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DESMID FLORA (CHLOROPHYTA, ZYGNEMATOPHYCEAE) OF THE DANUBE IN THE PROVINCE OF VOJVODINA (NORTHERN SERBIA)

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Abstract —This paper presents results of a detailed investigation into the qualitative composition of the desmid flora of the Danube performed from April of 2002 to May of 2003. A total of 70 desmid taxa belonging to four genera were recorded. Forty-seven taxa are new to the Vojvodina stretch of the Danube, while *Cosmarium kjellmanii*, *Staurastrum bloklandiae*, and *S. smithii* are taxa new to the algal flora of Serbia. Qualitative dominance of desmid taxa typical of alkaline and eutrophic ecosystems was observed. The qualitative composition of planktonic taxa, their quantitative composition, and regular seasonal dynamics of the desmid community were analyzed in the relation to physico-chemical characteristics of the water. Water quality was analyzed on the basis of desmids, which are bioindicators. The partly unexpected presence of certain desmid taxa, i.e., several typical acidophilous species, alpine forms, and/or taxa characteristic of oligotrophic water was recorded.

Key words: Desmids, composition, ecological notes, Danube, Vojvodina, Serbia

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INTRODUCTION

The Danube is a typical lowland river flowing through the Province of Vojvodina (Northern Serbia). In Vojvodina, it has an average depth 19 m, velocity of 3.5–4 km h^{-1}, and average throughput of around 5000 m^3 s^{-1} (Gavrilović and Dukić, 2002).

The lowest parts of the Pannonian Plain consist of Precambrian and Paleozoic volcanic rocks, covered by sedimentary layers and thick layers of loess rich in limestone (Čanović and Kemenci, 1988). Due to the geological base and human impact, the Danube's water in Vojvodina is slightly alkaline, with high concentrations of mineral salts and a high degree of total hardness, being periodically enriched with various biodegradable compounds (Litheráty et al., 2002).

Characterized by a moderate continental climate and rich in natural resources, the Province of Vojvodina is an important agricultural and industrial region. There are therefore many pollutants the in Danube, because of which it is not a suitable site for the development of a rich desmid flora. As typical organisms of peat bogs, marshes, fens, and lakes, desmids are predominantly inhabitants of acidic and soft water with low conductivity and concentration of organic biodegradable compounds (Růžička, 1977).

Desmids were rarely found in earlier algological studies of the Serbian stretch of the Danube. The occurrence of a small number of representatives of the genera *Closterium*, *Cosmarium*, and *Staurastrum* was previously reported (Protić, 1939; Milovanović and Živković, 1950; Milovanović, 1965; Senćanski, 1972; Obušković, 1982, 1989; Obušković and Kalafatić, 1983; Kojčić et al., 1992; Miljanović et al., 2003; Nemeš and Pujin, 2003; Đurković and Čađo, 2004), but without illustrations or any descriptions of desmid taxa. In the present study, desmids of the Danube are extensively researched for the first time, and the majority of them are depicted and briefly annotated.

MATERIAL AND METHODS

A detailed investigation into the desmid community was carried out from April of 2002 to May of 2003. In all, 54 samples of water for qualitative phytoplankton and physico-chemical analyses were collected from seven localities along the Danube: Bezdan (1), Bogojevo (2), Bačka Palanka (3), Čenta (4), Zemun (5), Pančevo (6), and Banatska Palanka (7) (Fig. 1; Table 1).

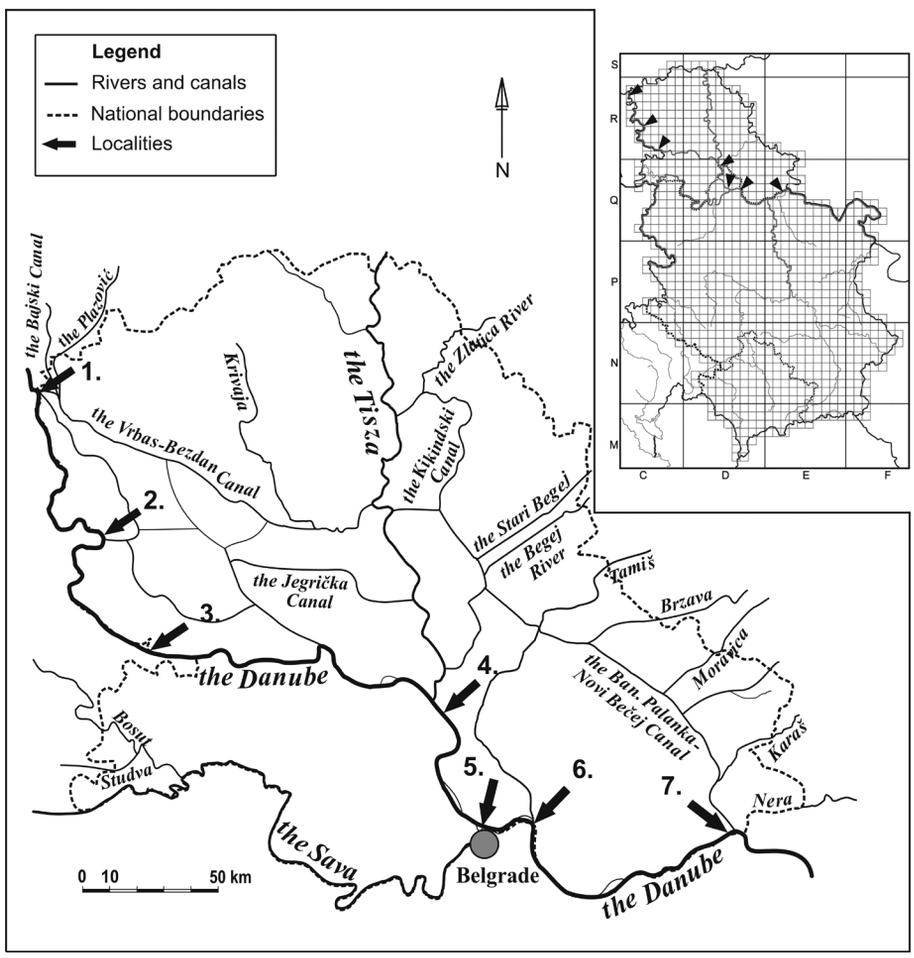

Fig. 1. Map of the Province of Vojvodina (North Serbia) with the location of the investigated sites (1–7).

Table 1. Position and description of the investigated localities of the Danube.

Locality	Position on the Danube (km)	Altitude above sea level (m)	Description
1. Bezdan	1425.5	80.64	Placed at the confluence of the Vrbas-Bezdan Canal into the Danube.
2. Bogojevo	1367.4	77.46	There is a big river pier near the sampling station.
3. Bačka Palanka	1298.6	97.00	Placed near the side-arm „Tikvara“ of the Danube River.
4. Čenta	1189.0	80.50	The banks of the Danube River are covered with slime.
5. Zemun	1164.0	67.87	Placed exactly in the city; the banks are enclosed by a levee.
6. Pančevo	1154.6	67.33	Placed in the city, near the river pier and numerous industrial plants.
7. Banatska Palanka	1076.6	62.85	Placed upstream the confluence of the Banatska Palanka-Novi Bečej Canal into the Danube.

Table 2. Physico-chemical characteristics of the Danube water, in period from April 2002 to May 2003 (T in °C; conductivity in μS cm–1; free CO_2, CO_3^{2-}, HCO_3^-, total hardness, dissolved O_2, BOD, COD /$KMnO_4$/, suspended solids, NH_4^+, NO_3^-, NO_2–, SO_4^{2-}, Cl^-, PO_4^{3-}, total phosphorus, Ca^{2+}, Mg^{2+}, Na^+ and K^+ in mg l^{-1}; Pb, Cu, Fe, Mn and evaporable phenols in μg l^{-1}, β-radioactivity in Bq l^{-1}; according to the Republic Hydrometeorological Service of Serbia 2002, 2003).

