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.107.57-113

SPECIES COMPOSITION OF CYANOPROKARYOTA IN THE SUMMER PHYTOPLANKTON OF 55 SELECTED LAKES AND RESERVOIRS, SAMPLED IN BULGARIA IN THE YEARS 2018, 2019, 2021 AND 2023

MAYA P. STOYNEVA-GÄRTNER*, BLAGOY A. UZUNOV, GEORG GÄRTNER, MIROSLAV ANDROV AND KRISTIAN IVANOV

Department of Botany, Faculty of Biology, Sofia University 'St Kliment Ohridski', 8 Dragan Tsankov Blvd., 1164 Sofia, Bulgaria

Abstract. The paper presents detailed results on cyanoprokaryote diversity in the summer phytoplankton of 55 lakes, small and large reservoirs sampled in Bulgaria in the frame of three joined projects related to algal blooms threat to human health and national security. The phytoplankton of twenty from these selected waterbodies was sampled for first time. In total, 185 species and one variety from 55 genera have been identified, 54 of which (29%) were novel for the country. The average contribution of cyanophytes to the phytoplankton per site was 8 species (or 44% of the total biodiversity), reaching in some sites 80%. According to the morphology, the recorded algae were distributed as follows: 83 coccal, 52 non-heterocytous filamentous and 51 heterocytous filamentous cyanoprokaryotes. Their average contribution to the phytoplankton diversity was estimated as 4 coccal, 2 non-heterocytous and 2 heterocytous species per site. Most of the cyanoprokaryote species (94, or 51%) were recorded only once, even in the case of wetlands and sites which have been repeatedly visited during all sampling campaigns. These 96 species embrace 39 coccal, 23 non-heteroctous and 32 heterocytous forms. No species was found in all studied waterbodies. The most widely spread species were *Microcystis aeruginosa* (19 records), *Planktolyngbya limnetica* (17 records), *Aphanizomenon klebahnii* (16 records), *Microcystis wesenbergii* (16 records), *Aphanocapsa delicatissima* (13 records), *Cuspidothrix issatschenkoi* (12 records), *Coelomoron pusillum* (11 records), *Pseudanabaena limnetica* (11 records), *Anagnostidinema amphibium* (10 records), *Raphidiopsis raciborskii* (10

**corresponding author*: M. Stoyneva-Gärtner - Department of Botany, Faculty of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tsankov blvd., 1164 Sofia, Bulgaria; mstoyneva@uni-sofia.bg.

records), *Limnococcus limneticus* (10 records), and separate cells of *Microcystis* as well (15 records). The record of the chytrid parasite *Rhizosiphon anabaenae* on separate trichomes of *Sphaerospermopsis aphanizomenoides* is described.

Key words: algal blooms, biodiversity, chytrids, drone observations, *Rhizosiphon anabaenae*, rare species, zoosporic parasites

INTRODUCTION

Peculiar group of organisms with a prokaryotic cell organization, commonly known as blue-green algae (Cyanophyta) or cyanobacteria (Cyanobacteria), was renamed taxonomically as Cyanoprokaryota about three decades ago with recognition of both the prokaryotic organization of these organisms with algal morphological organization and their physio-ecological function of primary producers capable of photosynthesis with oxygen production (Komárek & Anagnostidis 1999). Cyanoprokaryotes occurred in the Early Archaean and currently are among the most diverse organisms on the Planet (Whitton & Potts 2012). They were the main players in the enrichment of Earth's atmosphere by oxygen that drove to the "Great Oxygen Event" about 2400 mln years ago (Schopf 2012). Moreover, up to now, they are the only phototrophs capable to utilize directly the atmospheric nitrogen in the process commonly known as nitrogen-fixation (Schopf 2012; Stal 2012). In addition, cyanoprokaryotes are proved producers of unique substances important for the modern biotechnology, pharmacology and medicine, some of which are with potent anti-Covid and anti-HIF properties (Teas et al. 2004; Mader et al. 2016; Mitchell et al. 2017; Carpine & Sieber 2021; Mazur-Marzec et al. 2021; Konkel et al. 2023, *etc*.). However, despite these very important and useful features, during the last decades cyanoprokaryotes became more popular and better known from their negative side – the ability to produce great diversity of toxic substances, which can harm both human and ecosystem health (*e.g.*, Merel et al. 2013; Meriluoto et al. 2017). In this respect, a lot of attention of the scientific community was sharpened on their driving factors and their increasing abundance in the waterbodies was proved as related with current global climatic changes and anthropogenically speeded-up eutrophication caused by increased nutrient loading (*e.g.*, Yan et al. 2019, 2020; Xu et al. 2021; Zhang et al. 2023).

Although this all raised the interest of the algologists, ecologists, physiologists, toxicologists and specialists in molecular-genetics, currently there is a decrease of papers which deal with the total phytoplankton species composition identified by conventional light microscopic (LM) studies. The aim of the present paper is to provide detailed data on the biodiversity of cyanoprokaryotes in the summer phytoplankton of different Bulgarian waterbodies determined by standard LM methods. The results are obtained after processing of samples obtained from 55 selected lakes, large and small reservoirs during four sampling campaigns in the frame of three complementary projects related with human health and national security of Bulgaria (*i.e.*, grants DN-13/9 - 15.12.2017, KP-06-OPR 03/18 - 19.12.2018, and KP-06-OPR06/2 - 18.12.2018 funded by the Scientific Research Fund of the Bulgarian Ministry of Education). Up-to now the revealed general phytoplankton biodiversity was discussed only in a paper oriented towards possibilities to identify algal indicators for water quality assessment (Stoyneva et al. 2023), the detailed species composition is currently published only for 21 small reservoirs, sampled for first time (Stoyneva et al. this volume) and some important species involved in potential toxin production have been discussed in a set of papers based on a polyphasic approach (Radkova et al. 2020; Stefanova et al. 2020; Stoyneva-Gärtner et al. 2021, 2022, 2023; Uzunov et al. 2021a, b). In these papers some genetically proved species were outlined as novel for the country, but here they are notified again with providing the relevant references in order to obtain a generalized summary on all data obtained by us on phytoplanktonic cyanoprokaryotes during the period 2018-2023. The potential alien character and possible transporting vectors of the species recorded for first time in the country, will be discussed elsewhere.

It has to be mentioned that there are some small differences in the number of cyanoprokaryote species in comparison with our previous paper (Stoyneva et al. 2023). They appear due to four main reasons: 1) this paper is based on samplings from four years (2018, 2019, 2021, 2023), while the former one is based on samplings from three years (2018, 2019, 2021); 2) for the purposes of the present paper all samples were once more processed taxonomically; 3) some taxonomic changes in names and synonymy currently included in Algaebase (Guiry & Guiry 2023) have been considered; 4) the average numbers for this paper were calculated separately for each sampling year, while in the paper of Stoyneva et al. (2023) the average values are calculated in a generalized way for each waterbody. After these notes, it is possible to state that all obtained data revealed significant biodiversity of Cyanoprokaryota in the sampled waterbodies (182 species) on the background of their already noticed high contribution to the biomass (Stoyneva et al. 2023).

MATERIAL AND METHODS

Sampling sites and periods

The paper is based on phytoplankton samples from 55 selected lakes, large reservoirs and microreservoirs in Bulgaria collected during three summer campaigns in June 2018, August 2019, August 2021 and July 2023 (**Table 1**, **Fig. 1**). These 55 waterbodies were sampled simultaneously for phytoplankton species composition identification and for assessment of algal biomass through HPLC (Stoyneva-Gärtner et al. 2019, 2021, 2022, 2023, this volume; Radkova et al. 2020; Stefanova et al. 2020; Uzunov et al. 2021a, b; Valskys et al. 2022). Although the sampling details and periods have been explained in the forementioned papers for completeness of the present publication we recall that: 1) the sampling campaign

Table 1. Sampling sites in Bulgarian waterbodies and their environmental parameters during summer sampling campaigns in years 2018, 2019, 2021 and 2023. Legend: Type – Type of waterbody: M (small reservoir / "microreservoir", <100 ha), R (large reservoir, >100 ha) and L (lake), 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 [mg L^{-1}], TN – total nitrogen [mg L^{-1}]. Waterbodies are presented according to their geographical location in counter-clockwise order, starting from South-Western Bulgaria. Asterisks indicate the waterbodies which are sampled for first time.

	WBN and IBW	Abbr	Type	Year	Alt	Latitude	Longitude	WT	pH	CN	TDS	DO	TP	TN
1	*Yazovir Hadzhidimovo	Hd	M	2021	156	41°29.8933'	23°50.1890'	29.1	9.5	300	192	17.00	0.1	0.1
2	*Yazovir Dubnitsa (IBW3698)	Db	M	2021	600	41°33.8500'	23°50.7500'	25.2	9.6	246	159	9.21	0.1	0.1
3	*Yazovir Ablanitsa (IBW6013)	Ab	M	2021	682	41°32.8594'	23°55.5869'	27.2	8.8	242	157	8.54	1.0	0.5
4	*Yazovir Satovcha 2 (IBW1197)	St	M	2021	1017	41°36.8222'	23°58.1446'	27.4	8.7	272	176	9.00	0.5	0.1
5	Yazovir Batak (IBW1316)	Bt	R	2023	1115	42°01.2536'	24°12.1739'	26.7	8.9	94	63	9.4	0.1	0.1
6	Yazovir Toshkov Chark (IBW1315)	TC	M	2023	1430	41°48.6333'	24°09.8833'	25.5	8.3	123	81	9.04	0.1	0.1
7	Yazovir Dospat (IBW3155)	Ds	R	2021	1214	41°39.1495'	24°89.5596'	25.9	9.9	81	52	8.73	0.1	0.5
				2021	1212	41°39.1493'	24°89.5918'	25.6	9.5	83	52	8.70	0.3	0.5
				2023	1207	41°39.4268'	24°09.5933'	27.4	8.3	78	49	8.3	0.2	0.3
8	Yazovir Golyam Beglik (IBW1314)	GB	R	2021	1540	41°48.8927'	24°07.8725'	22.0	9.1	99	63	8.92	1.5	1.0
				2023	1546	41°48.9792'	24°07.7179'	24.1	8.1	92	59	8.56	0.5	0.5
9	Yazovir Shiroka Polyana (IBW3144)	SP	R	2021	1550	41°46.1776'	24°08.8201'	25.3	8.9	66	42	8.70	0.5	0.5
				2023	1534	41°46.1722'	24°08.8157'	25.4	7.7	59	38	8.32	0.3	0.1
10	Yazovir Beglika (IBW3141)	Bg	M	2021	1535	41°49.7963'	24°07.8196'	21.7	9.1	242	157	9.11	1.0	0.8
				2023	1515	41°49.8081'	24°07.8460'	19.6	7.9	200	130	9.5	0.5	0.1
	WBN and IBW	**Abbr**	**Type**	**Year**	**Alt**	**Latitude**	**Longitude**	**WT**	**pH**	**CN**	**TDS**	**DO**	**TP**	**TN**

11	Yazovir Vucha (3143)	Vc	R	2023	546	41°54.0874'	24°26.7470'	26.4	8.9	224	144	9.52	0.1	0.1
12	Yazovir Krichim (IBW1366)	Kr	M	2023	425	41°59.5718'	24°28.0848'	23.4	8.9	219	143	10.45	1.0	0.3
13	Yazovir Ivaylovgrad (IBW2271)	Iv	R	2023	135	41°35.0193'	26°06.5330'	29.7	8.7	305	197	8.96	0.1	0.1
14	Yazovir Studen Kladenets (IBW1763)	SK	R	2023	234	41°37.0963'	25°38.4232'	31	8.8	284	183	8.94	0.1	0.1
15	Yazovir Kurdzhali (IBW1668)	Kz	R	2023	333	41°38.3578'	25°19.3461'	29.2	8.2	222	144	8.76	0.3	0.1
16	Yazovir Trakiets (IBW1677)	Tr	R	2023	259	41°52.2592'	25°25.8222'	29	8.9	346	224	9.35	0.3	0.1
17	Yazovir Rozov Kladenets (IBW2209)	RK	R	2023	111	42°08.9716'	25°53.2100'	30	9.1	970	627	11.97	0.8	0.1
18	Yazovir Malko Sharkovo (IBW2481)	MH	R	2023	243	42°06.9834'	26°51.1590'	30.6	8.5	451	293	9.54	0.5	0.3
19	*Yazovir Chetiridesette Izvora (IBW1523)	CI	M	2021	246	42°00.5510'	24°56.2819'	28.7	7.5	402	263	8.66	1.0	0.5
20	Yazovir Mechka (IBW1584)	Mc	M	2021	319	41°55.8970'	25°06.1595'	27.1	9.0	241	154	8.50	1.5	1.0
21	*Yazovir Byalata Prust-Mezek	BP	M	2021	167	41°45.1080'	26°05.2403'	29.7	8.5	291	188	9.37	2.0	1.0
22	*Yazovir Birgo (Shtit)	Br	M	2021	215	41°49.7743'	26°22.1889'	27.3	8.0	594	385	8.75	1.5	1.8
23	*Yazovir Studena (Fishera) (IBW2421)	St	M	2021	282	41°54.2136'	26°24.5964'	29.3	9.0	652	423	3.35	1.0	0.3
24	*Yazovir Mogila (Kaynaka) (IBW2626)	Mg	M	2021	166	42°29.8310'	26°36.1043'	29.2	9.5	682	442	15.75	4.0	1.0
25	*Yazovir Hadzhi Yani (Lozen-ets) (IBW2893)	HY	M	2021	12	42°12.0333'	27°47.3000'	26.1	7.5	751	488	8.42	1.5	0.8
26	Yazovir Mandra (IBW1720)	Mn	R	2018	12	42°24.0643'	27°26.1120'	25.9	8.3	649	421	6.81	3.0	3.0
				2018		42°24.0670'	27°19.1310'	26.2	8.2	663	461	5.89	6.0	4.0
				2018		42°26.1420'	27°26.5860'	24.9	8.5	639	415	7.91	4.0	3.3
	WBN and IBW	**Abbr**	**Type**	**Year**	**Alt**	**Latitude**	**Longitude**	**WT**	**pH**	**CN**	**TDS**	**DO**	**TP**	**TN**

				2019		42°24.0295'	27°19.1194'	25.8	7.9	676	436	7.93	0.7	0.5
				2019		42°25.9303'	27°26.7652'	27.2	8.5	578	375	7.87	1.5	1.8
				2021		42°24.2370'	27°19.1205'	27.3	9.0	513	333	9.32	7.0	4.0
				2021		42°25.9282'	27°26.7675'	27.3	9.0	513	333	10.70	7.5	4.0
				2023		42°24.0854'	27°19.1397'	34.4	9.5	602	391	12.7	3.0	1.0
				2023		42°25.9346'	27°26.7735'	31.6	9.1	582	378	12.66	3.5	1.0
27	Uzungeren (IBW0710)	Uz	L	2018	7	42°26.1782'	27°27.1998'	25.9	8.1	1458	9351	7.83	5.0	2.8
				2019		42°26.1551'	27°27.2235'	27.6	8.5	1748	1132	9.70	0.4	0.3
				2021		42°26.1532'	27°27.2214'	28.1	9.0	18520	12000	11.21	5.5	4.0
28	Burgasko Ezero (Vaya) (IBW0191)	BE	L	2018	0	42°30.5940'	27°22.0750'	26.9	9.7	2588	1682	12.51	13	5.4
				2018		42°28.4540'	27°25.482	28.28	8.9	1183	768	11.94	11	3.7
				2018		42°29.1850'	27°26.5310'	23.7	9.5	1024	665	7.01	12	4.6
				2019		42°30.5940'	27°22.075'	27.9	9.2	490	170	7.69	0.5	0.3
				2021		42°30.7934'	27°24.2425'	26.6	9.0	4421	2873	1.26	12	5.3
				2023	0.2	42°30.6944'	27°25.6881'	32.9	9.7	936	60.95	13.42	10	5
29	Yazovir Poroy (IBW3038)	Pr	M	2018	41	42°43.0190'	27°37.3160'	25.10	8.3	762	495	9.45	1.0	2.8
				2019		42°43.3403'	27°37.5255'	27.5	8.1	644	416	7.60	0.1	0.3
				2021		42°43.4683'	27°36.8757'	26.1	9.0	792	514	11.68	2.1	1.5
				2023		42°43.2500'	27°37.2500'	29.6	8.5	834	544	8.78	1.5	0.5
30	Yazovir Aheloy (IBW3032)	Ah	M	2018	144	42°42.8230'	27°30.9740'	25.4	8.5	614	399	8.92	1	4.1
31	*Yazovir Yunets	Yn	M	2021	79	42°55.6700'	27°45.3074'	27.4	8.5	965	765	11.00	2.5	1.8
32	Yazovir Tsonevo (IBW3022)	Ts	R	2019	75	43°01.8055'	27°24.3965'	24.8	8.8	355	231	8.20	0.1	0.1
				2021		43°01.8278'	27°24.3954'	26.6	8.0	417	272	10.65	0.1	0.1
				2023		43°01.8173'	27°24.3943'	26	8.9	454	295	9.21	0.1	0.1
	WBN and IBW	**Abbr**	**Type**	**Year**	**Alt**	**Latitude**	**Longitude**	**WT**	**pH**	**CN**	**TDS**	**DO**	**TP**	**TN**

33	Yazovir Eleshnitsa (IBW3023)	El	M	2019	44	43°00.3344'	27°28. 0744'	26.7	8.4	532	347	6.78	0.1	0.3
34	Ezeretsko Ezero (Ezerets, IBW0233)	Ez	L	2018	0	43°35.2770'	28°33.2290'	26.4	8.4	1084	10	9.94	0.5	5.3
				2019	6	43°35.2681'	28°33.2096'	25.9	8.6	1669	1739	8.58	0.1	0.1
35	Shablensko Ezero (Shabla, IBW0219)	Sb	L	2018	0	43°33.8180'	28°34.1860'	27.1	8.5	1087	706	9.97	0.1	5.1
				2019		43°33.8212'	28°34.8204'	25.9	8.7	1842	1196	9.64	0.1	1.0
36	Durankulashko Ezero (Du-rankulak, IBW0216)	Dr	L	2018	4	43°40.3240'	28°32.0470'	24.03	8.5	1111	722	7.35	21	2.8
				2018		43°40.3340'	28°32.0220'	24.7	8.2	1094	711	7.79	20	4.0
				2018		43°40.5300'	28°32.9930'	24.6	8.5	1075	698	6.19	24	3.9
				2018		43°40.6950'	28°32.6000'	26.5	8.5	1087	706	9.60	20	3.2
				2019		43°40.0006'	29°32.6166'	26.5	8.9	974	631	7.86	0.3	0.7
				2019		43°40.5355'	28°33.0806'	26.7	8.9	1048	680	6.04	0.3	0.6
				2021		43°40.6935'	28°32.6000'	25.5	9.0	2960	736	10.70	14	4.5
				2021		43°40.5300'	28°33.0826'	25.5	9.0	3008	1952	7.40	11	2.0
37	*Yazovir Plachidol 2 (IBW5073)	Pl	M	2019	220	43°33.3504'	27°52.6338'	24.6	9.0	1225	793	9.13	0.2	0.4
38	*Yazovir Malka Smolnitsa (IBW3107)	MS	M	2019	211	43°36.2606'	27°44.5367'	25.2	9.1	755	490	7.05	0.6	0.6
39	*Yazovir Preselka (IBW3078)	Ps	M	2019	281	43°25.3767'	27°16.6214'	24.1	9.0	138	282	10.05	0.6	2.8
40	*Yazovir Izvornik 2 (IBW3082)	Iz	M	2019	255	43°27.3838'	27°21.111'	24.5	9.4	389	253	13.26	9.0	4.8
41	*Yazovir Fisek (IBW2674)	Fs	M	2019	182	43°18.8453'	26°44. 3765'	27.2	8.7	690	397	7.52	0.2	0.1
42	*Yazovir Shumensko Ezero (IBW2754)	SE	M	2019	152	43°14.8140'	26°57.5675'	25.2	8.5	471	445	6.32	0.2	0.5
	WBN and IBW	**Abbr**	**Type**	**Year**	**Alt**	**Latitude**	**Longitude**	**WT**	**pH**	**CN**	**TDS**	**DO**	**TP**	**TN**

43	*Yazovir Kriva Reka (IBW3071)	KR	M	2019	133	43°22.6573'	27°10.9807'	23.7	8.4	662	428	6.24	1.0	9.0
44	Yazovir Beli Lom (IBW2810)	BL	R	2023	280	43°24.5966'	26°41.0196'	23	9.2	604	391	9.32	0.1	0.1
45	Yazovir Suedinenie (IBW2642)	Sn	R	2019	133	43°20.0734'	26°33.6368'	28.1	7.6	739	481	6.77	0.1	0.3
				2023	181	43°19.4392'	26°35.9789'	26.6	8.9	928	603	9.17	0.1	0.1
46	Yazovir Yastrebino (IBW2602)	Ys	R	2023	350	43°08.2573'	26°16.7987'	26	8.7	391	252	8.34	1.0	0.5
47	*Yazovir Nikolovo (IBW3176)	Nk	M	2021	89	43°50.9768	26°05.1796	26.0	9.8	2156	1400	11.88	11	2.0
48	Yazovir Shilkovtsi (Iovkovtsi) (IBW2105)	Sh	R	2019	410	42°55.2320'	25°47.6743'	27.2	8.9	746	479	7.48	0.03	0.1
49	Yazovir Koprinka (IBW2062)	Kp	R	2019	450	42°37.0172'	25°19.4795'	27.2	8.2	250	163	7.21	0.1	0.2
50	Yazovir Zhrebchevo (IBW2545)	Zh	R	2019	253	42°36.6024'	25°51.2345'	27.6	7.7	358	233	8.01	0.1	0.2
51	Yazovir Al. Stamboliyski (IBW2056)	AS	R	2019	190	43°07.0000'	25°07.3936'	29.4	8.9	670	433	9.82	1.4	3.5
52	Yazovir Krapets (IBW2000)	Kt	M	2019	410	43°04.0316'	24°52.3835'	28.7	8.3	870	564	7.74	0.1	1.0
53	Yazovir Sopot (IBW1437)	Sp	R	2019	376	40°00.7017'	24°52.6045'	29.0	8.3	779	490	3.44	0.1	0.1
54	*Yazovir Duvanli (IBW1483)	Dv	M	2019	250	42°23.1851'	24°43.1000'	26.3	8.8	4050	291	7.09	0.1	0.3
55	Yazovir Sinyata Reka (IBW1890)	SR	M	2018	317	42°28.1480'	24°42.2170	27.4	9.7	470	305	9.36	25	4.8
				2018		42°28.1473'	24°42.2175	26.7	9.4	468	306	9.21	27	4.3
				2019		42°28.1518'	24°42.0159'	28.2	10.4	490	317	14.76	1.0	0.2

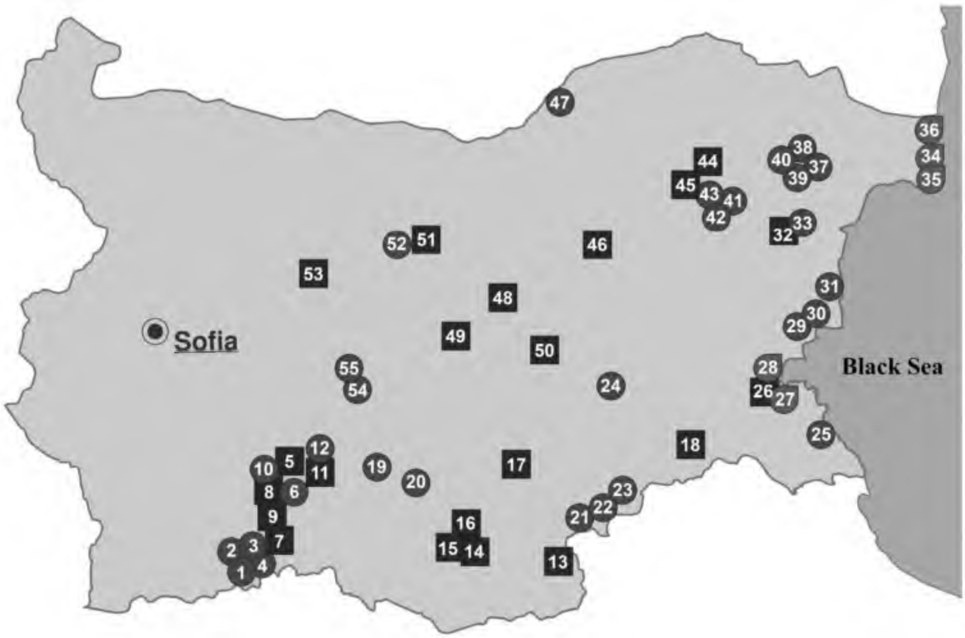


Fig. 1. Map of Bulgaria (modified after Ginkgo maps) with locations of the studied waterbodies and indication of their type. The waterbodies are represented by numbers that follow those in **Table 1**. Type of waterbody: small reservoir / ”microreservoir”, <100 ha - circle, large reservoir, >100 ha - square and lake - teardrop.

in the year 2020 was omitted during Covid-19 pandemics, and in 2020 there was no sampling campaign because of transitional reporting period of the projects; 2) different meteorological conditions led to sampling in different summer months in the years 2018, 2019, 2021 and 2023 (the last one in the end of July after cold and rainy period of April-June); 3) sampling from boats was preceded by sending of a drone for selection of the sampling sites with visible algal blooms; two types of drones have been used, both supplied by photocameras: DJI Mavic Pro, Model: M1P GL200A (SZ DJI Technology Co., LTD, Shenzhen, China) in 2018 and DJI Mavic 2 Enterprise Dual Pro (DJI Technology Co, LTD, Shenzhen, China) in 2019, 2021; 4) detailed data on the waterbodies (except for Hadzhidimovo, Byalata prust and Yunets) are available from the Database of the Inventory of Bulgarian wetlands (IBW - Michev & Stoyneva 2007) using their identification numbers provided in **Table 1**; 5) In July 2023 we visited also the reservoir Tsankov Kamuk, but it did not contain water layer; 6) 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) were done by using the Aquameter AM-200 and Aquaprobe AP-2000 from Aquaread water monitoring instruments, 2012 Aquaread Ltd, while for the ex situ measurements of the total nitrogen (TN) and total phosphorus (TP) Aqualytic AL410 Photometer from

AQUALYTIC®, Dortmund, Germany was used.

