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DESMID FLORA FROM FOUR PEAT BOGS IN SERBIA

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Abstract – The main objective of this paper is to report the desmid taxa identified from four Serbian peat bogs: Pešter, Daić Lake on Mt. Golija, Crvene pode on Mt. Tara and Horgoš. Samples were collected in the period from 2007 to 2011. In total, 220 desmid taxa from 22 genera were identified. The most species-rich genera are *Cosmarium* (81), *Staurastrum* (38) and *Closterium* (31). Of the total number, 66 desmid taxa are new for the Serbian desmid flora.

Key words: Desmids, peat bog, Pešter, Daić lake, Crvene pode, Horgoš, Serbia

INTRODUCTION

Desmids occur exclusively in freshwater habitats, with a clear preference of oligo- to mesotrophic, slightly acidic environments (Kouwets, 2008). Rich desmid communities may be found amongst submerged macrophytes and mosses. Diversity of desmid algae is highest in *Sphagnum* peat bogs (Brook, 1981). Phylogenetically, peat bogs are very important as significant relict habitats. In Serbia, they are not as numerous as in northern and western Europe. In addition, they gradually disappear due to the expansion of agricultural areas, deforestation and creation reservoirs. These factors mutually affect the composition of the total algal flora, including desmid flora (Fužinato et al., 2011a).

The first reports concerning desmids in Serbia were published in 1883 (Schaarschmidt, 1883). In the first decade of the 20th century Košanin, Katić and Đorđević started more serious studies of desmid diversity and distribution in Serbian peat bogs (Košanin, 1908a, 1908b, 1910a, 1910b; Katić, 1910; Đorđević, 1910). Milovanović greatly contributed to the knowledge floristics, taxonomy and ecology of desmid flora in Serbia by studying this group of algae in Vlasina peat bog, Daić Lake on Mt. Golija and peat bogs on Mts. Kopaonik, Željin and Ostrozub (Milovanović, 1959, 1960a, 1960b, 1960c, 1962; Cvijan and Fužinato, 2010).

Recent desmid investigation in four peat bogs in Serbia started in 2007. The samples for study were collected from 3 mountain peat bogs (Pešter, Daić Lake on Mt. Golija and Crvene pode on Mt. Tara) and 1 lowland peat bog (Horgoš). This study reports on the biodiversity of desmids in these peat bogs.

Study sites

The peat bog Pešter is situated on the Pešter plateau (southwest Serbia) at an altitude of 1155-1161 m a.s.l., and it is one of the last large preserved peat bogs in Serbia. Dominant mosses are *Calliergon giganteum* (Schimp.) Kindb., *Sphagnum subsecundum* Ness, *Sphagnum contortum* Schultz and *Hypnum* sp. Detailed algological studies of the Pešter peat bog have not been undertaken thus far.

Daić Lake is situated on the northwest side of Mt. Golija at an altitude of 1556 m a.s.l. It is a small, triangular lake with a maximal depth of 3 m. Study of the desmid flora of sphagnum water of Daić Lake was carried out by Košanin (1908b) and Milovanović (1960c).

The peat bog Crvene pode is situated on a plateau in the central part of Mitrovac, Mt. Tara, at an altitude of 1080 m a.s.l. Most of this peat bog is forested (forest peat bog) and its smaller part is overgrown with mosses (especially the genus *Sphagnum*). The desmid flora of peat bog Crvene pode was researched by Milovanović (1962) in the middle of the last century.

The peat bog Horgoš is situated in the north of Serbia, next to the Hungarian border. It is a lowland peat bog, at an altitude of 75 m a.s.l. In the peat bog's vicinity is a fishpond that was created due to long-term peat exploitation. There is no data about algological research of peat bog Horgoš.

MATERIALS AND METHODS

A detailed study of desmid from the four peat bogs described above was carried from 2007 to 2011.

Eighty-five water samples for physicochemical and algological analysis were collected. The samples from the peat bog Horgoš were collected in April, June, August and October 2008; from the locality Pešter in June and September 2008, May 2009, June 2010, August 2011; from Daić Lake (Mt. Golija) in May and June 2009, from a peat bog Crvene pode (Mt. Tara) in June 2009.

Phytoplankton samples were collected by towing a plankton net (25 μm) through the open water. Samples of phytobenthos were collected with a pipette from the surface of the bottom deposits. Epiphytic samples were collected by squeezing out or scraping off dominant submerged macrophytes and mosses. All samples were fixed with formaldehyde to a final concentration of about 4% shortly after sampling.

Water temperature and transparency were measured *in situ* at all localities. Water temperature was measured at the sampling sites by digital thermometer, with accuracy 0.1°C.