Locality	**1. Bezdan**	**2. Bogojevo**	**3. Bačka Palanka**	**4. Čenta**	**5. Zemun**	**6. Pančevo**	**7. Banatska Palanka**
Period of sampling	15.05.02 – 09.04.03	01.07.02 – 21.10.02	29.08.02 – 21.10.02	10.06.02 – 05.05.03	19.06.02 – 16.04.03	10.06.02 – 05.05.03	23.05.02 – 17.04.03
Parameters	Ranges of the parameter values						
T	1.6 - 24.4	12.0 - 24.0	12.0 - 22.5	12.8 - 23.0	11.0 - 23.2	13.6 - 23.8	1.2 - 28.2
pH	7.9 - 8.6	7.8 - 8.6	7.7 - 8.1	7.7 - 8.1	7.7 - 8.5	7.6 - 8.0	7.7 - 8.2
Conductivity	287 - 494	289 - 381	332 - 382	305 - 450	270 - 440	322 - 429	293 - 497
Free CO_2	0 - 3.6	0 - 3.6	1.4 - 5.6	1.8 - 3.5	0 - 4.8	1.8 - 3.3	1.9 - 4.2
CO_3^{2-}	0 - 8.9	0 - 11.9	0	0	0 - 9.0	0	0
HCO_3^-	132 - 210	138 - 199	186 - 205	158 - 199	164 - 202	156 - 182	150 - 227
Total hardness	137 - 247	152 - 199	179 - 207	163 - 198	140 - 220	174 - 186	145 - 212
Dissolved O_2	7.5 - 13.9	6.8 - 10.0	6.0 - 9.5	7.5 - 9.3	6.1 - 13.2	7.0 - 9.0	5.6 - 12.0
Saturation O_2 %	81 - 168	78 - 120	68 - 97	82 - 102	66 - 119	83 - 103	64 - 105
BOD	1.3 - 7.0	1.3 - 3.5	1.3 - 5.7	1.5 - 3.2	2.3 - 4.8	1.3 - 4.4	1.0 - 3.3
COD ($KMnO_4$)	3.8 - 7.3	4.7 - 5.6	4.7 - 5.8	3.8 - 7.1	3.5 - 4.4	4.0 - 5.8	3.9 - 7.1
Suspend. solids	8 -73	15 - 34	5 - 17	7 - 36	5 - 78	21 - 43	2 -52
NH_4^+	0.07 - 0.23	0.13 - 0.22	0.10 - 0.27	0.10 - 0.23	0.05 - 0.30	0.16 - 0.25	0.17 - 0.38
NO_3^-	0.7 - 2.8	0.8 - 2.1	1.4 - 2.1	0.9 - 1.9	1.3 - 2.0	0.8 - 1.6	0.6 - 2.1
NO_2^-	0.014 - 0.057	0.019 - 0.032	0.020 - 0.028	0.018 - 0.023	0.021 - 0.124	0.023 - 0.025	0.018 - 0.090
SO_4^{2-}	25 - 51	37 - 42	35 - 42	32 - 45	8 - 25	33 - 47	30 - 52
Cl^-	14 - 22	16 - 17	16 - 18	16 - 22	11 - 22	21 - 26	11 - 23
PO_4^{3-}	0.006 -0.076	0.005 - 0.064	0.061 - 0.090	0.009 - 0.059	0.040 - 0.082	0.023 - 0.066	0.033 - 0.072
Total phosph.	0.100 - 0.205	0.101 - 0.129	0.101 - 0.215	0.076 - 0.118	0.094 - 0.104	0.103 - 0.140	0.097 - 0.162
Ca^{2+}	42 - 63	45 - 57	53 - 59	45 - 62	43 - 62	45 - 56	37 - 65
Mg^{2+}	7 - 22	9 - 14	12 - 14	11 - 15	8 - 16	9 - 18	8 - 13
Na^+	10.3 - 19.0	11.5 - 13.5	10.1 - 16.9	11.4 - 15.0	8.6 - 16.0	11.4 - 20	10.0 - 21.0
K^+	1.5 - 3.0	1.5 - 3.2	2.2 - 3.1	2.0 - 2.4	1.6 - 2.9	2.0 - 2.8	1.4 - 2.4
Pb	1 - 16	–	–	1 - 3	0 - 2	–	2 - 6
Cu	10 - 62	–	–	10 - 129	7 - 10	–	19 - 32
Fe	71 - 165	131 - 181	96 - 184	67 - 166	138 - 185	142 - 194	90 - 175
Mn	13 - 58	20 - 94	28 - 119	38 - 940	37 - 43	40 - 176	16 - 85
Evapor. phenols	1 - 4	1 - 2	1 - 4	0 - 2	0 - 5	1 - 5	1 - 6
β–radioactivity	0.13 - 0.28	0.18 - 0.19	0.18 - 0.23	0.17 - 0.24	0.13 - 0.27	–	0.10 - 0.15

Phytoplankton samples were collected by towing a plankton net (mesh size 25 μm) through open water. They were immediately fixed with formaldehyde to a final concentration of about 4%. Taxonomical analysis of the sampled material was performed at the Institute of Botany and Jevremovac Botanical Garden, Faculty of Biology, University of Belgrade. Material was studied using a Reichart Diastar™ microscope equipped with a Canon Power Shot S40 digital camera. Drawings of desmids were made with the aid of a drawing tube. Physico-chemical analyses were performed in the Belgrade laboratory of the Republic Hydrometeorological Service of Serbia (RHMSS) and presented in its Annual

Reports (RHMSS, 2002, 2003).

In this paper, the classification of the phylum Chlorophyta according to Brook and Johnson (2003) is used. A modification concerning the Peniaceae (Kouwets and Coesel, 1984) is also accepted. Taxa new to the algal flora of Serbia are designated with two asterisks (**), taxa new only to the Vojvodina stretch of the Danube with one asterisk (*), and taxonomically doubtful taxa with the symbol #. The relative abundance of desmids in the samples was estimated according to the following scale: very frequent, frequent, common, rare, and very rare. The following abbreviations are used: Dim – **dimensions (in** μm), L - length of cell, Bc - breadth of cell, Ba - breadth of apex, L:B - length of cell/breadth of cell ratio, I - breadth of isthmus, Th – thickness, **Loc – locality along the Danube, and** Comm - comment.

RESULTS AND DISCUSSION

Physico-chemical analyses

The results of detailed physico-chemical analyses for the investigated localities are presented in Table 2.

The sampled Danube water was slightly to moderately alkaline, with relatively high values of conductivity and total hardness. Exceedingly high pH values were recorded at the Bezdan and Bogojevo sites. High values of dissolved O_2, low values of BOD and COD, and low concentrations of nutrients point to a relatively small amount of biodegradable organic compounds in the water. High NO_3^- and NO_2^- concentrations were recorded mainly in the winter months and marked the presence and degradation of nitrogen-containing organic compounds. The O_2 supersaturation recorded in the summer months at the Bezdan site might be attributable to intensive phytoplankton photosynthesis.

HCO_3^- was the dominant anion and Ca^{2+} the dominant cation. The composition of ions was almost equal and balanced at all of the investigated localities. Relatively low concentrations of heavy metals were recorded at all localities, except the Pančevo site, where high quantities of Fe and Mn were noticed. In addition to this, a high concentration of Cu was measured at the Čenta locality. The concentrations of volatile phenols were high during almost all the investigated months, especially in the localities situated in big cities. The measured values of β-radioactivity in the water were also high during the whole period.

Annotated list of desmid species

Order: Zygnematales

Suborder: Closteriineae

Family: Closteriaceae Ehr. ex Pritch.

Closterium Nitzsch ex Ralfs

1. ***C. acerosum*** (Schr.) Ehr. ex Ralfs
   Plate 1: 4.
   Ref: Růžička (1977, p. 154, pl. 18: 1–4).
   Dim: L: 305–460; B: 25.5–41.25; Ba: 6.5–7; L:B= 7.4–17.4.
   Previous records: Protić (1939), Milovanović (1965), Obušković and Kalafatić (1983), Đurković and Čađo (2004).
   Loc: 5 and 6, common.

2. ***C. aciculare*** T. West
   Plate 1: 5.
   Ref: Růžička (1977, p. 108, pl. 8: 21–24).
   Dim: L: 230–450; B: 4.5–7.5; Ba: 2; L:B = 51.1–87.5.
   Previous records: Protić (1939), Senćanski (1972), Obušković (1989). Loc: 2, rare; 7, common.
   Comm: Cells from the Bogojevo site were considerably shorter (by 20 μm) than indicated in the consulted reference work (up to 250 μm).

3. ***C. acutum*** Bréb. var. ***acutum***
   Plate 1: 1.
   Ref: Růžička (1977, p. 95).
   Dim: L: 90.5–140.5; B: 4–5.5; Ba: 1; L:B = 20.5–25.5.
   Previous record: Protić (1939).
   Loc: 4, rare.

4.* ***C. acutum*** var. ***linea*** (Perty) W. & G. S. West

Plate 1: 2.
Ref: Růžička (1977, p. 95, pl. 6: 25–31).
Dim: L: 125–177.5; B: 3.5–4.5; Ba: 1; L:B = 25–39.4.
Previous record: None exist.
Loc: 1 and 2, very rare.