Algal identification and counting by light microscopy

This paper is based on results obtained after processing by light microscopy (LM) only of the fixed by 2-4% formalin phytoplankton samples, collected in a volume of 0.5, 1l or 1.5 L (depending on the visible trophic state) at each site from the surface layer (0-50 cm). All these fixed samples were transported in a dark box to the lab with a subsequent sedimentation 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 three times: 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; 3) in the months January - July 2023 for the needs of this paper the samples have been processed taxonomically for a third time, while samples from 2023 were looked on in July-October 2023. 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, this volume).

The algal identification, based on features used in standard European taxonomic literature (*e.g.*, Geitler 1932; Gollerbakh et al. 1953; Starmach 1966; Komárek & Anagnostidis 1999, 2005; Hindák 2008; Komárek 2013), was done under magnification 100x with application of immersion oil on non-permanent slides and later on was consulted with recent taxonomic changes in AlgaeBase (Guiry & Guiry 2023).

Algae were evaluated by their relative abundance using their frequency of appearance and biomass contribution according to the following relative scale: "rare species" - single specimens in the whole microscopic slide (<0.5% of the biomass), "occasional species" - up to five specimens (<5% of the biomass), "common, or abundant species"– six to 30 specimens in a slide (5-20% of the biomass), and dominants and sub-dominants were evaluated among the most numerous species which contributed with >20 and >25% of the biomass, respectfully (Stoyneva-Gärtner et al. 2023). For this purpose, algae have been 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 (*e.g.*, Stoyneva-Gärtner et al. 2023).

Comparison of the biodiversity of the studied reservoirs and lakes with data of other authors

The general knowledge on the aquatic cyanoprokaryote diversity is summarized in the Inventory of Bulgarian Wetlands (Stoyneva & Temniskova-Topalova 2007), in the DrSc thesis of Stoyneva (2014) and in the assessment paper by Stoyneva-

Gärtner et al. (2017). Afterwards, some data on cyanoprokaryotes from the waterbodies included in this study have been published. They concern earlier investigations of the reservoirs Eleshnitsa, Malko Sharkovo and Yasna Polyana (years 2009-2018 – Gecheva et al. 2019), Batak (year 2015 – Dochin et al. 2018), Kurdzhali (years 2015, 2016 – Dochin & Iliev 2019), Koprinka (2017 – Dochin et al. 2017), and Dospat, Studen Kladenets, Kurdzhali and Zhrebchevo (years 2016, 2017 – Dochin 2019), as well as more recent investigations of the reservoirs Mechka (year 2019 – Dochin 2022) and Aheloy (years 2020, 2021 – Dochin 2023). In addition, data on planktonic cyanoprokaryotes from some wetlands in some years, which coincide with some of our samplings were published for the coastal lake Burgasko Ezero (Vaya) (2018 - Teneva et al. 2020) and for the inland reservoirs Sinyata Reka and Koprinka (2019 - Dochin 2021). Therefore, in order to have realistic comparisons concerning diversity in similar periods, the species observed in this study have been compared in the provided taxonomic list with those published by Teneva et al. (2020) and Dochin (2021).

RESULTS AND DISCUSSION

Totally 186 cyanoprokaryotes (185 species and one variety) from 55 genera were identified, 54 of which (29%) were novel for the country. Most of the species (94, or 51%) were recorded only once, even in the case of wetlands and sites which have been repeatedly visited during all sampling campaigns. No species was found in all studied waterbodies. The most widely spread species were *Microcystis aeruginosa* (19 records), *Planktolyngbya limnetica* (17 records), *Aphanizomenon klebahnii* (16 records), *Microcystis wesenbergii* (16 records), *Aphanocapsa delicatissima* (13 records), *Cuspidothrix issatschenkoi* (12 records), *Coelomoron pusillum* (11 records), *Pseudanabaena limnetica* (11 records), *Anagnostidinema amphibium* (10 records), *Limnococcus limneticus* (10 records), *Raphidiopsis raciborskii* (10 records), and separate cells of *Microcystis* as well (15 records).

Species list of cyanoprokaryotes found in the summer phytoplankton of 55 lakes and reservoirs in Bulgaria, sampled in the years 2018. 2019, 2021 and 2023. (The list is organized in alphabetical order of the generic names, for each species the site and year of finding is indicated together with its role in the phytoplankton assemblages, based on relative frequency and biomass: x - rare, xx – common, xxx – abundant/frequent, xxxx - subdominant, xxxxx – dominant/co-dominant (Stoyneva-Gärtner et al. 2023). Taxonomical notes are provided only for species in which some taxonomical peculiarities or deviations from diagnoses have been recorded. For each species our relevant publication is provided, as it is explained in the text of the paper. Published data of other authors concerning the waterbodies sampled in the year/years, which coincide with our sampling of the certain lake or reservoir, are shown.)

CYANOPROKARYOTA

**Anabaena minderi* Huber-Pestalozzi 1938: Yunets 2021/x

Anabaena cf. *oscillarioides* Bory ex Bornet & Flahault 1886: Burgasko Ezero 2018/xx. Additional information in Stefanova et al. (2020).

Anabaena cf. *torulosa* Lagerheim ex Bornet & Flahault 1886: Burgasko Ezero 2018/xx. Additional information in Stefanova et al. (2020).

Anabaena sp. ster. 1 (straight trichomes, ?*Aphanizomenon* sp.): Mechka 2021/x, Uzungeren 2019/x

Anabaena sp. ster. 2 (straight trichomes, ?*Chrysosporum* sp.): Burgasko Ezero 2018/x. Additional information in Stefanova et al. (2020).

Anabaenopsis arnoldii Aptekar 1926: Burgasko Ezero 2018/x, Malka Smolnitsa 2019/xxx, Sinyata Reka 2019/x. Reported for Sinyata Reka in 2019 (Dochin 2021).

Anabaenopsis circularis (G. S. West) Wołoszyńska et V. V. Miller 1923: Kriva Reka 2019/xx, Duvanli 2019/x

Anabaenopsis cunningtonii W. R. Taylor 1932: Shablensko Ezero 2019/x, Malka Smolnitsa 2019/x

Anabaenopsis elenkinii V. V. Miller 1923: Mogila 2021/xxxxx, Burgasko Ezero 2021/xxx, Duvanli 2019/x, Sinyata Reka 2018/x. Additional information in Stoyneva-Gärtner et al. (2023). Reported among the dominants of Burgasko Ezero in July and September 2018 (Teneva et al. 2020).

**Anabaenopsis milleri* Woronichin 1929: Burgasko Ezero 2018/x, Izvornik 2 2019/xxxx. Additional information in Stoyneva-Gärtner et al. (2023).

**Anathece bachmannii* (Komárek & Cronberg) Komárek, Kastovsky & Jezberová 2011: Krichim 2023/xx

Anathece clathrata (West & G. S. West) Komárek, Kastovsky & Jezberová 2011: Shiroka Polyana 2023/x, Durankulashko Ezero 2018/x (cf. – single young colony). Reported as occurring in Sinyata Reka in 2019 and as dominant in Koprinka in 2019 (Dochin 2021).

**Anathece floccosa* (Zalessky) Cronberg & Komárek 1994: Durankulashko Ezero 2018/x

**Anathece minutissima* (West) Komárek, Kastovsky & Jezberová 2011: Aheloy 2018/x, Durankulashko Ezero 2021/x

Anathece smithii (Komárková-Legnerová & Cronberg) Komárek, Kastovsky & Jezberová 2011: Kriva Reka 2019/x

Anagnostidinema acutissimum (Kufferath) Strunecký, Bohunická, J. R. Johansen & J. Komárek 2017: Mogila 2021/xx

Anagnostidinema amphibium (C. Agardh ex Gomont) Strunecký, Bohunická, J. R. Johansen & J. Komárek 2017: Dubnitsa 2021/x, Ablanitsa 2021/x, Chetiridesette Izvora 2021/x, Burgasko Ezero 2018/x and 2019/x, Poroy 2018/x and 2023/x, Plachidol 2 2019/xxx, Byalata Prust 2023/x, Al. Stamboliyski 2019/x

**Anagnostidinema pseudacutissimum* (Geitler) Strunecký, Bohunická, J. R.

Johansen & J. Komárek 2017: Duvanli 2019/x

Aphanizomenon gracile Lemmermann 1907: Satovcha 2021/x, Byalata Prust 2021/x, Mandra 2018/x and 2023/x, Poroy 2019/x, Eleshnitsa 2019/xx. Reported for Sinyata Reka and Koprinka in 2019 (Dochin 2021).

Aphanizomenon klebahnii (Elenkin) Pechar & Kalina ex Komárek & Komárková 2006: Vucha 2023/x, Ivaylovgrad 2023/xxxx, Mechka 2021/xx, Byalata Prust 2021/xx, Mogila 2021/x, Hadzhi Yani 2021/xxxx, Mandra 2019/xxxxx, 2021/xxx and 2023/xxxxx, Poroy 2019/xxxxx and 2021/xxxxx, Durankulashko Ezero 2019/xx and 2021/x, Plachidol 2 2019/xxx, Yastrebino 2023/xxx, Zhrebchevo 2019/xx. Additional information in Uzunov et al. (2021b), Stoyneva-Gärtner et al. (2023). Reported among the dominants of Burgasko Ezero in July and September 2018 (Teneva et al. 2020).

Aphanizomenon yezoense M. Watanabe 1991: Studena 2021/xxxxx, Mandra 2021/xxx, Poroy 2018/xx and 2019/x, Durankulashko Ezero 2018/xx, 2019/xx and 2021/xxxx, Yastrebino 2023/xxx. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2023).

Aphanocapsa conferta (West & G. S. West) Komárková-Legnerová & Cronberg 1994: Burgasko Ezero 2023/x, Poroy 2023/xxx, Birgo 2021/xx, Studena 2021/x, Koprinka 2019/xx

Aphanocapsa delicatissima West & G. S. West 1912: Dospat 2021/x, Shiroka Polyana 2021/x, Golyam Beglik 2021/x, Mechka 2021/x, Burgasko Ezero 2018/x, Poroy 2019/x, Aheloy 2018/xx, Eleshnitsa 2019/xx, Burgasko Ezero 2018/x, Durankulashko Ezero 2019/x, Fisek 2019/x, Shumensko Ezero 2019/xxxx, Sopot 2019/xx. Additional information in Stoyneva-Gärtner et al. (2023). Reported for Sinyata Reka in 2019 (Dochin 2021).

Aphanocapsa elachista West & G.S.West 1894: Mandra 2023/x

**Aphanocapsa fusco-lutea* Hansgirg 1893: Kriva Reka 2019/xxxx

Aphanocapsa grevillei (Berkeley) Rabenhorst 1865: Tsonevo 2023/x

Aphanocapsa holsatica (Lemmermann) G. Cronberg & Komárek 1994: Hadzhi Yani 2021/xxxx, Burgasko Ezero 2018/x and 2023/xxx, Durankulashko Ezero 2018/xxxx and 2019/xx, Izvornik 2 2019/xxx. Additional information in Stoyneva-Gärtner et al. (2023).

Aphanocapsa incerta (Lemmermann) G. Cronberg & Komárek 1994: Burgasko Ezero 2018/x, Durankulashko Ezero 2018/xx and 2019/x, Suedinenie 2019/x

Aphanocapsa nubila Komárek & H. J. Kling 1991: Aheloy 2018/x, Durankulashko Ezero 2018/x, Plachidol 2 2019/x, Yastrebino 2023/xxx, Al. Stamboliyski 2019/x

Aphanocapsa planctonica (G. M. Smith) Komárek & Anagnostidis 1995: Toshkov Chark 2023/x, Izvornik 2 2019/xx

Aphanocapsa sp.: Trakiets 2023/x

Aphanothece elabens (Meneghini) Elenkin 1936: Duvanli 2019/xx

Arthrospira platensis Gomont 1892: Shablensko Ezero 2019/x

*_Aulosira_ cf. _fertilissima_ S. L. Ghose 1924: Malko Sharkovo 2023/x
*_Borzia brevis_ (Kufferath) Anagnostidis 2001: Poroy 2018/x
Borzia trilocularis Cohn ex Gomont 1892: Shiroka Polyana 2021/x, Trakiets 2023/x
*_Chroococcopsis gigantea_ Geitler 1925: Golyam Beglik 2023/x
Chroococcus distans (G. M. Smith) Komárková-Legnerová & Cronberg 1994: Plachidol 2 2019/x
Chroococcus minimus (Keissler) Lemmermann 1904: Satovcha 2 2021/x
Chroococcus minutus (Kützing) Nägeli 1849: Ablanitsa 2021/xx (cf.), Hadzhi Yani 2021/x (cf.), Durankulashko Ezero 2018/xxx, Shumensko Ezero 2019/xx
*_Chroococcus limneticus_ var. _elegans_ G. M. Smith 1918: Durankulashko Ezero 2019/xx, Plachidol 2 2019/x
*_Chroococcus obliteratus_ Richter 1885: Malko Sharkovo 2023/xx
Chroococcus sp.: Poroy 2023/x
Chrysosporum bergii (Ostenfeld) E. Zapomelová, O. Skácelová, P. Pumann, R. Kopp & E. Janecek 2012: Burgasko Ezero 2018/xx, Zhrebchevo 2019/xx. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2023).
*_Chrysosporum minus_ (Kisselev) Komárek 2012: Poroy 2021/xx, Plachidol 2 2019/xxxxx. Additional information in Stoyneva-Gärtner et al. (2023).
Chrysosporum sp. ster. (?_Sphaerospermopsis_ sp. ster./_Aphanizomenon_ sp. ster.): Burgasko Ezero 2023/x, Malka Smolnitsa 2019/xxx
Coelomoron pusillum (Van Goor) Komárek 1988: Mogila 2021/x, Byalata Prust 2021/xx, Mandra 2018/x, Preselka 2019/xx, Izvornik 2 2019/x, Kriva Reka 2019/xxxx, Yastrebino 2023/x, Suedinenie 2019/x, Al. Stamboliyski 2019/x, Sopot 2019/x, Duvanli 2019/xx. Additional information in Stoyneva-Gärtner et al. (2023).
Coelomoron sp.: Burgasko Ezero 2018/x
Coelosphaerium aerugineum Lemmermann 1898: Duvanli 2019/xx
Coelosphaerium cf. _kuetzingianum_ Nägeli 1849: Durankulashko Ezero 2019/x
*_Cronbergia paucicellularis_ Komárek, Zapomelová & Hindák 2010: Burgasko Ezero 2018/x
*_Cronbergia planctonica_ Komárek, Zapomelová & Hindák 2010: Plachidol 2 2019/x
Cuspidothrix elenkinii (I. A. Kisselev) P. Rajaniem, J. Komárek, R. Willame, P. Hrouzek, K. Kastovská, L. Hoffmann & K. Sivonen 2005: Mechka 2021/x, Byalata Prust 2021/xx (cf.), Mogila 2021/xx, Burgasko Ezero 2018/x, Durankulashko Ezero 2018/x (as _Raphidiopsis_ sp. ster.) and 2019/x, Yastrebino 2023/xxx, Koprinka 2019/x. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2022, 2023).
Cuspidothrix issatschenkoi (Usachev) P. Rajaniemi, Komárek, R. Willame, P. Hrouzek, K. Kastovská, L. Hoffmann & K. Sivonen 2005: Mogila 2021/xxxxx, Mandra 2018/x, Uzungeren 2018/x, Burgasko Ezero 2018/x, Poroy

2081/x and 2019/x, Eleshnitsa 2019/x, Durankulashko Ezero 2018/x, Plachidol 2019/x, Izvornik 2 2019/x, Duvanli 2019/x, Sinyata Reka 2018/x. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2022, 2023). Reported for Koprinka in 2019 (Dochin 2021).

**Cuspidothrix tropicalis* (Horecká & Komárek) Rajaniem & al. 2005: Byalata Prust 2021/xx, Studena 2021/xx (similar to Umezakia natans sensu Yoneda 1953 – fig. 959 in Komárek 2013), Mogila 2021/xx, Hadzhi Yani 2021/x, Burgasko Ezero 2018/x, Poroy 2018/x, Durankulashko Ezero 2018/xx, Sinyata Reka 2018/x and 2019/x. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2022, 2023).

Cyanodictyon planctonicum B. A. Mayer 1994: Batak 2023/xxxx, Golyam Beglik 2021/x, Krichim 2023/xxxxx, Mandra 2018/x, Burgasko Ezero 2018/x, Durankulashko Ezero 2018/x, Beli Lom 2023/x

Cyanodictyon reticulatum (Lemmermann) Geitler 1925: Toshkov Chark 2023/x, Durankulashko Ezero 2018/x and 2021/x

Dolichospermum cf. *affine* (only sterile trichomes): Izvornik 2 2019/x

**Dolichospermum circinale* (Rabenhorst ex Bornet & Flahault) Wacklin, Hoffmann & Komárek 2009: Beli Lom 2023/x

Dolichospermum crassum (Lemmermann) P. Wacklin, L. Hoffmann & J. Komárek 2009: Burgasko Ezero 2018/xx. Additional information in Stefanova et al. (2020).

Dolichospermum compactum (Nygaard) P. Wacklin, L. Hoffmann & J. Komárek 2009: Mogila 2021/xxx, Burgasko Ezero 2018/x, Izvornik 2 2019/xxxxx. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2023).

Dolichospermum flos-aquae (Bornet & Flahault) P. Wacklin, L. Hoffmann & Komárek 2009: Trakiets 2023/xxx, Mogila 2021/xx, Burgasko Ezero 2018/xxx. Additional information in Stefanova et al. (2020). Reported among the dominants of Burgasko Ezero in July and September 2018 (Teneva et al. 2020) and as occurring in Sinyata Reka in 2019 (Dochin 2021).

**Dolichospermum mucosum* (Komárková-Legnerová & Eloranta) Wacklin, L. Hoffmann & Komárek 2009: Izvornik 2 2019/x

Dolichospermum perturbatum (H. Hill) Wacklin, L. Hoffmann & Komárek 2009: Burgasko Ezero 2018/xxxxx, Durankulashko Ezero 2018/x, Izvornik 2 2019/xxxx. Additional information in Stefanova et al. (2020), Stoyneva-Gärtner et al. (2023).

**Dolichospermum planctonicum* (Brunnthaler) Wacklin, L. Hoffmann & Komárek 2009: Ablanitsa 2021/xxxxx, Toshkov Chark 2023/x, Golyam Beglik 2021/xxxxx, Dospat 2023/xxxx, Ivaylovgrad 2023/xx, Mechka 2021/xx, Sopot 2019/x, Yastrebino 2023/x. Additional information in Stoyneva-Gärtner et al. (2023).

Dolichospermum scheremetieviae (Elenkin) Wacklin, L. Hoffmann & Komárek

2013: Yunets 2021/xxxxx. Additional information in Stoyneva-Gärtner et al. (2023).

Dolichospermum cf. *tenericaule* (Nygaard) E. Zapomelová, O. Skácelová, P. Pumann, R. Kopp & E. Janecek 2012: Mogila 2021/xx

Dolichospermum sp. ster. 1: Byalata Prust 2021/x

Dolichospermum sp. ster. 2 (?*Chrysosporum* sp. ster.): Shiroka Polyana 2021/x, Burgasko Ezero 2018/x, Izvornik 2 2019/xx, Zhrebchevo 2019/x, Sopot 2019/x. Additional information in Stefanova et al. (2020).

Eucapsis aphanocapsoides (Skuja) Komárek & Hindák 2016: Dubnitsa 2021/x, Burgasko Ezero 2018/x, Uzungeren 2021/xx

Eucapsis microscopica (Komárková-Legnerová & G. Cronberg) Komárek & Hindák 2016: Burgasko Ezero 2018/x, Durankulashko Ezero 2021/x

Geitlerinema sp. (?*Anagnostidinema* sp.): Byalata Prust 2021/x, Burgasko Ezero 2018/x, Beli Lom 2023/x

Glaucospira laxissima (G. S. West) Simic, Komárek & Dordevic 2014: Burgasko Ezero 2018/x, Shablensko Ezero 2019/xxx, Plachidol 2 2019/xxx, Malka Smolnitsa 2019/xx, Preselka 2019/xxx, Duvanli 2019/xxxxx. Additional information in Uzunov et al. (2021b).

Gloeocapsa sp. (colorless mucilage, cell content destroyed, single colony of 8 cells): Izvornik 2 2019/x

Gomphosphaeria aponina Kützing 1836: Burgasko Ezero 2018/x

Jaaginema geminatum (Schwabe ex Gomont) Anagnostidis & Komárek 1988: Duvanli 2019/x

Jaaginema gracile Anagnostidis & Komárek 1988: Uzungeren 2021/x, Izvornik 2 2019/xx

**Jaaginema metaphyticum* Komárek 1988: Malka Smolnitsa 2019/x

**Jaaginema subtilissimum* (Kützing ex Forti) Anagnostidis & Komárek 1988: Beglika 2023/x

Kamptonema chlorinum (Kützing ex Gomont) Strunecký, Komárek & J. Smarda 2014: Burgasko Ezero 2023/xx

Komvophoron cf. *constrictum* (Szafer) Anagnostidis & Komárek 1988: Durankulashko Ezero 2021/x

Komvophoron schmidlei (Jaag) Anagnostidis & Komárek 1988: Burgasko Ezero 2023/xxx

Lemmermanniella pallida (Lemmermann) Geitler 1942: Duvanli 2019/x

Leptolyngbya cf. *tenuis* (Gomont) Anagnostidis & Komárek 1988: Kurzdhali 2023/xx

Leptolyngbya cf. *valderiana* (Gomont) Anagnostidis & Komárek 1988: Krichim 2023/x

Limnococcus limneticus (Lemmermann) Komárková, Jezberová, O. Komárek & Zapomelová 2010: Byalata Prust 2019/x, Studena 2021/x, Aheloy 2018/x, Tsonevo 2021/x, Durankulashko Ezero 2018/x and 2019/x, Fisek 2019/x, Suedinenie 2019/xx, Nikolovo 2021/x, Duvanli 2019/xx

**Limnothrix mirabilis* Anagnostidis 2001: Uzungeren 2018/xx, Poroy 2018/xxxx. Additional information in Stoyneva-Gärtner et al. (2023).

Limnothrix planctonica (Wołoszyńska) Meffert 1988: Toshkov Chark 2023/x (cf.), Burgasko Ezero 2021/x, Poroy 2021/x, Yunets 2021/x (cf.), Durankulashko Ezero 2019/x

Limnothrix redekei (Goor) Meffert 1988: Mandra 2018/x, Shablensko Ezero 2019/xxx, Malka Smolnitsa 2019/xxx, Preselka 2019/xxxxx. Additional information in Stoyneva-Gärtner et al. (2023). Reported among the dominants of Burgasko Ezero in April 2018 (Teneva et al. 2020).

