10.1515/botlit-2016-0012

DE GRUYTER OPEN

BOTANICA LITHUANICA
ISSN 2029-932X

2016, 22(2): 113–122

DESMID FLORA IN THE LAKES OF THE KHREBTOVYI NATURE RESERVE IN THE POLAR URAL (RUSSIA)

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Abstract

Briškaitė R., Patova E., Juzėnas S., 2016: Desmid flora in the lakes of the Khrebtovyi Nature Reserve in the Polar Ural (Russia) [Dvyniečių flora Chrebtovyj draustinio ežeruose Šiaurės Urale (Rusija)]. – Bot. Lith., 22(2): 113–122.

Fourteen thermokarst lakes and one mountain lake were explored in the study period. A total of 116 species of desmids belonging to 22 genera were identified. The genera *Cosmarium* (29), *Staurastrum* (18) and *Closterium* (13) were most abundant. The highest number of species (88) was recorded in the habitats with *Sphagnum* and brown mosses. Twenty-seven species and one variety of desmids were observed for the first time in the Polar Ural Mountains.

Keywords: algae, benthos, *Desmidiales*, Polar Ural Mountains, Russia.

INTRODUCTION

Desmids are one of the most diverse groups of algae in the mountain-tundra water bodies. They play an important role in the formation of algocenoses in water bodies and especially are typical in phytobenthos and periphyton (Getzen, 1985). Desmids belong to one of the groups that can inhabit water bodies with low concentration of organic materials. To date, the Arctic regions experience increasing anthropogenic impact on natural landscapes, accelerating processes of global climate change, and degradation of the natural complexes. Mainly because of remoteness and limited accessibility of the territory, the diversity and distribution of desmids are not sufficiently explored in the Polar Ural water bodies, including mountain lakes. The aim of this paper was to review the diversity and distribution of species in the explored water bodies in the territory of the Khrebtovyi Nature Reserve.

STUDY AREA

The Urals are the mountain range that stretches in the north-south direction in Russia, making border between Asian and European continents. The total area of the mountains is about 25 000 km. The Polar Ural covers the northern end of the overall structure of the Ural Mountains – starts from the origins of the Khulga River in the southern part and stretches almost for 550 km, up to the Konstantynov Kamen' Mountains in the north. In 1989, in the part of this territory, the Khrebtovyi Nature Reserve was established, the aim of which is to preserve typical and rare landscape of the Polar Ural (Fig. 1).

In the area of the Reserve, different types of vegetation are also under protection, including rare larch forests, crooked birch forests, willow forests, palsas, lichen mountain tundra, rocky tundra, brushwood moss lichen tundra and barrens. The list of protected objects consists of thermokarst and mountain

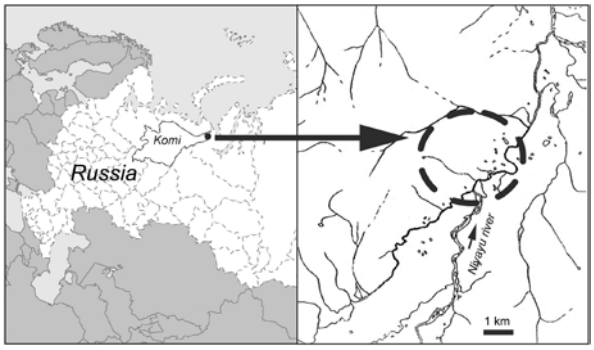

Fig. 1. Location of the Khrebtovyi Nature Reserve (Polar Ural). The research was carried out in the territory marked by a dotted line

lakes, river valleys with rare plant and bird species recorded in the Red Data Book of Komi Republic (Taskaev, 2009). The area of the Reserve covers 4000 hectares of the southeast slope of the Enganepe Ridge within the Polar Urals.

The climate of the Polar Ural is distinctly continental. The Polar Ural belongs to the Eastern region of the Atlantic climate area. The average annual temperature is below zero, and in different regions it varies from –6°C to –9°C (the average temperature in January is –20°*C*). Period without frosts lasts from 21 June to 21 August (the average temperature in July varies from 8°C to 11°C). The average temperature of growing season is above 10°C. In the Polar Ural, the amount of precipitation during the year is 1000–1500 mm. Permanent snow cover comes on the 20th of October and remains until the 10th of March. The depth of snow cover reaches 80–90 cm (Kemmerix, 1966; švareva, 1962).

A detailed description of the natural resources at the nature complex named the Khrebtovyi Nature Reserve is provided in the monograph "The biological diversity of protected areas in Komi Republic"(Degteva, 2010).

MATERIALS AND METHODS

The research of desmids was conducted in the Khrebtovyi Nature Reserve in the Polar Ural in 14 thermokarst and one mountain lakes in July 2008 (Fig. 2).