Water samples for chemical analysis were collected using a Ruttner sampler. The samples were stored in plastic containers at 4°C while being transferred to the laboratory for further analyses. The analysis of physicochemical parameters of water was performed at the Institute of Public Health of Serbia "Dr Milan Jovanović-Batut", by standard analytical methods.

The taxonomical analysis of the sampled material was done in the Institute of Botany and Botanical Garden "Jevremovac", Faculty of Biology, University of Belgrade. Algological samples were observed with a Carl Zeiss Axio Imager, M1 microscope and digital camera AxioCam MRc5 with AxioVision 4.8. sofware. Desmid taxa were identified according to Brook and Johnson (2003), Coesel and Meesters (2007), Kossinskaja (1952, 1960), Lenzenweger (1996, 1997, 1999, 2003), Palamar-Mordvinceva (1982), Preskott et al. (1975, 1977, 1981), Růžička (1977, 1981), W. and G. S. West (1904, 1905, 1908, 1912, 1923). New taxa for the desmid flora of Serbia are marked with an asterisk (*).

RESULTS AND DISCUSSION

The physicochemical water characteristics

In general, the physicochemical characteristics of the peat bogs in Serbia favor the development of a rich desmid flora. It should be noted that large peat bogs in Serbia are of rare occurrence, owing to the southern position of these regions with respect to peat bog distribution centers in Europe.

Table 1. Physicochemical characteristics of water of peat bogs Horgoš (H), Crvene pode (CP), Daić lake (DL) and Pešter (P).

Locality	P	DL	CP	H
Parameters	Ranges of the parameter values			
Temperature [°C]	9.0-24.0	21.0	12	13.0-22.0
Transparency [mm]	-	-	300	200-500
pH	6.5-7.3	7.3	6.8	6.5-7.8
Conductivity [µS cm^{-1}]	59-78	54	210	530-720
Susp. solids [mg l^{-1}]	11-22	29	14	8-14
Dissolved O_2 [mg l^{-1}]	6.1-9.0	11.6	3.4	5.0-10.6
Saturation O_2 [%]	72-86	120	31.5	57.2-119
BOD [mg l^{-1}]	3.7-6.0	>20	0.4	4.7-10.0
Total hardness [mg l^{-1}]	2.1-3.9	4.3	2.4	12.8-24
HCO_3^- [mg l^{-1}]	43-73	56	89	262-430
NH_4^+ [mg l^{-1}]	1.10-1.50	1.20	3.00	0.25-1.10
NO_2- [mg l^{-1}]	0.012-0.038	<0.005	<0.005	<0.005-0.011
NO_3- [mg l^{-1}]	<0.50-0.90	2.30	3.8	<0.50-47.00
PO_4^{3-} [mg l^{-1}]	<0.010-0.016	<0.010	<0.010	<0.010-0.020
Total phosph. [mg l^{-1}]	0.021-0.085	0.050	0.030	0.010-0.093
Cl^- [mg l^{-1}]	1-3	12	13	21-45
SO_4^{2-} [mg l^{-1}]	2-3	1.2	3.1	47-74
Na^+ [mg l^{-1}]	0.9-1.7	0.4	7.3	15.8-20.8
K^+ [mg l^{-1}]	0.4-1	0.3	0.5	0.9-3.1
Ca^{2+} [mg l^{-1}]	3-18	27	14	35-96
Mg^{2+} [mg l^{-1}]	7-9	2.2	1.6	35-46

The results of detailed analysis of the physical and chemical characteristics of water are summarized in Table 1.

The results of physicochemical water analysis of Pešter peat bog show a low ion concentration, which is in accordance with the fact that this is a high-mountain peat bog. Water pH varies from 6.5 to 7.3. A higher concentration of ammonia probably originates from local arable land.

