application of immersion oil and was based on standard European taxonomic literature consulted with recent data in AlgaeBase (Guiry & Guiry

2023). The floristic similarity was based on Sørensen Correlation Index (SCI) with considering the presence/absence of the species (Sørensen 1948).

Algae were counted on a Thoma blood-counting chamber, in minimum four reiterations for each sample with the cell taken as the main counting unit and further estimation of the biomass (Stoyneva et al. 2015; Stoyneva-Gärtner et al. 2019, 2021, 2022, 2023; Radkova et al. 2020; Uzunov et al. 2021a). Likewise in our former article (Stoyneva-Gärtner et al. 2023), here the relative abundance of species is expressed using the modification of the Starmach's scale (Starmach 1955) according to the species contribution to the biomass Stoyneva 2000): "rare species" were those seen as single specimens in the whole microscopic slide (<0.5% of the biomass), "occasional species" – those represented by up to five specimens (<5% of the biomass), "common, or abundant species"– those seen with six to 30 specimens in a slide (5-20% of the biomass), whereas dominants and sub-dominants were evaluated among the most numerous species which contributed with >20 and >25% of the biomass, respectfully.

RESULTS

Total biodiversity of the phytoplankton

Total biodiversity of the phytoplankton comprises 414 species, varieties and forms from seven phyla (**Fig. 2**). Green algae were represented by the highest number of taxa (164), comprising 40% of the total biodiversity, with predominance of the phylum Chlorophyta (143, or 34%) over the second green phylum – Streptophyta (17, or 4%). Cyanoprokaryota, represented with 110 species, occupied the second place in the total taxonomic structure (27%), followed by Ochrophyta (70, or 17%, mainly diatoms – 55 taxa), Euglenophyta, Pyrrhophyta and Cryptophyta (**Fig. 2**).

Likewise in the total phytoplankton diversity, in almost all microreservoirs, chlorophytes were the main contributors to the phytoplankton structure: if the average number of species per waterbody was 36, about half of them (15) were green algae (14 chlorophytes and one streptophyte). The second position belonged to the blue-green algae (9 species per site), followed by yellow-brown algae (5, mainly diatoms - 4) and euglenophytes (4), with very low contribution of pyrrhophytes and cryptophytes - two and one species per site, respectively (**Fig. 3**).

Seven, or almost one third of the sampled microreservoirs, had total number of species over the calculated average per site, with the highest number (97) detected in Duvanli – **Fig. 3**. Only in Shumensko Ezero, commonly used for sport fishing, quite low number of species (9) was identified.

The number of widespread algae was very low: only 18 (or 4% from all) were found in more than 5 waterbodies. They belonged to Chlorophyta (8), Cyanoprokaryota (3), Pyrrhophyta (2), Euglenophyta (1) and Cryptophyta (1). The most widely spread chlorophytes were: *Tetraedron minimum* (16 sites), followed by *Coelastrum astroideum* and *Nephrochlamys subsolitaria* (each in 9 sites), *Golenkinia radiata* (8 sites) and *Oocystis lacustris* (7 sites), *Monactinus simplex*, *Monactinus simplex* var. *echinulatum* and *Tetradesmus lagerheimii* (each in 6 sites). The most widespread algae from other taxonomic groups in descending order of findings were: the pyrrhophytes *Parvodinium elpatiewskyi* (9 sites) and *Parvodinium goslaviense* (7 sites), the cyanoprokaryote *Planktolyngbya limnetica* and *Microcystis wesenbergii* (each in 7 sites), *Aphanizomenon klebahnii, Coelomoron pusilum, Microcystis aeruginosa* and *Pseudoanabaena limnetica* (each in 6 sites), as well as the cryptophyte *Cryptomonas erosa* (7 sites) and by the euglenophyte *Trachelomonas volvocina* (6 sites). No algal species was found as spread in all sampled microreservoirs, despite of their similar morphometry.

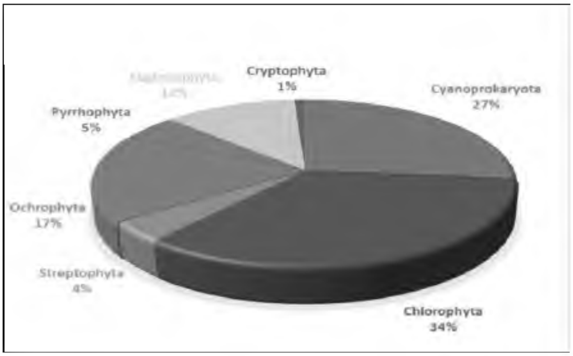


Fig. 2. Total biodiversity of the summer phytoplankton of 21 Bulgarian microreservoirs colected in the years 2019 and 2021.

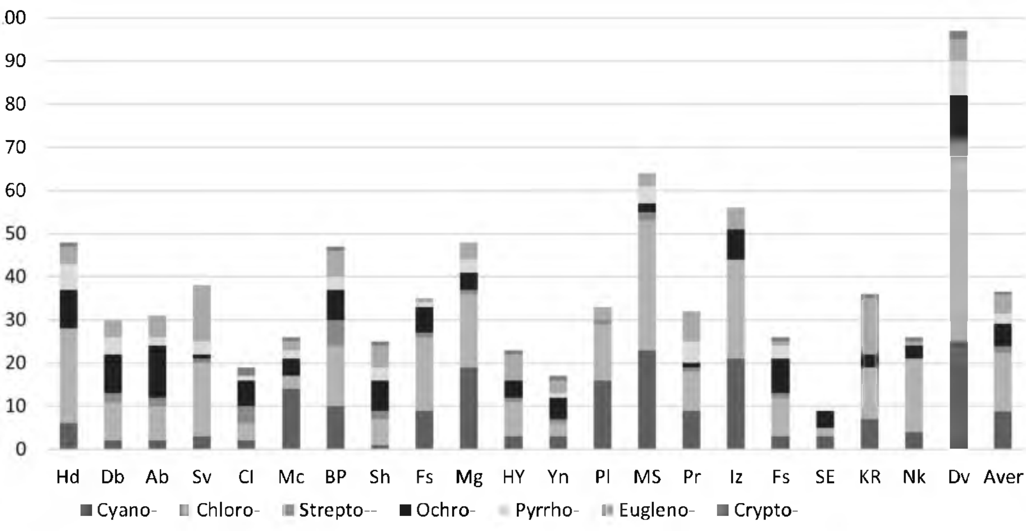


Fig. 3. Number of species in the main taxonomic phyla in the summer phytoplankton of 21 Bulgarian microreservoirs (abbreviations of their names follow those in **Table 1**) in comparison with their average number (Aver): Cyano – Cyanoprokaryota, Chloro – Chlorophyta, Strepto – Streptohyta, Pyrrho - Pyrrhophyta, Eugleno – Euglenophyta, Ochro - Ochrophyta, and Crypto – Cryptophyta.