Limnothrix sp. 1 (fragments): Birgo 2021/x

Limnothrix sp. 2 (transparent / empty cells) – Hadzhi Yani 2021/xx

**Mantellum communis* Hindák 2002: Durankulashko Ezero 2018

Merismopedia glauca (Ehrenberg) Kützing 1845: Durankulashko Ezero 2018/x, Izvornik 2 2019/x

**Merismopedia marssonii* Lemmermann 1900: Durankulashko Ezero 2018/xx

Merismopedia tranquilla (Ehrenberg) Trevisan 1845: Hadzhidimovo 2021/x, Mogila 2021/x, Durankulashko Ezero 2018/xx, Tsonevo 2021/x, Malka Smolnitsa 2019/xx, Izvornik 2 2019/xx

Merismopedia tenuissima Lemmermann 1898: Uzungeren 2018/x, Burgasko Ezero 2018/x, Aheloy 2018/x, Kriva Reka 2019/xxx

Merismopedia warmingiana (Lagerheim) Forti 1907: Burgasko Ezero 2018/x, Poroy 2018/x, Durankulashko Ezero 2018/xx and 2019/xxx, Malka Smolnitsa 2019/xxx, Preselka 2019/x

Microcrocis cf. *obvoluta* (Tiffany) T. H. Frank & A. G. Landman, nom. inval. 1988: Burgasko Ezero 2018/x

Microcystis aeruginosa (Kützing) Kützing 1846: Mogila 2021/xx, Mandra 2018/x, 2019/xx, 2021/xxxx and 2023/xxxx, Uzungeren 2019/x, Burgasko Ezero 2018/x and 2021/xx, Poroy 2021/xxx, Durankulashko Ezero 2018/xxx and 2021/xxxx, Plachidol 2 2019/xx, Malka Smolnitsa 2019/x, Preselka 2019/x, Izvornik 2 2019/x, Koprinka 2019/x, Zhrebchevo 2019/x, Duvanli 2019/x, Sinyata Reka 2019/x. Additional information in Radkova et al. (2020), Stoyneva-Gärtner et al. (2021, 2023), Uzunov et al. (2021a, b). Reported as occurring in Koprinka and as a dominant in Sinyata Reka in June 2019 together with *Aphanizomenon flos-aquae* Ralfs ex Bornet et Flahault, in July 2019 together with *Pseudanabaena mucicola* (Dochin 2021).

Microcystis botrys Teiling 1942: Burgasko Ezero 2018/x, Durankulashko Ezero 2018/x. Additional information in Radkova et al. (2020).

Microcystis cf. *botrys* Teiling 1942: Burgasko Ezero 2018/x. Additional information in Radkova et al. (2020).

**Microcystis comperei* Komárek 1984: Izvornik 2 2019/xx, Duvanli 2019/x. Additional information in Uzunov et al. (2021a, b).

Microcystis firma (Kützing) Schmidle 1902: Durankulashko Ezero 2018/x

Microcystis flos-aquae (Wittrock) Kirchner 1898: Hadzhidimovo 2021/x, Mogila 2021/xx, Burgasko Ezero 2018/x, Mandra 2021/x, Durankulashko Ezero 2018/x, Izvornik 2 2019/xx. Additional information in Radkova et al. (2020).

**Microcystis microcystiformis* (Hindák) Joosten 2006: Izvornik 2 2019/x

Microcystis natans Lemmermann ex Skuja 1934: Durankulashko Ezero 2018/x, Izvornik 2 2019/xx, Zhrebchevo 2019/x, Duvanli 2019/xxx. Additional information in Radkova et al. (2020), Uzunov et al. (2021a, b).

Microcystis cf. *natans* Lemmermann ex Skuja 1934: Duvanli 2019/x. Additional information in Uzunov et al. (2021a).

**Microcystis novacekii* (Komárek) Compère 1974: Burgasko Ezero 2018/x, Mandra 2018/xx. Additional information in Radkova et al. (2020), Uzunov et al. (2021b), Stoyneva-Gärtner et al. (2023).

Microcystis cf. *novacekii* (Komárek) Compère 1974: Burgasko Ezero 2018/x, Poroy 2018/x. Additional information in Radkova et al. (2020), Stoyneva-Gärtner et al. (2023).

**Microcystis pseudofilamentosa* Crow 1923: Mogila 2021/x, Plachidol 2 2019/x, Malka Smolnitsa 2021/x, Duvanli 2019/x. Additional information in Uzunov et al. (2021a).

**Microcystis smithii* Komárek & Anagnostidis 1995: Studena 2021/x, Mandra 2018/x, Uzungeren 2021/xx, Burgasko Ezero 2021, Durankulashko Ezero 2018/x, Malka Smolnitsa 2019/xx, Zhrebchevo 2019/x, Sinyata Reka 2019/x. Additional information in Radkova et al. (2020), Uzunov et al. (2021a, b).

Microcystis cf. *viridis* (A. Braun) Lemmermann 1903: ?Poroy 2019/x, ?Ezerets 2019/x, Malka Smolnitsa 2019/x, Preselka 2019/x, ?Koprinka 2021/x, Zhrebchevo 2021/x, Duvanli 2019/x. Additional information in Stoyneva-Gärtner et al. (2021, 2023), Uzunov et al. (2021a).

Microcystis wesenbergii (Komárek) Komárek ex Komárek 2006: Mandra 2019/x, 2021/xxx and 2023/xxxxx, Burgasko Ezero 2018/x, Poroy 2019/x, Durankulashko Ezero 2018/x, Plachidol 2 2019/xx, Malka Smolnitsa 2019/xx, Preselka 2019/x, Izvornik 2 2019/xx, Kriva Reka 2019/xxxxx, Nikolovo 2021/xxxxx, Koprinka 2021/x, Duvanli 2019/x, Sinyata Reka 2018/xxxxx and 2019/xxx. Additional information in Radkova et al. (2020), Stoyneva-Gärtner et al. (2021, 2022, 2023), Uzunov et al. (2021a, b). Reported as dominant in August 2019 in Sinyata Reka together with *Microcystis aeruginosa* and *Dolichospermum* cf. *spiroides* (Klebahn) Wacklin, L. Hoffman et Komárek (Dochin 2021).

Microcystis cf. *wesenbergii* (Komárek) Komárek ex Komárek 2006 (transitional form without strong mucilage): Durankulashko Ezero 2019/x, Malka Smolnitsa 2019/x, Kriva Reka 2019/xxx, Duvanli 2019/xx

Microcystis spp. (as separate cells): Uzungeren 2018/x, Poroy 2018/x, Tsonevo 2019/x, Ezeretsko Ezero 2019/x, Durankulashko Ezero 2019/x, Plachidol 2

2019/x, Malka Smolnitsa 2019/x, Preselka 2019/x, Izvornik 2 2019/xx, Fisek 2019/x, Shumensko Ezero 2019/x, Suedinenie 2019/x, Koprinka 2021/x, Zhrebchevo 2019/x, Duvanli 2019/xxxx. Additional information in Radkova et al. (2020), Uzunov et al. (2021a, b), Stoyneva-Gärtner et al. (2023).

Microcystis sp. juv.: Uzungeren 2021/x, Poroy 2019/x, Shablensko Ezero 2019/x, Preselka 2019/x. Additional information in Uzunov et al. (2021a).

**Myxobactron* sp.: Hadzhidimovo 2021/xxx, Dospat 2021/x

Oscillatoria sancta Kützing ex Gomont 1892: Mogila 2021/x

Oscillatoria simplicissima Gomont 1892: Beglika 2023/x, Mechka 2021/x, Burgasko Ezero 2021/xxxx and 2023/x. Additional information in Stoyneva-Gärtner et al. (2023).

Oscillatoria cf. *tenuis* C. Agardh ex Gomont 1892: Dubnitsa 2021/x, a 2021/x, Beli Lom 2023/x, Durankulashko Ezero 2021/x, Nikolovo 2021/x

Oscillatoria sp. 1 (?*Phormidium* sp.): Poroy 2018/x

Oscillatoria sp. 2: Burgasko Ezero 2018/x. Additional information in Stefanova et al. (2020).

**Pannus planus* Hindák 1993: Durankulashko Ezero 2018/x

**Pannus punctiferus* (Komárek & Komárková-Legnerová) Joosten 2006: Burgasko Ezero 2018/x

**Pannus spumosus* B. Hickel 1991: Durankulashko Ezero 2018/xx

Pannus sp. (fragment of colony, cells ca. 0.8 μm): Al. Stamboliyski 2019/x

Phormidium granulatum (N. L. Gardner) Anagnostidis 2001: Ezeretsko Ezero 2019/x

Phormidium inundatum Kützing ex Gomont 1892: Burgasko Ezero 2018/x

Phormidium terebriforme (C. Agardh ex Gomont) Anagnostidis & Komárek 1988: Izvornk 2 2019/x

Phormidium sp. (? Lyngbya sp.): Duvanli 2019/x

**Planktolyngbya brevicellularis* G. Cronberg & Komárek 1994: Kurdzhali 2023/x, Burgasko Ezero 2018/x and 2023/xx, Durankulashko Ezero 2019/x

Planktolyngbya limnetica (Lemmermann) Komárková-Legnerová & Cronberg 1992: Hadzhidimovo 2021/x, Trakiets 2023/xx, Chetiridessette Izvora 2021/x, Mechka 2021/x, Byalata Prust 2021/xx, Studena 2021/xxx, Burgasko Ezero 2018/x, Eleshnitsa 2018/xxxx, Shablensko Ezero 2019/xx, Durankulashko Ezero 2018/x, Plachidol 2 2019/x, Malka Smolnitsa 2019/x, Suedinenie 2019/x, Yastrebino 2023/xx, Zhrebchevo 2019/xxx, Sopot 2019/xx, Duvanli 2019/xx. Reported for Sinyata Reka and Koprinka in 2019 (Dochin 2021). Additional information in Stoyneva-Gärtner et al. (2022, 2023).

Planktolyngbya undulata Komárek & H. Kling 1991: Eleshnitsa 2019/x, Yastrebino 2023/x

Planktolyngbya sp. 1: Satovcha 2021/x, Burgasko Ezero 2023/x

Planktolyngbya sp. 2 (transparent cells): Hadzhidimovo 2021/x, Byalata Prust 2021/x Burgasko Ezero 2023/x, Mechka 2021/x, Yastrebino 2023/x

Planktothrix agardhii (Gomont) Anagnostidis & Komárek 1988: Burgasko Ezero 2018/xxxx, 2019/xx and 2021/x, Suedinenie 2019/x. Reported among the dominants of Burgasko Ezero in July and September 2018 (Teneva et al. 2020) and as occurring in Koprinka in 2019 (Dochin 2021). It has to be underlined that we observe a decline of this species, known since years as one of the most frequent species in Burgasko Ezero (Dimitrova et al. 2014; Descy et al. 2018), and its replacement by the combination *P. isothrix* and *P. suspensa* (see below).

Planktothrix isothrix (Skuja) Komárek & Komárková 2004: Burgasko Ezero 2018/xxxxx and 2019/xxxxx, Durankulashko Ezero 2019/x, Malka Smolnitsa 2019/xx, Preselka 2019/x. Additional information in Uzunov et al. (2021b), Stoyneva-Gärtner et al. (2023). Reported among the dominants of Burgasko Ezero in July and September 2018 (Teneva et al. 2020).

**Planktothrix suspensa* (Pringsheim) Anagnostidis & Komárek 1988: Satovcha 2021/xxx, Mandra 2021/xx, Burgasko Ezero 2019/xxxxx, Shablensko Ezero 2019/xx. Additional information in Uzunov et al. (2021b), Stoyneva-Gärtner et al. (2023).

Pseudanabaena articulata Skuja 1948: Mogila 2021/x, Plachidol 2 2019/x, Duvanli 2019/x

**Pseudanabaena balatonica* Scherffel & Kol 1938: Burgasko Ezero 2018/x

Pseudanabaena catenata Lauterborn 1915: Mechka 2021/x, Mandra 2018, Burgasko Ezero 2018/x and 2023/xx, Durankulashko Ezero 2018/xx

Pseudanabaena galeata Böcher 1949: Yunets 2021/x, Shablensko Ezero 2019/xxx, Durankulashko Ezero 2019/x, Izvornik 2 2019/xx

Pseudanabaena limnetica (Lemmermann) Komárek 1974: Mechka 2021/x, Burgasko Ezero 2019/x and 2023/xx, Yunets 2021/x, Eleshnitsa 2019/x, Shablensko Ezero 2019/xxxx, Plachidol 2 2019/x, Malka Smolnitsa 2019/xxxxx, Preselka 2019/xxxx, Suedinenie 2019/x, Duvanli 2019/xxxxx. Additional information in Uzunov et al. (2021b), Stoyneva-Gärtner et al. (2023). Reported for Sinyata Reka in 2019 (Dochin 2021).

Pseudanabaena mucicola (Naumann & Huber-Pestalozzi) Schwabe 1964: Hadzhidimovo 2021/x, Mandra 2023/xxxx, Durankulashko Ezero 2018/xx and 2021/xxxx, Nikolovo 2021/xxxx, Koprinka 2019/x. Additional information in Radkova et al. (2020), Stoyneva-Gärtner et al. (2023). Reported as dominant in Sinyata Reka in July 2019 together with *Microcystis aeruginosa* and as occurring in Koprinka in 2019 (Dochin 2021).

Pseudanabaena sp. 1: Dospat 2021/x. "*Pseudanabaena* sp." without notes has been reported for Sinyata Reka in 2019 (Dochin 2021).

Pseudanabaena sp. 2 (?Unconstricted form of *Ps. limnetica*): Zhrebchevo 2019/x

**Raphidiopsis acuminato-crispa* (Couvy & Bouvy) Aguilera, Berrendero Gómez, Kastovsky, Echeniqe & Salerno 2018: Mechka 2021/xxxx. Additional information in Stoyneva-Gärtner et al. (2023).

**Raphidiopsis cuspis* (Komárek & Kling) Aguilera, Berrendero Gómez, Kastovsky, Echenique & Salerno 2018: Mechka 2021/xxxx (as *R. raciborskii* p.p. in STOYNEVA-GÄRTNER ET AL. 2023), Byalata Prust 2021/xxxx, Shablensko Ezero 2019/xx

**Raphidiopsis gangetica* (G. U. Nair) Aguilera, Berrendero Gómez, Kastovsky, Echenique & Salerno 2018: Mechka 2021/xxxxx. Additional information in STOYNEVA-GÄRTNER ET AL. (2023).

**Raphidiopsis helicoidea* (Cronberg & Komárek) Aguilera, Berrendero Gómez, Kastovsky, Echenique, & Salerno 2018: Burgasko Ezero 2018/x

Raphidiopsis mediterranea Skuja 1937: Mogila 2021/xxx, Burgasko Ezero 2018/x, Shablensko Ezero 2019/xxx, Plachidol 2 2019/xxxxx, Malka Smolnitsa 2019/xxx, Suedinenie 2019/xx. Additional information in STEFANOVA ET AL. (2020), STOYNEVA-GÄRTNER ET AL. (2023).

Raphidiopsis cf. *mediterranea* Skuja 1937 (?*Raphidiopsis setigera* (Aptekarj) Eberly 1966): Burgasko Ezero 2018/x, Poroy 2018/x, Durankulashko Ezero 2019/x

**Raphidiopsis philippinensis* (W. R. Taylor) Aguilera, Berrendero Gómez, Kastovsky, Echenique & Salerno 2018: Shablensko Ezero 2019/x, Malka Smolnitsa 2019/x

Raphidiopsis raciborskii (Woloszynska) Aguilera & al. 2018: Mechka 2021/xxxxx, Byalata Prust 2021/xxxx, Mogila 2021/xxx, Uzungeren 2018/xxx, Burgasko Ezero 2018/xx, Poroy 2018/xxxx, Tsonevo 2019/xx, Shablensko Ezero 2019/xxxx, Malka Smolnitsa 2019/xxxxx, Preselka 2019/xxxx. Additional information in STEFANOVA ET AL. (2020), STOYNEVA-GÄRTNER ET AL. (2022, 2023).

Raphidiopsis setigera* (Aptekarj) Eberly 1966): Mogila 2021/xxx. The name belongs to an entity that is currently accepted taxonomically (GUIRY & GUIRY 2023). According to KOMÁREK (2013) this species, described from Ukraine, is possibly a form of *Cuspidothrix* or *Raphidiopsis* without heterocytes and akinetes. In the material from Mogila we never saw heterocytes, but very rarely wider cells (?initial akinetes – **Fig. 5, 168) have been seen below the apical cell, and once a young akinete was observed below the apical cell. It is more cylindrical than the oval akinetes of *R. mediterranea*, which does not allow us to make a strong statement. However, the often common finding of the trichomes of both species, allowed us tentatively to suppose their close relationship and the possibility *R. setigera* to be a stage of *R. mediterranea* with undeveloped akinetes. Doubtless, further molecular-genetic studies are necessary to clarify the both species.

**Raphidiopsis turcomanica* Kogan 1967: Mechka 2021/xx. Despite finding of trichomes with akinetes fitting to the diagnosis, we tentatively suppose that this is a stage of *R. mediterranea* Skuja 1937.

**Rhabdoderma compositum* (G. M. Smith) Fedorov 1967: Mandra 2018/x

Rhabdoderma lineare Schmidle & Lauterborn 1900: Burgasko Ezero 2018/x (cf., <1 µm wide), Shablensko Ezero 2019/xx

Rhabdoderma sp.: Ezeretsko Ezero 2019/x

**Romeria gracilis* (Koczwara) Koczwara 1932: Burgasko Ezero 2018/x, Ezeretsko Ezero 2018/x

Romeria simplex (Hindák) Hindák 1988: Izvornik 2 2019/xxx, Duvanli 2019/xxxxx. Additional information in Stoyneva-Gärtner et al. (2022, 2023).

Snowella arachnoidea Komárek & Hindák 1988: Durankulashko Ezero 2019

Snowella lacustris (Chodat) Komárek & Hindák 1988: Malka Smolnitsa 2019/x, Izvornik 2 2019/xx, Beli Lom 2023/x, Koprinka 2019/xxx, Zhrebchevo 2019/xx, Duvanli 2019/xx. Reported as abundant in July and dominant in August 2019 in Koprinka and as occurring in Sinyata Reka in 2019 (Dochin 2021).

Snowella litoralis (Häyrén) Komárek & Hindák 1988: Plachidol 2 2019/x, Duvanli 2019/xx. Reported among the dominants of Burgasko Ezero in April 2018 (Teneva et al. 2020).

Snowella septentrionalis Komárek & Hindák 1988: Durankulashko Ezero 2018/x

Spirulina cf. *major* Kützing ex Gomont 1892: (?*Vorticella* fragment): Burgasko Ezero 2023/x

Sphaerospermopsis aphanizomenoides (Forti) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková & Komárková 2010: Byalata Prust 2021/xx, Studena 2021/xxxxx, Mogila 2021/xxx, Burgasko Ezero 2019/x and 2021/xxxxx, Shablensko Ezero 2019/xxxxx (as "*Chrysosporum ovalisporum*" – err. typogr. in Stoyneva-Gärtner et al. 2023), Malka Smolnitsa 2019/xxx, Yastrebino 2023/x. Additional information in Stoyneva-Gärtner et al. (2023).

**Sphaerospermopsis* cf. *reniformis* (Lemmermann) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková & Komárková 2010: Studena 2021/xx

**Sphaerospermopsis torques-reginae* (Komárek) Werner, Laughinghouse IV, Fiore & Sant'Anna 2012: Sinyata Reka 2019/xxxxx. Additional information in Uzunov et al. (2021b), Stoyneva-Gärtner et al. (2022, 2023).

**Synechococcus endogloeicus* Hindák 1996: Plachidol 2 2019/x, Sinyata Reka 2018/x and 2019/xx

**Synechococcus epigloeicus* Hindák 1996: Mandra 2021/xx, Burgasko Ezero 2023/xx, Plachidol 2 2019/xx, Sinyata Reka 2019/xx

Synechococcus cf. *nidulans* (Pringsheim) Komárek 1970: Burgasko Ezero 2018/xx

Synechococcus sp. 1 (?*Cyanobium* sp.): Shablensko Ezero 2019/x

Synechococcus sp. 2 (?*Synechocystis* sp.): Krapets 2019/x

Synechocystis cf. *aquatilis* Sauvageau 1892: Uzungeren 2018/x, Burgasko Ezero 2018/x, Poroy 2018/x. Additional information in Radkova et al. (2020).

**Synechocystis endobiotica* (Elenkin & Hollerbach) Elenkin 1938: Burgasko Ezero 2018/x, Durankulashko Ezero 2018/xx and 2021/xxxx, Plachidol 2 2019/xx, Koprinka 2019/x, Sinyata Reka 2019/xxx. Additional information in Stoyneva-Gärtner et al. (2023).

Synechocystis sp. (af. *S. bigranulatus* Skuja 1933): Poroy 2019/xx

**Trichodesmium iwanoffianum* Nygaard 1926: Yunets 2021/x

Trichormus cf. *variabilis* (Kützing ex Bornet & Flahault) Komárek & Anagnostidis 1989: Toshkov Chark 2023/x

Trichormus sp. ster. 1 (af. *T doliolum* Bharadwaja) Komárek & Anagnostidis 1989): Burgasko Ezero 2018/x

Trichormus sp. ster. 2: Beli Lom 2023/xx

**Tychonema sequanum* (J. W. G. Lund) Anagnostidis & Komárek 1988: Durankulashko Ezero 2019x and 2021/x, Beli Lom 2023/x

**Wollea* sp.: Studena 2021/x

Woronichinia elorantae Komárek & Komárková-Legnerová 1992: Durankulashko Ezero 2019/xx

**Woronichinia microcystoides* (Komárek) Joosten 2006: Durankulashko Ezero 2018/x

Woronichinia naegeliana (Unger) Elenkin 1933: Yastrebino 2023/x. Reported for Koprinka in 2019 (Dochin 2021).

The highest total number of cyanoprokaryote species was found in Burgasko Ezero in the year 2018 – 55 species, followed by Durankulashko Ezero in 2018 – 34, Duvanli in 2019 – 29, Izvornik 2 in 2019 – 26 and Malka Smolnitsa in 2019 – 23 (**Fig. 2**). The lowest number (1 species) was detected in the reservoirs Batak (2023), Vucha (2023), Shiroka Polyana (2023), Tsonevo (2019, 2023), Shilkovtsi (2019) and Krapets (2019), and in the lakes Ezeretsko Ezero (2018) and Shablensko Ezero (2018). The representatives of this group have not been recorded in the samples processed from the following four reservoirs: Beglika (2021), Studen Kladenets (2023), Rozov Kladenets (2023) and Suedinenie (2023) – **Fig 2**.

With this large variation in the diversity, ranging from 0 to 55 species per site, the average contribution of cyanoprokaryotes to the summer phytoplankton of each waterbody was estimated as 8 species, or 44% of the total phytoplankton diversity (**Fig. 3**) In 12 cases their contribution exceeded 50% of the total biodiversity, being the highest in Plachidol 2 in 2019 (84%), Golyam Beglik in 2021 (80%), Burgasko Ezero 2021 and 2023 (70 and 77%), Mechka in 2021 (71%), Shumensko Ezero in 2021 (66%), Preselka in 2019 (64%), Izvornik 2 in 2019 (57%), Koprinka in 2021 (52%) and Mogila 2021 (51%) – **Fig. 3**.

Considering the total number of taxa per site, one of the results from this study has to be boldly underlined – this number varied significantly from year to year and, since the identification was done by one and the same person, we state that it reflects the real changes in the biodiversity depending on the moment conditions in the certain waterbodies. For example, in the years 2019, 2021 and 2023, after the strong spring and early summer rains, the number of cyanoprokaryotes in Burgasko Ezero was much lower – 7, 7 and 12, respectively in comparison with the drier and warmer 2018, when they were represented by 55 taxa (**Fig. 2**). In the same time, the contribution of these algae to the biodiversity in the years 2019 and 2021 was much higher (70 and 77%, respectively) than in 2018 (43%) - **Fig 3**. According to the morphology, the recorded algae were distributed as follows: 83 coccal, 52 non-heterocytous filamentous and 51 heterocytous filamentous cyanoprokaryotes. Their average contribution to the phytoplankton diversity was estimated as 4 coccal, 2 non-heterocytous and 2 heterocytous species per site. In the results below are not mentioned the waterbodies, in which cyanoprokaryotes have not been detected. The highest number of coccal unicellular and colonial species was found in Durankulashko Ezero in the year 2018 – 27, followed by Burgasko Ezero in 2018 – 23 and Duvanli in 2019 – 19 (Fig. 4). In the reservoirs with detected biodiversity

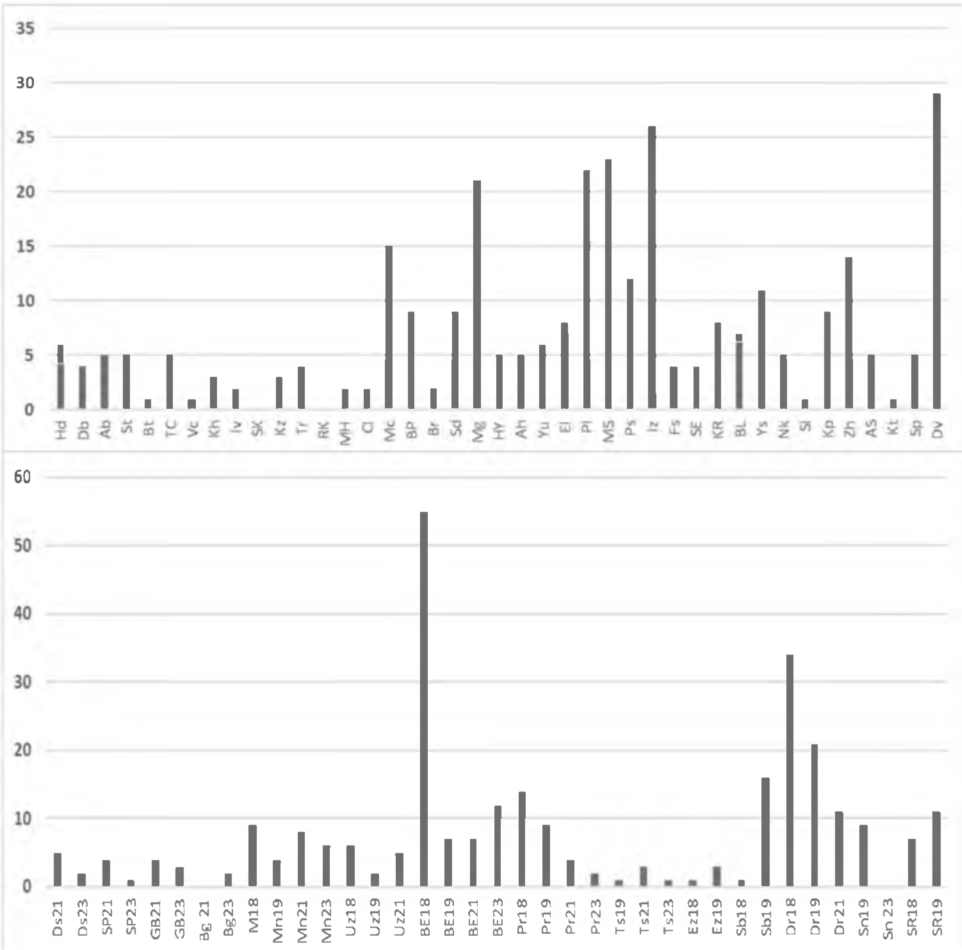


Fig. 2. Total number of cyanoprokaryote species in the summer phytoplankton of Bulgarian lakes and reservoirs sampled once (upper part of the figure) and sampled repeatedly (lower part of the figure). Abbreviations of the names of the waterbodies are according to **Table 1**.