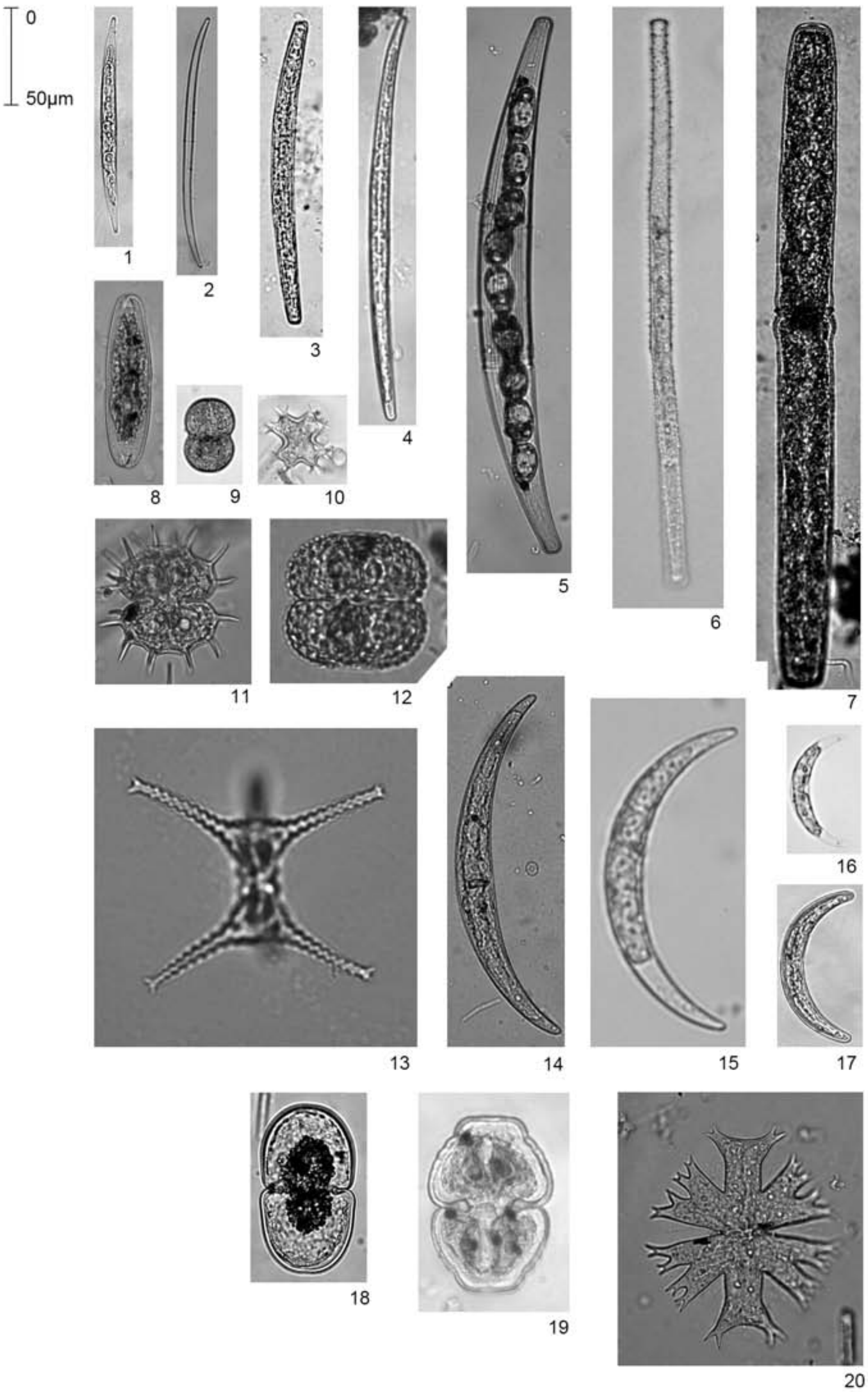
According to physicochemical analysis, water from Daić Lake is slightly acidic with high values of conductivity. Oxygen concentration (11.6 mg/l) and BOD (>20) point to high organic loading. A relatively high nitrate concentration probably indicates a high content of plant material that is deposited in the substrate.

At the time of sampling, the water pH from peat bog Crvene pode was 6.8 with a low concentration of ions. Increased ammonia concentration (3 mg/l) seems to derive from the surrounding areas that are used for cattle grazing.