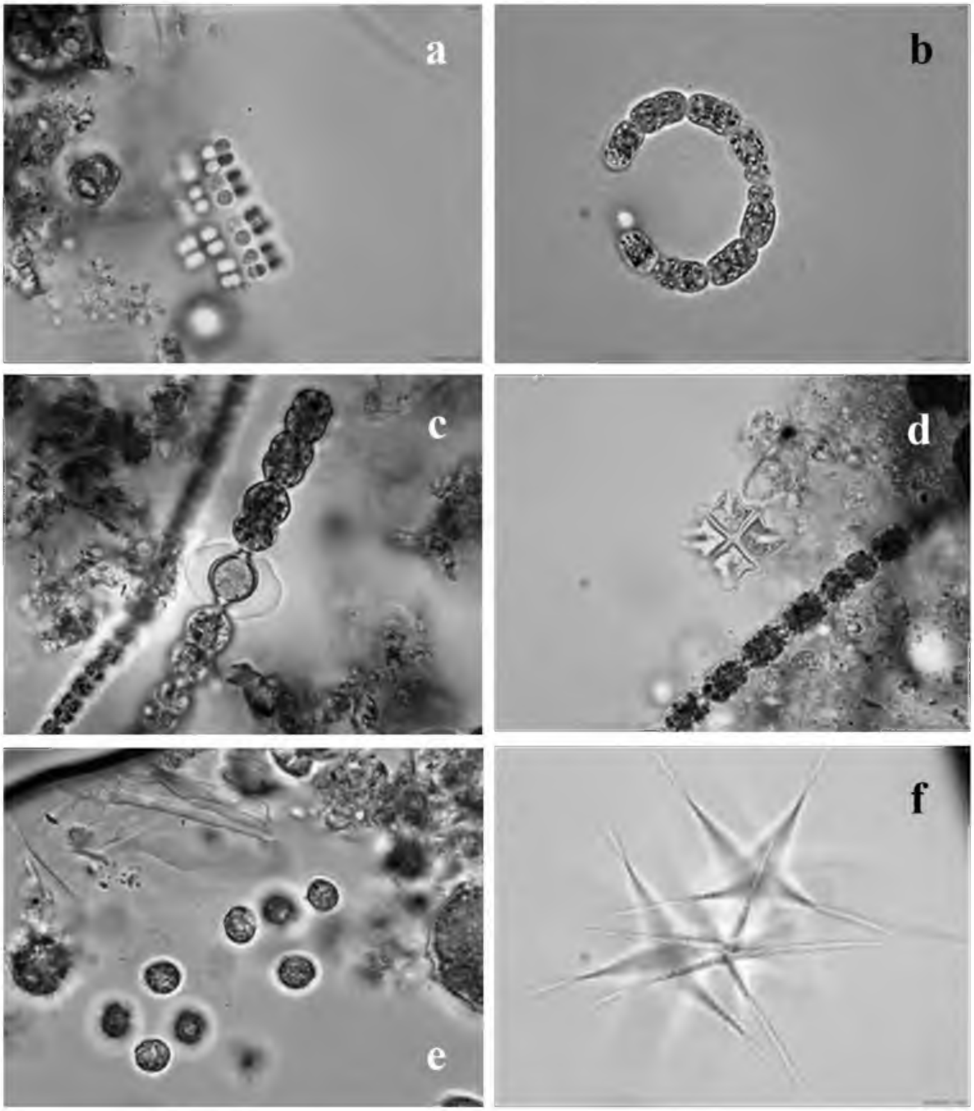
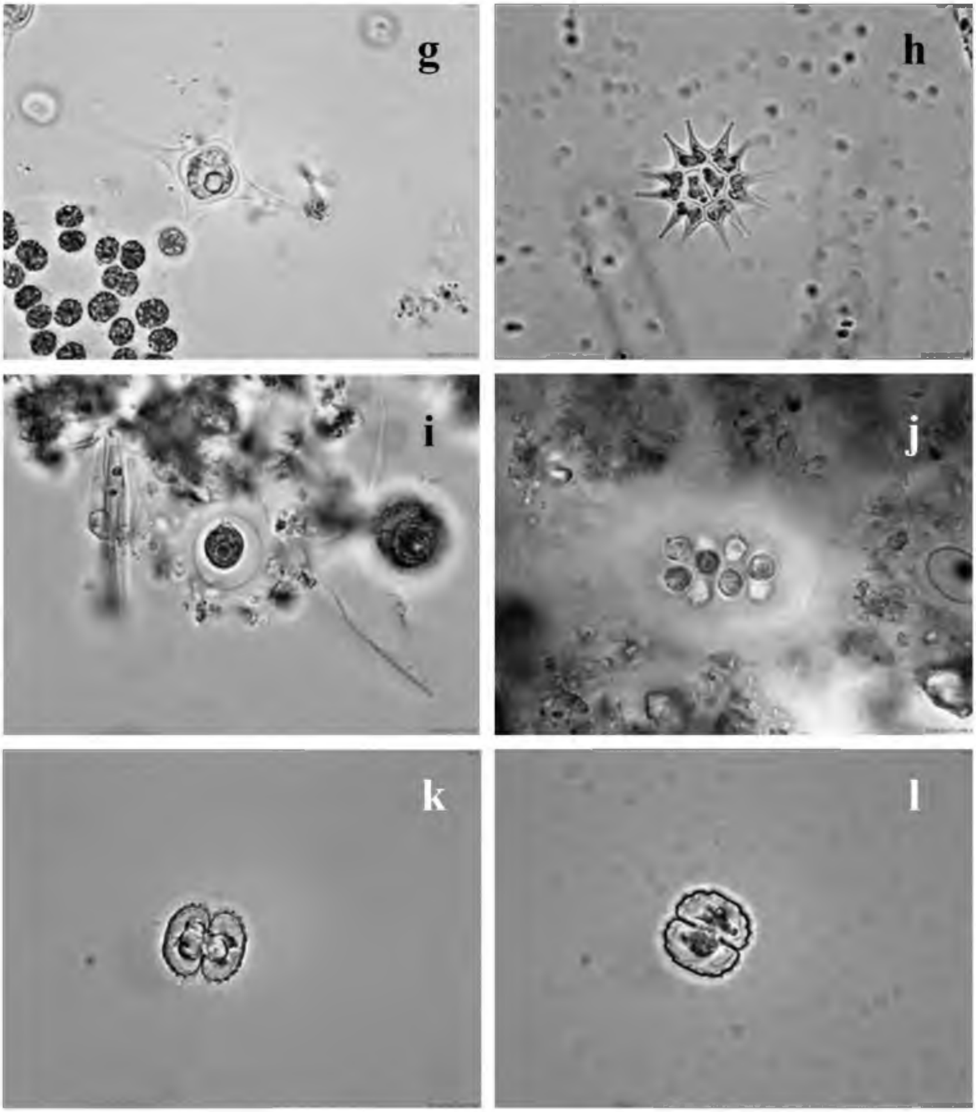
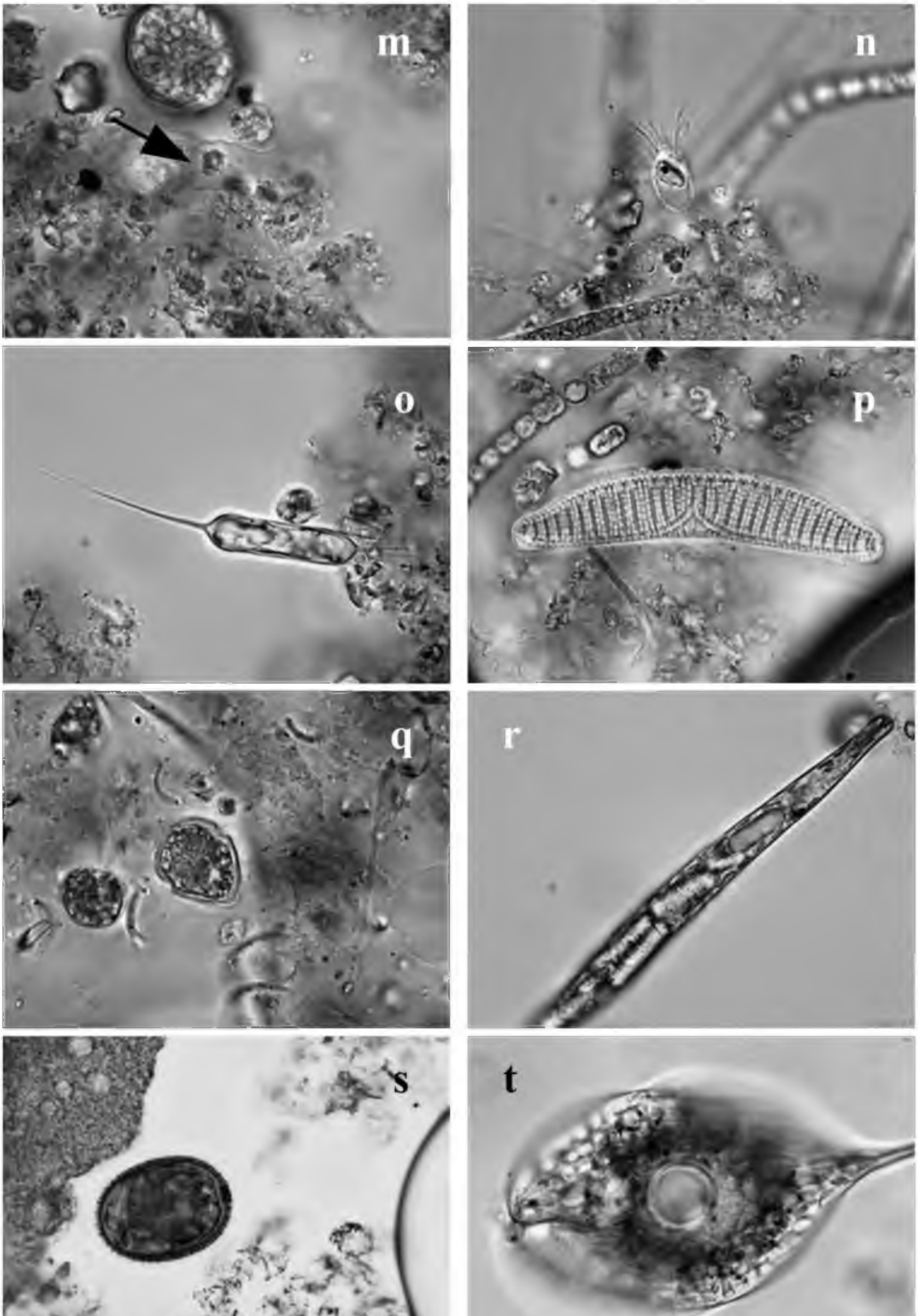