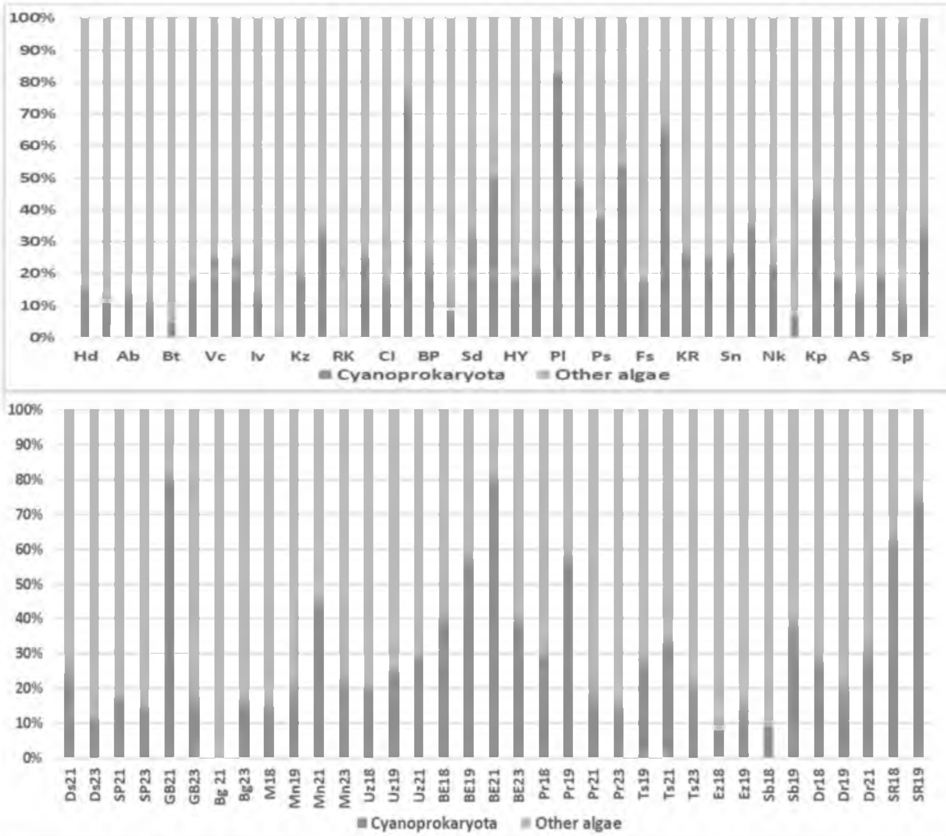


Fig. 3. Contribution of cyanoprokaryotes (%) to the total biodiversity of the summer phytoplankton of Bulgarian lakes and reservoirs sampled once (upper part of the figure) and sampled repeatedly (lower part of the figure). Abbreviations of the names of the waterbodies are according to **Table 1**, with indication of the sampling year.

of cyanoprokaryotes, their coccal representatives have not been seen in the samples from the reservoirs Dospat, Beglika, Vucha, Ivaylovgrad and Kurdzhali (all from 2023), Chetiridesette Izvora and Yunets (all from 2021), as well as in the lakes Uzungeren (2019), Shablensko Ezero (2018) – **Fig. 4**. The highest number of the non-heterocytous filamentous forms was 12 and 8 in Burgasko Ezero (2018 and 2023), followed by 7 species in the Malka Smolnitsa, and 6 species in Shablensko Ezero and Duvanli (all from 2019). These algae have not been documented: 1) in the samples from 2018 collected from Ezeretsko Ezero; 2) in 2019 samples from Mandra, Uzungeren, Poroy, Aheloy, Tsonevo, Fisek, Shumensko Ezero, Kriva Reka and Krapets; 3) in 2021 samples from Golyam Beglik, Beglika, Tsonevo and Yunets, and 4) in 2023 samples from Batak, Dospat, Shiroka Polyana, Vucha, Ivaylovgrad, Malko Sharkovo and Tsonevo. The highest number of heterocytous

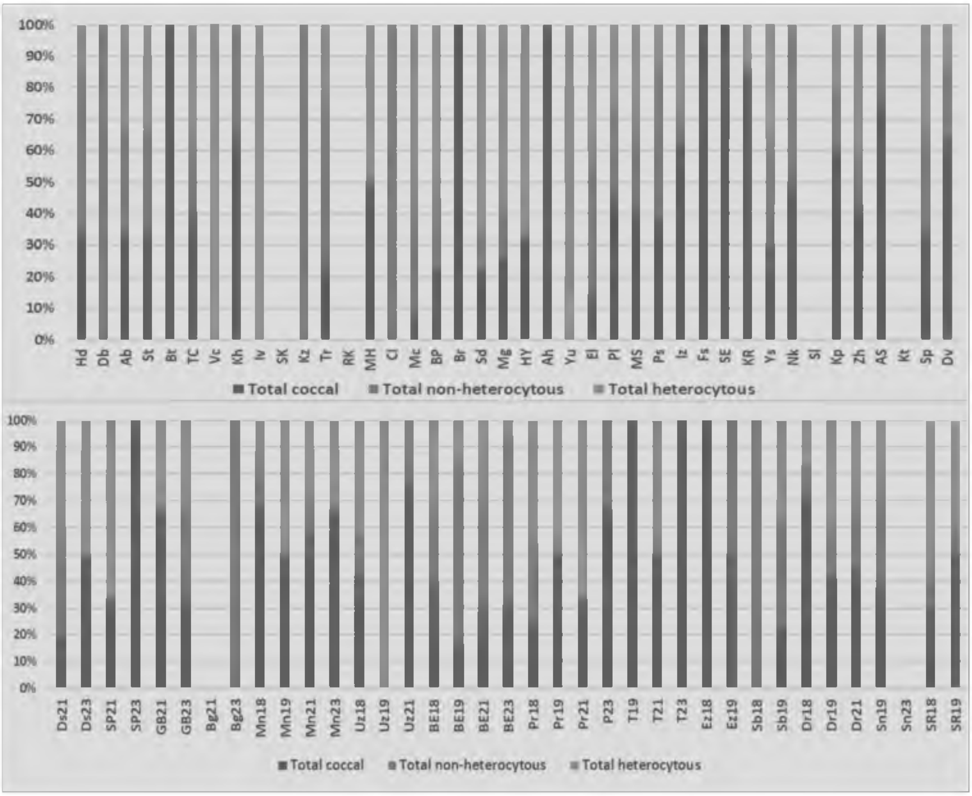


Fig. 4. Contribution of different morphological types of cyanoprokaryotes (coccal, filamentous non-heterocytous and filamentous heterocytous) to their biodiversity in of the summer phytoplankton of Bulgarian lakes and reservoirs sampled once (upper part of the figure) and sampled repeatedly (lower part of the figure). Abbreviations of the names of the waterbodies are according to **Table 1**.

filamentous taxa was recorded in the lake Burgasko Ezero in 2018 – 20, followed by 13 in the microreservoir Mogila (2021) and 8 in the microreservoir Izvornik 2 (2019) 2021 – **Fig. 4**. Heterocytous cyanoprokaryotes have not been found in the samples from Aheloy, Ezeretsko Ezero, Shablensko Ezero (all in 2018), from Tsonevo, Ezeretsko Ezero, Fisek, Shumensko Ezero, Aleksandur Stamboliyski and Krapets (all in 2019), from Hadzhidimovo, Dubnitsa, Beglika, Chetiridisette Izvora, Birgo, Uzungeren, Nikolovo (all in 2021), and from Batak, Shiroka Polyana, Beglika, Krichim, Kurdzhali, Poroy and Tsonevo (all in 2023).

Among the most rarely spread algae, which have been recorded only once, 39 were coccal, 23 were non-heterocytous and 32 were heterocytous forms.

It is out of the scope of this paper to discuss the driving forces that favor and factors detrimental for the cyanoprokaryote biodiversity, among which currently increased the interest to the fungal parasites (*e.g.*, Rasconi et al. 2012, 2014, 2022). Although the phytoplankton algae long ago have been pointed as hosts for zoosporic parasites (*e.g.*, Skuja 1948; Canter 1950, 1972; Canter & Lund 1948, 1951), according to our best knowledge, there are no current data concerning the spread of such fungi in Bulgarian waterbodies. Therefore, here we would like to note that during all four sampling campaigns, chytrid parasites were recorded only once. Although *Sphaerospermopsis aphanizomenoides* was found eight times in seven sites, chytrids have been observed only in the microreservoir Studena (2021) on some of the trichomes and have been tentatively identified as *Rhizosiphon anabaenae* (Rodhe & Skuja) Canter 1951 (Syn. *Phlyctidium anabaenae* Rodhe & Skuja 198) – **Fig. 5, 176**.

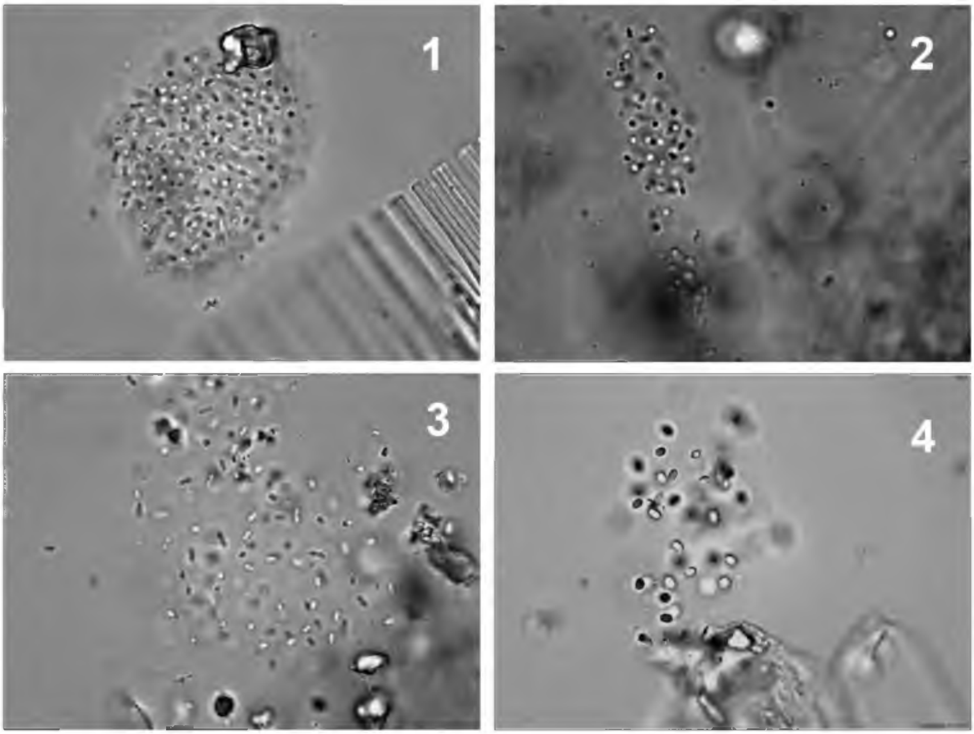
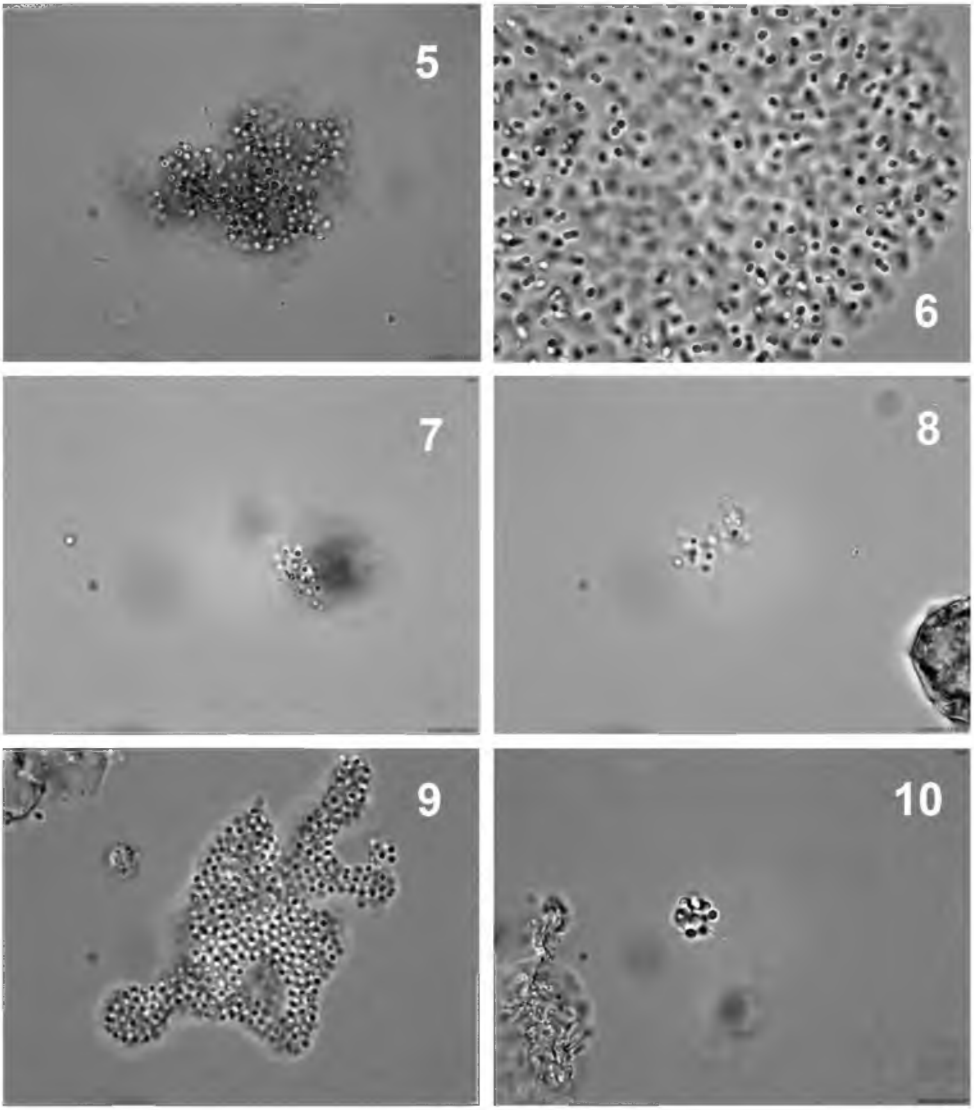
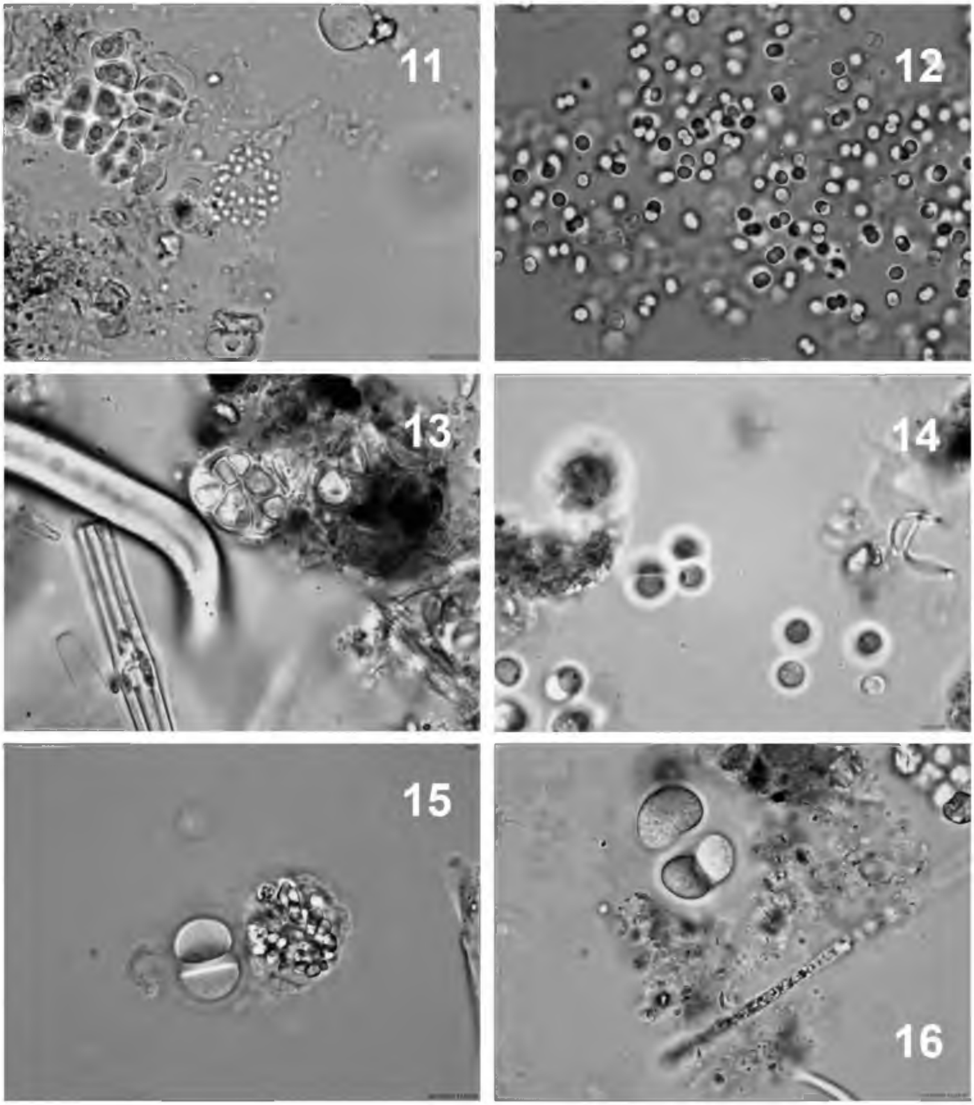


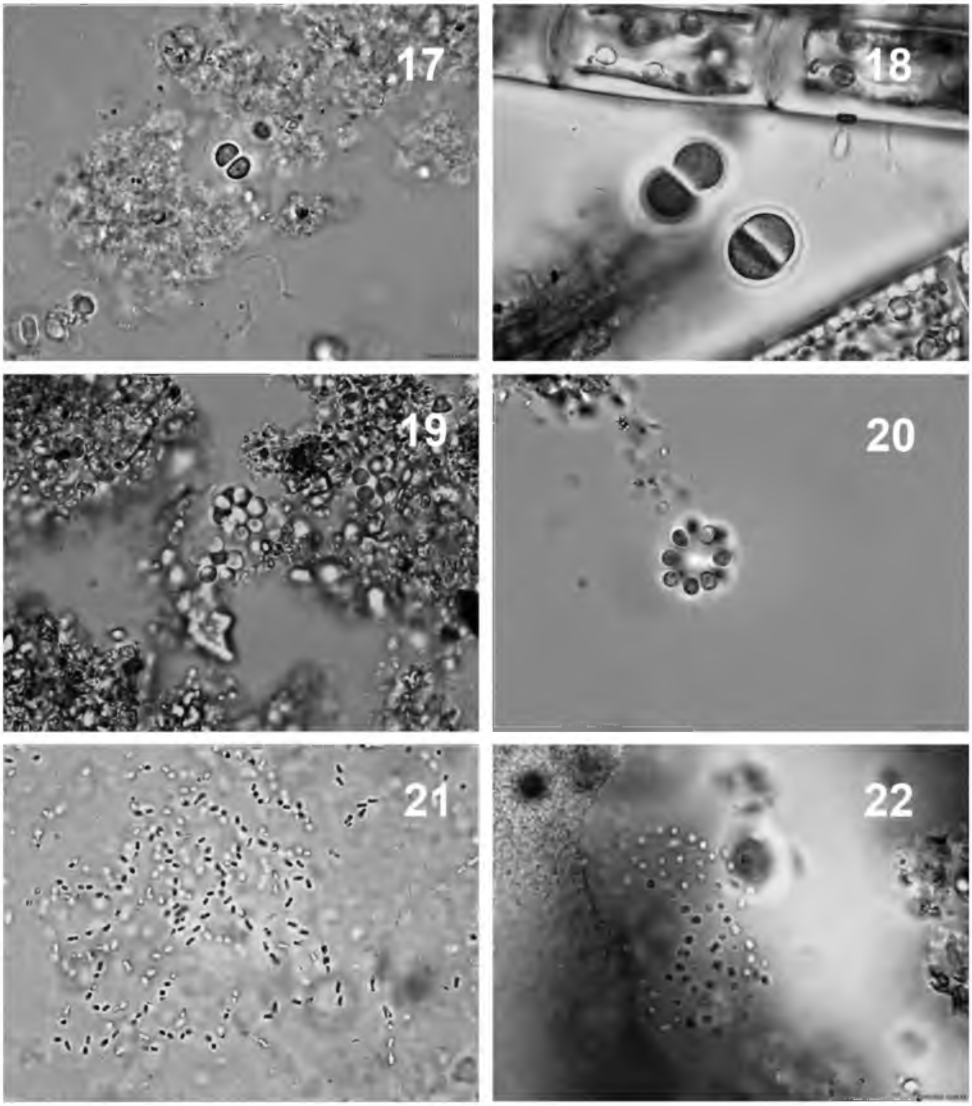
Fig. 5. Microphotos of cyanoprokaryotes from the phytoplankton samples of 55 waterbodies in Bulgaria: **1** - *Anathece bachmannii* in reservoir Krichim (2023); **2** - *Anathece floccosa* in lake Durankulashko Ezero (2018); **3** - *Anathece minutissima* in reservoir Zhrebchevo (2019); **4** - *Anathece smithii* in reservoir Kriva Reka (2019); **5** - *Aphanocapsa fusco-lutea* in reservoir Kriva Reka (2019); **6** - *Aphanocapsa conferta* in lake Burgasko Ezero (2023); **7** - *Aphanocapsa delicatissima* in reservoir Duvanli (2019); **8** - *Aphanocapsa delicatissima* in reservoir Eleshnistsa (2019); **9** - *Aphanocapsa holsatica* in lake Burgasko Ezero (2023); **10** - *Aphanocapsa incerta* in lake Durankulashko Ezero (2018); **11** - *Aphanocapsa nubila* in lake Durankulashko Ezero (2018); **12** - *Aphanocapsa planctonica* in reservoir Izvornik 2 (2019); **13** - *Chroococcopsis gi-*