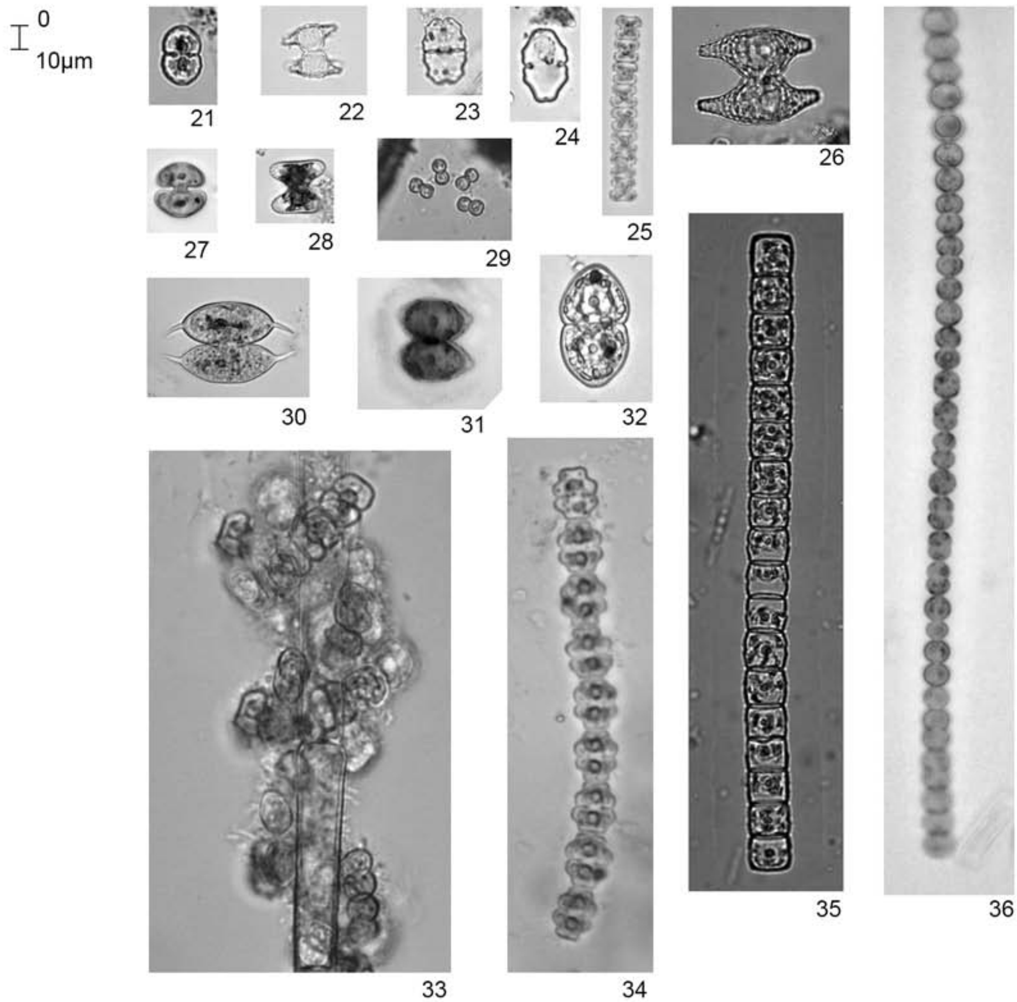
During the survey, the water pH of Horgoš peat bog ranged from 6.5 to 7.8. Given that in the immediate vicinity of the peat bog the land is cultivated, it can be presumed that the increased nitrate concentration (to 47 mg/l) originates from the surrounding land.

Desmid community composition

A taxonomically diverse desmid flora – 220 species and varieties, was identified in the studied samples (Table 2). All desmid taxa were classified into four



Figs. 1-20. **1**. *Closterium cornu*; **2.** *Closterium gracile;* **3**. *Closterium directum;* **4**. *Closterium toxon*; **5**. *Closterium striolatum*; **6**. *Gonatozygon brebissonii*; **7**. *Haplotaenium rectum*; **8**. *Tetmemorus laevis*; **9**. *Cosmarium pseudoconnatum*; **10**. *Xanthidium smithii*; **11**. *Xanthidium basidentatum*; **12**. *Cosmarium pseudoornatum*; **13**. *Staurastrum planctonicum*; **14**. *Closterium dianae* var. *minus*; **15**. *Closterium venus*; **16**. *Closterium incurvum*; **17**. *Closterium jenneri* var. *robustum*; **18**. *Cosmarium cucumis*; **19**. *Cosmarium cymatopleurum* var. *archerii*; **20**. *Micrasterias crux – melitensis.*



Figs. 21-36. 21. *Cosmarium paragranatoides* var. *dickii*; **22**. *Staurastrum boreale* var. *quadriradiatum*; **23**. *Euastrum elegans*; **24**. *Cosmarium anceps*; **25**. *Teilingia granulata*; **26**. *Staurastrum proboscideum*; **27**. *Cosmarium ocellatum*; **28**. *Cosmarium bitriangulatum*; **29**. *Cosmocladium constrictum*; **30**. *Staurodesmus convergens*; **31**. *Staurastrum varians*; **32**. *Cosmarium granatum* var. *elongatum*; **33**. *Heimansia pusilla*; **34**. *Spondylosium pulchellum*; **35**. *Hyalotheca mucosa*; **36**. *Spondylosium pygmaeum.*

families with 22 genera. The most abundant genera were *Cosmarium* (81), *Staurastrum* (38), and *Closterium* (31); less abundant genera were *Euastrum* (13), *Xanthidium* (7), *Actinotaenium* (5) and *Micrasterias* (4). Three or less species presented other genera.

This study confirmed the presence of taxa previously recorded in Serbia, but the number is increased by 66 new desmid taxa, which have been recorded for the first time in Serbia. These taxa are marked with an asterisk in the list of determined desmid taxa (Table 1). In addition, two genera (*Cosmocladium* and *Heimansia*) with three new species have been reported in Serbia for the first time.