5.* ***C. acutum*** var. ***variabile*** (Lemm.) Krieg.
Plate 1: 3.
Ref: Růžička (1977, p. 95, pl. 6: 32–37).
Dim: L: 140–144; B: 4–5; L:B. = 30.5–32.
Previous record: None exist.
Loc: 4, common.

6.* ***C. ceratium*** Perty
Plate 1: 8.
Ref: Růžička (1977, p. 98, pl. 7: 1–3); Lenzenweger (1996, p. 35, pl. 2: 15).
Dim: L: 217.5–260; B: 6.5–7; L:B = 30.4–37.1.
Previous record: None exist.
Loc: 2 and 5, very rare.

7.* ***C. ehrenbergii*** Menegh. ex Ralfs var. ***atumidum*** Grönbl.
Plate 2: 2.
Ref: Růžička (1977, p. 141, pl. 15: 5–7.
Dim: L: 275–280; B: 45–55; Ba: 11.5–13; L:B = 6.2–7.
Previous record: None exist.
Loc: 1, very rare.
Comm: Cells were without any trace of a convex mid-region, in contrast to other specimens of *C. ehrenbergii* from samples of Danube water. In this paper, the found specimens are separated from the type-variety. Their cells are noticeably concave and strongly curved, with numerous scattered pyrenoids. The cell wall is provided with delicate striae, visible only using high magnification.

8. ***C. ehrenbergii*** var. ***ehrenbergii***
Plate 2: 1.
Ref: Růžička (1977, p. 141, pl. 15: 1–3).
Dim: L: 220–500; B: 50–100; Ba: 10–12.5; L:B = 4.5–6.1.
Previous records: Miljanović et al. (2003).
Loc: 1 and 3, rare.

9.* ***C. gracile*** Bréb. ex Ralfs var. ***elongatum*** W. & G. S. West
Plate 1: 7.
Ref: Růžička (1977, p. 168, pl. 21: 6–8); Lenzenweger (1996, p. 39, pl. 5: 2).
Dim: L: 375–390; B: 5–6.5; Ba: 2.5–3; L:B = 50–70.5.
Previous record: None exist.
Loc: 5 and 7, rare.
Comm: Cells with pseudo-girdle bands and clearly visible end-pore.

10. ***C. gracile*** var. ***gracile***
Plate 1: 6.
Ref: Růžička (1977, p. 168, pl. 21: 1–4); Kouwets (1991, p. 384, pl. 1: 3–6).
Dim: L: 190–270; B: 4.5–8; Ba: 2.5–3; L:B = 25.3–38.5.
Previous records: Milovanović and Živković (1950).
Loc: 1, 2, 4, 5, and 7, rare.
Comm: This taxon is widely distributed in the Danube, although it is not frequent.

11. ***C. leibleinii*** Kütz. ex Ralfs
Plate 1: 10.
Ref: Růžička (1977, p. 125).
Dim: L: 120–120.5; B: 25–25.5; Ba: 2.5–3.5; L:B = 4.5–4.8.
Previous records: Obušković (1982, 1989).
Loc: 4, very rare.
Comm: The breadth of cells is at the maximum level indicated by the consulted reference. The L:B ratio is therefore very low, so these specimens were not included in the type-variety. The end-pore is clearly visible.

12. ***C. leibleinii*** var. ***leibleinii***
Plate 1: 11.
Ref: Růžička (1977, p. 125, pl. 12: 11–18).
Dim: L: 145–175; B: 18–20.5; Ba: 2.5–3; L:B = 7.3–8.7.
Previous records: Kojčić et al. (1992).
Loc: 1 and 7, rare.

13. ***C. limneticum*** Lemm.
Plate 1: 17
Ref: Růžička (1977), p. 171.
Dim: L: 220–270; B: 6.5–10; Ba: 1–1.2; L:B = 22–33.8.

Previous records: Obušković (1989).

Loc: 3, 4, 5, 6, and 7, common.

Comm: Forms characterized by dimensions and ratio L:B values intermediate between var. *limneticum* and var. *fallax* were commonly found at several localities and determined only to the species level.

14.* ***C. limneticum*** var. ***fallax*** Růžička

Plate 1: 20.

Ref: Růžička (1977), p. 171, pl. 21: 15–17.

Dim: L: 200.5–290–299.5; B: 8.8–10.5; Ba: 1.7–2; L:B = 20.5–33.1.

Previous record: None exist.

Loc: 3 and 4, frequent; 1, 2, and 5: common; 7, rare.

Comm: Cells found at localities 3 and 4 were considerably longer (by 9.5 μm) than in the nominal variety, whose length is up to 290 μm accodcing to Růžička (1977).

15. ***C. limneticum*** var. ***limneticum***

Plate 1: 18.

Ref: Růžička (1977, p. 171, pl. 21: 9–11).

Dim: L: 132.5–287.5–355; B: 4.5–7.5; Ba: 1–1.2; L:B = 17–48.5–64–71.

Previous records: Miljanović et al. (2003), Nemeš and Pujin (2003).

Loc: 1, 3, and 6, frequent; 2, 4, 5, and 7, very frequent.

Comm: Cells found at locality 4 were distinctly longer (by 65 μm) and with a higher L:B ratio (by a value of 23) than in the nominal variety [length up to 290 μm and L:B ratio up to 48 according to Růžička (1977)]. This taxon was exceedingly frequent at localities along the Danube, in almost all investigated months.

16. ***C. limneticum*** var. ***tenue*** Lemm.

Plate 1: 19.

Ref: Růžička (1977, p. 171, pl. 21: 12–14).

Dim: L: 167.5–272.5; B: 3.5–4; Ba: 0.7–1; L:B = 44.4–76.4.

Previous record: None exist.

Loc: 1 and 2, rare; 4 and 7, common.

17.* ***C. macilentum*** Bréb.

Plate 1: 9.

Ref: Růžička (1977, p. 212, pl. 31: 9–13).

Dim: L: 272.5–340; B: 12–14.5; Ba: 4.5; L:B = 26.5–27.2

Previous record: None exist.

Loc: 3, rare.

Comm: The cells are moderately long, in mid-region straight, evenly and slightly curved towards the cell end; apices are narrowly rounded. The cell wall is slightly brownish, with girdle bands.

18.* ***C. moniliferum*** (Bory) Ehr. ex Ralfs var. ***concavum*** Klebs #

Plate 2: 3.

Ref: Růžička (1977, p. 137, pl. 14: 7–9).

Dim: L: 260–275; B: 45–50; Ba: 6.5–7; L:B = 5.5–5.7.

Previous record: None exist.

Loc: 3, very rare.

Comm: This variety is doubtful because of insignificant morphological differences relative to the nominal variety (Lenzenweger, 1996). Clearly concave specimens of *C. moniliferum* (without any trace of swelling), in contrast to the type-variety, were separated in var. *concavum*.

19. ***C. moniliferum*** var. ***moniliferum***

Plate 2: 4.

Ref: Růžička (1977, p. 137, pl. 14: 3–6).

Dim: L: 192–262.5; B: 37.5–50; Ba: 8–10; L:B = 4.8–5.8.

Previous records: Protić (1939), Milovanović (1965), Senćanski (1972), Miljanović et al. (2003).

Loc: 1, 5 and 7, common; 2, rare.

20.* ***C. moniliferum*** var. ***submoniliferum*** (Woronich.) Krieg. #

Plate 2: 5.

Ref: Růžička (1977, p. 137, pl. 14: 10–11).

Dim: L: 217.5–227; B: 50–55; Ba: 6.5–8.5; L:B = 5–6.7.

Previous record: None exist.

Loc: 1, very rare.

Comm: This variety is considered doubtful (Růžička, 1977). Cells characterized by pyrenoids slightly deviating from the cell axis were observed and separated from the type-variety.

21.* ***C. parvulum*** Näg. var. ***cornutum*** (Playf.)

Krieg.

Plate 2: 6

Ref: Růžička (1977, p. 121, pl. 11: 23–24); Kouwets (1998, p. 123, fig. 1).

Dim: L: 165–167.5; B: 27.5–30; Ba: 5; L:B = 6.1–6.5.

Previous record: None exist.

Loc: 6, very rare.

Comm: Specimens of this taxon completely corresponded to the description given by Kouwets (1998), but cell size was larger than the dimensions given by Růžička (1977). Small end-pores are on the narrowly rounded apices.

22.* ***C. praelongum*** Bréb. var. ***brevius*** (Nordst.) Krieg.