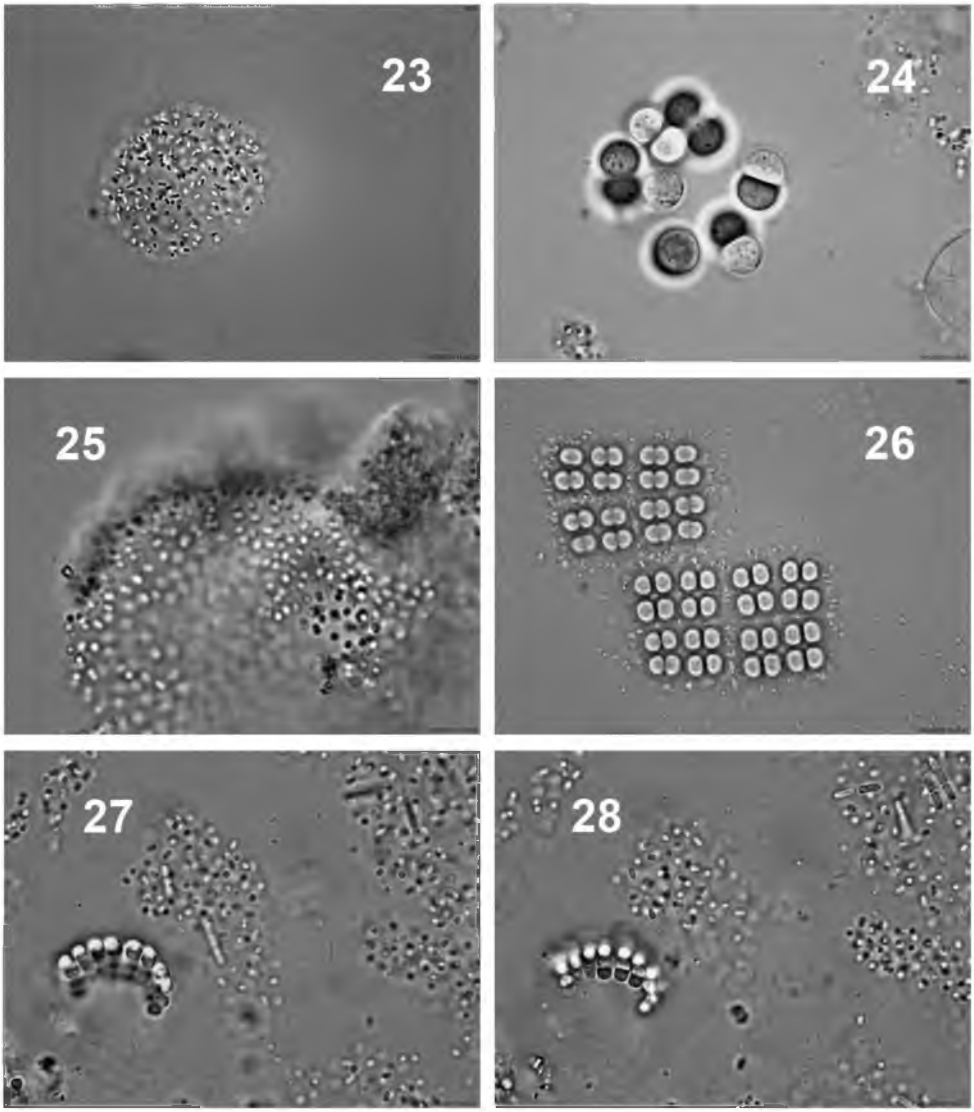
gantea in reservoir Golyam Beglik (2023); **14** - *Chroococcus distans* in reservoir Plachidol 2 (2019); **15, 16** - *Chroococcus limneticus* var. *elegans* in lake Durankulashko Ezero (2019); **17** - *Chroococcus minutus* in lake Durankulashko Ezero (2018); **18** - *Chroococcus obliteratus* in reservoir Malko Sharkovo (2023); **19** - *Coelomoron pusillum* in reservoir Izvornik 2 (2019); **20** - *Coelomoron pusillum* in reservoir Duvanli (2019); **21** - *Cyanodictyon planctonicum* in reservoir Batak (2023); **22** - *Cyanodictyon reticulatum* in lake Durankulashko Ezero (2021); **23** - *Lemmermanniella pallida* in reservoir Duvanli (2019); **24** - *Limnococcus limneticus* in lake Durankulashko Ezero (2019); **25** - *Mantellum communis* in lake Durankulashko Ezero (2018); **26** - *Merismopedia glauca* in reservoir Izvornik 2 (2019); **27, 28** - *Merismopedia marssonii* in lake Durankulashko Ezero (2018); **29** - *Merismopedia tranquilla* in lake Durankulashko Ezero (2018); **30** - *Merismopedia warmingiana* in lake Durankulashko Ezero (2019); **31** - *Microcystis*



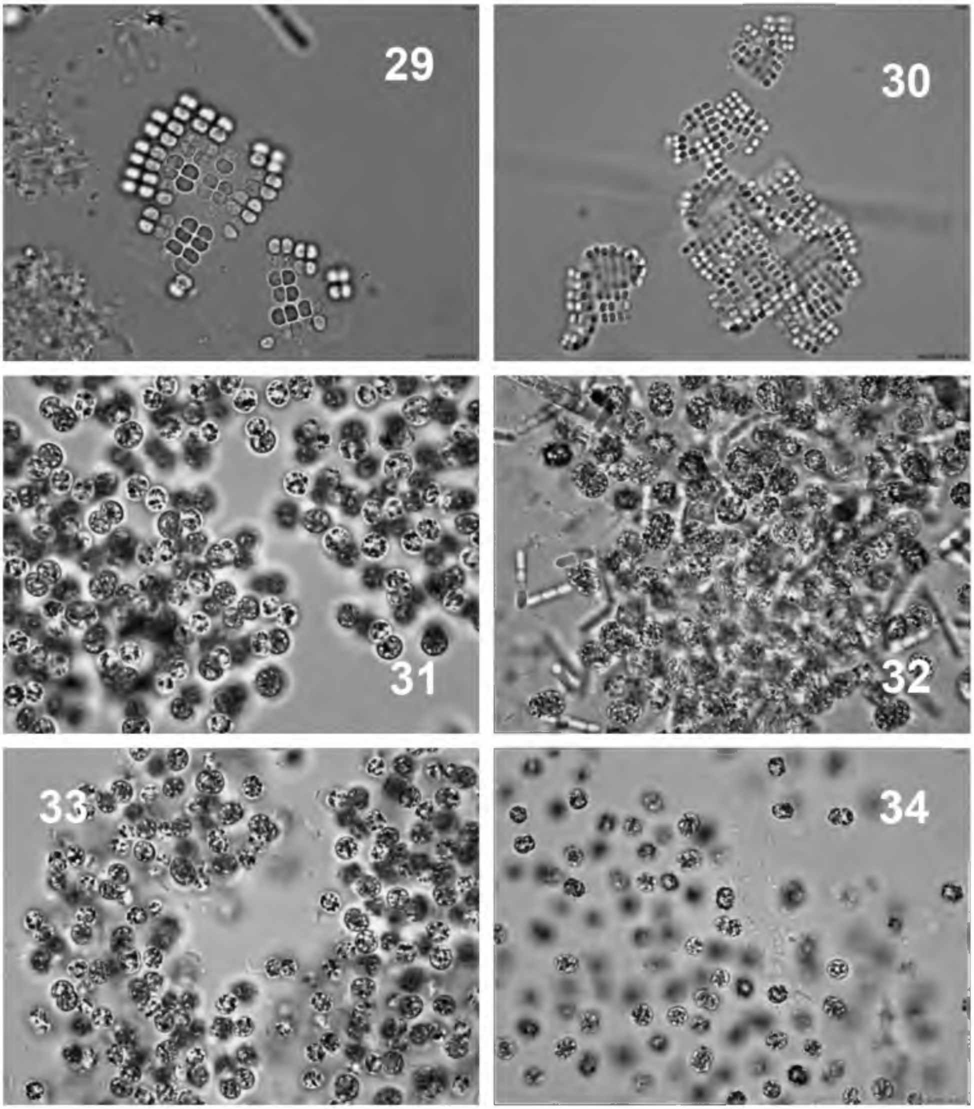
aeruginosa in lake Burgasko Ezero (2023); **32** - *Microcystis aeruginosa* with *Pseudanabena mucicola* in reservoir Mandra (2023); **33** - *Microcystis aeruginosa* with *Synechococcus epigloeicus* in lake Burgasko Ezero (2023); **34** - *Microcystis aeruginosa* with *Synechocystis endobiotica* in reservoir Sinyata Reka (2019); **35** - *Microcystis comperei* in reservoir Izvornik 2 (2019); **36** - *Microcystis firma* in lake Durankulashko Ezero (2018); **37** - *Microcystis flos-aguae* in reservoir Izvornik 2 (2019); **38** - *Microcystis microcystiformis* in reservoir Izvornik 2 (2019); **39** - *Microcystis natans* in reservoir Zhrebchevo (2019); **40** - *Microcystis novacekii* in reservoir Mandra (2018); **41** - *Microcystis pseudofilamentosa* in reservoir Plachidol 2 (2019); **42** - *Microcystis smithii* in reservoir Zhrebchevo (2019); **43** - *Microcystis* cf. *smithii* in reservoir Studena (2021); **44** - *Microcystis smithii* in lake Uzungeren (2021); **45** - *Microcystis wesenbergii* in reservoir Mandra (2021); **46** - *Microcystis wesenbergii* in reservoir Mandra (2023); **47** - *Pannus planus* in



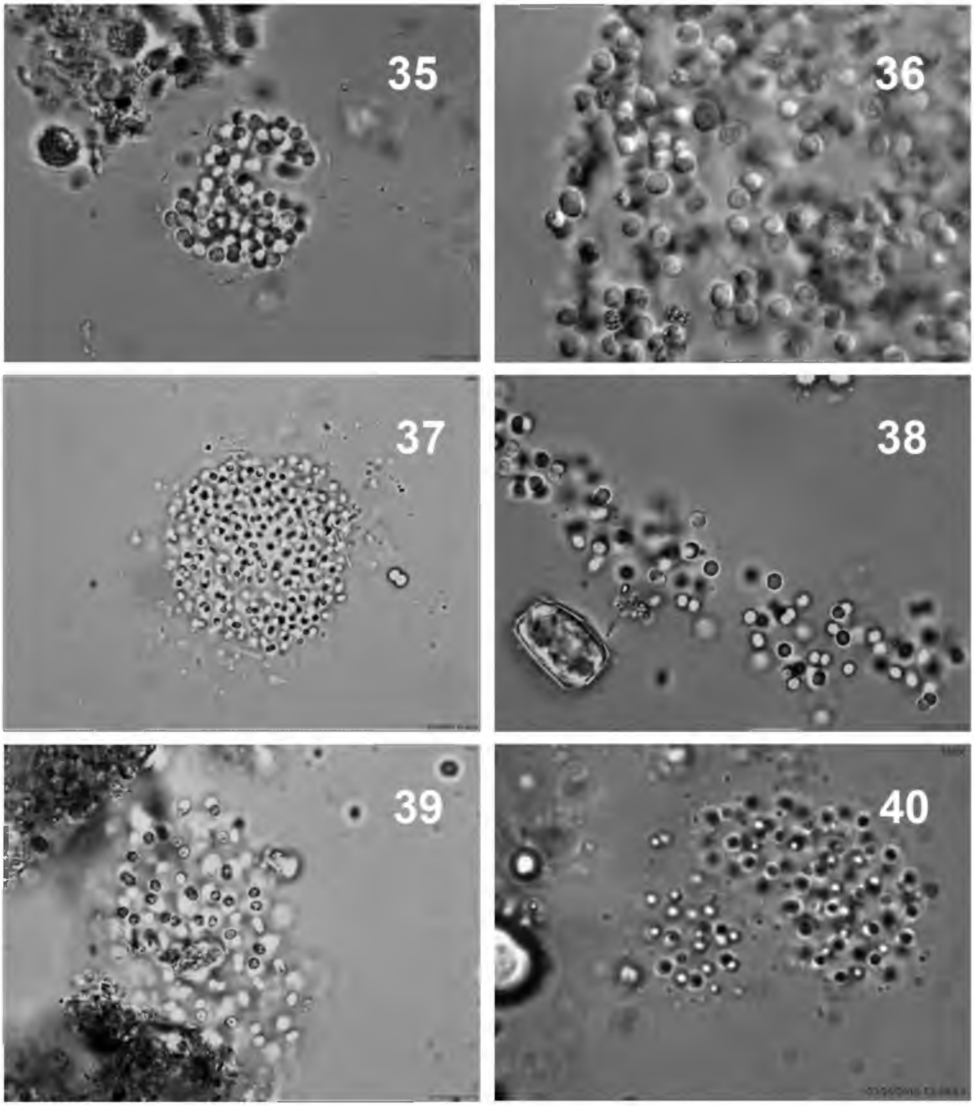
lake Durankulashko Ezero (2019); **48** - *Pannus punctiferus* in lake Burgasko Ezero (2018); **49**, **50** - *Pannus spumosus* in lake Durankulashko Ezero (2018); **51**, **52** - *Pannus spumosus* with *Synechocystis endobiotica* in lake Durankulashko Ezero (2018); **53** - *Rhabdoderma compositum* in reservoir Mandra (2018); **54** - *Rhabdoderma lineare* in lake Burgasko Ezero (2018); **55** - *Rhabdoderma lineare* in lake Shablensko Ezero (2019); **56** - *Rhabdoderma* sp. in lake Ezeretsko Ezero (2019); **57**, **58** - *Snowella arachnoidea* – the same colony at different focus in lake Durankulashko Ezero (2019); **59**, **60** - *Snowella lacustris* in reservor Zhrebchevo (2019); **61** - *Snowella lacustris* in reservoir Duvanli (2019); **62** - *Snowella septentrionalis* in lake Durankulashko Ezero (2018); **63**, **64** - *Synechocystis endogloeicus* in *Microcystis wesenbergii* in reservoir Sinyata Reka (2019); **65** - *Synechococcus epigloeicus* on *Microcystis aeruginosa* in reservoir Plachidol 2 (2019); **66** - *Synechococcus epigloeicus* on *Microcystis wesenbergii* in reservoir



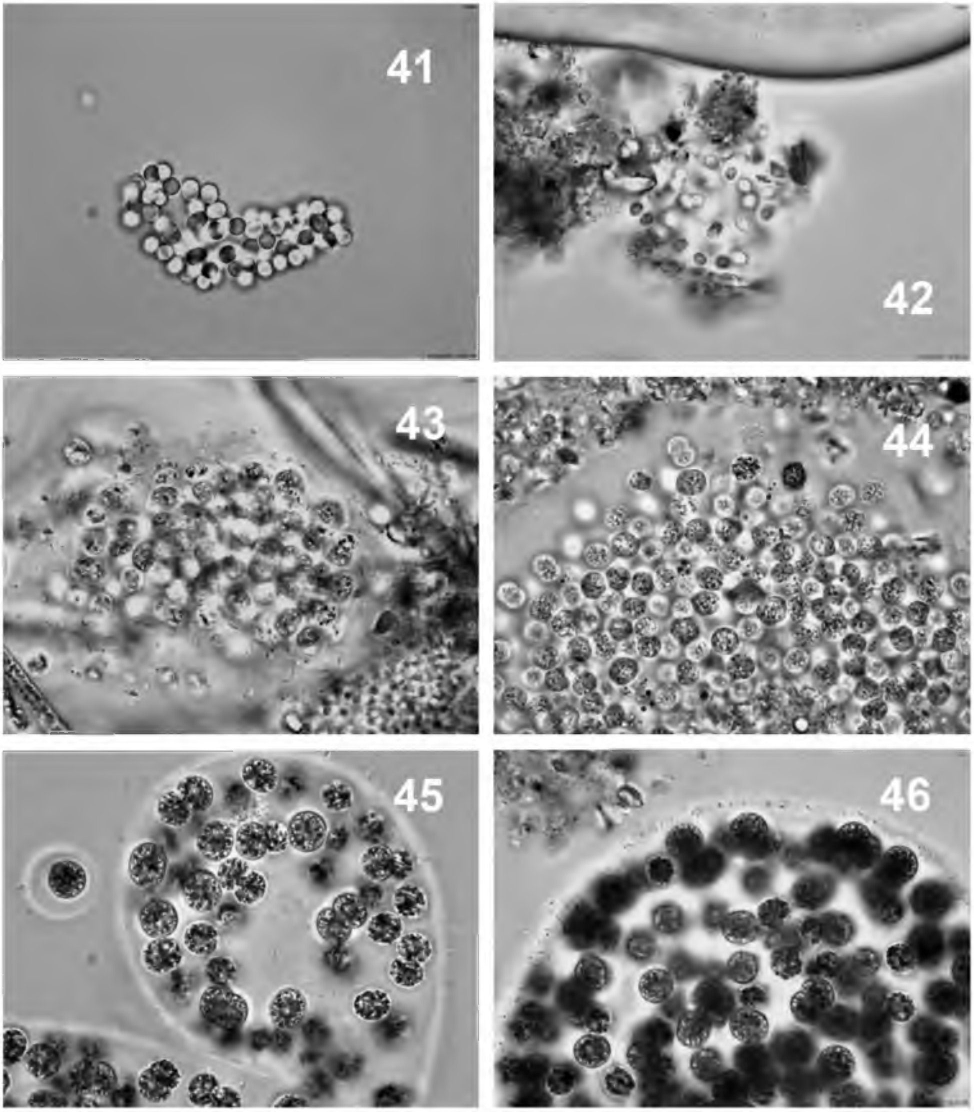
Sinyata Reka (2019); **67** - *Synechococcus* sp. (?*Cyanobium* sp.) in lake Shablensko Ezero (2019); **68** - *Synechococcus* sp. in reservoir Poroy (2019); **69** - *Synechococcus* sp. (?*Synechocystis* sp.) in reservoir Krapets (2019); **70** - *Synechocystis endobiotica* in *Microcystis aeruginosa* in lake Durankulashko Ezero (2018); **71**, **72** - *Woronichinia microcystoides* – the same colony at two focuses in lake Durankulashko Ezero (2018); **73** - *Woronichinia elorantae* in lake Durankulashko Ezero (2019); **74** - *Woronichinia naegeliana* in reservoir Yastrebino (2023); **75** - *Anagnostidinema amphibium* in reservoir Plachidol 2 (2019); **76** - *Anagnostidinema pseudoacutissimum* in reservoir Duvanli (2019); **77** - *Borzia brevis* in reservoir Poroy (2018); **78** - *Borzia trilocularis* in reservoir Shiroka Polyana (2021); **79** - *Glaucospira laxissima* in lake Shablensko Ezero (2019); **80** - *Glaucospira laxissima* in reservoir Duvanli (2019); **81** - *Jaaginema gracile* in reservoir Izvornik 2 (2019); **82** - *Jaaginema metaphyticum* in reservoir Malka Smolnitsa (2019); **83**



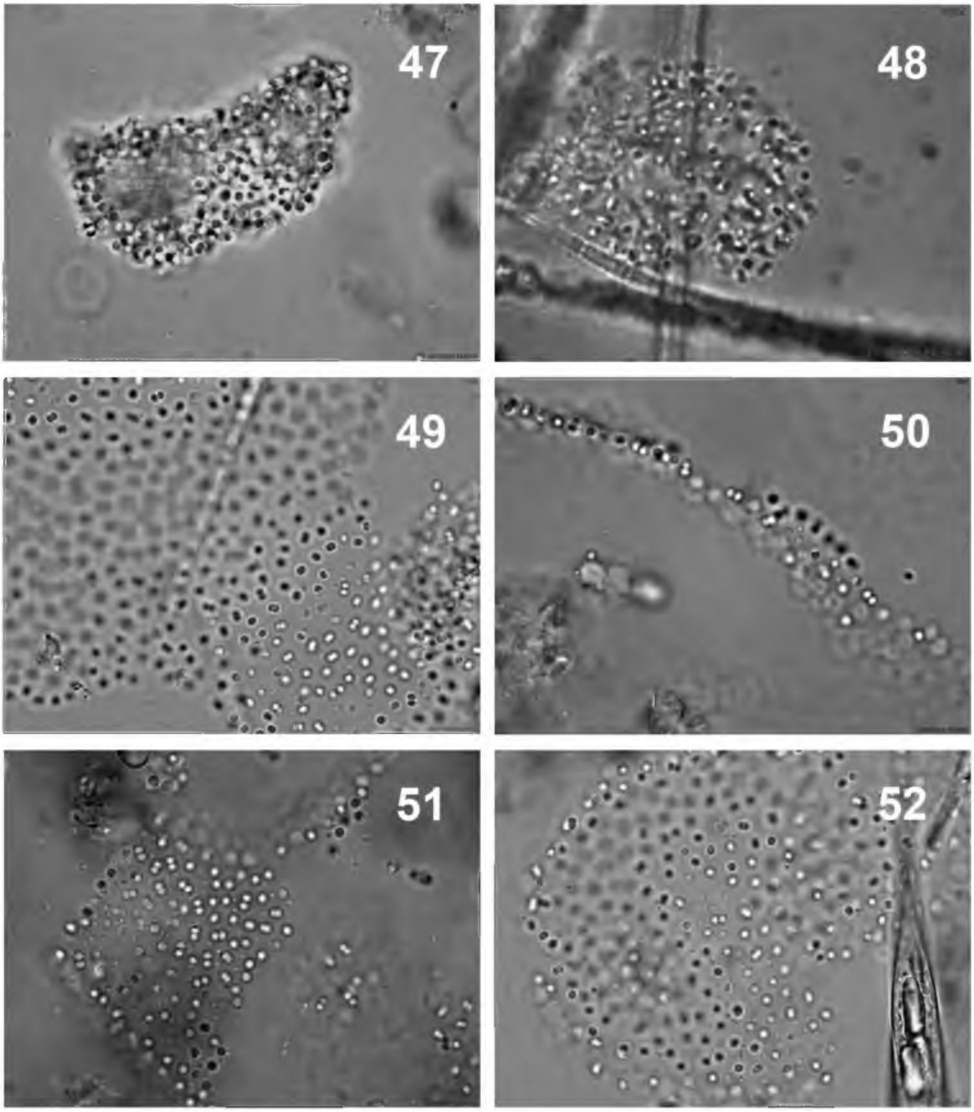
- *Jaaginema subtilissimum* in reservoir Beglika (2023); **84** - *Kamptonema chlorinum* in lake Burgasko Ezero (2023); **85** - *Komvophoron* cf. *constrictum* in lake Durankulashko Ezero (2021); **86** - *Komvophoron schmidlei* in lake Burgasko Ezero (2023); **87**, **88** - *Limnothrix mirabilis* in reservoir Poroy (2018); **89**, **90**, **91** - *Limnothrix mirabilis* – typical fragmentation without necridic cells in reservoir Poroy (2018); **92** - *Limnothrix planctonica* in reservoir Poroy (2021); **93** - *Limnothrix redekii* in lake Shablensko Ezero (2019); **94** - *Limnothrix redekei* in reservoir Preselka (2019); **95** - *Limnothrix* sp. 2 (transparent cells) in reservoir Hadzhi Yani (2021); **96** - *Myxobactron* sp. in reservoir Hadzhidimovo (2021); **97** - *Oscillatoria simplicissima* in lake Burgasko Ezero (2021); **98** - *Oscillatoria sancta* in reservoir Mogila (2021); **99** - *Oscillatoria tenuis* with necridic bands in reservoir Nikolovo (2021); **100** - *Oscillatoria* cf. *tenuis* with necridic bands in reservoir Dubnitsa (2021); **101** - *Planktolyngbya articulata* in reservoir Mogila



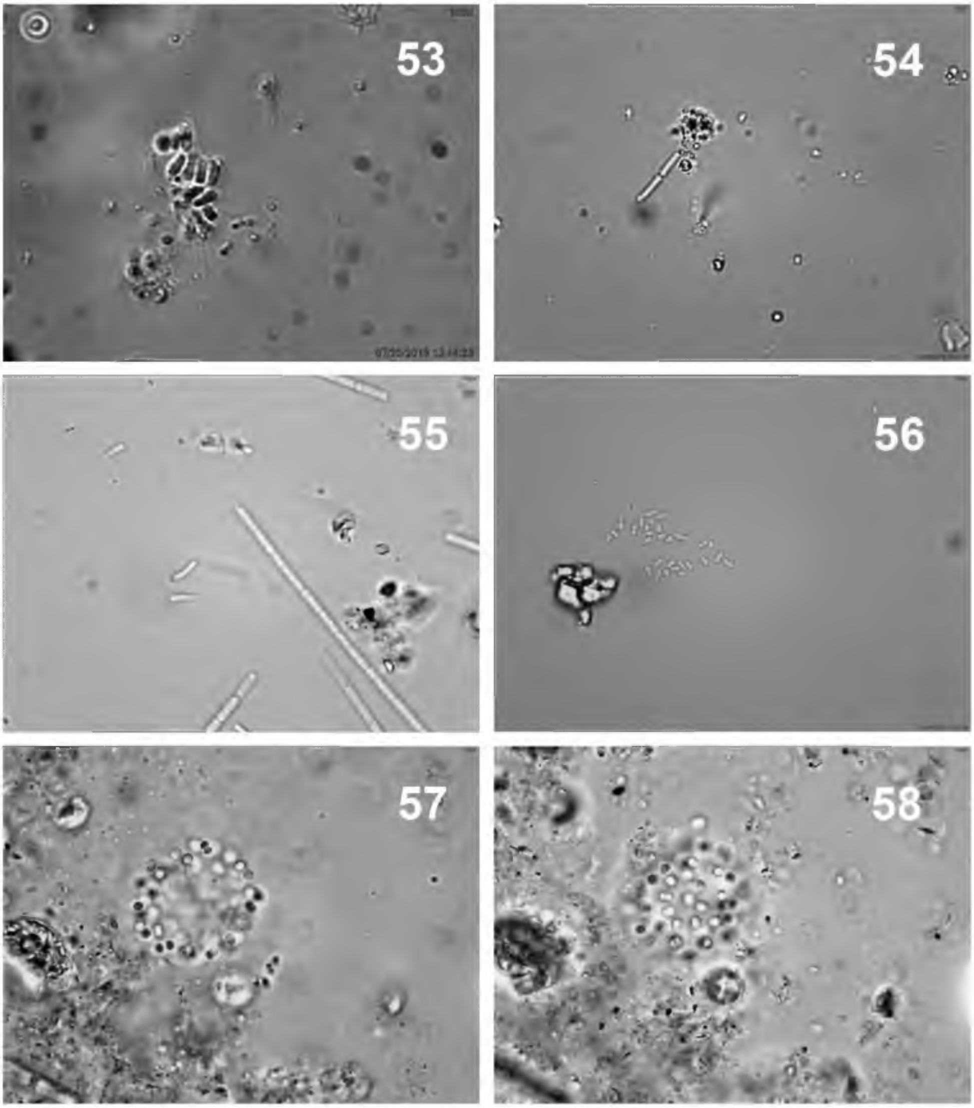
(2021); **102** - *Planktolyngbya brevicellularis* in reservoir Kurdzhali (2023); **103, 104** - *Planktolyngbya brevicellularis* – trichome and hormogonium in lake Burgasko Ezero (2023); **105** - *Planktolyngbya limnetica* in reservoir Yastrebino (2023); **106** - *Planktolyngbya limnetica* in reservoir Studena (2021); **107** - *Planktolyngbya* sp. in reservoir Satovcha (2021); **108** - *Planktolyngbya* sp. (transparent cells) in reservoir Mechka (2021); **109** - *Planktothrix agardhii* in lake Burgasko Ezero (2019); **110, 111** - *Planktothrix isothrix* in lake Burgasko Ezero (2019); **112** - *Planktothrix isothrix* in reservoir Preselka (2019); **113, 114** - *Planktothrix suspensa* – apical cell and part of trichome with well visible isodiametric cells - in lake Burgasko Ezero (2019); **115** - *Planktothrix suspensa* in reservoir Satovcha 2 (2021); **116** - *Planktothrix suspensa* in reservoir Mandra (2021); **117** - *Pseudanabaena galeata* in reservoir Yunets (2021); **118** - *Pseudanabaena limnetica* in lake Burgasko Ezero (2019); **119** - *Pseudanabaena mucicola* - in lake