A total of 189 desmid taxa were recorded in the Pešter peat bog. Among 18 genera (*Actinotaenium, Closterium, Cosmarium, Desmidium, Euastrum, Gonatozygon, Haplotaenium, Hyalotheca, Micrasterias, Netrium, Pleurotaenium, Roya, Spondylosium, Stau-*

Table 2. List of desmid taxa found in peat bogs Pešter (P), Daić lake (D), Crvene pode (CP) and Horgoš (H). Species name are listed in alphabetic order. New taxa for desmid flora of Serbia are marked with an asterisk (*).

Taxon	Locality
Mesotaeniaceae	
Cylindrocystis brebissonii (Meneghini *ex* Ralfs) De Bary	CP
C. crassa De Bary	CP
**Mesotaenium chlamydosporum* De Bary	P, CP
**M. degreyi* Turner	P
**M. endlicherianum* Nägeli	P
Netrium digitus (Ehrenberg *ex* Ralfs) Itzigsohn *et* Rothe	P, D
**Roya anglica* G. S. West *in* Hodgetts	D
R. obrusa (Brébisson) W. *et* G. S. West	P
Closteriaceae	
Closterium acerosum Ehrenberg *ex* Ralfs	H
C. acerosum var. *elongatum* Brébisson	H
C. aciculare T. West	P, CP
C. acutum Brébisson *in* Ralfs	P, D, CP, H
C. acutum var. *linea* (Perty) W. *et* G. S. West	H
C. acutum var. *variabile* (Lemmermann) Krieger	H
C. cornu Ehrenberg *ex* Ralfs **(Fig. 1)**	P, H
C. dianae Ehrenberg *ex* Ralfs	P, H
C. dianae* var. *minus* Hieronymus **(Fig. 14)	P
C. directum Archer **(Fig. 3)**	P, D
C. ehrenbergii Meneghini *ex* Ralfs	P
C. gracile Brébisson *ex* Ralfs **(Fig. 2)**	P, D, CP
C. idiosporum W. *et* G. S. West	CP
C. incurvum* Brébisson **(Fig. 16)	P, D, CP
C. jenneri Ralfs	P
**C. jenerri* var. *curvatissimum* (W. *et* G. S West) Brook *et* Williamson	P, D, CP
C. jenneri* var. *robustum* G. S. West **(Fig. 17)	P
C. limneticum Lemmermann	P
C. limneticum var. *falax* Růžička	P
C. lunula Nitzsch *ex* Ralfs	H
C. macilentum Brébisson	H
C. moniliferum Ehrenberg *ex* Ralfs	P, D, CP
C. navicula (Brébisson) Lütkemüller	P, D
C. parvulum Nägeli	P, D; H
C. parvulum var. *angustum* W *et* G. S. West	P, D
C. pronum Brébisson	P
C. pseudolunula Borge	P
**C. regulare* Brébisson	P
C. rostratum Ehrenberg *ex* Ralfs	P
C. setaceum Ehrenberg *ex* Ralfs	P
C. striolatum Ehrenberg *ex* Ralfs **(Fig. 5)**	P, D
C. subfusiforme Messikommer	P
**C. submoniliferum* Woronichin	P
C. toxon W. West **(Fig. 4)**	P, CP
C. tumidum Johnson	P
C. venus Kützing *ex* Ralfs **(Fig. 15)**	P, D, CP
Gonatozygaceae	
Gonatozygon brebissonii De Bary **(Fig. 6)**	P, D, CP, H
G. kinahanii (Archer) Rabenhorst	P