Plate 1: 14.

Ref: Růžička (1977, p. 163, pl. 20: 4–13).

Dim: L: 295–310; B: 16–20; Ba: 4–4.5; L:B = 14.8–18.

Previous record: None exist.

Loc: 3, rare.

Comm: Striae on the cell wall are dense and visible; 15–17 str./10 μm.

23. ***C. pronum*** Bréb.

Plate 1: 15.

Ref: Růžička (1977, p. 102, pl. 7: 23–26).

Dim: L: 197.5–305; B: 7.5–9.5; Ba: 2–2.5; L:B = 25.8–34.

Previous records: Milovanović and Živković (1950).

Loc: 1, common; 7, frequent.

24. ***Closterium*** sp.

Plate 1: 12, 13.

Dim: L: 166–187.5; B: 8.5–11; Ba: 2–2.2; L:B = 17.5–20.3.

Loc: 5 and 7, very rare.

Comm: The data insuficient for determination, e.g., only a few specimens were found.

With respect to morphological characteristics and cell size, they corresponded to *Closterium idiosporum* W. & G. S. West. Zygospores were not observed.

25. ***C. strigosum*** Bréb.

Plate 1: 21.

Ref: Růžička (1977, p. 173).

Dim: L: 227.5–247.5; B: 11.5–17; Ba: 2–2.5; L:B = 11.4–18.8.

Previous records: Đurković and Čađo (2004).

Loc: 2, 3, and 6, rare.

Comm: An intermediate form characterized by a weakly prominent mid-region, was found at several localities.

26.* ***C. strigosum*** var. ***elegans*** (G. S. West) Krieg.

Plate 1: 22.

Ref: Růžička (1977, p. 173, pl. 22: 1–11).

Dim: L: 162.5–207.5; B: 15–16.5; Ba: 2.5–3; L:B = 13.1–13.8.

Previous record: None exist.

Loc: 1 and 7, rare.

27. ***C. strigosum*** Bréb. var. ***strigosum***

Plate 1: 23.

Ref: Růžička (1977, p. 173, pl. 21: 18–26).

Dim: L: 180–330; B: 10.5–19; Ba: 2–2.5; L:B = 12.7–21.8.

Previous record: Obušković (1982).

Loc: 2 and 3, common; 4, 5, and 7, frequent; 6, very frequent.

28.* ***C. subulatum*** (Kütz.) Bréb.

Plate 1: 16.

Ref: Růžička (1977, p. 109, pl. 9: 23–26).

Dim: L: 200.5–212.5; B: 12.5–13.5; Ba: 2.5; L:B = 13.5–17.

Previous record: None exist.

Loc: 7, very rare.

Comm: Cells are moderately curved, their inner margin slightly tumid, evenly attenuated towards the apices, which are acutely rounded; the cell wall is smooth.

Order: Zygnematales

Suborder: Desmidiineae

Family: Desmidiaceae Ralfs

Cosmarium Corda ex Ralfs

29.* *C. bioculatum* Bréb. in Ralfs var. *depressum* (Schaarschm.) Schmidle

Plate 2: 12, 13.

Ref: Prescott et al. (1981, p. 81, pl. 174: 6, 7); Kouwets (2001, p. 35, pl. 4: 1–8).

Dim: L: 13.5–15; B: 13.5–17; I: 4.5–5.5; Th: 7.5–8.

Previous record: None exist.

Loc: 2, rare.

Comm: Typical representatives of var. *depressum* were recorded. Forms intermediate in comparison with the type-variety were not observed.

30.* ***C. calcareum*** Wittr.

Plate 3: 7.

Ref: West and G. S. West (1908, p. 235, pl. 87: 1, 2); Prescott et al. (1981, p. 94, pl. 223: 2).

Dim: L: 25–26.5; B: 23–23.5; I: 6.5; Th: 13.5.

Previous record: None exist.

Loc: 1, very rare.

Comm: Cells completely corresponded to the description given by West and G. S. West (1908). Semicells are oblong-trapeziform with a truncate and weakly crenate apex. The lower part of sides is quadri-crenate, the upper part with one emarginate crenation. The median protrusion of semicells is furnished with eight peripheral granules surrounding the central one. The vertical aspect of semicells is broadly elliptical with a prominent tri- or quadri-granulate protrusion in the middle on each side.

31.* ***C. contractum*** Kirchn.

Plate 2: 22.

Ref: Lenzenweger (1999, p. 41, pl. 50: 16, 17).

Dim: L: 35–37.5; B: 22.5–23; I: 6.5–7; Th: 17.5.

Previous record: None exist.

Loc: 7, very rare.

*32. ***C. depressum*** (Näg.) Lund. var. ***granulatum*** Turner

Plate 2: 20.

Ref: Krieger and Gerloff (1962, p. 20, pl. 8: 6); Prescott et al. (1981, p. 125, pl. 179: 8, 9).

Dim: L: 25–25.5 μm; B: 27–27.5 μm; I: 6–7.5; Th.:12.5–13.5.

Previous record: None exist.

Loc: 3 and 5, rare.

33.* ***C. formosulum*** Hoff in Nordst.

Ref: Palamar – Mordvintseva (1982, p. 477); Lenzenweger (1999, p. 133).

Dim: L: 38–44.5; B: 36–45.5; I: 12.5–13; Th: 22–24.5.

Previous record: None exist.

Loc: 3, very rare.

Comm: Empty or somewhat damaged cell walls of *C. formosulum* were encountered in small numbers and were not determined to the final variety.

34.* ***C. formosulum*** var. ***formosulum***

Plate 2: 10.

Ref: Palamar – Mordvintseva (1982, p. 477, pl. 125: 6, 7); Lenzenweger (1999, p. 133, pl. 64: 5).

Dim: L: 40–43.5; B: 34.5–37.5; I: 12.5–14; Th: 22.5–24.5.

Previous record: None exist.

Loc: 3, rare.

Comm: This variety occurred together with var. *nathorstii*; intermediate forms were not observed.

35.* ***C. formosulum*** var. ***nathorstii*** (Boldt) W. & G. S. West

Plate 2: 11.

Ref: Palamar – Mordvintseva (1982, p. 477, pl. 125: 8, 9); Lenzenweger (1999, p. 133, pl. 64: 6–8).

Dim: L: 44–53; B: 44.5–47; I: 13.5–14; Th: 23–25.

Previous record: None exist.

Loc: 3, rare.

36. ***C. granatum*** Bréb. in Ralfs

Plate 2: 18.

Ref: Prescott et al. (1981), p. 146, pl. 185: 1–3; Lenzenweger (2001), p. 255, pl. 1: 13–15.

Dim: L: 40–47.5; B: 27.5–30.5; I: 7.5–10; Th: 16–17.5.

Previous records: Obušković and Kalafatić (1983).

Loc: 1 and 5, common.

Comm: Serbian specimens are proportionally larger than the cells found in lentic habitats of the Danube flood plain in Vienna and Lower Austria (length 40 μm and breadth 28 μm according to Lenzenweger, 2001). Length of *C. granatum* from the Serbian stretch of the Danube deviated by

7.5 μm, breadth by 2.5 μm.

37.* ***C. humile*** (Gay) Nordst. in De Toni var. ***humile***
Plate 3: 4.
Ref: Palamar – Mordvintseva (1982, p. 484, pl. 129: 1–3); Lenzenweger (1999, p. 134, pl. 63: 18); Kouwets (1987, p. 225, pl. 14: 11–12).
Dim: L: 14–15.5; B: 13.5–14; I: 4–5.5; Th: 7.5–9.
Previous record: None exist.
Loc: 7, rare.

38.* ***C. humile*** var. ***substriatum*** (Nordst.) Schmidle
Plate 2: 6.
Ref: Palamar – Mordvintseva (1982, p. 484, pl. 129: 6); Fehér (2003, p. 679, fig. 15).
Dim: L: 22.5–24; B: 19–20.5; I: 5.5–6; Th: 12.5–13.
Previous record: None exist.
Loc: 3, very rare.

39.** ***C. kjellmanii*** Wille
Plate 3: 3.
Ref: Palamar – Mordvintseva (1982, p. 484, pl. 129: 6).
Dim: L: 28.5–30; B: 27–27.5; I: 8–9; Th: 15.5.
Previous record: None exist.
Loc: 1, very rare.
Comm: This taxon is new to the Serbian flora.

40. ***C. laeve*** Rabenh.
Plate 2: 23.
Ref: West and G. S. West (1908, p. 99, pl. 73: 8–19); Lenzenweger (1999, p. 91, pl. 52: 24).
Dim: L: 25–27.5; B: 17.5–19; I: 6.5–8; Th: 12.5–13.
Previous records: Miljanović et al. (2003).
Loc: 7, rare.