Fig. 4. Microphotos of algae from the phytoplankton samples of 21 microreservoirs in Bulgaria, organized by taxonomic groups: **a** - *Merismopedia tranquilla* (Ehrenberg) Trevisan 1845 in reservoir Mogila; **b** - *Anabaenopsis elenkinii* V. V. Miller 1923 in reservoir Mogila; **c** - *Dolichospermum scheremetieviae* (Elenkin) Wacklin, L. Hoffmann & Komárek 2013 in reservoir Yunets; **d** - *Stauridium tetras* (Ehrenberg) E. Hegewald 2005 and *Dolichospermum planctonicum* (Brunnthaler) Wacklin, L. Hoffmann & Komárek 2009 in reservoir Ablanitsa; **e** - *Neocystis ovalis* (Korshikov) Hindák 1988 in reservoir Hadzhidimovo; **f** - *Ankistrodesmus fusiformis* Corda 1838 in reservoir Satovcha 2; **g** - *Treubaria schmidlei* (Schröder) Fott & Kovácik 1975 in reservoir Nikolovo; **h** - *Pseudopediastrum boryanum* var. *longicorne* (Reinsch) P. M. Tsarenko 2011 in reservoir Studena; **i** - *Vitreochlamys fluviatilis* (F. Stein) Batko 1970 in reservoir Yunets; **j** - *Eudorina cylindrica* Korshikov 1938 in reservoir Hadzi Yani; **k** - *Cosmarium phaseolus*



var. *elevatum* Nordstedt 1873 in reservoir Dubnitsa; **l** - *Cosmarium subcostatum* Nordstedt in reservoir Chetiridesette Izvora; **m** - *Dinobryon sertularia* var. *annulatum* Z. X. Shi et Y. X. Wei (arrow) in reservoir Birgo; **n** - *Mallomonas* cf. *tonsurata* Teiling 1912 in reservoir Studena; **o** - *Centritractus belenophorus* (Schmidle) Lemmermann 1900 in reservoir Byalata Prust-Mezek; **p** - *Epithemia adnata* (Kützing) Brébisson 1838 in reservoir Yunets; **q** - *Parvodinium goslaviense* (Woloszyńska) Carty 2008 - in reservoir Mechka; **r** - *Lepocinclis longissima* (Deflandre) Zakryś & Chaber – in reservoir Satovcha 2; s - *Trachelomonas hispida* (Perty) F. Stein 1878 in reservoir Birgo; **t** - *Phacus convexus* Zakryś & Łukomska 2020 in reservoir Hadzhi Yani.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Most the algal taxa (256, or 61%) were found in a single waterbody, and most of them were with very low abundance, found as single specimens (**Table 2**). In the same time, altogether 46 algae were identified as dominants, co-dominants or sub-dominants (**Table 2**). Among them the most significant were cyanoprokaryotes (25 species, out of which 17 dominated/co-dominated in 12 waterbodies and 11 were sub-dominants in seven microreservoirs), followed by Euglenophyta (seven species: three dominants in two microreservoirs and four sub-dominants in three microreservoirs), Pyrrhophyta (five species, out of which four dominants in five microreservoirs and two were sub-dominants in three microreservoirs), Chlorophyta (four species: one dominant and three sub-dominants in one and two microreservoirs, respectively), Ochrophyta (two species dominating, each in a single microreservoir) and Streptophyta (two varieties, dominat-ing and sub—dominating, each in a single microreservoir) – **Table 2**.

Florisric similarity of the studied sites

The floristic similarity between the microreservoirs was quite low, with values of SCI varying between 0 and 43%, and being mostly between 1-20%: 50% of the microreservoirs were with similarity between 1 and 10%, 35% were with similarity between 11 and 20%. Only three sites (1%) showed similarity between 21 and 30% - Mogila, Duvanli and Malka Smolnitsa (**Table 3**), and the highest similarity (43%) was estimated for Mogila and Preselka. It has to be noted that 9% of the estimated SCI values were 0, or that 18 pairs of sites had no similarity with each other. Among them the most striking was the lack of similarity between Shumensko Ezero and 13 other microreservoirs. Detaileded checking of the common species between each pair of microreservoirs revealed that in most of the cases, the similarity was due to species with low abundance in the studied microreservoirs.

DISCUSSION

Results from the present study demonstrated high phytoplankton diversity in the sampled microreservoirs, in which 414 taxa (species, varieties and forms) from seven phyla were identified. The green algae, represented by 160 species (39% from all identified taxa) comprised the taxonomically richest group and were followed by Cyanoprokaryota (110 species). Although occupying the second place in the taxonomical structure, cyanoprokaryotes comprised the highest number of species in dominant and sub-dominant complexes: 23 species out of the totally 46 algae with such significant quantitative role. This is consistent with our previous results obtained on the quantitative phytoplankton structure, according to which blue-greens dominated in 13 of the discussed in this paper microreservoirs (*i.e.*, Chetiridesette Izvora, Duvanli, Fisek, Hadzhi Yani, Izvornik 2, Mogila, Kriva Reka, Malka Smolnitsa, Nikolovo, Plachidol 2, Preselka, Satovcha 2, Yunets) and with the well-known summer dominance of cyanoprokaryotes in nutrient-rich waters in lowlands, plains and kettles (for details see Stoyneva-Gärtner et al. 2023).