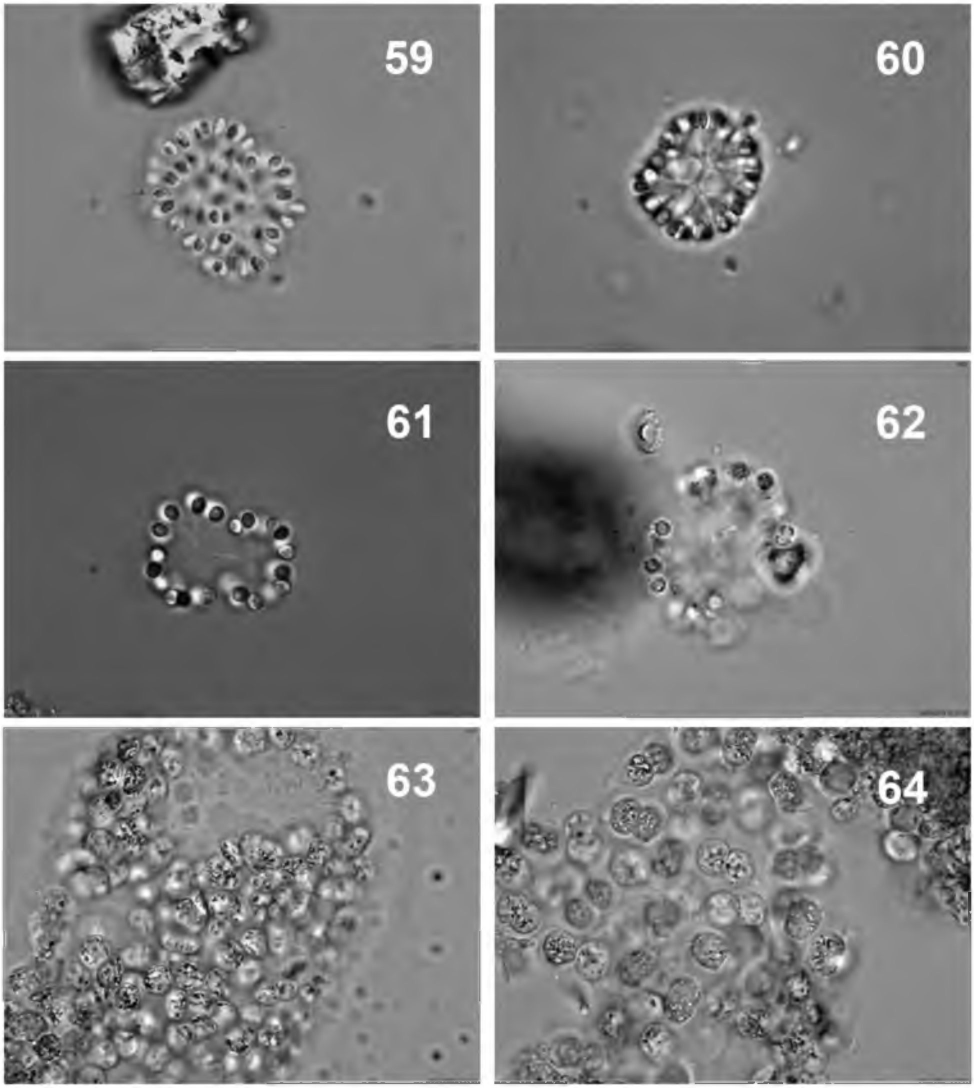
Durankulashko Ezero (2021); **120** - *Pseudanabaena mucicola* on *M. wesenbergii* in reservoir Nikolovo (2021); **121** - *Pseudanabaena* sp. 2 in reservoir Zhrebchevo (2019); **122** - *Romeria simplex* in reservoir Duvanli (2019); **123** - *Romeria gracilis* in lake Ezeretsko Ezero (2018); **124** - *Spirulina* cf. *major* in lake Burgasko Ezero (2023); **125** - *Trichodesmium iwanoffianum* in reservoir Yunets (2021); **126** - *Tychonema sequanum* in lake Durankulashko Ezero (2021); **127** - *Anabaena minderi* in reservoir Yunets (2021); **128** - *Anabaena* cf. *tenericaule* in reservoir Mogila (2021); **129** - *Anabaenopsis circularis* in reservoir Duvanli (2019); **130** - *Anabaenopsis cunningtonii* in reservoir Malka Smolnitsa (2019); **131** - *Anabaenopsis milleri* in reservoir Izvornik 2 (2019); **132** - *Aphanizomenon klebahnii* in reservoir Yastrebino (2023); **133**, **134** - *Aphanizomenon klebahnii* trichome with apical cell and trichome with akinete in reservoir Mandra (2019); **135** - *Aphanizomenon yezoense* in reservoir Studena (2021); **136** - *Aphanizomenon grac-*



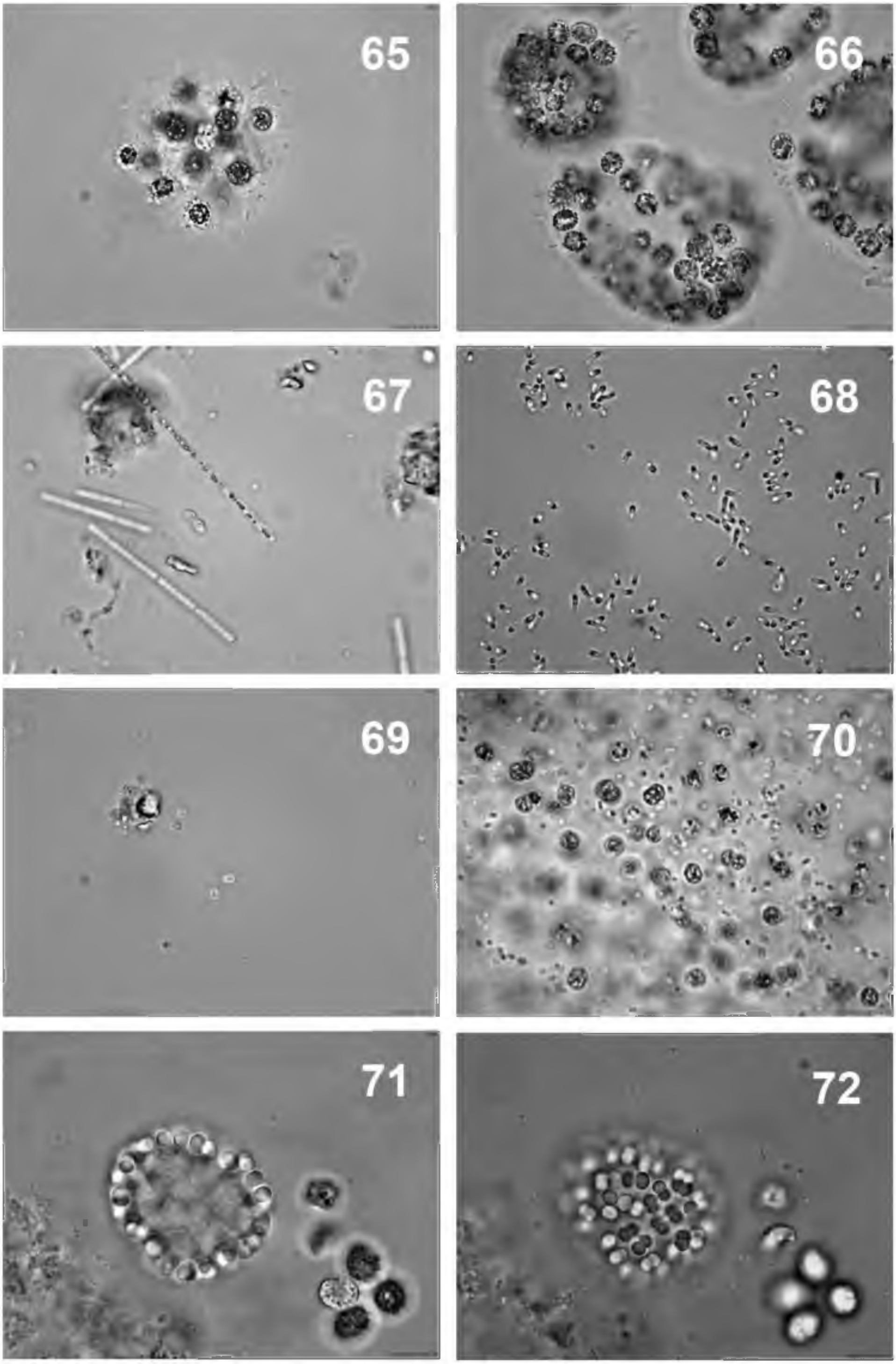
ile in reservoir Byalata Prust (2021); **137** - *Aulosira* cf. *fertilissima* in reservoir Malko Sharkovo (2023); **138** - *Cronbergia paucicellularis* in lake Burgasko Ezero (2018); **139** - *Cronbergia planctonica* in reservoir Plachidol 2 (2019); **140** - *Chrysosporum bergii* with akinete in reservoir Zhrebchevo (2019); **141**, **142** - *Chrysosporum minus* in reservoir Plachidol 2 (2019); **143**, **144** - *Cuspidothrix elenkinii* with heterocyte and young akinetes in reservoir Yastrebino (2023); **145** - *Cuspidothrix tropicalis* in reservoir Byalata Prust (2021); **146** - *Cuspidothrix tropicalis* (?*Umezakia natans*) in reservoir Studena (2021); **147** - *Dolichospermum* cf. *affine* in reservoir Izvornik 2 (2019); **148** - *Dolichospermum circinale* - trichome and akinete in reservoir Beli Lom (2023); **149** - *Dolichospermum compactum* in reservoir Izvornik 2 (2019); **150** - *Dolichospermum flos-aquae* in reservoir Trakiets (2023); **151** - *Dolichospermum mucosum* – trichome with heterocyte and young akinete - in reservoir Izvornik 2 (2019); **152** - *Dolichospermum perturba-*

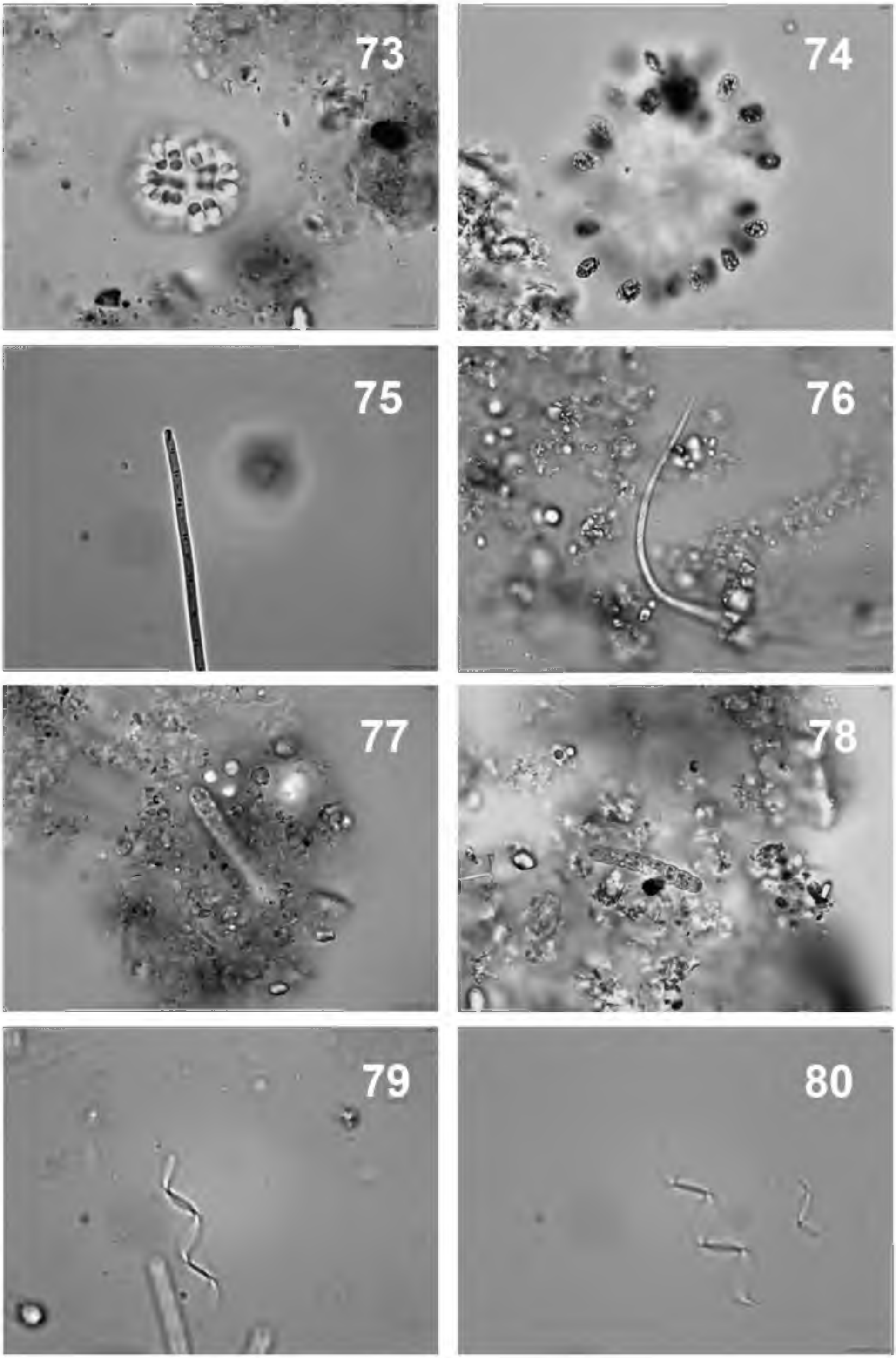


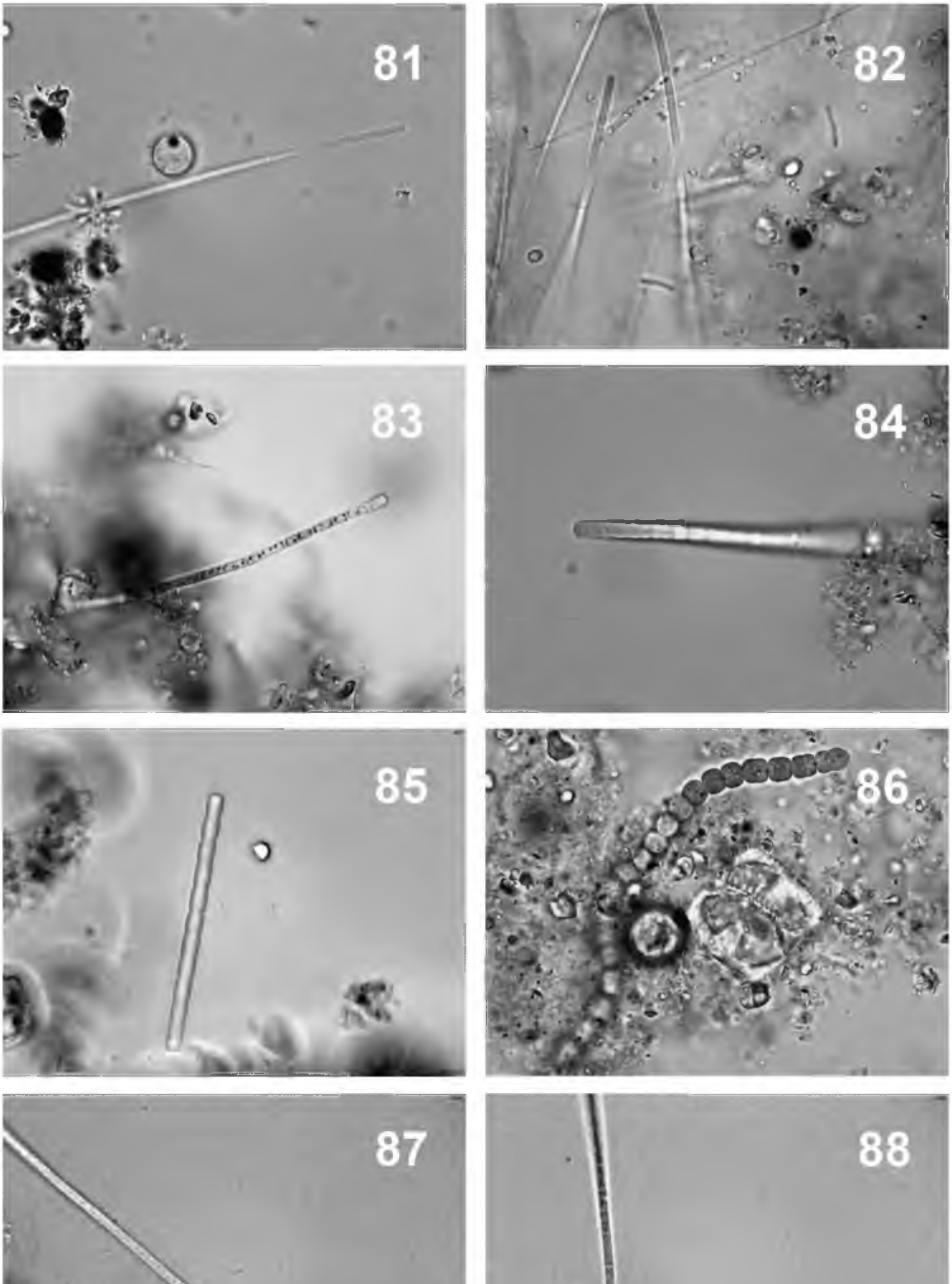
tum with akinete in reservoir Izvornik 2 (2019); **153** - *Dolichospermum perturbatum* in reservoir Izvornik 2 (2019); **154** - *Dolichospermum planctonicum* in reservoir Ablanitsa (2021); **155**, **156** - *Dolichospermum scheremetievei* -sterile and with akinete - in reservoir Yunets (2021); **157** - *Raphidiopsis cuspis* in reservoir Byalata Prust (2021); **158** - *Raphidiopsis cuspis* in reservoir Mogila (2021); **159** - *Raphidiopsis cuspis* in reservoir Mechka (2021); **160** - *Raphidiopsis mediterranea* – fragment with apical cell and an akinete – in lake Shablensko Ezero (2019); **161**, **162** - *Raphidiopsis mediterranea* – fragment with apical cell and akinete, trichome with an akinete – in reservoir Mogila (2021); **163** - *Raphidiopsis raciborskii* in lake Shablensko Ezero (2019); **164** - *Raphidiopsis raciborskii* in reservoir Eleshnitsa (2019); **165** - *Raphidiopsis raciborskii* in reservoir Malka Smolnitsa (2019); **166** - *Raphidiopsis raciborskii* – akinete and heterocyte – in reservoir Malka Smolnitsa (2019); **167** - *Raphidiopsis setigera* in lake Shablensko Ezero (2019);

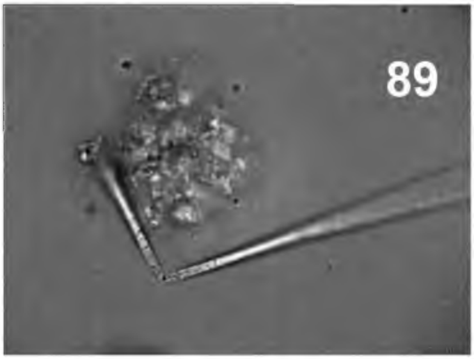
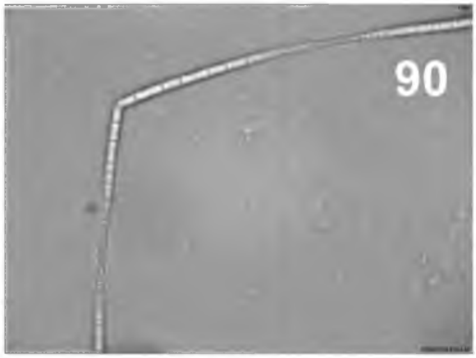
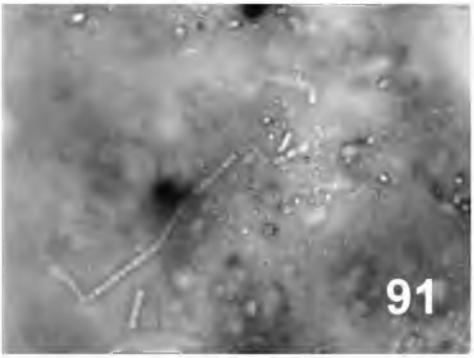


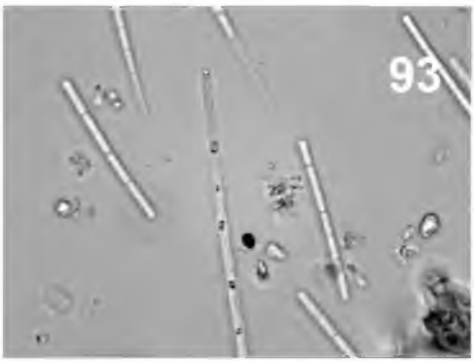
168 - *Raphidiopsis setigera* in reservoir Mogila (2021); **169, 170** - *Raphidiopsis setigera* with initial akinetes below the apical cell and with a young akinete in reservoir Mogila (2021); **171, 172** - *Raphidiopsis turcomanica* with apical hyaline cell and two akinetes in reservoir Mogila (2021); **173, 174** - *Sphaerospermopsis aphanizomenoides* with apical cell, heterocyte and akinete in lake Burgasko Ezero (2019); **175** - *Sphaerospermopsis aphanizomenoides* in lake Shablesnko Ezero (2019); **176** - *Phlyctidium anabaenae* on *Sphaerospermopsis aphanizomenoides* in reservoir Studena (2021); **177** - *Sphaerospermopsis* cf. *reniformis* in reservoir Studena (2021); **178, 179, 180, 181, 182** - *Sphaerospermopsis torqua-reginae* in reservoir Sinyata Reka (2019); **183, 184, 185, 186** - *Wollea* sp. – sterile trichomes, trichomes with young akinetes, akinete - in reservoir Studena (2023).