41.* ***C. pseudopyramidatum*** Lund.
Plate 2: 21.
Ref: Lenzenweger (1999, p. 60, pl. 48: 9–12).
Dim: L: 45–46.5; B: 32.5; I: 10–11; Th: 18–19.
Previous record: None exist.
Loc: 3, very rare.

42.* ***C. punctulatum*** Bréb.
Plate 3: 2.
Ref: Prescott et al. (1981, p. 253, pl. 235: 5, 6).
Dim: L: 32.5–35; B: 30–34.5; I: 10.5–11; Th: 19.5.
Previous record: None exist.
Loc: 4, rare.

43. ***C. pygmaeum*** Arch.
Plate 2: 16, 17.
Ref: Palamar – Mordvintseva (1982, p. 439, pl. 118: 13–21); Kouwets (1987, p. 229, pl. 13: 11–14); Kouwets (1988, p. 295, pl. 1: 16–21).
Dim: L: 8.5–10; B: 10–12.5; I: 4–5.5; Th: 5–6.5.
Previous record: None exist.
Loc: 1, rare.
Comm: A few typical biradiate cells of *C. pygmaeum* were recorded. Unlike French specimens (Kouwets 1987, 1988), our material is characterized by symmetrically placed subapical granules. Semicells are oblong-elliptical in apical view, with a slight central inflation. A small conical papilla is visible on semicells viewed laterally.

44. ***Cosmarium*** sp.
Plate 2: 15.
Dim: L: 15.5; B: 13.5; I: 5.
Loc: 6, very rare.
Comm: The data are insufficient for determination, e.g., only one specimen of *Cosmarium* sp. was found. It morphologically resembled *C. laeve* Rabenh. var. *pseudooctangulare* Fritsch & Rich (according to Kouwets, 1991, p. 395, pl. 3: 9–17; and Lenzenweger 2003, p. 12, pl. 2: 7).

45. ***C. subspeciosum*** Nordst. var. ***transiens*** Messik.
Plate 3: 1.
Ref: Lenzenweger (1999, p. 151, pl. 64: 9); Kouwets (1987, p. 234, pl. 15: 15).
Dim: L: 33.5–35; B: 27–29; I: 10–10.5; Th: 15.5–16.
Previous record: None exist.
Loc: 7, very rare.

46. ***C. subtumidum*** Nordst.
Plate 2: 19.
Ref: Palamar – Mordvintseva (1982, p. 422, pl. 111: 5–9).
Dim: L: 32.5–36; B: 26.5–29; I: 9–10; Th: 17.5–18.
Previous record: None exist.

Loc: 4, rare.

47. ***C. tenue*** Arch.
Plate 2: 14.
Ref: Lenzenweger (1999, p. 69, pl. 51: 16, 17); Kouwets (1987, p. 235, pl. 13: 32–35).
Dim: L: 12.5–13.5; B: 12–13; I: 5–6.5; Th: 5.5–8.
Previous record: None exist.
Loc: 1, rare.

48.* ***C. thwaitesii*** Ralfs
Plate 2: 7.
Ref: West and G. S. West (1908, p. 104, pl. 73: 27, 28); Prescott et al. (1981, p. 328, pl. 170: 10, 11, pl. 222: 5, 9).
Dim: L: 59.5; B: 27; I: 22.5; Th: 25.
Previous record: None exist.
Loc: 3, very rare.

49.* ***C. turpinii*** Bréb.
Plate 2: 9.
Ref: Lenzenweger (1999), p. 153, pl. 65: 6; Fehér (2003), p. 680, fig. 16.
Dim: L: 72.5–75; B: 64–65; I: 19–20; Th: 35.5.
Previous record: None exist.
Loc: 5, very rare.

50.* ***C. wembaerense*** Schmidle [= ***C. laeve*** Rabh. var. ***tumidum*** Grönbl.]
Plate 3: 5.
Ref: Prescott et al. (1981, p. 350, pl. 186: 14–16); Fehér (2003, p. 680, fig. 49).
Dim: L: 20–22.5; B: 16–17.5; I: 5.5–6.5; Th: 12–13.5.
Previous record: None exist.
Loc: 1 and 2, common.

Euastrum Ehr. ex Ralfs

51.* ***Euastrum spinulosum*** Delp.
Plate 2: 8.
Ref: Růžička (1981, p. 533, pl. 86: 8–10).
Dim: L: 56.5–60; B: 50–55; I: 18–20; Th: 35.5–37.
Previous record: None exist.
Loc: 3, very rare.

Staurastrum Meyen ex Ralfs

52.* ***S. alternans*** (Bréb.) Ralfs
Ref: Lenzenweger (1997, p. 66, pl. 25: 15, 16).
Dim: L: 28–29.5; B: 30–32; I: 10–11.
Previous record: None exist.
Loc: 3, rare.

53. ***S. anatinum*** Cooke & Wills f. ***paradoxum*** (Meyen) Brook
Plate 3: 12.
Ref: Lind and Brook (1980, p. 104, fig 156 D); Lenzenweger (1997, p. 69, pl. 34: 10).
Dim: L (excluding processes): 20–22; L: 30–31.5; B: 40.5–42; I: 7.5–8.
Previous records: Milovanović (1965), Obušković and Kalafatić (1983).
Loc: 1 and 5, rare.
Comm: This taxon was previously found and identified as *S. paradoxum*, but it was not reported to be numerous.

54.** ***S. bloklandiae*** Coesel & Joosten
Plate 3: 14.
Ref: Coesel and Joosten (1996, p. 9–12, figs: 1–6).
Dim: L (excluding processes): 18.5; L: 40; B: 40.5; I: 5. Th: 8.5.
Previous record: None exist.
Loc: 7, very rare.
Comm: This taxon is new to the Serbian flora.

55. ***S. chaetoceras*** (Schröder) G. M. Smith
Ref: Palamar – Mordvintseva (1982, p. 211, pl. 52: 7, 9).
Dim: L (excluding processes): 14.5–25; L: 25.5–67.5; B: 30.5–75; I: 4–10.
Previous records: Miljanović et al. (2003), Đurković and Čađo (2004).
Loc: 1, 4, and 6, common; 2, frequent; 5 and 7, very frequent.
Comm: Two-radiate and three-radiate specimens were frequently encountered. Dichotypical cells were also observed. Specimens from Loc. 4 were characterized by proportionally small size. Length with processes was smaller by 1.5 μm and breadth with processes smaller by 4.5 μm than the dimensions given by Palamar – Mordvintseva (1982).

56.* ***S. crenulatum*** (Näg.) Delp.
Ref: Lenzenweger (1997, p. 82, pl. 33: 2).

Dim: L: 24.5–26.5; B: 29–29.5; I: 8.5.
Previous record: None exist.
Loc: 5, very rare.

57.* ***S. cyrtocerum*** (Bréb.) Ralfs
Plate 3: 21.
Ref: Lenzenweger (1997, p. 84, pl. 33: 9); Brook (2003, p. 569, pl. 139: O).
Dim: L: 29–30; B: 35–36.5; I: 10–10.5.
Previous record: None exist.
Loc: 3, rare.

58.* ***S. dispar*** Bréb.
Ref: Lenzenweger (1997, p. 86, pl. 26: 3, 4).
Dim: L: 24.5–27; B: 30–34.5; I: 7–7.5.
Previous record: None exist.
Loc: 5, rare.

59.* ***S. floriferum*** W. & G. S. West
Plate 3: 16.
Ref: Palamar – Mordvintseva (1982, p. 242, pl. 61: 6, 7).
Dim: L (excluding processes): 23–24; B: 45–47.5; I: 7.5.
Previous record: None exist.
Loc: 5, very rare.
Comm: Cells are tri-radiate in vertical view, semicells trapeziform, their lateral margins slightly inflated and smooth. The sinus is open, with an acute apex. The processes are moderately long and horizontal, provided with five concentric circles of small irregular spines, three or four diverging spines being situated at the end of the processes. The cell wall of the apex is furnished with two bifid warts on the base of processes; the central part of the apex is smooth.