Table 2. Species composition of the summer phytoplankton in 21 microreservoirs in Bulgaria, organized by A-Z order in each taxonomic group. Abbreviations of the waterbodies names follow those in **Table 1; d** - dominant/co-dominant, **s** - subdominant; **f** - frequent; **c** - common; **r** - rare/very rare

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Cyanoprokaryota																					
Anabaena minderi Huber-Pestalozzi 1938												r									
Anabaena sp. ster.						r															
Anabaenopsis arnoldii Aptekar 1926														f							
Anabaenopsis circularis (G. S. West) Wołoszyńska et V. V. Miller 1923																			c		r
Anabaenopsis cunningtonii W. R. Taylor 1932														r							
Anabaenopsis elenkinii V. V. Miller 1923										d											r
Anabaenopsis milleri Woronichin 1929																s					
Anagnostidinema acutissimum (Kufferath) Strunecký, Bohunická, J. R. Johansen et J. Komárek 2017										c											
Anagnostidinema amphibium (C. Agardh ex Gomont) Strunecký, Bohunická, J. R. Johansen et J. Komárek 2017		r	r		r		r						f								
Anagnostidinema pseudocutissimum (Geitler) Strunecký, Bohunická, J. R. Johansen & J. Komárek 2017																					r
Anathece smithii (Komárková-Legnerová et Cronberg) Komárek, Kastovsky et Jezberová 2011																			r		
Aphanizomenon gracile Lemmermann 1907				r			r														
Aphanizomenon klebahnii (Elenkin) Pechar et Kalina ex Komárek et Komárková 2006						c	c			r	s		f								

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Aphanizomenon cf. *manguinii* Bourrelly 1952									c												
Aphanizomenon yezoense M. Watanabe 1991							r		d												
Aphanocapsa conferta (West et G. S. West) Komárková-Legnerová et Cronberg 1994								c	r												f
Aphanocapsa delicatissima West et G. S. West 1912						r											r	s			
Aphanocapsa fusco-lutea Hansgirg 1893																			f		
Aphanocapsa holsatica (Lemmermann) G. Cronberg et Komárek 1994											s					f					
Aphanocapsa nubila Komárek et H. J. Kling 1991													r								
Aphanocapsa planctonica (G. M. Smith) Komárek & Anagnostidis 1995																r					
Aphanothece elabens (Meneghini) Elenkin 1936																					c
Chroococcus distans (G. M. Smith) Komárková-Legnerová & Cronberg 1994													r								
Chroococcus limneticus var. *elegans* G. M. Smith 1918													r								
Chroococcus minimus (Keissler) Lemmermann 1904				r																	
Chroococcus minutus (Kützing) Nägeli 1849			c								r							c			
Chrysosporum minus (Kisselev) Komárek 2012													d								
Chrysosporum sp. ster.														f							
Coelomoron pusillum (Van Goor) Komárek 1988							c			r					c	r			s		c
Coelomoron sp.							r														

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Coelosphaerium aerugineum Lemmermann 1898																					c
Cronbergia plancionica Komárek, Zapomelová & Hindák 2010													r								
Cuspidothrix elenkinii (I. A. Kisselev) P. Rajaniem, J. Komárek, R. Willame, P. Hrouzek, K. Kastovská, L. Hoffmann et K. Sivonen 2005						r	c			c											
Cuspidothrix issatschenkoi (Usachev) P. Rajaniemi, Komárek, R. Willame, P. Hrouzek, K. Kastovská, L. Hoffmann et K. Sivonen 2005										d			r			r					r
Cuspidothrix tropicalis (Horecká et Komárek) Rajaniem et al. 2005							c		c	c	r										
Cuspidothrix cf. *tropicalis* (Horecká et Komárek) Rajaniem et al. 2005/? *Umezakia* sp.(fig 979 in Komarek 2013)									c		r										
Dolichospermum cf. *affine*																r					
Dolichospermum compactum (Nygaard) P. Wacklin, L. Hoffmann et J. Komárek 2009										f						d					
Dolichospermum flos-aquae (Bornet et Flahault) P. Wacklin, L. Hoffmann et Komárek 2009										c											
Dolichospermum mucosum (Komárková-Legnerová & Eloranta) Wacklin, L. Hoffmann & Komárek 2009																r					
Dolichospermum perturbatum (H. Hill) Wacklin, L. Hoffmann et Komárek 2009																s					
Dolichospermum planctonicum (Brunnthaler) Wacklin, L. Hoffmann et Komárek 2009			d			c															
Dolichospermum scheremetieviae (Elenkin) Wacklin, L. Hoffmann et Komárek 2013												d									

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Dolichospermum cf. *tenericaule* (Nygaard) E. Zapomelová, O. Skácelová, P. Pumann, R. Kopp & E. Janecek 2012										c											
Dolichospermum sp. ster. 1							r														
Dolichospermum sp. ster. 2																c					
Geitlerinema sp.							r														
Glaucospira laxissima (G. S. West) Simic, Komárek & Dordevic 2014													f	c	f						d
Gloeocapsa sp.																r					
Jaaginema geminatum (Schwabe ex Gomont) Anagnostidis et Komárek 1988																					r
Jaaginema gracile Anagnostidis et Komárek 1988																c					
Jaaginema metaphyticum Komárek 1988														r							
Lemmermanniella pallida (Lemmermann) Geitler 1942																					r
Limnococcus limneticus (Lemmermann) Komárková, Jezberová, O. Komárek et Zapomelová 2010							r		r								r			r	c
Limnothrix planctonica (Wołoszyńska) Meffert 1988												r									
Limnothrix redekei (Goor) Meffert 1988														f	d						
Limnothrix sp. 1								r													
Limnothrix sp. 2											r										
Merismopedia glauca (Ehrenberg) Kützing 1845																r					
Merismopedia tenuissima Lemmermann 1898																			f		

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Merismopedia tranquilla (Ehrenberg) Trevisan 1845	r									r				c		c					
Merismopedia warmingiana (Lagerheim) Forti 1907														f	r						
Microcystis aeruginosa (Kützing) Kützing 1846										c			c	r	r	r					r
Microcystis comperei Komárek 1984																c					r
Microcystis flos-aquae (Wittrock) Kirchner 1898	r									c						c					
Microcystis microcystiformis (Hindák) Joosten 2006																r					
Microcystis natans Lemmermann ex Skuja 1934																c					f
Microcystis cf. *natans* Lemmermann ex Skuja 1934																					r
Microcystis pseudofilamentosa Crow 1923										r			r	r							r
Microcystis smithii Komárek et Anagnostidis 1995									r					c							
Microcystis cf. *viridis* (A. Braun) Lemmermann 1903														r	r						r
Microcystis wesenbergii (Komárek) Komárek ex Komárek 2006													c	c	r	c			d	d	r
Microcystis cf. *wesenbergii* (Komárek) Komárek ex Komárek 2006														r					f		
Microcystis sp. juv.															r						
Microcystis spp. - separate cells													r	r	r	c	r	r			s
Myxobactron sp.	r																				
Oscillatoria sancta Kützing ex Gomont 1892										r											
Oscillatoria simplicissima Gomont 1892						r															
Oscillatoria tenuis C. Agardh ex Gomont 1892		r																		r	