Table 2. *Continued*

Desmidiaceae	
**Actinotaenium cruciferum* (De Bary) Teiling	P
A. cucurbita (Brébisson *ex* Ralfs) Teiling	D, CP
A. didymocarpum (Lundell) Coesel *et* Delfos	P, D
**A. inconspicuum* (W. *et* G. S. West) Teiling	P
A. spinospermum (Joshua) Kouwetas *et* Coesel	P
Cosmarium anceps Lundell **(Fig. 24)**	P
C. angulosum Brébisson	P
C. angulosum var. *concinnum* (Rabenhorst) W. *et* G. S. West	P
C. bioculatum Brébisson *ex* Ralfs	H
C. bitriangulatum* Grönblad **(Fig. 28)	P
C. botrytis Meneghini *ex* Ralfs	P, D, CP, H
C. botrytis var. *gemmiferum* (Brébisson) Nordstedt	P, D
C. botrytis var. *mediolaeve* W.West	P
C. botrytis var. *tumidum* Wolle	P, H
**C. clepsydra* Nordstedt	H
C. connatum Brébisson *ex* Ralfs	P, D, H
C. conspersum Ralfs var. *latum* (Brébisson) W. *et* G. S. West	P, D, CP
C. contractum Kirchner	P
C. cucumis Corda *ex* Ralfs **(Fig. 18)**	P, D, CP, H
C. cymatopleurum Nordstedt	P
C. cymatopleurum* var. *archerii* W. *et* G. S. West **(Fig. 19)	P
C. depressum (Nägeli) Lundell	P, D, CP
C. depressum var. *minutum* Heimerl	P, D
C. depressum var. *planctonicum* Reverdin	P
C. dickii Coesel	P
**C. difficile* Lütkemüller var. *subimpressulum* Messikommer	P
C. furcatospermum W. *et* G. S. West	P, CP
C. garrolense Roy *et* Bissett	P
C. granatum Brébisson *ex* Ralfs	P
C. granatum* var. *elongatum* Nordstedt **(Fig. 32)	P
C. humile (Gay) Nordstedt *in* De Toni	P, CP
C. laeve Rabenhorst	P, D, H
C. laeve var. *octangulare* (Wille) W. *et* G. S. West	P, D
**C. limnophilum* Schmidle	P
C. meneghinii Brébisson *ex* Ralfs	H
C. novae-semliae Wille	P, D
C. obtusatum (Schmidle) Schmidle	P, D, H
C. ocellatum* Eichler *et* Gutwinski **(Fig. 27)	P, D, H
C. ochtodes Nordstedt	P
**C. paragranatoides* Skuja	P
C. paragranatoides* var. *dickii* Krieger *et* Gerloff **(Fig. 21)	P, D
**C. perycimatium* Nordstedt	P
C. phaseolus Brébisson *ex* Ralfs	P, D, CP, H
C. phaseolus var. *elevatum* Nordstedt	P
C. polygonum (Nägeli) Archer	P
C. portianum Archer	P, D, CP
**C. praecisum* Borge var. *suecicum* (Borge) Krieger *et* Gerloff	P, D
C. pseudoconnatum* Nordstedt **(Fig. 9)	P, D
**C. pseudoexiguum* Raciborski	P
C. pseudoornatum* Eichler *et* Gutwinski **(Fig. 12)	P, CP

Table 2. *Continued*

**C. pseudospeciosum* Raciboski	P
C. pygmaeum Archer	P, D
C. pygmaeum var. *heimerlii* (W. *et* G. S. West) Kriger *et* Gerloff	P
C. quadratulum (Gay) De Toni	P
C. quadratum Ralfs	P
C. quadratum var. *willei* (Schmidle) Krieger *et* Gerloff	P
**C. quadrum* Lundell	P
C. regnellii Wille	P, D
C. regnellii var. *minimum* Eichler *et* Gutwinski	P
C. reniforme (Ralfs) Archer	P, D
C. reniforme var. *compressum* Nordstedt	P, D
C. simplicius (W. *et* G. S. West) Grönblad	P, D
**C. sparsepunctatum* (Schmidle) W. *et* G. S. We	P
C. speciosum Lundell	P
C. speciosum var. *rostafinski* (Gutwinski) W. *et* G. S. West	P, D
**C. sphagnicola* W. *et* G. S. West	P
**C. sphyrelatum* Coesel	P
C. sportella Brébisson *ex* Kützing	P
**C. staurastroides* Eichler *et* Gutwinski	H
**C. subbromei* Schmidle f. *isthmochondrum* Coesel	P
C. subcostatum Nordstedt	P, H
C. subcostatum var. *minus* W. *et* G. S. West	P, D
C. subcrenatum Hantzsch	P
C. subgranatum (Nordstedt) Lütkemüller	P, H
**C. subgranatum* var. *borgei* Krieger	P
**C. subreinschii* Schmidle	P
C. subtumidum Nordstedt	P
C. tenue Archer	P, D, CP
C. tetraophthalmum Brébisson *ex* Ralfs	P, D, CP
**C. tinctum* Ralfs var. *subretusum* Messikommer	P
C. truncatellum (Perty) Rabenhorst	H
C. tumidum Lundell	P
C. undulatum Corda *ex* Ralfs var. *minutum* Wittrock	H
C. venustum (Brébisson) Archer *in* Pritchard	P, D
C. vexatum W. West	P, D
**C. zonatum* Lundell	H
Cosmocladium constrictum* (Archer) Archer **(Fig. 29)	CP
**C. saxonicum* De Bary	H
Desmidium aptogonum Brébisson *ex* Ralfs	P, D, CP
D. aptogonum var. *acutius* Nordstedt	P
D. swartzii Ralfs	P, CP
Euastrum ansatum Ralfs	P, D, CP
E. bidentatum Nägeli	P, D
E. binale Ralfs	D
E. denticulatum (Kirchner) Gay	P, D
E. dubium Nägeli	D
E. elegans Ralfs **(Fig. 23)**	P, D
E. gemmatum Ralfs	P, D
E. insulare (Wittrock) Roy	P
**E. lacustre* (Messikommer) Coesel	P
**E. montatum* W. G. S. West	P