60. ***S. gracile*** Ralfs ex Ralfs
Plate 3: 13.
Ref: West et al. (1923, p. 96, pl. 144: 8, 9); Kouwets (1987, p. 252, pl: 18: 25); Brook (2003, p. 569, pl. 139: N).
Dim: L: 19.5–22; B: 23–24.5; I: 4.5–5.
Previous record: Miljanović et al. (2003).
Loc: 3 and 5, rare
Comm: A small number of quadri-radiate cells were recorded. Specimens were smaller than in the type-variety, with much shorter processes and a slightly convex apex. Those specimens corresponded to *S. gracile* var. *nanum* Wille (according to West et al., 1923) and were similar to the description given by Kouwets (1987), although cell ornamentation was in accordance with the type-variety. The authors of previous investigations did not precisely state the variety of *S. gracile*.

61. ***S. gracile*** var. ***gracile***
Plate 3: 17.
Ref: Lenzenweger (1997, p. 100, pl. 35: 3); Brook (2003, p. 569, pl. 139: N).
Dim: L: 36–40; B. (including processes): 47–49.5; I: 8.5–9.
Previous record: Milovanović (1965).
Loc: 2, 3, 4, 5 and 7, rare.

62.* ***S. longipes*** (Nordst.) Teil.
Plate 3: 20.
Ref: Lenzenweger (1997, p. 100, pl. 35: 3).
Dim: L: 70–78 μm; B: 75–95.5 μm; I: 8–8.5 μm.
Previous record: None exist.
Loc: 7, very rare.

63.* ***S. punctulatum*** Bréb. ex Ralfs
Plate 3: 19.
Ref: Lenzenweger (1997, p. 120).
Dim: L: 35.5 μm; B: 34 μm; I: 11 μm.
Previous record: None exist.
Loc: 6, very rare.
Comm: Cells are tri-radiate, slightly longer than wide. Semicells are oval and laterally inflated; their apex is broadly rounded. The specimen showed strong resemblance to *S. punctulatum* var. *kjellmanii* Wille (Lenzenweger, 1997, pl. 25: 4), although its size was maximal in comparison with the reference. A single finding of this taxon was not enough to confirm the identification completely.

64. ***S. punctulatum*** var. ***punctulatum***
Plate 3: 15.
Ref: Lenzenweger (1997, p. 120, pl. 25: 2).
Dim: L: 35–37.5 μm; B: 35.5–38 μm; I: 10–12.5 μm.
Previous record: None exist.
Loc: 2, common.

65.* ***S. retusum*** Turn.
Plate 3: 10
Ref: W. and G. S. West (1912, p. 160, pl. 125: 6, 7).

Dim: L: 22–25 μm; B: 22–25.5 μm; I: 7–9.5 μm.
Previous record: None exist.
Loc: 7, rare.

66.** ***S. smithii*** (G. M. Smith) Teil.
Plate 3: 11.
Ref: Lenzenweger (1997, p. 130, pl. 34: 18).
Dim: L: 42–47 μm; B: 42–47 μm; I: 7–8 μm.
Previous record: None exist.
Loc: 4, rare.
Comm: Proportionally small specimens of this taxon were observed, cell length and breadth including processes being smaller by 3 μm than the dimensions given by Lenzenweger (1997).
This taxon is new to the Serbian flora.

67. ***Staurastrum*** sp.
Loc: 2 and 3.
Comm: The data are insufficient for determination - only a few empty and noticeably damaged semicells were found.

68.* ***S. sublongipes*** G. M. Smith
Plate 3: 18.
Ref: Irenée – Marie (1957), p. 198, pl. 2: 23; Palamar – Mordvintseva 1982, p. 213, pl. 52: 5, 6.
Dim: L: 35–38.5; L (excluding processes): 18–19; B: 40–41; I: 10.
Previous record: None exist.
Loc: 6, rare.
Comm: Cells are tri-radiate in apical view, the semicell body cup-shaped with insignificantly swollen lateral margins. The apex is slightly convex and provided with small emarginate or irregular verrucae (placed within each lateral apical margin, clearly visible in vertical view). The processes are long, diverging, and furnished with five or six series of warts tipped with three minute spines.

69. ***S. tetracerum*** (Kütz.) Ralfs var. ***tetracerum***
Plate 3: 9.
Ref: Lenzenweger (1997, p. 137, pl. 34: 15).
Dim: L: 23.5–29.5; B: 25–30.5; I: 5–6.
Previous record: Milovanović (1965).
Loc: 1, 4, and 6, rare; 2, common.
Comm: The cells are larger than in the nominal variety. Cell length and breadth including processes are greater by 6.5 μm than the dimensions given by Lenzenweger (1997).

70.* ***S. tetracerum*** (Kütz.) Ralfs var. ***tetracerum*** f. ***trigona*** Lund.
Plate 3: 8.
Ref: Lenzenweger (1997, p. 137, pl. 34: 16).
Dim: L: 20–22.5; B: 22–23; I: 5.
Previous record: None exist.
Loc: 7, very rare.

General remarks

A total of 70 desmid taxa were recorded, which was due to comparatively good quality of the Danube water sampled (see below). Qualitatively, the genus *Closterium* was dominant (28 taxa; 40%) in the desmid community, *Cosmarium* was subdominant (22 taxa, 31.43%), and the genus *Staurastrum* was represented by 19 taxa (27.14%). A few specimens of *Euastrum spinulosum* (1.43%) were found at the Bačka Palanka site.

The highest diversity of desmids was observed in the summer months (June and July of 2002), when pH, conductivity, total hardness, and concentration of NO_3^- were lower than in the other months.

During June and July of 2002 the following taxa were frequently found: *S. tetracerum*, *Closterium limneticum*, and *Staurastrum chaetoceras*, which are indicators of oligosaprobity, o-β-mesosaprobity, and β-mesosaprobity, respectively (Sev, 1977; Gulyás, 1998). During the whole research period, only *C. limneticum* var. *limneticum* was frequently observed at all the investigated localities. As an indicator of o–β-mesosaprobity, the presence of *C. limneticum* var. *limneticum* over the whole period of investigations points to relatively good water quality. Occasional deterioration of water quality was particularly noticed at localities situated in the large cities of Zemun and Pančevo. During August of 2002, high values of water temperature, BOD, and NH_4^+ concentration as well as relatively low values of dissolved oxygen were recorded at these sites. As a result, the qualitative composition of the desmid flora was altered, i.e., qualitative impoverishment of the desmid community occurred and indicators of α–β-mesosaprobity (*Closterium acutum* and *C.*