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Oscillatoria sp.																r					
Phormidium terebriforme (C. Agardh ex Gomont) Anagnostidis & Komárek 1988																r					
Phormidium sp.																					r
Planktolyngbya limnetica (Lemmermann) Komárková-Legnerová et Cronberg 1992	r				r	r	c		f				r	r							c
Planktolyngbya spp.	r					r	r														
Planktothrix isothrix (Skuja) Komárek et Komárková 2004														c	r						
Planktothrix suspensa (Pringsheim) Anagnostidis & Komárek 1988				f																	
Pseudanabaena articulata Sjuka 1948										r			r								r
Pseudanabaena catenata Lauterborn 1915						r															
Pseudanabaena galeata Böcher 1949												r				c					
Pseudanabaena limnetica (Lemmermann) Komárek 1974						r						r	r	d	s						d
Pseudanabaena mucicola (Naumann et Huber-Pestalozzi) Schwabe 1964	r																			s	
Raphidiopsis acuminato-crispa (Couvy et Bouvy) Aguilera, Berrendero Gómez, Kastovsky, Echeniqe et Salerno 2018						s															
Raphidiopsis africana (Komárek et H. Kling) Aguilera et al. 2018						c															
Raphidiopsis cuspis (Komárek & Kling) Aguilera, Berrendero Gómez, Kastovsky, Echenique & Salerno 2018						s															
Raphidiopsis gangetica (G. U. Nair) Aguilera, Berrendero Gómez, Kastovsky, Echenique et Salerno 2018						d															

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Raphidiopsis mediterranea Skuja 1937										f			f	f							
Raphidiopsis philippinensis (W. R. Taylor) Aguilera, Berrendero Gómez, Kastovsky, Echenique et Salerno 2018														r							
Raphidiopsis raciborskii (Woloszynska) Aguilera et al. 2018						d	s			f				d	s						
Raphidiopsis seigera (Aptekarj) Eberly 1966										f											
Raphidiopsis turcomanica Kogan 1967						c															
Romeria simplex (Hindák) Hindák 1988																f					d
Snowella lacustris (Chodat) Komárek et Hindák 1988														r		c					c
Snowella litoralis (Häyrén) Komárek et Hindák 1988													r								c
Snowella sp.				r																	
Sphaerospermopsis aphanizomenoides (Forti) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková et Komárková 2010							c		d	f				f							
Sphaerospermopsis cf. *reniformis* (Lemmermann) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková et Komárková 2010									c												
Synechococcus endogloeicus Hindák 1996													r								
Synechococcus epigloeicus Hindák 1996													c								
Synechocystis endobiotica (Elenkin et Hollerbach) Elenkin 1938													c								
Trichodesmium iwanoffianum Nygaard 1926												r									
Wollea sp.									r												

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Chlorophyta																					
Acanthosphaera zachariasii Lemmermann 1899														r							c
Acinastrum hantzschii Lagerheim 1882									c												
Actinastrum hantzschii var. *subtile* Woloszynska 1911																					r
Amphikrikos buderi (Heynig) Hindák 1977																					c
Amphikrikos hexacosta (R. H. Thompson) Hindák 1977															r						
Ankistrodesmus fusiformis Corda 1838				f			c														
Ankistrodesmus tortus Komárek et Comas González 1982		r																			
Ankyra judayi (G. M. Smith) Fott 1957																c					r
Binuclearia lauterbornii (Schmidle) Proshkina-Lavrenko 1966																	r				
Botryococcus braunii Kützing 1849											r										
Carteria sp.				r																	
Chlamydomonas sp.											r			c		r				f	
Chlorella elongata (Hindák) C. Bock, Krienitz et Pröschold 2011																					r
Chlorogonium sp.																r					
Choricystis sp.																		r			
Closteriopsis longissima (Lemmermann) Lemmermann 1899							c														
Coelastrum astroideum De Notaris 1867	s			c	c		r	r	r					f	r						r
Coelasirum microporum Nägeli 1855												r									

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Coelastrum microporum var. *octaëdricum* (Skuja) Sodomková 1972																	f				
Coelastrum pseudomicroporum Korshikov 1953										f				r							
Coelastrum pulchrum Schmidle 1892																					c
Coelastrum reticulatum (P. A. Dangeard) Senn 1899	f							r													
Coelastrum reticulatum var. *cubanum* Komárek 1975									f												
Coelastrum sphaericum Nägeli 1849																					r
Coenochloris fottii (Hindák) P. M. Tsarenko 1990		c																		f	
Desmodesmus abundans (Kirchner) E. H. Hegewald 2000	c			r						r										r	
Desmodesmus armatus (Chodat) E. H. Hegewald 2000									r												
Desmodesmus bicaudatus (Dedusenko) P. M. Tsarenko 2000																r					
Desmodesmus bicellularis (Chodat) S. S. An, T. Friedl et E. Hegewald 1999	r	c	r																		
Desmodesmus communis (E. Hegewald) E. Hegewald 2000									r				r	r							c
Desmodesmus denticulatus (Lagerheim) S. S. An, T. Friedl et E. Hegewald 1999																r					
Desmodesmus granulatus (West et G. S. West) P. M. Tsarenko 2000																r				f	
Desmodesmus hystrix (Lagerheim) E. Hegewald 2000																				r	
Desmodesmus intermedius (Chodat) E. Hegewald 2000	r																		r		

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Desmodesmus insignis (West et G. S. West) E. Hegewald 2000			r																		
Desmodesmus magnus (Meyen) P. M. Tsarenko 2000															r						
Desmodesmus opoliensis (P. G. Richter) E. Hegewald 2000									r												r
Desmodesmus opoliensis var. *carinatus* (Lemmermann) E. Hegewald 2000	f																				
Desmodesmus opoliensis var. *mononensis* (Chodat) E. Hegewald 2000	r			r										r		c					f
Desmodesmus pannonicus (Hortobágyi) E. Hegewald 2000														c							
Desmodesmus pleiomorphus (Hindák) E. Hegewald 2000														r							
Scenedesmus praetervisus Chodat 1926									r												
Desmodesmus protuberans (F. E. Fritsch et M. F. Rich) E. Hegewald 2000																			r		
Desmodesmus spinosus (Chodat) E. Hegewald 2000				r												r					c
Desmodesmus subspicatus (Chodat) E. Hegewald et A. W. F. Schmidt 2000														r							
Dictyosphaerium granulatum Hindák 1977														r							
Dictyosphaerium simplex Korshikov 1953																			f		
Didymocystis comasii Komárek 1983	c																r				r
Diplochloris sp.														c							
Echinosphaeridium quadriseium Behre 1956																					c
Echinosphaeridium nordstedtii Lemmermann 1904													c			r					c

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Echinosphaeridium sp.	r																				
Elakatothrix inflexa Hindák 1966			c																		
Elakatothrix lacustris Korshikov 1953														r							
Eudorina cylindrica Korshikov 1938											r										r
Eudorina elegans Ehrenberg 1832																				r	
Franceia javanica (C. Bernard) Hortobágyi 1962																				r	
Golenkinia radiata Chodat 1894	f			f				r					s	f	r	c					r
Hegewaldia parvula (Woronichin) Pröschold, C. Bock, W. Luo et L. Krienitz 2010										c											
Hindakia tetrachotoma (Printz) C. Bock, Pröschold et Krienitz 2010																					c
Granulocystis chlamydomonadoides Hindak 1980										c											r
Granulocystis helenae Hindák 1977				r																	
Granulocystopsis decorata (Svirenko) P. M. Tsarenko 2000																r					r
Juranyiella javorkae (Hortobágyi) Hortobágyi 1962																					r
Komarekia appendiculata (Chodat) Fott 1981									r												
Korshikoviella limnetica (Lemmermann) P. C. Silva 1959										f											
Korshikoviella mystacina (Hortobágyi et Németh) Philipose 1967														r							
Lacunastrum gracillimum (West et G. S. West) H. McManus in McManus et al. 2011				c						r					r						r
Lagerheimia ciliata (Lagerheim) Chodat 1895														r			r				