A total of twenty-three samples of phytobenthos algae were collected by squeezing water from plant material of two different types: roots and rhizomes

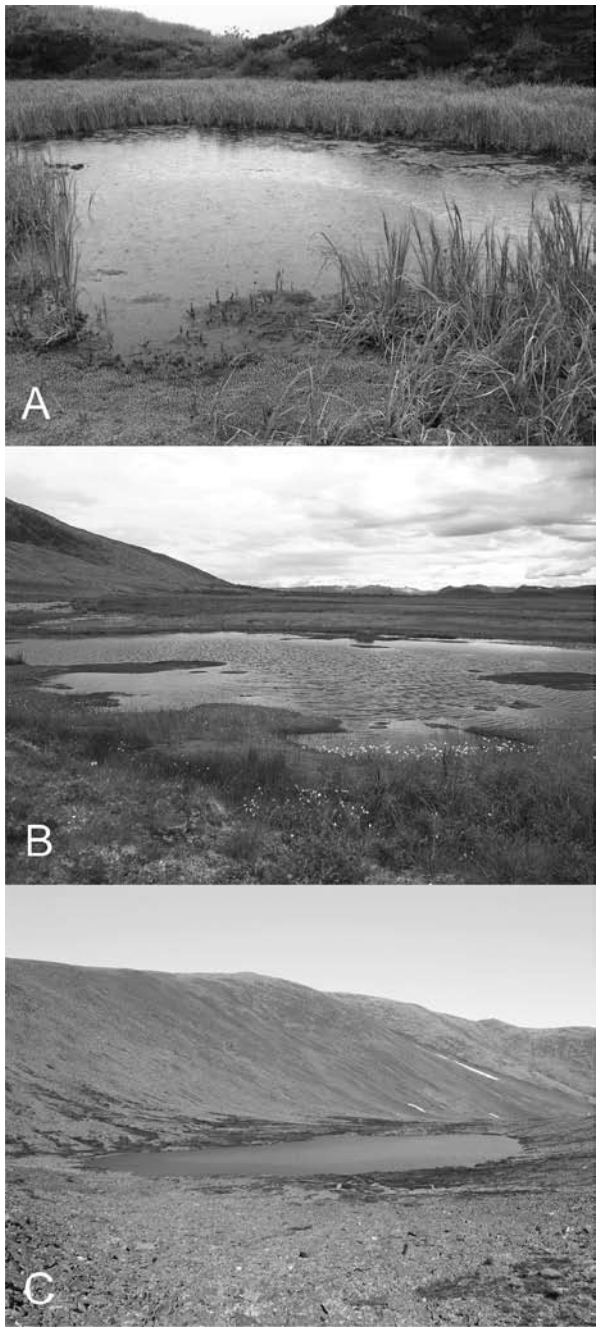

Fig. 2. The investigated habitats in the Khrebtovyi Nature Reserve. Photo A: lake with a dominant *Carex aquatilis* Wahlenb.; photo B: lake with a floating mat of *Sphagnum* spp.; photo C: mountain lake

of vascular plants taken in the helophyte zone dominated by *Carex aquatilis* Wahlenb. (habitat a) and *Sphagnum* spp. and/or other mosses taken on the edges of lakes or floating mats (habitat b) (Table 1).

Table 1 provides the data on lake geographical

Table 1. Characteristics of the lakes and habitats investigated in the Khrebtovyi Nature Reserve in the Polar Ural

Lake number	Geographic coordinates	Elevation, m	Temperature, °C	pH	Conductivity, µS/cm	Macrophytes	Habitat types*
1	67°19'15.7" N; 65°03'28.5" E	182	16.6	6.5	25	*Carex aquatilis* Wahlenb., *C. canescens* L., *Comarum palustre* L., *Equisetum fluviatile* L.	a
2	67°19'14.6" N; 65°03'23.9" E	183	16.0	6.2	60	*Carex aquatilis*, *Comarum palustre*, *Equisetum fluviatile*/ mosses	a, b
3	67°19'13.7" N; 65°03'04.7" E	179	17.3	6.8	25	*Carex aquatilis*, *Eriophorum* sp., *Hippuris vulgaris* L., *Sparganium* sp., mosses	a, b
4	67°19'43.4" N; 65°04'48.6" E	182	20.3	7.0	73	*Carex aquatilis*, *Eriophorum* sp., *Comarum palustre*, *Fontinalis* sp., *Polytrichum* sp.	a, b
5	67°20'30.0" N; 65°06'4.0"E	188	20.0	6.6	12	*Carex aquatilis*	a
6	67°20'0.7" N; 65°05'27.3" E	191	6.3	4.5	23	*Carex aquatilis*, *Eriophorum chamissonis* C.A.Mey., *E. scheuchzeri* Hoppe, *Sphagnum* spp. and other mosses	b
7	67°20'13.0" N; 65°05'49.2" E	177	16.5	5.8	5	*Carex aquatilis, Comarum palustre*, mosses	a, b
8	67°20'29.1" N; 65°05'57.3" E	182	16.8	5.8	10	*Carex aquatilis*, *Comarum palustre*, *Sphagnum* spp.	a, b
9	67°20'25.9" N; 65°06'33.0" E	180	17.7	6.5	11	*Carex aquatilis*, *Comarum palustre*, *Eriophorum* sp.	a
10	67°19'44.3" N; 65°05'36.2" E	181	19.5	6.4	14	*Carex aquatilis*, *Comarum palustre*, mosses	a, b
11	67°19'36.6" N; 65°04'40.5" E	183	19.1	5.7	8	*Carex aquatilis*, *Comarum palustre*, mosses	a, b
12	67°19'36.9" N; 65°04'36.3" E	181	18.4	6.4	2	*Comarum palustre*, *Sphagnum* spp. and other mosses	a, b
13	67°20'12.1" N; 65°01'12.1" E	481	8.8	7.0	4	*Carex aquatilis*, *Eriophorum* sp., *Polygonum* sp., *Saxifraga* sp., mosses	b
14	67°19'20.1" N; 65°03'38.2" E	186	13.4	6.4	15	*Comarum palustre*, *Eriophorum vaginatum* L., *Hippuris vulgaris*, *Sphagnum* spp. and other mosses	b
15	67°19'22.7" N; 65°03'58.3" E	183	12.4	6.6	4	*Carex aquatilis*, *Comarum palustre*, *Petasites* sp., *Sphagnum* spp. and other mosses	b