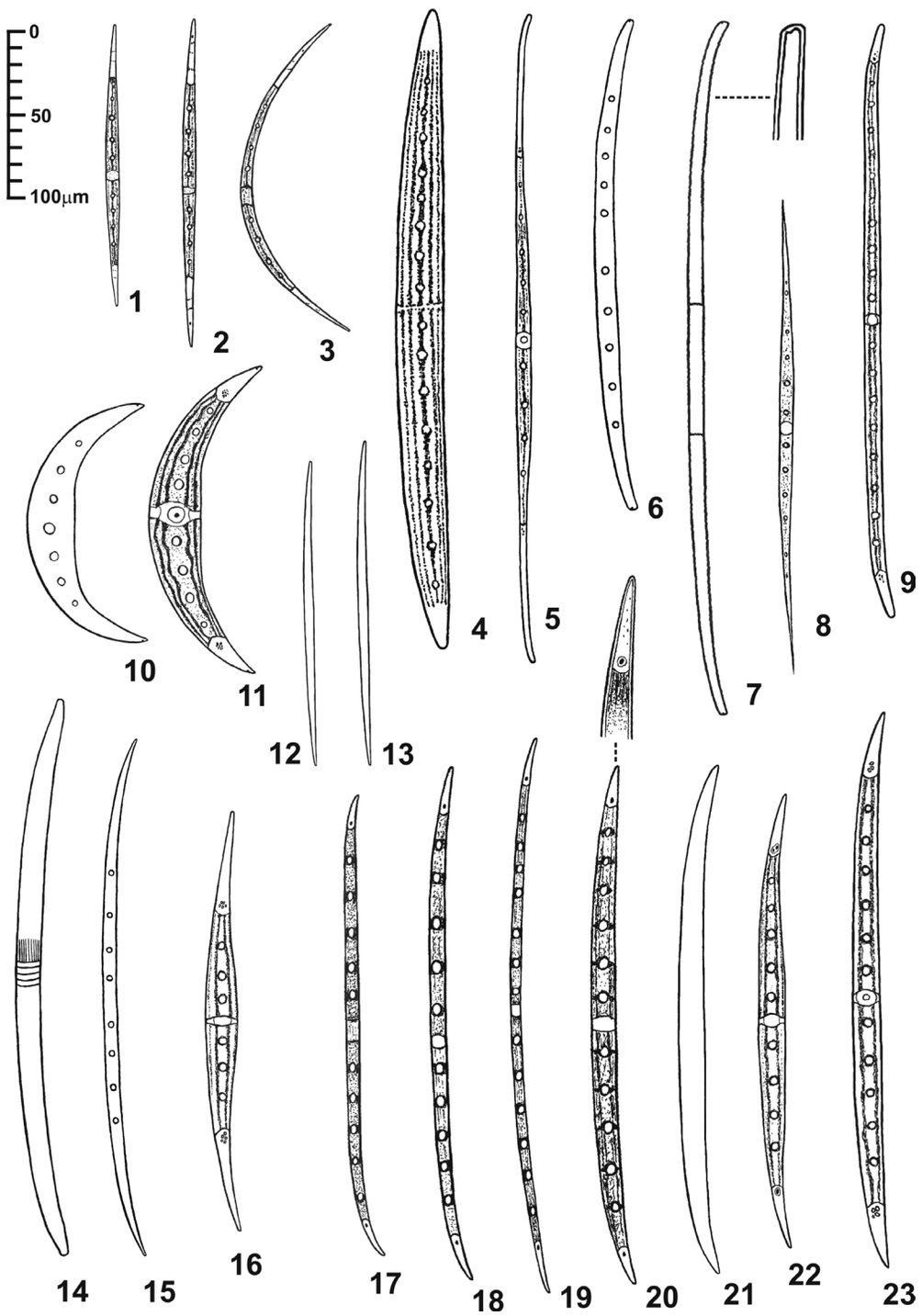

Plate 1. 1 – *Closterium acutum* var. *acutum*, 2 – *C. acutum* var. *linea*, 3 – *C. acutum* var. *variabile*, 4 – *C. acerosum*, 5 – *C. aciculare*, 6 – *C. gracile* var. *gracile*, 7 – *C. gracile* var. *elongatum,* 8 – *C. ceratium*, 9 – *C. macilentum*, 10 – *C. leibleinii*, 11 – *C. leibleinii* var. *leibleinii*, 12, 13 – *Closterium* sp., 14 – *C. praelongum* var. *brevius*, 15 – *C. pronum*, 16 – *C. subulatum*, 17 – *C. limneticum*, 18 – *C. limneticum* var. *limneticum*, 19 – *C. limneticum* var. *tenue,* 20 – *C. limneticum* var. *fallax*, 21 – *C. strigosum*, 22 – *C. strigosum* var. *elegans*, 23 – *C. strigosum* var. *strigosum.*

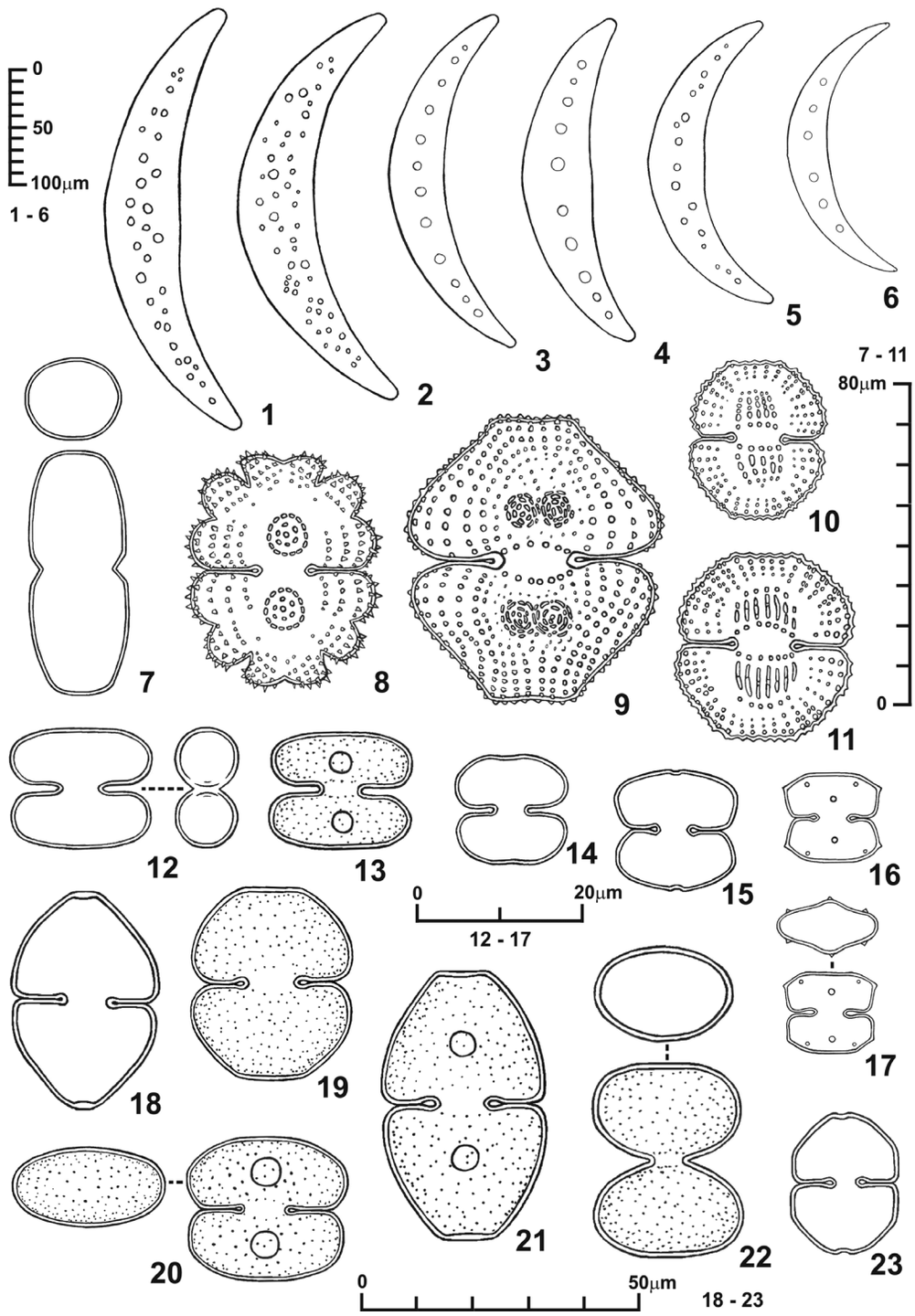

Plate 2. 1 – *Closterium ehrenbergii* var. *ehrenbergii*, 2 – *C. ehrenbergii* var. *atumidum*, 3 – *C. moniliferum* var. *concavum*, 4 – *C. moniliferum* var. *moniliferum*, 5 – *C. moniliferum* var. *submoniliferum*, 6 – *C. parvulum* var. *cornutum*, 7 – *Cosmarium thwaitesii*, 8 – *Euastrum spinulosum*, 9 – *Cosmarium turpinii*, 10 – *C. formosulum* var. *formosulum*, 11 – *C. formosulum* var. *nathorstii*, 12, 13 – *C. bioculatum* var. *depressum*, 14 – *C. tenue*, 15 – *Cosmarium* sp., 16, 17 – *C. pygmaeum*, 18 – *C. granatum*, 19 – *C. subtumidum*, 20 – *C. depressum* var. *granulatum*, 21 – *C. pseudopyramidatum*, 22 – *C. contractum*, 23 – *C. laeve*.