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Lemmermannia komarekii (Hindák) C. Bock et Krienitz 2013										r										r	
Lemmermannia tetrapedia (Kirchner) Lemmermann 1904				r	r														c		
Lemmermannia triangularis (Chodat) C. Bock et Krienitz 2013		r																			
Lobocystis sp.													r		r						
Lobomonas ampla Pascher 1927																r					
Messastrum gracile (Reinsch) T. S. Gareia 2016																					r
Micraciinium crassiseium Hortobágyi 1973													r								
Micraciinium pusillum Fresenius 1858	c												r								
Monactinus simplex (Meyen) Corda 1839	r	f							c		d									c	c
Monactinus simplex var. *echinulatum* (Wittrock) Pérez, Maidana et Comas 2009		r							c		c			f						c	c
Monactinus simplex var. *sturmii* (Reinsch) Pérez, Maidana et Comas 2009																					
Monoraphidium griffithii (Berkeley) Komárková-Legnerová 1969				r																	
Monoraphidium komarkovae Nygaard 1979													r								
Mucidosphaerium pulchellum (H. C. Wood) C. Bock, Proschold et Krienitz 2011										r											
Mychonastes fluviatilis (Hindák) Krienitz, C. Bock, Dadheech et Proschold 2011							f									c					f
Nephrochlamys subsolitaria (G. S. West) Korshikov 1953				c						f				c	r	r	r		r	r	r
Neocystis ovalis (Korshikov) Hindák 1988	f																				

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Oocystis lacustris Chodat 1897			c						f		c			r		f			r	c	
Oocystis parva West et G. S. West 1898				c																	
Oocystis sp. 1					r																
Oocystis sp. 2						r	r	r													
Oocystella sp.																					f
Oonephris obesa (West et G. S. West) Fott 1964																	f				
Pachycladella sp.																					r
Pandorina morum (O. F. Müller) Bory 1826										r						f					
Pediastrum duplex Meyen 1829																r					
Polyedriopsis spinulosa (Schmidle) Schmidle 1899				f						f			r								f
Pseudocharacium acuminatum Korshikov 1953								r													
Pseudodidymocystis lineata (Korshikov) Hindák 1990																			r		
Pseudopediastrum boryanum (Turpin) E. Hegewald 2005									r											r	
Pseudopediastrum boryanum var. *longicorne* (Reinsch) P. M. Tsarenko 2011									r				c								
Quadricoccus ellipticus Hortobágyi 1973							r														
Radiococcus sp.																	r				
Scenedesmus acuminatus var. *elongatus* G. M. Smith 1926														c							r
Scenedesmus acunae Comas Gonzáles 1980																				f	
Scenedesmus apiculatus var. *indicus* Hortobágyi 1969																c					

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Scenedesmus ecornis (Ehrenberg) Chodat 1926		r	c				c												r		
Scenedesmus ecornis var. *concavus* Hortobágyi 1969														r							
Scenedesmus ellipticus Corda 1835 (= *Scenedesmus linearis* Komárek 1974)		f	r											r							
Scenedesmus nanus var. *spinosus* Chodat 1913													r	r						r	r
Scenedesmus cf. *nanus* var. *spinosus* Hortobágyi 1969	c																				
Scenedesmus obtusus Meyen 1829	r							r									r				r
Scenedesmus obtusus f. *disciformis* (Chodat) Compère 1977																r					
Scenedesmus quadricauda (Turpin) Brébisson 1835	c									c				r							
Scenedesmus quadrispina Chodat 1913							r														
Scenedesmus semipulcher Hortobágyi 1960																					r
Scenedesmus cf. *soli* Hortobágyi 1960	r													r							
Scenedesmus subspicatus Chodat 1926																			c		
Scenedesmus sp.																					r
Schroederia setigera (Schröder) Lemmermann 1898				c		r			c										r		
Siderocelis kolkwitzii (Naumann) Fott 1934																			r		
Siderocystopsis pseudoblonga (Hindák) Hindák 1984														f							
Stauridium tetras (Ehrenberg) E. Hegewald 2005			c				r											r			
Tetradesmus cumbricus var. *apiculatus* Korshikov 1953																r					

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Tetraëdron caudatum (Corda) Hansgirg 1888													r								
Tetraëdron minimum (A. Braun) Hansgirg 1889	f	r	f	f	r	f	c		r	f		r	r	f	c	c	c				c
Tetraëdron punctulatum (Reinsch) Hansgirg 1889											r										
Tetraëdron triangulare Korshikov 1953														f							
Tetradesmus dimorphus (Turpin) M. J. Wynne 2016	f									c					c						r
Tetradesmus lagerheimii M. J. Wynne et Guiry 2016	r						r			c				r					c		r
Tetradesmus lagerheimii var. *tetradesmoides* (G. M. Smith) Taşkin et Alp 2019										r											r
Tetradesmus obliquus (Turpin) M. J. Wynne 2016																					r
Tetrallantos lagerheimii Teiling 1916	s			r			f														
Tetrastrum glabrum (Y. V. Roll) Ahlstrom et Tiffany 1934							f			r											
Tetrastrum heteracanthum (Nordstedt) Chodat 1895																				r	
Tetrastrum staurogeniaeforme f. *brasiliense* C.E.M.Bicudo et Ventrice 1968													r	r							
Thelesphaera alpina Pascher 1943									f												
Thoracomonas sp.											c					r					
Treubaria planctonica (G. M. Smith) Korshikov 1953									r							r					r
Treubaria schmidlei (Schröder) Fott et Kováčik 1975														r						r	
Treubaria sp.																					c

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Vitreochlamys fluviatilis (F. Stein) Batko 1970												c									
Vitreochlamys gloeosphaera (Pascher et Jahoda) Masjuk 2003																					f
Willea apiculata (Lemmermann) D. M. John, M. J. Wynne et P. M. Tsarenko 2014							c														
Streptophyta																					
Closterium aciculare T. West 1860								c													
Closterium limneticum Lemmermann 1899							c		r	r	c										r
Closterium venus Kützing ex Ralfs 1848			r																		
Cosmarium contractum O. Kirchner 1878													r								
Cosmarium depressum var. *planctonicum* Reverdin 1919							c							c			d				r
Cosmarium laeve Rabenhorst 1868			c	r																	
Cosmarium phaseolus Brébisson ex Ralfs 1848							r														
Cosmarium phaseolus var. *elevatum* Nordstedt 1873		s			c																
Cosmarium porteanum f. *extensum* G. W. Prescott 1981								r													
Cosmarium regnellii var. *minimum* Eichler et Gutwinski 1894														r							
Cosmarium subcostatum Nordstedt 1876					r																
Gonatozygon kinahanii (W. Archer) Rabenhorst 1868					r										f						c
Hyalotheca sp.							r														
Mougeotia sp.							r					c									

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Staurastrum anatinum Cooke et Wills 1881					r		r														
Staurastrum chaetoceras (Schröder) G. M. Smith 1924																					c
Staurodesmus cuspidatus (Brébisson) Teiling 1967		r																			
Pyrrhophyta																					
Biecheleria pseudopalustris (J. Schiller) Moestrup, K. Lindberg et Daugbjerg 2009														c							
Ceratium furcoides (Levander) Langhans 1925	r													r	c						r
Ceratium rhomvoides B. Hickel 1988																					r
Ceratium hirundinella (O. F. Müller) Dujardin 1841									r												
Glenodiniopsis uliginosa (A. J. Schilling) Wołoszyńska 1928								f		c		f									
Gymnodinium saginatum T. M. Harris 1940				c																	
Gymnodinium schueitii J. Schiller 1955						r															
Gymnodinium schueitii J. Schiller 1955																	r				
Gymnodinium wawrikae J. Schiller 1955		r	c																		
Kolkwitziella acuta (Apstein) Elbrächter 1993					r																
Parvodinium cunningtonii (Lemmermann) Pandeirada, Craveiro, Daugbjerg, Moestrup et A. J. Calado 2022	r	r	d												f						c
Parvodinium elpatiewskyi (Ostenfeld) Kretschmann, Zerdoner et Gottschling 2019		d		s			r	d		c				r	c		f				r
Parvodinium goslaviense (Wołoszyńska) Carty 2008	r			r		s	r			s/r					c						r