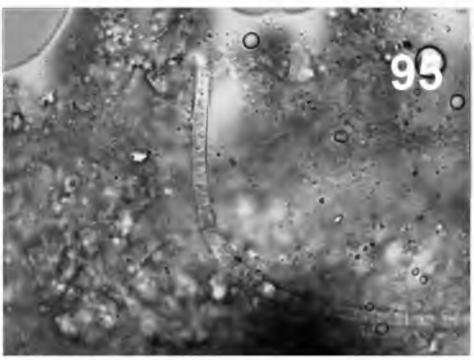
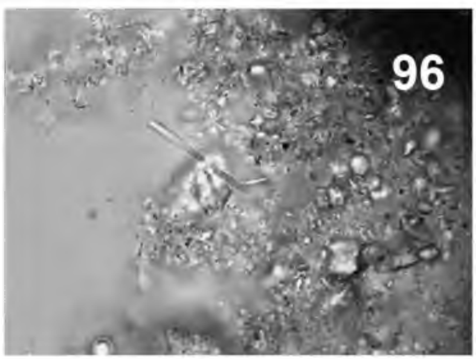

65
66
67
68
69
70
71
72

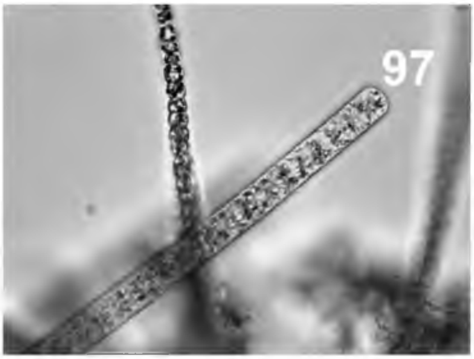

73
74
75
76
77
78
79
80


81
82
83
84
85
86
87
88

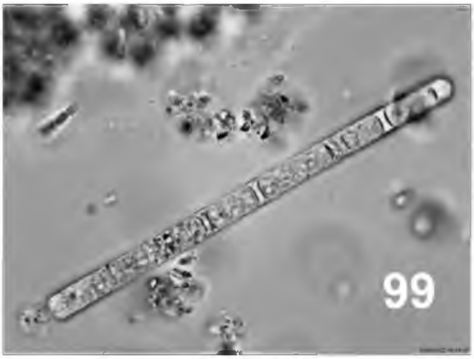

89

90

91

92

93

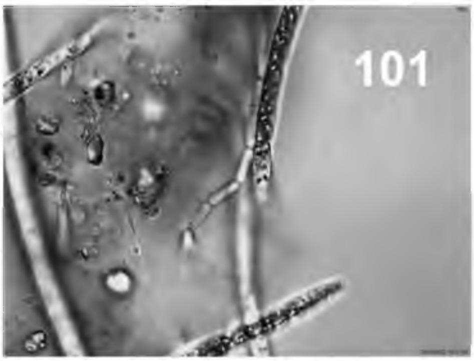
94

95

96

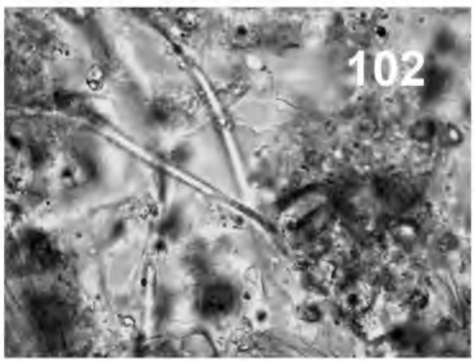

97

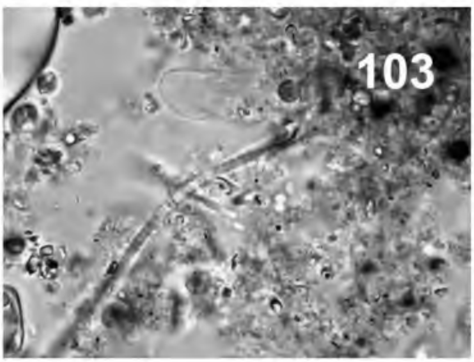

98

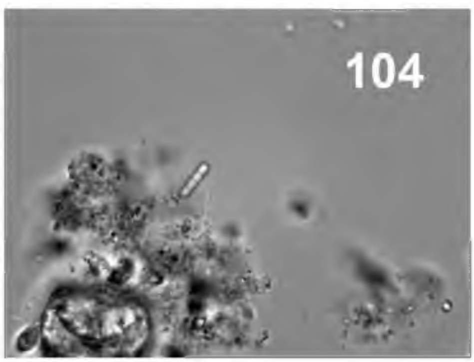

99

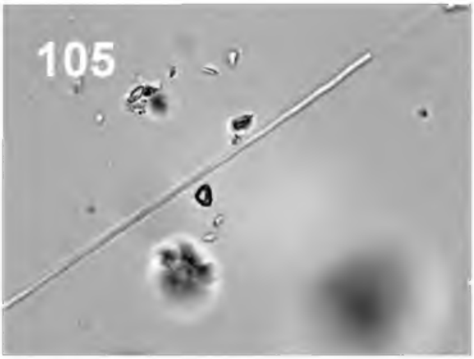
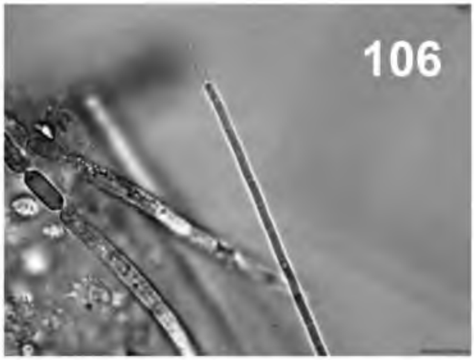
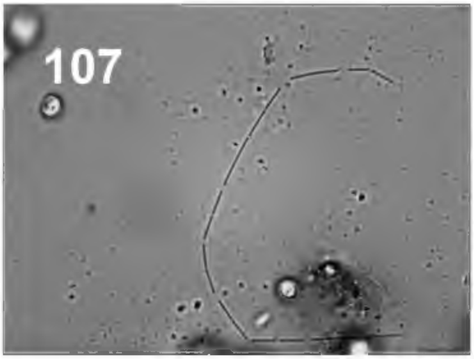
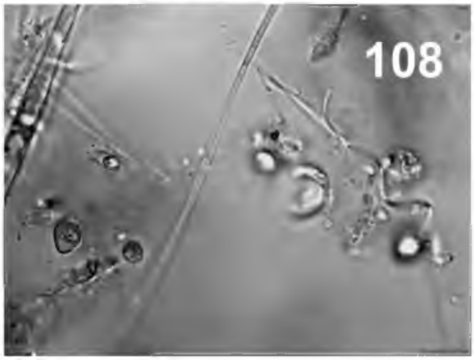
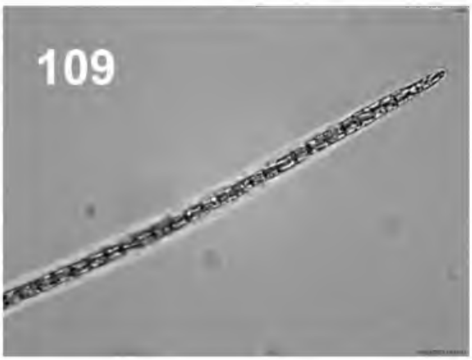
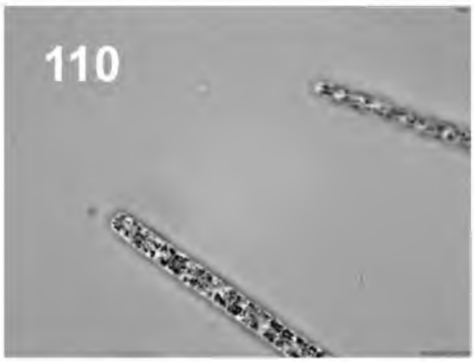
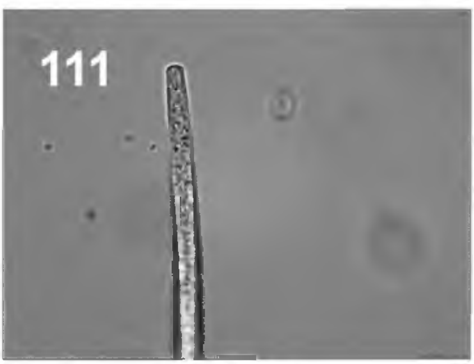
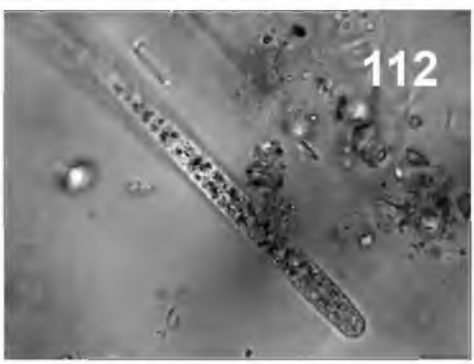

100

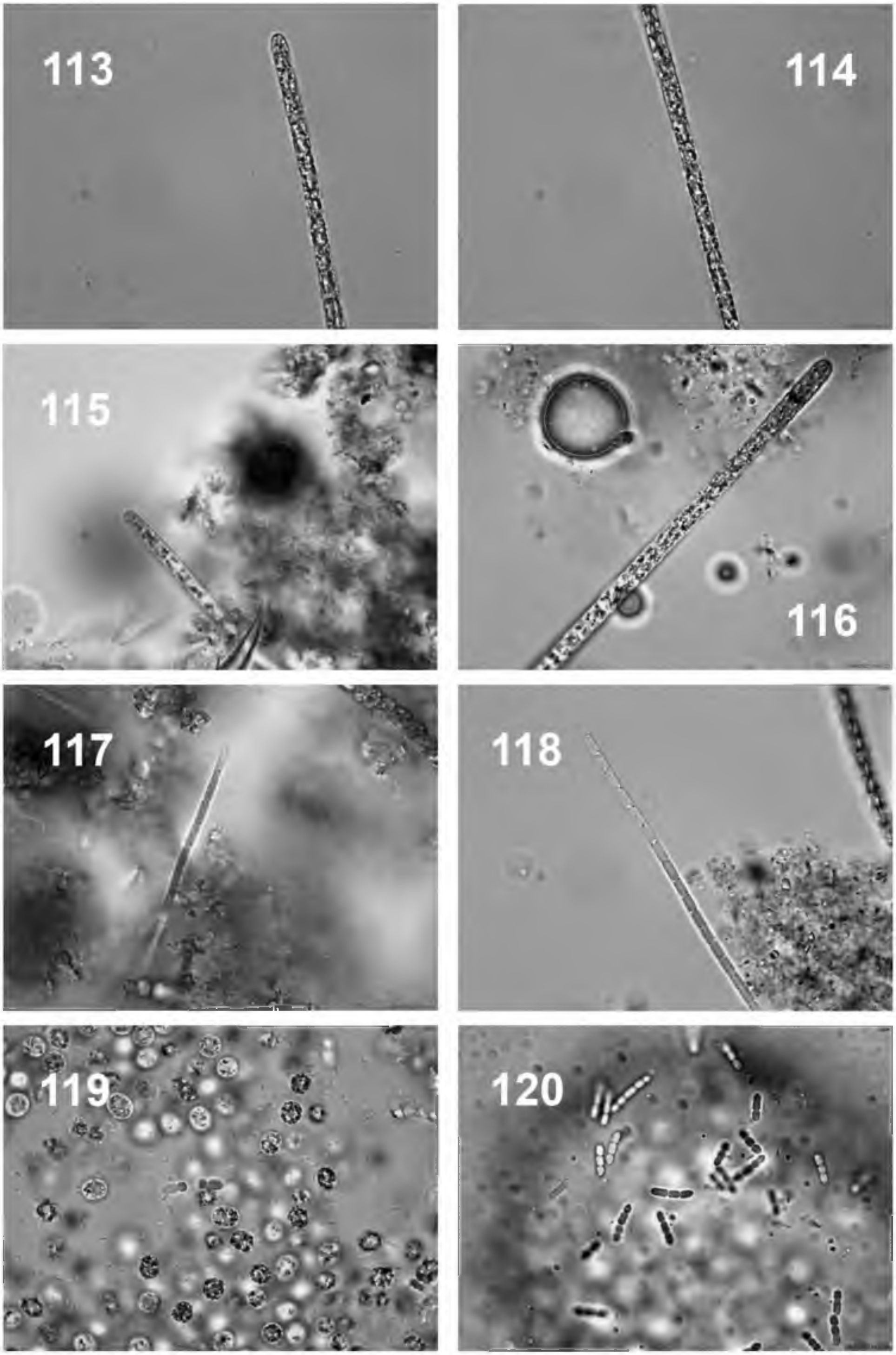

101

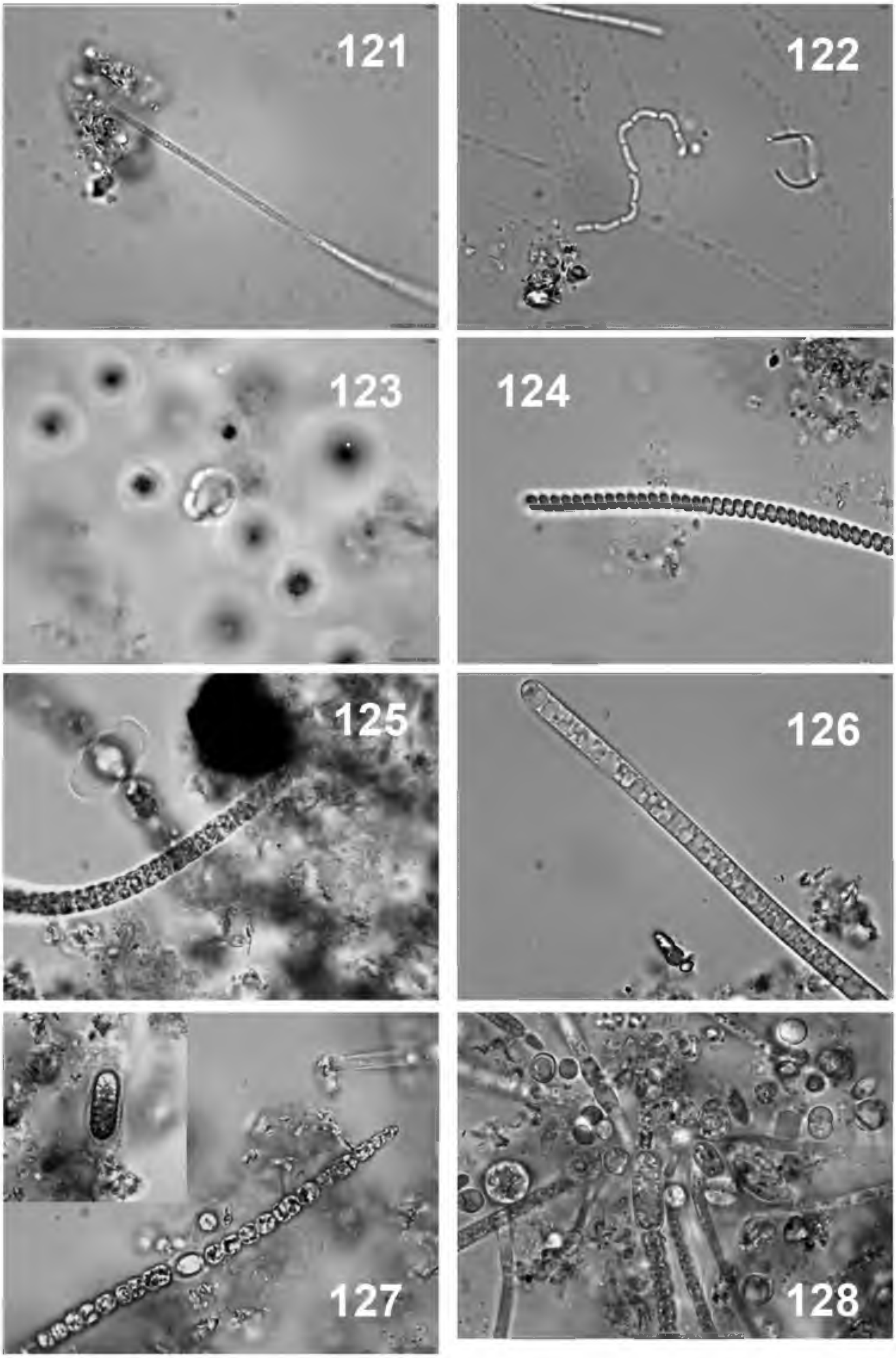

102


103

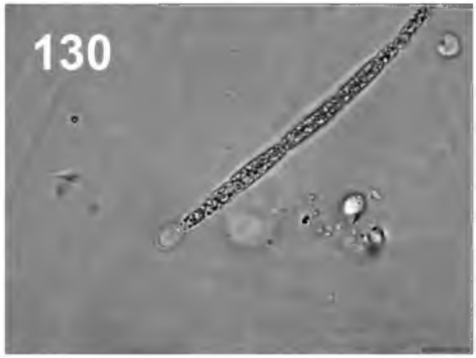

104


105

106

107

108

109

110

111

112


113
114
115
116
117
118
119
120


121
122
123
124
125
126
127
128

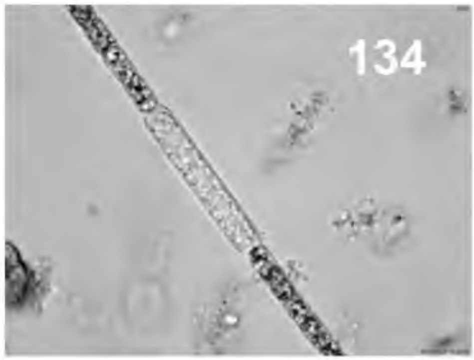

129


130

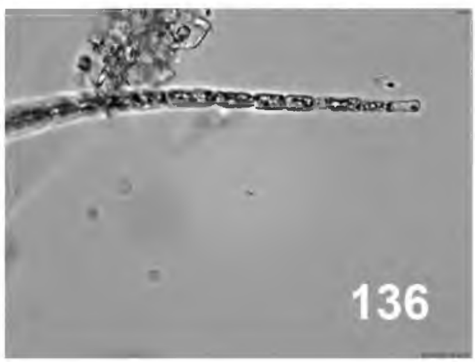

131

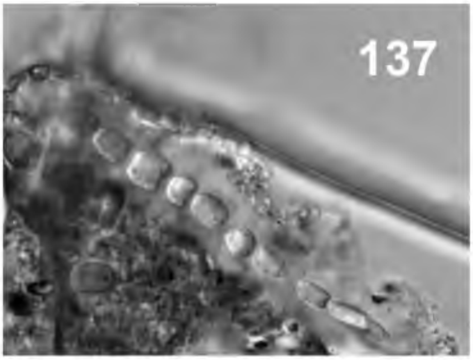

132


133

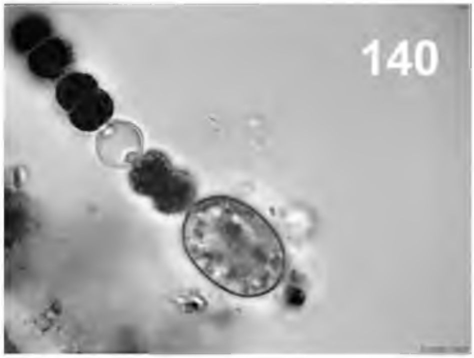

134


135


136

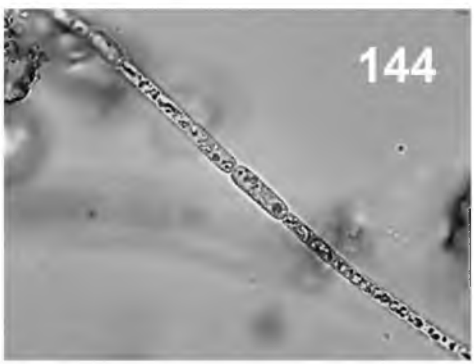

137

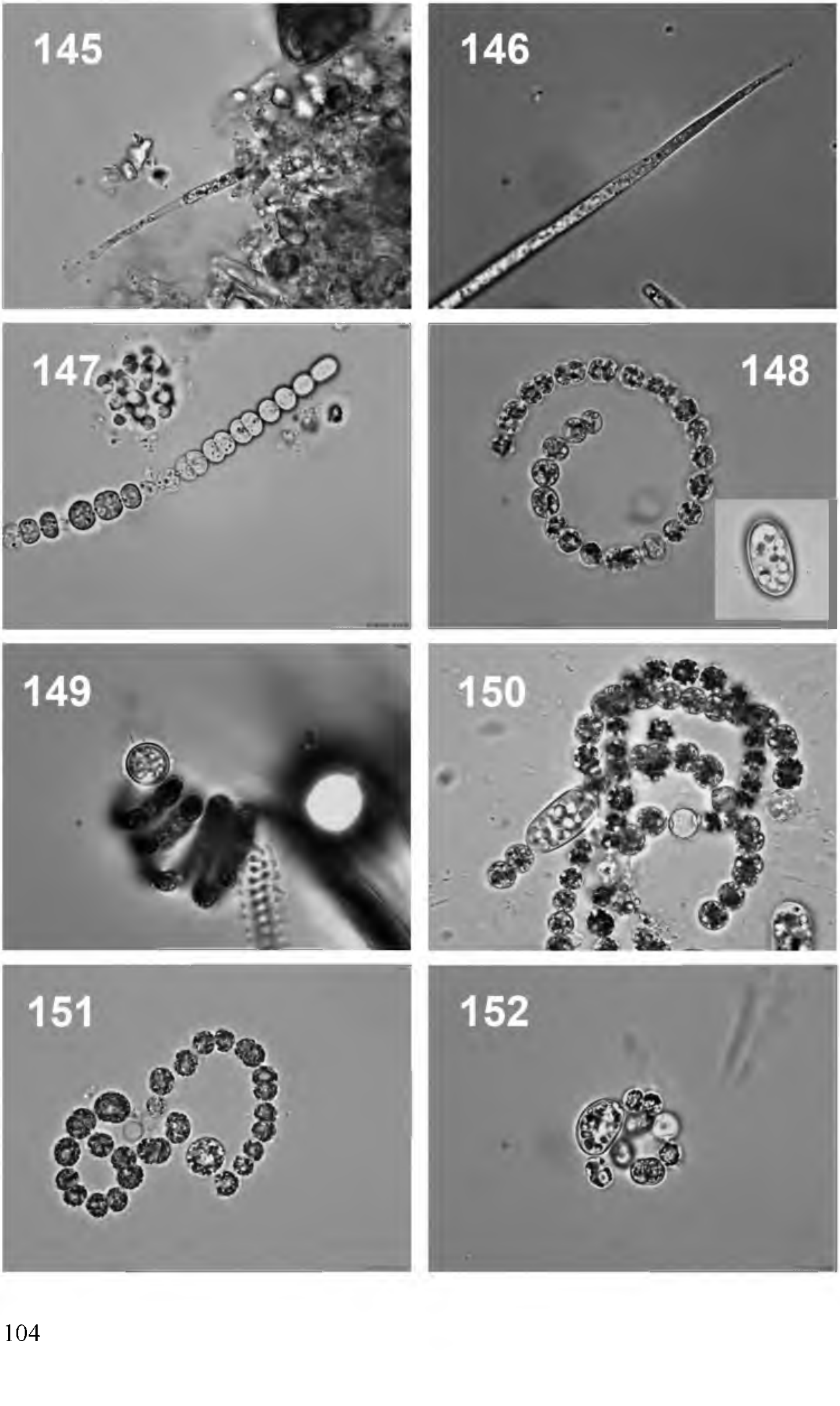
138

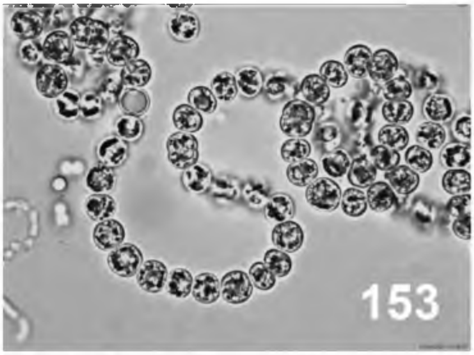
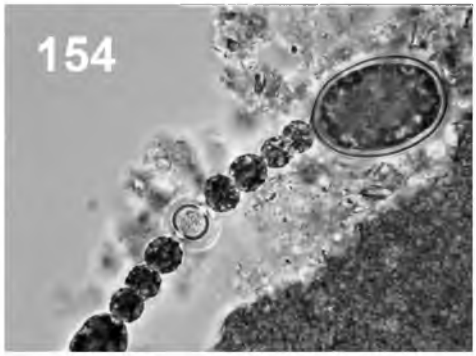
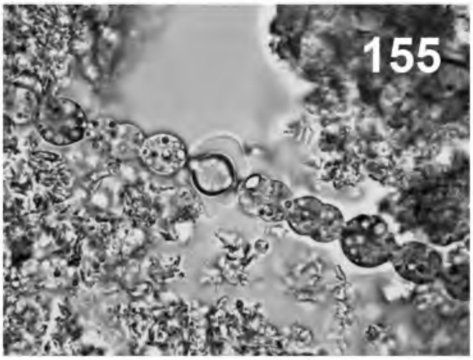
139