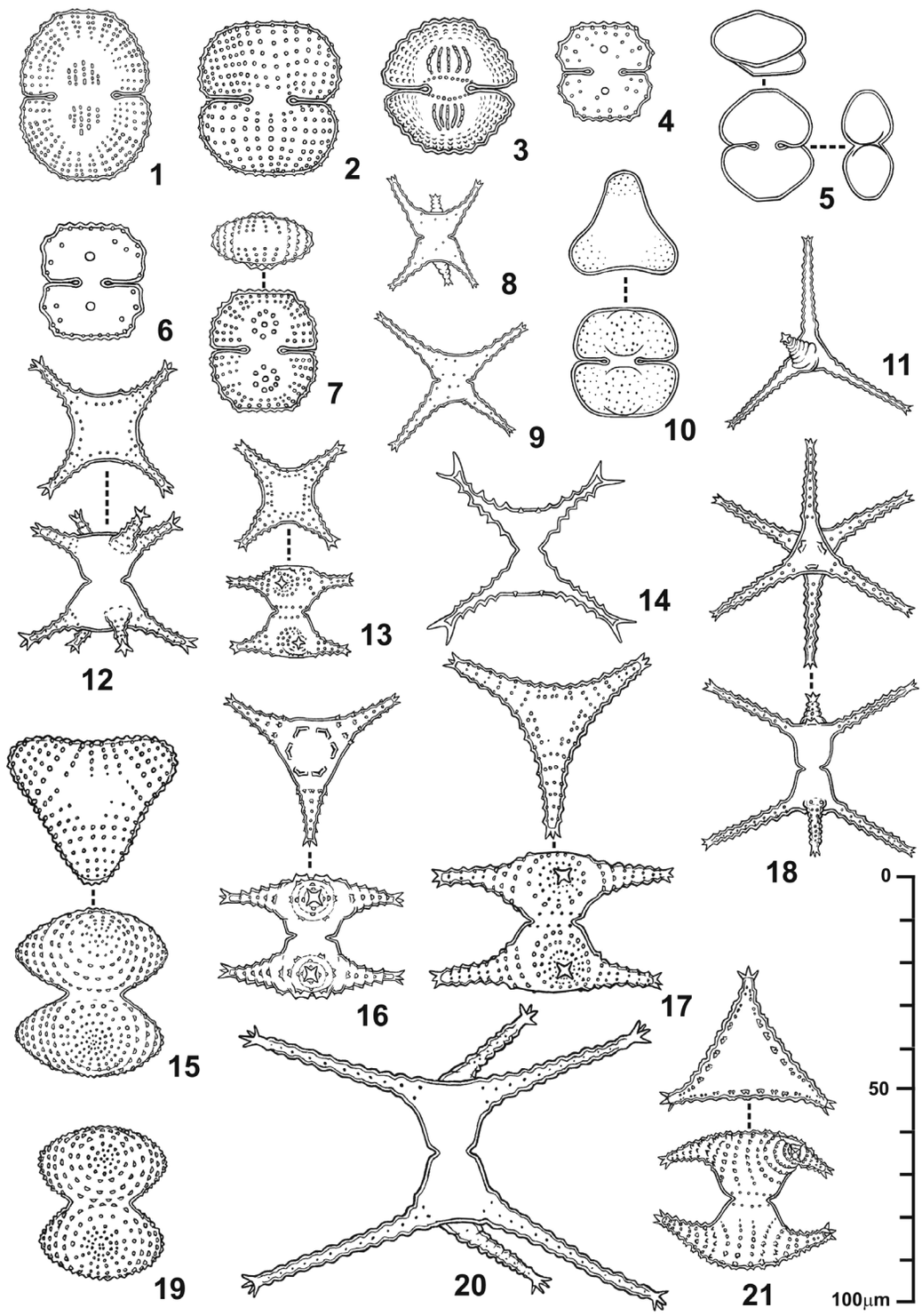

Plate 3. 1 – *Cosmarium subspeciosum* var. *transiens*, 2 – *C. punctulatum*, 3 – *C. kjellmanii*, 4 – C. *humile* var. *humile*, 5 – *C. wembaerense*, 6 – *C. humile* var. *substriatum*, 7 – *C. calcareum*, 8 – *Staurastrum tetracerum* var. *tetracerum* f. *trigona* 9 – *S. tetracerum* var. *tetracerum*, 10 – *S. retusum*, 11 – *S. smithii*, 12 – *S. anatinum* var. *paradoxum* 13 – *S. gracile*, 14 – *S. bloklandiae*, 15 – *S. punctulatum* var. *punctulatum*, 16 – *S. floriferum*, 17 – *S. gracile* var. *gracile*, 18 – *S. sublongipes*, 19 – *S. punctulatum*, 20 – *S. longipes*, 21 – *S. cyrtocerum*.

strigosum) appeared.

Although during the autumn months, the quality of the Danube's water was improved, lower diversity of desmids was recorded. Progressive lowering of water temperature and increases in conductivity, total hardness, and NO_3^- concentration, resulted in qualitative impoverishment of the desmid community. Also, it should be borne in mind that Bacillariophyta prefer cold water and higher concentration of nutrients, and their qualitative and quantitative presence is therefore higher under these conditions, in contrast to the situation with other groups of algae (R e y n o l d s , 1984).

In December, under conditions of low water temperature and exceedingly high total hardness, desmids were not found, whereas *Closterium limneticum* var. *limneticum*, was recorded at several localities in January of 2003.

Parallel with the increase of water temperature in spring of 2003, the desmid community became ever more diverse, although the total number of taxa was lower than in summer. The low water temperature, moderately alkaline reaction, and high values of conductivity, hardness, and NH_4^+ and NO_3^- concentrations were more suitable for Bacillariophyta, owing to they had a competitive advantage over Chlorophyta.

Some rare desmids (e.g., *Closterium subulatum*, *Cosmarium thwaitesii*, *C. turpinii*, *Staurastrum smithii*, *S. dispar*, *S. floriferum* and *S. retusum*) were present at the investigated localities, although the Danube is not an appropriate natural environment for them. Typical acidophilous (e.g., *Closterium gracile*, *C. macilentum*, *Cosmarium pygmaeum* and *Staurastrum punctulatum*) and alpine taxa (e.g., *Cosmarium kjellmanii* and *Staurastrum longipes*) were also found. These desmids were represented by a few specimens only. It is most unlikely that these species can complete their whole life cycle under the habitat conditions prevailing in the Danube. It is assumed that the majority of these desmid taxa were flushed into the Danube from its tributaries, nearby lakes, marshes, fens, and bogs, which thereby represent a more or less continual source of phytoplanktonic organisms. In addition, the threshold of tolerance of many desmid taxa to various physical and chemical parameters has changed considerably, as a consequence of constant pollution of their native habitats.

During the whole research period, only *Closterium limneticum* var. *limneticum* was frequently recorded at all the investigated localities. This taxon can be considered a true euplanktonic organism in the Vojvodina stretch of the Danube.

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ФЛОРА ДЕЗМИДИЈАЛНИХ АЛГИ (CHLOROPHYTA, ZYGNEMATOPHYCEAE) ВОЈВОЂАНСКОГ ДЕЛА ДУНАВА (СЕВЕРНА СРБИЈА)

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У периоду од априла 2002. до маја 2003. године проведена су детаљна истраживања флоре дезмидијалних алги на 7 локалитета у току Дунава кроз Војводину. У раду је прецизно назначен положај сваког локалитета, дат је његов опис, као и физичко-хемијске карактеристике воде на њему.

Укупно је забележено 70 таксона дезмидијалних алги. За сваки таксон су дате његове основне таксономске карактеристике, ранији налази у Дунаву (уколико постоје), нови налази, а за већину и оригинални цртежи.

Врсте *Cosmarium kjellmanii*, *Staurastrum bloklandiae* and *Staurastrum smithii* нове су за алгалну флору Србије, док је за војвођански део Дунава ново 47 таксона.

Очекивано, највећи диверзитет дезмидијалних алги забележен је у летњим месецима. У току јесени заједница дезмидијалних алги постепено осиромашује, да би у зимском периоду, и то на неким локалитетима, био присутан само *Closterium limneticum* var. *limneticum*. У пролеће се заједница дезмидијалних алги постепено обогаћује.

Током јуна и јула 2002. год. (највећи диверзитет дезмидијалних алги), често налажени таксони указивали су на добар квалитет воде (*Staurastrum chaetoceras*, индикатор - β-мезосапробности; *Closterium pronum* - β–олигосапробности; *Closterium limneticum*, *C. aciculare*, *Cosmarium granatum* - о–β-мезосапробности; *Staurastrum tetracerum* – индикатор олигосапробности). То додатно потврђује и често присуство *Closterium limneticum* var. *limneticum* (индикатор о–β-мезосапробности), како на свим истраженим локалитетима, тако и у току целог периода истраживања. Погоршање квалитета воде утврђено је на локалитетима у већим градовима (Земун и Панчево), где је у августу забележено присуство индикатора β–α- и α–β-мезосапробности (*Closterium acutum*, *C. leiblenii* и *C. strigosum*).

Иако Дунав није уобичајено окружење за развој дезмидијалних алги, на истраженим локалитетима, поред врста које су нове за Србију, нађене су и неке, генерално ретко налажене (нпр. *Closterium subulatum*, *Cosmarium thwaitesii*, *C. turpinii*, *Staurastrum smithii*, *S. dispar*, *S. floriferum* и *S. retusum*).

Од интереса је и налаз ацидофилних (**нпр.** *Closterium gracile*, *C. macilentum*, *Cosmarium pygmaeum* и *Staurastrum punctulatum*), као и алпских таксона (нпр. *Cosmarium kjellmanii* и *Staurastrum longipes*) без обзира на њихову заступљеност малим бројем јединки на месту налаза.