Table 2. *Continued*

E. oblongum Ralfs	P, D
E. verrucosum Ralfs	P, D
**E. verrucosum* var. *alpinum* (Huber-Pestalozzi) Krieger	P
Haplotaenium rectum (Delponte) Bando **(Fig. 7)**	P, D
Heimansia pusilla* (Hilse) Coesel **(Fig. 33)	D
Hyalotheca dissilens Brébisson *ex* Ralfs	P, D, CP
H. dissilens var. *minor* Delponte	P, CP
H. mucosa* Ralfs **(Fig. 35)	CP
Micrasterias crux – melitensis Ralfs **(Fig. 20)**	D
M. papilifera Brébisson *ex* Ralfs	P, D
M. papilifera var. *glabra* Nordstedt	P, D
M. radiosa Ralfs	P
Pleurotaenium ehrenbergii (Ralfs) De Bary	P, CP
P. trabecula Nägeli	D
**Spondylosium ellipticum* W. *et* G. S. West	P
S. pulchellum (Archer) Archer *in* Pritchard **(Fig. 34)**	D
S. pygmaeum* Cooke **(Fig. 36)	P, D
**Staurastrum acutum* Brébisson	P, D
S. alternans Brébisson *in* Ralfs	P
S. arcuatum Nordstedt	P
S. avicula Brébisson *in* Ralfs	P
S. avicula var. *subarcuatum* (Wolle) W. *et* G. S. We	P, D
S. boreale W. *et* G. S. West	P
S. boreale* var. *quadriradiatum* Korshikov **(Fig. 22)	P
S. brebissonii Archer *in* Pritchard	P, D
S. chaetoceras (Schröder) Smith	P, CP
S. crenulatum (Nägeli) Delponte	P
S. dilatatum Ehrenberg *ex* Ralfs	D
S. dispar Brébisson	P
**S. erasum* Brébisson	P
S. furcigerum (Brébisson *ex* Ralfs) Archer *in* Pritchard	P, D
S. gracile Ralfs *ex* Ralfs	CP
S. gracile var. *nanum* Wille	P
**S. hexacerum* Wittrock	P, H
S. hirsutum Brébisson *in* Ralfs	P, CP
St. inflexum Brébisson	P
**S. kouwetsii* Coesel	P
S. lapponicum (Schmidle) Grön	P
S. lunatum Ralfs	P, D
S. lunatum var. *planctonicum* W. *et* G. S. West	P
S. margaritaceum Meneghini *ex* Ralfs	P, D
**S. obscurum* Coesel	P
**S. orbiculare* Meneghini *ex* Ralfs var. *depressum* Roy *et* Bisset	P
S. planctonicum* Teiling **(Fig. 13)	P
S. polymorphum Brébisson *in* Ralfs	P
S. proboscideum* (Brébisson) Archer **(Fig. 26)	P
S. punctulatum Brébisson *in* Ralfs	P, D
S. punctulatum var. *pygmaeum* (Brébisson *ex* Ralfs) W. *et* G. S. West	P
S. pungens Brébisson *in* Ralfs	P
**S. setigerum* Cleve	P
S. striatum (W. *et* G. S. West) Růžička	P

Table 2. *Continued*

**S. subavicula* (W. West) W. *et* G. S. West	P
S. tetracerum Ralfs *ex* Ralfs	P, D, CP
S. tetracerum var. *irregulare* (W. *et* G. S. West) Brook	D
S. varians* Raciborski **(Fig. 31)	P, D
Staurodesmus brevispina (Brébisson) Croasdale	P
S. convergens (Ehrenberg *ex* Ralf) Lilleroth **(Fig. 30)**	P, D
S. cuspidatus (Brébisson) Teiling	P, CP
S. dejectus (Brébisson) Teiling	CP
**S. dejectus* var. *robustus* (Messikommer) Coesel	P
S dickiei (Ralfs) Lillieroth	P, D
S. extensus (Borge) Teiling	P
S. glaber (Ralfs) Teiling	CP
**S. glaber* var. *deberyanus* (Jacobsen) Teiling	P
**S. lanceolatus* (Archer) Croasdale var. *compressus* (W. *et* G. S.West) Teiling	P
**S mucronatus* (Ralfs *ex* Ralfs) Croasdale	P
**S. subhexagonus* (W. *et* G. S. West) Coesel	P
Teilingia granulata (Roy *et* Bisset) Bourrelly **(Fig. 25)**	P, DP, CP
Tetmemorus laevis Kützing *ex* Ralfs **(Fig. 8)**	D
Xanthidium antilopaeum Kützing	D
**X. antilopaeum* var. *planum* Roll	P
X. basidentatum* (Børgesen) Coesel **(Fig. 11)	P
X. cristatum Brébisson *ex* Ralfs	P
X. fasciculatum Ehrenberg *ex* Ralfs	P, D, CP
X. octocorne Ehrenberg *ex* Ralfs	D
X. smithii* Archer **(Fig. 10)	P, D, CP