Taxa/Sample	**Hd**	**Db**	**Ab**	**Sv**	**Cl**	**Mc**	**BP**	**Br**	**Sd**	**Mg**	**HY**	**Yn**	**Pl**	**MS**	**Pr**	**Iz**	**Fs**	**SE**	**KR**	**Nk**	**Dv**
Parvodinium umbonatum (F. Stein) Carty 2008	d						r	c													
Parvodinium umbonatum var. *spiniferum* (M. Lefèvre) Moestrup 2018	r																r				
Peridinium bipes F. Stein 1883	r																				
Peridiniopsis borgei Lemmermann 1904		r																			
Peridiniopsis cunningtonii var. *excavata* (M. Lefèvre) Moestrup 2018																					r
Sphaerodinium polonicum Wołoszyńska 1916																					d
Sphaerodinium sp.															r						
Tovellia apiculata (Stosch) Moestrup, K. Lindberg et Daugbjerg 2005																					r
Tyrannodinium edax (A.J.Schilling) Calado 2011														r							
Euglenophyta																					
Anisonema sp.																f					
Colacium sp.		c																			
Discoplastis gasterosteus (Skuja) Zakryś et Łukomska 2021	c																				
Discoplastis spathirhyncha (Skuja) Triemer 2006															r	f			s		r
Euglena hemichromata Skuja 1948										f	c	c							r		
Euglena pavlovskoënsis (Elenkin et Poljanski) T. G. Popova 1951																			s		
Euglena texta (Dujardin) Hübner 1886																					r
Euglena sp. 1																			r		
Euglena sp. 2															c				c		

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Euglena sp. 3															c						
Euglena sp. 4																r					
Euglena sp. 5																					r
Euglenaformis proxima (P. A. Dangeard) M. S. Bennett et Triemer 2014		c	c			r								f							
Euglenaria clavata (Skuja) Karnkowska et E. W. Linton 2010				d						c			c								
Lepocinclis acicularis Francè 1894				r																	
Lepocinclis acus (O. F. Müller) B. Marin et Melkonian 2000	r						r				r		r								
Lepocinclis globulus Perty 1849							r														
Lepocinclis fominii (Y. V. Roll) Zakryś et Lukomska 2019												r									
Lepocinclis fusiformis var. *amphirhynchus* Nygaard 1950																					r
Lepocinclis longissima (Deflandre) Zakryś et Chaber 2022				r								r									
Lepocinclis sp.			r																r		
Monomorphina nordstedtii (Lemmermann) T. G. Popova 1955				f																	
Monomorphina pyrum (Ehrenberg) Mereschkowsky 1877				c			r			c				f	r						
Phacus acuminatus A. Stokes 1885							r														
Phacus caudatus Hübner 1886													r						r		
Phacus convexus Zakryś et Łukomska 2020															r				c		
Phacus curvicauda Svirenko 1915											d										
Phacus torius (Lemmermann) Skvortzov 1928		r					r				f										

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Phacus onyx Pochmann 1942																			r		
Phacus orbicularis Hübner 1886											r								r		
Phacus pleuronecies (O. F. Müller) Nitzsch ex Dujardin 1841																			r		
Phacus textus Pochmann 1942											f										
Strombomonas australica var. *fusiformis* T. Yamagishi 2016				r																	
Strombomonas fluviailis (Lemmermann) Deflandre 1930																			c		
Strombomonas planctonica (Woloszyńska) T. G. Popova 1955							r														
Strombomonas urceolata (A. Stokes) Deflan-dre 1930				r																	
Trachelomonas dybowskii Drežepolski 1923				c																	
Trachelomonas hispida (Perty) F. Stein 1878				f				s							r					c	r
Trachelomonas hispida var. *crenulatocollis* (Maskell) Lemmermann 1910				c																	
Trachelomonas intermedia P. A. Dangeard 1902				s				r	r												
Trachelomonas intermedia f. *papillata* (Sku-ja) T. G. Popova 1966								r													
Tracheiomonas pavlovskoensis (Poijanskij) Popova 1955										r											
Trachelomonas planctonica Svirenko 1914				r																	
Trachelomonas volvocina (Ehrenberg) Ehrenberg 1834	r		c	d				f							f				r		
Trachelomonas volvocina var. *subglobosa* Lemmermann 1913	r		c					f								f					
Trachelomonas sp.		f	c			r															

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Urceolus cyclostomus (F. Stein) Mereschkowsky 1879																r					
Unidentified euglenophytes														r			r				
Bacillariophyceae																					
Achnanthes sp.																	r				
Amphora ovalis (Kützing) Kützing 1844			r																		
Aulacoseira distans (Ehrenberg) Simonsen 1979											r										
Aulacoseira granulata (Ehrenberg) Simonsen 1979																c			r	r	c
Aulacoseira italica (Ehrenberg) Simonsen 1979																r				r	
Brebissonia lanceolata (C. Agardh) R.K.Mahoney et Reimer 1986			r																		
Caloneis bacillum (Grunow) Cleve 1894	r																				
Ctenophora pulchella var. *lanceolaia* (O'Meara) Bukhtiyarova 1995		r																			
Ctenophora pulchella (Ralfs ex Kützing) D. M. Williams et Round 1986												c						d			
Cymbella affinis Kützing 1844																	r				
Cymbella tumida (Brébisson) Van Heurck 1880									r												
aff. *Diploneis* sp.														r							
Discostella stelligera (Cleve et Grunow) Houk et Klee 2004			f								f				r	r					
Encyonema elginense (Krammer) D. G. Mann 1990					r																
Epithemia adnata (Kützing) Brébisson 1838												c									

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Epithemia operculata (C. Agardh) Ruck et Nakov 2016					c																
Epithemia sorex Kützing 1844		r	r						c												
Eunotia exigua (Brébisson ex Kützing) Rabenhorst 1864			r																		
Fragilaria intermedia (Grunow) Grunow 1881																	r				
Fragilaria montana (Krasske ex Hustedt) Lange-Bertalot 1981						f															
Fragilaria sp.			r																		
Gomphonema constrictum Ehrenberg 1844			r																		
Gomphonema sp.																r					
Gyrosigma acuminatum (Kützing) Rabenhorst 1853	r																				
Hippodonta capitata (Ehrenberg) Lange-Bertalot, Metzeltin et Witkowski 1996		r																			
Iconella biseriata (Brébisson) Ruck & Nakov 2016	r		r																		
Iconella linearis (W. Smith) Ruck et Nakov 2016	r		r				r	r													
Lacustriella lacustris (W. Gregory) Lange-Bertalot et Kulikovskiy 2012			r																		
Lindavia comta (Kützing) T. Nakov et al. 2015					d											f					c
Navicula cf. *minima* Grunow 1880					r																
Navicula cf. *platystoma* Ehrenberg 1838							r	c													
Navicula sp.																		r			
Nitzschia sp.								r													