140

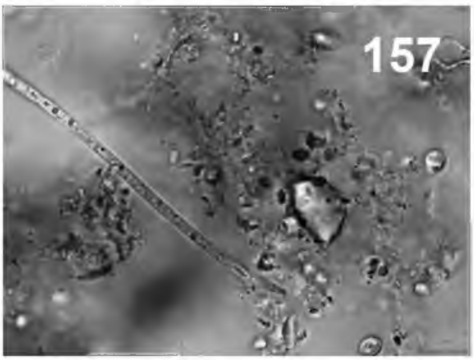
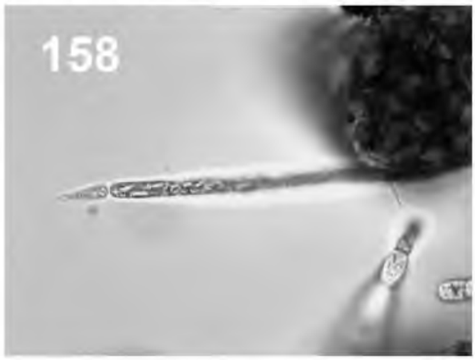
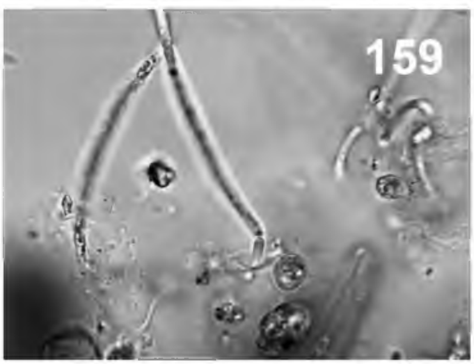
141

142

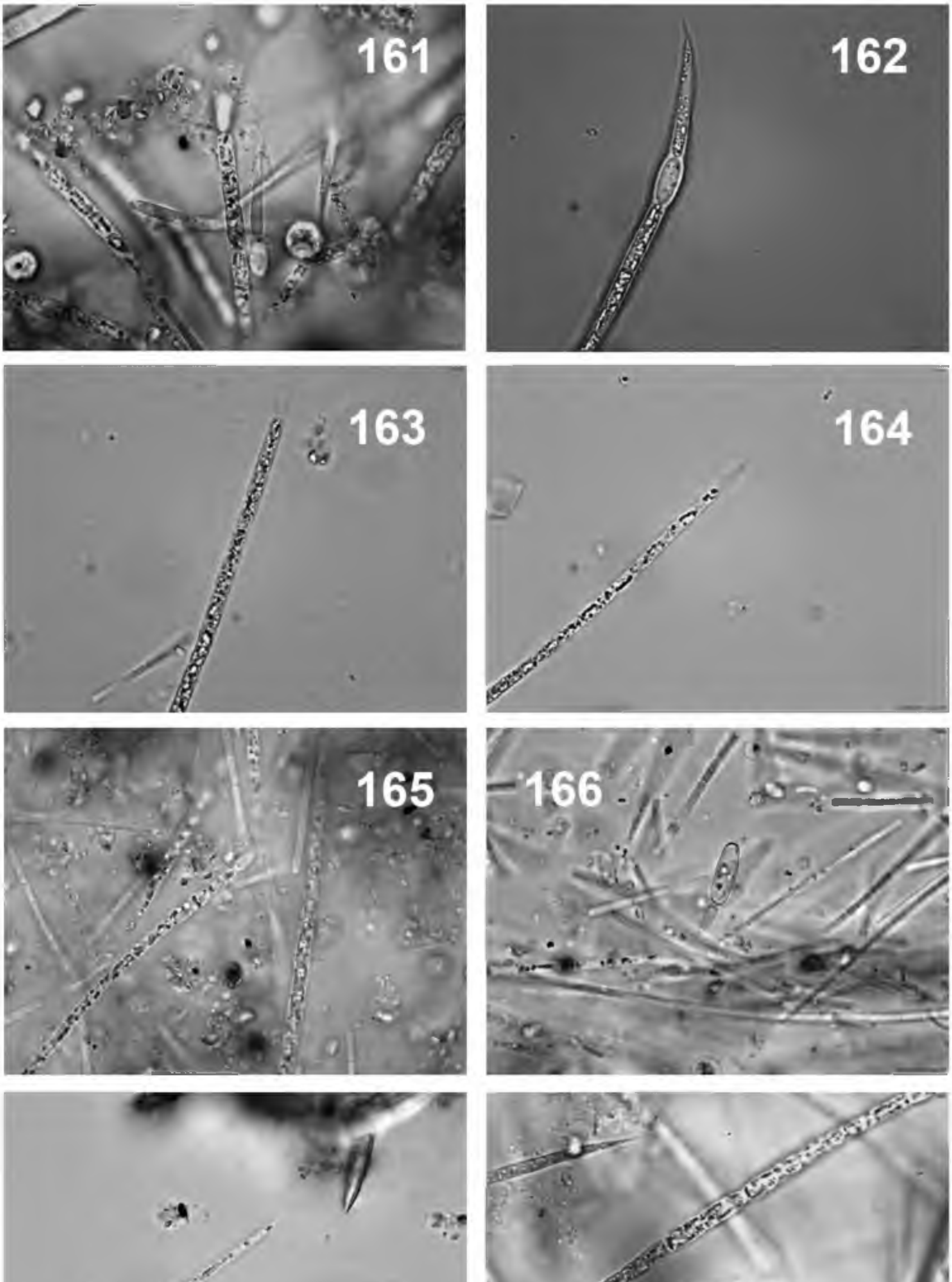
143

144

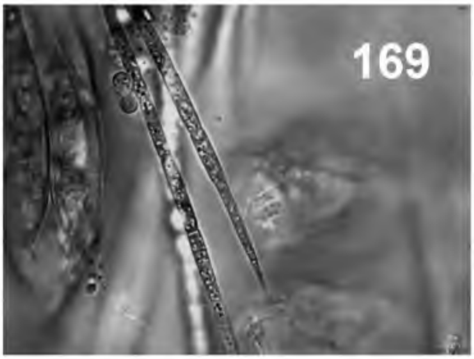

145
146
147
148
149
150
151
152

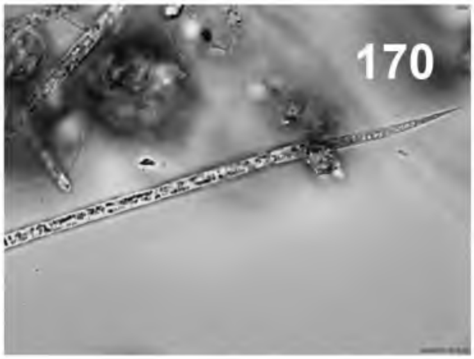

153

154

155

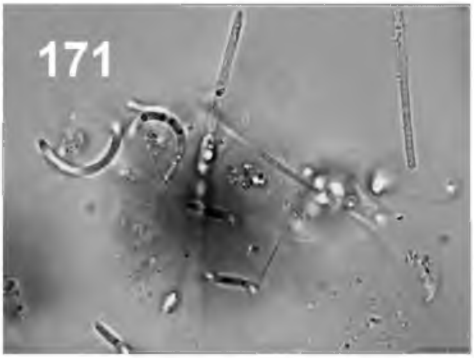
156

157

158

159

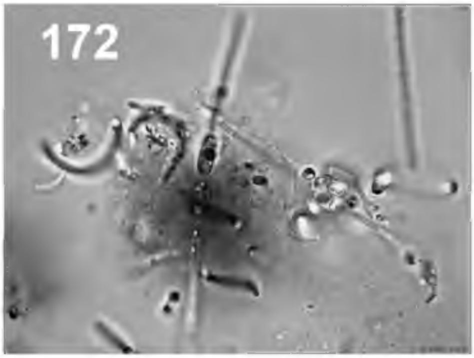
160


161
162
163
164
165
166
167
168


169


170

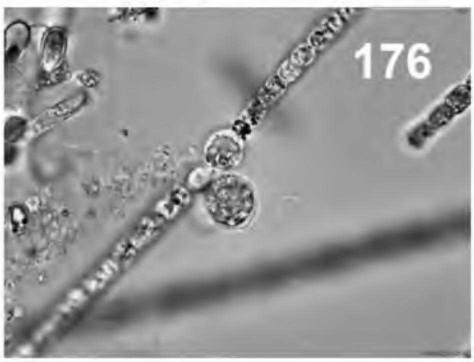

171


172

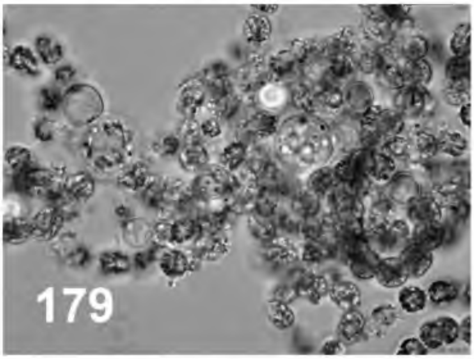
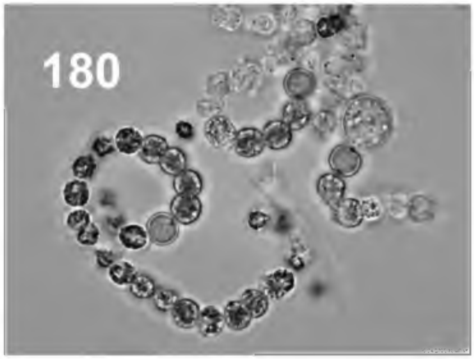
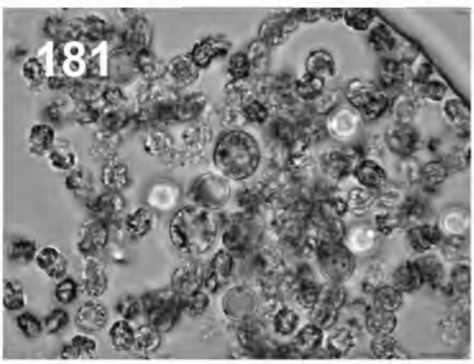

173

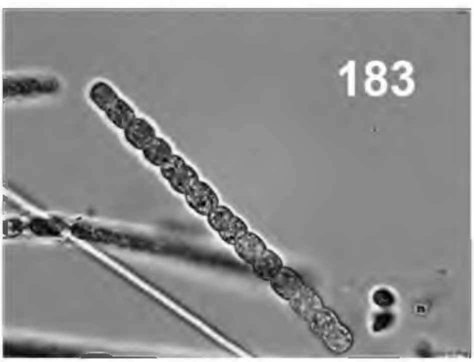
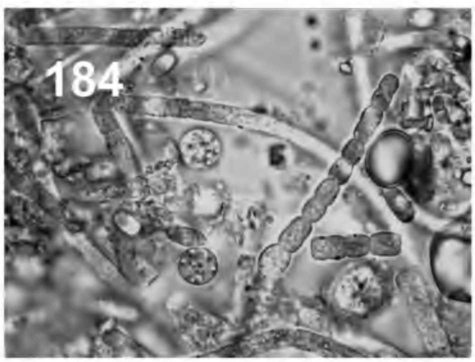

174

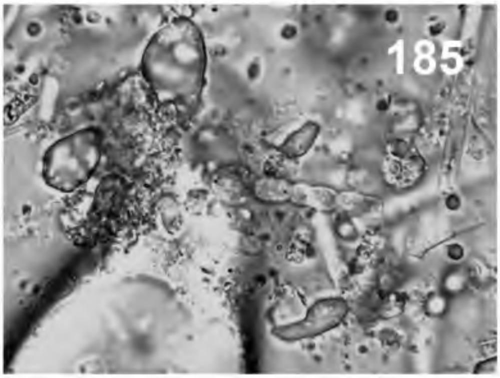

175


176


177

178

179

180

181

182

183

184



CONFLICT OF INTERESTS

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

ACKNOWLEDGEMENTS

This study was jointly supported by three projects of 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, and in 2023 – 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 – MSG, BU; funding acquisition – MSG, BU. All authors have read and agreed to the published version of the manuscript.

References

Canter H. M. 1950. Fungal parasites of the phytoplankton. I. - Annals of Botany 14: 263–289.

Canter H. M. 1972. A guide to the fungi occurring on planktonic blue-green algae. – In: Desikachary T. V. (Ed.) Taxonomy and biology of blue-green algae, University of Madras, Madras, 145–158.

Canter H. M. & Lund J. 1948. Studies on plankton parasites. - New Phytologist

47: 238–261.
CANTER H. M. & LUND J. 1951. Studies on plankton parasites. Examples of the interaction between parasitism and other factors determining the growth of diatoms. - Annals of Botany 15: 359–371.
CARPINE R. & S. SIEBER 2021. Antibacterial and antiviral metabolites from cyanobacteria: their application and their impact on human health. - CRBIOT 3: 65-81.
DESCY J.-P., M. P. STOYNEVA-GÄRTNER, B. A. UZUNOV, P. H. DIMITROVA, V. Ts. PAVLOVA & G. GÄRTNER 2018. Studies on cyanoprokaryotes of the water bodies along the Bulgarian Black Sea Coast (1890-2017): a review, with special reference to new, rare and harmful taxa. - In: PEEV D. R., G. GÄRTNER, M. P. STOYNEVA-GÄRTNER, N. V. POPOVA & E. E. GEORGIEVA (Eds), Proceedings of the First European Symposium "Research, Conservation and Management of Biodiversity of European Seashores" (RCMBES) Primorsko, Bulgaria, 8-12 May 2017. - Acta zoologica bulgarica, Suppl. 11: 43–52.
DIMITROVA R. E., E. P. NENOVA, B. A. UZUNOV, M. D. SHIHINIOVA & M. P. STOYNEVA 2014. Phytoplankton composition of Vaya Lake (2004-2006). – Bulgarian Journal of Agricultural Science 20, Suppl. 1: 165-172.
DOCHIN K. 2019. Functional and morphological groups in the phytoplankton of large reservoirs used for aquaculture in Bulgaria Bulgarian Journal of Agricultural Science 25 (1): 166-176.
DOCHIN K. 2021. Summer cyanoprokaryote blooms in eleven reservoirs in South Bulgaria. – Annual of Sofia University, Faculty of Biology, Book 2 – Botany 105: 5-17.
DOCHIN K. 2022. The dominance of invasive algae *Raphidiopsis raciborskii* in lowland reservoirs in Bulgaria. - Bulgarian Journal of Agricultural Science 28 (1): 158-165
DOCHIN K. 2023. Using phytoplankton as a tool for evaluating changes in the ecological status of two Bulgarian reservoirs (2020-2021). - Bulgarian Journal of Agricultural Science 29 (2): 252-261.
DOCHIN K., A. IVANOVA & I. ILIEV 2017. The phytoplankton of Koprinka Reservoir (Central Bulgaria): species composition and dynamics. - Journal of BioScience and Biotechnology (1): 73-82.
DOCHIN K., V. KUNEVA, A. IVANOVA & I. ILIEV 2018. Current state of phytoplankton in Batak reservoir (Southwestern Bulgaria). - Bulgarian Journal of Agricultural Science 24 (4): 686–697.
GECHEVA G. M., D. S. BELKINOVA, Y. G. HRISTEVA, R. D. MLADENOV & P. S. STOYANOV 2019. Phytoplankton and Macrophytes in Bulgarian Standing Water Bodies. – Ecologia Balkanica, Special edition 2: 45-61.
GEITLER L. 1932. Cyanophyceae. - In: Rabenhorst's Kryptogamen Flora. 14. Akad. Verlagsges., Leipzig, 1196 pp.
GOLLERBAKH M. M., KOSINSKAJA E. K. & POLJANSKIJ V. I. 1953. Opredelitel presnovodnykh vodoroslej SSSR, Vypusk 2: Sinezelionye vodorosli [The guide for

determination of the freshwater algae of the USSR Part 2: Blue-green algae]. Moscow: Publ. House Sovetskaya Nauka (Soviet science), 652 pp. (In Russian)

Hindák F. 2008. Colour Atlas of Cyanophytes. Publishing House of the Slovak Academic of Sciences VEDA, Bratislava, 253 pp.

Komárek J. 2013. Cyanoprokaryota. 3 Teil/Part 3: Heterocytous genera. – In: Büdel B., G. Gärtner, L. Krienitz & M. Shagerl (Hrsg./Eds.), Süßwasserflora von Mitteleuropa, 19/3, Springer-Spectrum, Springer Verlag, Berlin - Heidelberg, 1130 pp.

Komárek J. & Anagnostidis K. 1999. Cyanoprokaryota. 1 Teil: Chroococcales. – In: Ettl H., G. Gärtner, H. Heynig & D. Mollenhauer (Hrsg.), Süßwasserflora von Mitteleuropa, 19/1, Gustav Fischer, Jena, 548 pp.

Komárek J. & Anagnostidis K. 2005. Cyanoprokaryota. 2 Teil: Oscillatoriales. – In: Büdel B., G. Gärtner, L. Krienitz & M. Shagerl (Hrsg.), Süßwasserflora von Mitteleuropa, 19/2, Elsevier GmbH, Spektrum Akademischer Verlag, München, 759 pp.

Konkel R., A. Milewska, N. D. T. Do, E. B. Duran, A. Szczepanski, J. Plewka, E. Wieczerzak, S. Iliakopoulou, T. Kaloudis, D. Jochmans, J. Neyts, K. Pyrc & H. Mazur-Marzec 2023. Anti-SARS-CoV-2 activity of cyanopeptolins produced by *Nostoc edaphicum* CCNP1411. - Antiviral Research 219: 105731.

Mader J., Gallo A., Schommartz T., Handke W., Nagel C.-H., Günther P., Brune W. & Reich K. 2016. Calcium spirulan derived from *Spirulina platensis* inhibits herpes simplex virus 1 attachment to human keratinocytes and protects against herpes labialis. - The Journal of Allergy and Clinical Immunology 137: 197–203.

Mazur-Marzec H., Ceglowska M., Konkel R. & Pyrć K. 2021. Antiviral cyanometabolites - A review. - Biomolecules 11: 474.

Merel S., Walker D., Chicana R., Snyder S., Baurès E. & Thomas O. 2013. State of knowledge and concerns on cyanobacterial blooms and cyanotoxins. - Environment International 59: 303–327.

Meriluoto J., L. Spoof & Codd J. (Eds) 2017. Handbook of Cyanobacterial Monitoring and Cyanotoxin Analysis. John Wiley & Sons Ltd., Chichester, 548 pp.

Mitchell C. A., Ramessar K. & O'Keefe B. R. 2017. Antiviral lectins: selective inhibitors of viral entry. - Antiviral Research 142: 37–54.

Radkova M., Stefanova K., Uzunov B., Gärtner G. & Stoyneva-Gärtner M. 2020. Morphological and molecular identification of microcystin-producing Cyanobacteria in nine shallow Bulgarian water bodies. - Toxins 12 (1): 39.

Rasconi S., Niquil N & Sime-Ngando T. 2012. Phytoplankton chytridiomycosis: community structure and infectivity of fungal parasites in aquatic ecosystems. - Environmental Microbiology 14: 2151–2170.

Rasconi S., B. Grami, N. Niguit, M. Jobard & T. Sime-Ngando 2014. Parasitic chytrids sustain zooplankton growth during inedible algal bloom. - Frontiers in Microbiology 5: 229.

Rasconi S., Grossart H-P, Gsell A, Ibelings BW, van de Waal D, Agha R, Bacu A, Balode M, Beklioğlu M, Berden Zrimec M, Botez F, Butler T, Cerbin S, Cortina A, Cunliffe M, Frenken T, Garcés E, Gjyli L, Golan Y, Guerra T, Iacovides A, Idà A, Kagami M, Kisand V, Leshoski J, Marco P., Mazalica N., Miki T., Moza M. I., Neuhauser S., Özkundakci D., Panksep K., Patcheva S., Pestoric B., Petrova Stoyneva M., Pinto D., Polle J., Postolache C., Pozo Dengra J., Reñé A., Rychtecky P., Schmeller D. S. S., Scholz B., Selmeczy G., Sime-Ngando T,. Tapolczai K., Tasevska O., Trbojevic I., Uzunov B., Van den Wyngaert S., van Donk E., Vanthoor M., Veljanoska Sarafiloska E., Wood S. & Znachor P. 2022. Applications for zoosporic parasites in aquatic systems (ParAqua). - ARPHA Preprints. Submitted to Research Ideas and Outcomes. https://doi.org/10.3897/arphapreprints.e94590.

Schopf J. W. 2012. The fossil record of Cyanobacteria, - In: Whitton B. A. (Ed.), The ecology of Cyanobacteria II. Their diversity in space and time. Spinger, 15-38.

Skuja H. 1948. Taxonomie des Phytoplanktons einiger Seen in Uppland, Sweden. – Symbolae Botanicae Upsalienses 9 (3): 1-399.

Stal L. J. 2012. Cyanobacterial mats and stromatolites. - In: Whitton B. A. (Ed.), The ecology of Cyanobacteria II. Their diversity in space and time. Springer, 65-126.

Starmach K. 1966. Cyanophyta – Sinice. Glaucophyta – Glaukofity. – In: Starmach K. (Ed.), Flora Słodkowodna Polski. Tom 2. PWN, Warszawa, 806 pp. (In Polish)

Stefanova K., Radkova M., Uzunov B., Gärtner G. & Stoyneva-Gärtner M. 2020. Pilot search for cylindrospermopsin-producers in nine shallow Bulgarian waterbodies reveals nontoxic strains of *Raphidiopsis raciborskii*, *R. mediterranea* and *Chrysosporum bergii*. – Biotechnology and Biotechnological Equipment 34 (1): 384-394.

Stoyneva M. P. 2014. Contribution to the studies of the biodiversity of hydro- and aero-biontic prokaryotic and eukaryotic algae in Bulgaria. DrSc Thesis, Sofia University “St. Kliment Ohridski”, Faculty of Biology, Department of Botany, 825 pp. + Appendices (In Bulgarian, English summary).

Stoyneva-Gärtner M., Stefanova K., Uzunov B., Radkova M. & Gärtner G. 2022. *Cuspidothrix* is the first genetically proved anatoxin A producer in Bulgarian lakes and reservoirs. - Toxins 14: 778.

Stoyneva-Gärtner M. P., Descy J.-P., Uzunov B. A., Miladinov P., Stefanova K., Radkova M. & Gärtner G. 2023. Diversity of the summer phytoplankton of 43 waterbodies in Bulgaria and its potential for water quality assessment. - Diversity 15: 472.

Stoyneva-Gärtner M., Stefanova K., Descy J.-P., Uzunov B., Radkova M., Pavlova V., Mitreva M. & Gärtner G. 2021. *Microcystis aeruginosa* and *M. wesenbergii* were the primary planktonic microcystin producers in several

Bulgarian waterbodies (August 2019). - Applied Science 11: 357.
Teas J., J. R. Hebert, J. H. Fitton & P. V Zimba 2004. Algae – a poor man's HAART? - Medical Hypotheses 62 (4): 507-510.
Teneva I., D. Belkinova, R. Mladenov, P. Stoyanov, D. Moten, D. Basheva, S. Kazakov & B. Dzhambazov 2020. Phytoplankton composition with an emphasis of Cyanobacteria and their toxins as an indicator for the ecological status of Lake Vaya (Bulgaria) – part of the Via Pontica migration route. Biodiversity Data Journal 8: e57507
Uzunov B., Stefanova K., Radkova M., Descy J.-P., Gärtner G. & Stoyneva-Gärtner M. 2021a. First report on *Microcystis* as a potential microviridin producer in Bulgarian waterbodies. - Toxins 13 (1): 448.
Uzunov B., Stefanova K., Radkova M., Descy J.-P., Gärtner G. & Stoyneva-Gärtner M. 2021b. *Microcystis* species and their toxigenic strains in phytoplankton of ten Bulgarian wetlands (August 2019). – Botanica 27: 77–94.
Valskys V., Gulbinas Z., Stoyneva-Gärtner M., Uzunov B., Skorupskas R., Karosienė J., Kasperovičienė J., Rašomavičius V., Uogintas D., Audzijonytė A., Dainys J., Urbanavičius R., Urbanavičiūtė I., Vaičiūtė D., Bučas M., Grendaitė D., Stonevičius E., Gedvilas A. & Koreivienė J. 2022. Remote sensing in environmental studies: Advantages and challenges. – Annual of Sofia University, Faculty of Biology, Book 2-Botany 106 (1): 31-44.
Whitton B. A. & Potts M. 2012. Introduction to the Cyanobacteria. - In: Whitton B. A. (Ed.), The ecology of Cyanobacteria II. Their diversity in space and time. Springer, 1-14.
Xu H., McCarthy M.J., Paerl H. W., Brookes J. D., Zhu G., Hall N. S., Qin B., Zhang Y., Zhu M., Hampel J. J., Newell S. E. & Gardner W. S., 2021. Contributions of external nutrient loading and internal cycling to cyanobacterial bloom dynamics in Lake Taihu, China: implications for nutrient management. - Limnology and Oceanography 66 (4): 1492–1509.
Yan D., Xu H., Lan J., Yang M., Wang F., Hou W., Zhou K. & An Z. 2020. Warming favors subtropical lake cyanobacterial biomass increasing. - Science of the Total Environment 726: 138606.
Yan D., Xu H., Yang M., Lan J., Hou W., Wang F., Zhang J., Zhou K., An Z. & Goldsmith Y. 2019. Responses of cyanobacteria to climate and human activities at Lake Chenghai over the past 100 years. - Ecological Indicators 104: 755–763.
Zhang J., K. Shi, H. W. Paerl, K. M. Rühland, Y. Yuan, R. Wang, J. Chen, M. Ge, L. Zheng, Z. Zhang, B. Qin, J. Liu & Smol J. P. 2023. Ancient DNA reveals potentially toxic cyanobacteria increasing with climate change. - Water Research 229: 119435.

Received 1st November 2023
Accepted 17th November 2023