rastrum, Staurodesmus, Teilingia and *Xanthidium*) the most diverse and the most commonly genera were *Cosmarium* (74 taxa), *Staurastrum* (35 taxa) and *Closterium* (29 taxa).

In the 20th century, the desmid flora of the peat bog Daić Lake was observed during two periods. At the beginning of the last century Košanin determined 40 desmid taxa from 12 genera (Košanin, 1908b), and in 1948 Milovanović determined 49 desmid taxa from 13 genera (Milovanović, 1960c). She identified 18 taxa that were found in earlier studies. In total, 23 taxa that had previously been determined in this peat bog were not recorded later, and 31 taxa were new for the taxonomic list of desmids of Daić Lake. During our study, 81 desmid taxa from 19 genera (*Actinotaenium, Closterium, Cosmarium, Desmidium, Euastrum, Gonatozygon, Haplotaenium, Heimansia, Hyalotheca, Micrasterias, Netrium, Pleurotaenium, Roya, Spondylosium, Staurastrum, Staurodesmus, Teilingia, Tetmemorus* and *Xanthidium*) were identified, and 37 have not been recorded in previous researches. Altogether 16 taxa were established in earlier as well as in the present study. The genera *Cosmarium* (27 taxa), *Closterium* (11) and *Staurastrum* (11 taxa) were qualitatively dominant. In comparison to previous research, an increased number of eutrophic species was revealed, which could indicate the process of eutrophication. For the first time the genus *Heimansia* with 1 species has been recorded for desmid flora of Serbia.

During algological studies from 1949 to 1961 of the peat bog Crvene pode, Milovanović determined 56 desmid taxa from 10 genera (Milovanović, 1962). We recorded 44 desmid taxa from 15 genera (*Actinotaenium, Closterium, Cosmarium, Cosmocladium, Cylindrocystis, Desmidium, Euastrum, Gonatozygon, Hyalotheca, Mesotaenium, Pleurotaenium, Staurastrum, Staurodesmus, Teilingia* and *Xanthidium*), and the most diverse were *Cosmarium* (11 taxa) and *Closterium* (9 taxa).

In lowland peat bog Horgoš, 30 desmid taxa from five genera (*Closterium, Cosmarium, Cosmocladium, Gonatozygon* and *Staurastrum*) were recorded. The genus *Cosmarium*, with 17 taxa, was the most diverse. Genera *Gonatozygon* and *Staurastrum* were represented with only one taxon.

A total of 18 desmid taxa were common to the high-mountain peat bogs: Pešter, Daić Lake and Crvene pode. According to Coesel and Meesters (2007), most of these taxa prefer acidic to neutral oligo-mesotrophic or mesotrophic habitats. In contrast to high-mountain peat bogs where oligo-mesotrophic desmid taxa were dominant, the lowland peat bog Horgoš is characterized by a large number of meso- and eutrophic desmid taxa which prefer neutral to alkaline habitats. In total, only five taxa were found in all four peat bogs. The species *Cosmarium botrytis*, *C. phaseolus*, *C. cucumis* and *Gonatozygon brebissonii* are characteristic for mesotrophic acido-neutral habitats, while *Closterium acutum* could be found both in oligotrophic-acidic and eutrophic-alkaline habitats.

The majority of desmid taxa that have been recorded during this study are cosmopolites, which is in accordance with their global distribution. A relatively large number of desmid taxa are holarctic, boreal, boreal-arctic, arctic-alpine, alpine such as *Actinotaenium didymocarpum, Cosmarium costatum, C. cucumis, C. galeritum, C. garolense, C. novae-semliae, C. pygmaeum, C. speciosum, C. sphagnicola, C. sportella, S. inflexum, S. orbiculare* var. *depressum* (Coesel, 1996; Brook and Johnson, 2003; Lenzenweger, 1996, 1997, 1999; Kosteviciene et al., 2003; Sterlyagova, 2008). The presence of these floral elements in high-mountain peat bogs indicates the glacial origin of these peat bogs (Stamenković et al., 2008; Fužinato et al., 2011a, Fužinato et al., 2011b).

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