Taxa/Sample	Hd	Db	Ab	Sv	CI	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Pantocsekiella ocellata (Pantocsek) K. T. Kiss et Ács 2016		c						f													
Paraplaconeis placentula (Ehrenberg) Kulikovskiy et Lange-Bertalot 2012									f												
Pinnularia cocconeis (Ehrenberg) Ehrenberg 1854																	r				
Placoneis dicephala (Ehrenberg) Mereschkowsky 1903	r				r	r													c		r
Pleurosigma sp.	r																				
Pseudostaurosira brevistriata var. *inflata* (Pantocsek) M. B. Edlund 1994							c														
Rhopalodia gibba (Ehrenberg) O. Müller 1895		r										c									
Skeletonema subsalsum (A. Cleve) Bethge 1928																					r
Staurosira consiruens Ehrenberg 1843		r	c																		
Staurosirella martyi (Héribaud) Morales et Manoylov 2006																					r
Stephanodiscus asiraea (Kützing) Grunow 1880						c			r												
Stephanodiscus hantzschii Grunow 1880											r										
Stephanocyclus meneghinianus (Kützing) Kulikovskiy, Genkal et Kociolek 2022										c				r			r				
Surirella robusia Ehrenberg 1841 - broken		r																			
Synedra sp. s.l.	r					r						r									
Tabularia tabulata (C. Agardh) Snoeijs 1992								r		r									c		
Ulnaria acus (Kützing) Aboal 2003									r	r											
Ulnaria ulna (Nitzsch) Compère 2001	c			r																	f

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Ulnaria oxyrhynchus (Kützing) Aboal 2003			c																		
Urosolenia sp.																					r
Unidentified diatoms (broken frustules)							r				r					r					
Chrysophyceae																					
Dinobryon sertularia var. *annulatum* Z. X. Shi et Y. X. Wei								r													
Dinobryon bavaricum Imhof 1890																		r			
Dinobryon sertularia Ehrenberg 1834							r														
Ochromonas sp.																		r			
Unidentified chrysophycean flagellate																	r				
Synurophyceae																					
Mallomonas cf. *horrida* J. Schiller 1929		r																			
Mallomonas intermedia Kisselev 1931					f																
Mallomonas cf. *tonsurata* Teiling 1912								c	c												
Xanthophyceae																					
Centritractus belenophorus (Schmidle) Lemmermann 1900	c						r														
Dichotomococcus curvatus Korshikov 1939																r					
Nephrodiella cf. *acuta* Pascher 1938																	r				
Ophiocytium parvulum (Perty) A. Braun 1855							r														
cf. *Peroniella* sp.																	r				
Tribonema sp.												r									

Taxa/Sample	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	HY	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Eustigmatophyceae																					
Goniochloris cf. *ivengari* (Ramanathan) Ettl 1977																					r
Goniochloris cf. *mutica* (A. Braun) Fott 1960										r											r
Goniochloris pulchra Pascher 1938																				r	
Pseudostaurastrum hastatum (Reinsch) Chodat 1921		r																			
Cryptophyta																					
Chroomonas sp.					r																
Cryptomonas erosa Ehrenberg 1832					c	f	r	c									r			f	r
Cryptomonas sp. 1	r										f	r									c
Cryptomonas sp. 2																			r		

Table 3. Floristic similarity between the studied 21 microreservoirs, shown in the blue horizontal and vertical headings (abbreviations of the names follow those in **Table 1**). Diagonal boxes (brown colour) show the total number of phytoplankton species in each of the microreservoirs, numbers above the diagonal reflect the number of common species between the sites, and numbers below the diagonal show the percentage values of the Sorensen Similarity Index (SCI). Colour below the diagonal indicate different classes of SCI values: white – 0%, grey – 1-10%, green – 11-20%; bright yellow – 21-30%, bright brown – 31-40%, and brown – 41-50%.

	Hd	Db	Ab	Sv	Cl	Mc	BP	Br	Sd	Mg	Hy	Yn	Pl	MS	Pr	Iz	Fs	SE	KR	Nk	Dv
Hd	48	4	5	9	1	4	7	7	1	8	4	2	2	9	6	6	3	1	4	2	14
Db	10	30	11	1	2	2	5	2	4	2	3	2	1	5	3	1	2	0	1	4	5
Ab	13	3	31	3	2	4	5	3	3	1	2	1	1	4	4	4	1	1	4	1	2
Sv	21	3	12	38	1	4	7	4	4	7	2	2	5	7	10	5	1	0	3	1	10
Cl	3	8	8	4	19	2	6	2	1	1	0	1	2	3	3	2	2	0	1	1	5
Mc	11	7	14	13	9	26	7	2	3	5	1	2	4	5	4	1	3	1	2	1	6
BP	15	13	13	16	18	19	47	7	5	8	5	2	4	7	5	2	5	1	2	2	11
Br	19	7	11	13	9	8	19	25	3	3	0	1	1	3	3	2	3	0	2	2	7
Sd	2	12	9	11	4	10	12	10	35	4	5	1	4	8	2	3	1	0	2	4	10
Mg	17	5	3	16	3	14	17	8	10	48	3	1	6	12	9	9	3	0	3	2	17
Hy	11	11	7	7	0	4	14	0	17	8	23	2	2	1	1	5	0	0	2	5	5
Yn	6	9	4	7	6	9	6	5	4	8	10	17	1	1	1	2	0	0	1	0	1
Pl	9	3	3	14	8	14	10	3	12	28	7	4	33	12	7	5	2	0	2	2	13
MS	16	11	8	14	7	11	13	7	16	33	2	2	25	64	14	10	7	0	5	7	24
Pr	15	10	13	29	12	14	13	11	6	43	4	4	22	29	32	7	3	0	8	3	18
Iz	12	2	9	11	5	2	4	5	7	27	13	5	11	17	16	56	2	1	6	6	20
Fs	8	7	4	3	9	12	14	12	3	17	0	0	7	16	10	5	26	2	1	3	9
SE	4	0	5	0	0	6	4	0	0	0	0	0	0	0	0	3	11	9	0	0	1
KR	10	3	12	8	4	6	5	7	6	13	7	4	6	10	24	13	3	0	36	4	6
Nk	5	14	4	3	4	4	14	8	13	11	20	0	7	16	10	15	12	0	13	26	9
Dv	19	8	3	15	9	10	15	11	15	32	8	2	20	30	28	26	15	2	9	15	97

The high general phytoplankton biodiversity with the relatively high average number of 36 taxa per site was associated with a great variability from site to site: from 9 species in Shumensko Ezero to 97 in Duvanli. In this regard, the recorded high number of rarely spread species (256) correlates well with the low estimated floristic similarity (SCI ranging from 0 to 43%) between the studied microreservoirs. Since this similarity was mostly based on the algae found in a low abundance (**Table 2**), we would like to point on the necessity to investigate the whole species composition in limnological studies. Moreover, the notable recorded general biodiversity shows the great potential of the small waterbodies as unexplored genetic pool of algae.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

ACKNOWLEDGEMENTS

This research was funded by the Scientific Research Fund of the Bulgarian Ministry of Education, grant numbers DN-13/9 - 15.12.2017, KP-06-OPR 03/18 - 19.12.2018, and KP-06-OPR06/2 - 18.12.2018. Sampling in the years 2018 and 2021 was financed by the project DN-13/9 - 15.12.2017, whereas the sampling in 2019 was financed by KP-06-OPR 03/18 - 19.12.2018 and by KP-06-OPR06/2 - 18.12.2018.

AUTHORS CONTRIBUTION

Conceptualization and supervision - MSG; writing—original draft preparation, MSG, MA, KI; writing—review and editing, MSG, GG, BA; visualization - BA, MSG, GG; field sampling – BA, GG, MSG, MA; project administration - BU; funding acquisition – MSG, BU. All authors have read and agreed to the published version of the manuscript.

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Received 15th September 2023
Accepted 17th November 2023