Notes: *Abbreviations of the habitat types: a – roots and rhizomes of vascular plants taken in the helophyte zone dominated by *Carex aquatilis*, b – *Sphagnum* spp. and/or other mosses taken on the edges of lakes or floating mats.

coordinates, elevation, water parameters such as pH, temperature measured by using HANNA HI991300 portable pH/EC/TDS/temperature meter, and description of lake vegetation. Each algal sample contained 40 ml of lake water, which was later concentrated up to 10 ml by sedimentation method. The algae samples were preserved in 40% formaldehyde to reach the final concentration of 4%. In laboratory, samples were investigated using OLIMPUS BX51 microscope. The collection of samples is deposited at Vilnius University Herbarium (WI).

To identify desmid algae taxa, we used the research data of the following authors: Coesel & Meesters (2007), Dillard (1990, 1991, 1993), Krieger (1933, 1935, 1937), Krieger & Gerloff (1962, 1969), Lind & Brook (1980), Lenzenweger (1996), Palamar-Mordvinceva (1982a), Palamar-Mordvinceva & Petl'ovanyj (2009), Růžička (1977, 1981), West & West (1904, 1905, 1908, 1912), West et al. (1923). Distribution of desmids was determined after Palamar-Mordvinceva (1982b). The nomenclature of desmid species were checked in the "AlgaeBase" (Guiry & Guiry, 2016), macrophyte species – in The Plant List (2013). Standardized names of authors were given after The International Plant Name Index (2012).

Two-dimensional non-metric multidimensional scaling (NMDS) and the Jaccard similarity index for the presence/absence data were applied to compare algal species compositions in different study sites and habitats (Legendre & Legendre, 1998). The complete algal species richness was predicted using non-parametric estimator Chao 2, which is well suited for incidence based data (Gotelli & Colwell, 2010). Statistical data analysis was performed using the computer programme PAST version 3.14 (Hammer et al., 2001).

RESULTS AND DISCUSSION

Physicochemical characteristics of the lakes

The analysis of water parameters of the investigated thermokarst and mountain lakes showed that they belong to slightly acidic or neutral type, pH varied from (4.5)5.7 to 7.0, conductivity – from 2 to 73 µS/cm, and temperature – from (6.3)16.0°C to 20.3°C.

Desmid community composition

From the samples collected in the Khrebtovyi Nature Reserve, we identified 116 species of desmids belonging to five families: *Desmidiales*, *Closteriaceae*, *Mesotanenaceae*, *Peniaceae* and *Gonatozygaceae* (Table 2).

In the Khrebtovyi Nature Reserve, we found only 22% of desmid species compared to the northern territories of Russia (Luknitskaya, 2006). In the investigated territory of the Polar Ural, the families *Desmidiaceae* and *Closteriaceae* are predominant groups, this is consistent with the conclusions of other authors (Sterlyagova, 2008; Stepankovič et al., 2008; Šovran et al., 2013) that these families are most diverse in the northern mountainous areas. These families comprised 91.4% of all algae species found. However, the lowest number of desmid species were from such families as *Gomatozygaceae* and *Peniaceae* (2.6% of all desmid species found). The highest diversity of species was observed in *Cosmarium*, *Staurastrum*, *Euastrum* and *Closterium*. These four genera united 62.9% of all identified species. Such taxonomic composition is typical to the northern European and Russian regions (Luknitskaya, 2006; Stepankovič et al., 2008) Even though the genera *Cylindrocystis*, *Pleurotaenium*, *Teilingia* had the lowest number of species; they are still typical genera of the northern mountainous regions (Coesel, 1996; Getzen et al., 1994; Jarushina, 2004).

Table 2. Taxonomic composition of desmids in the habitats of the Khrebtovyi Nature Reserve

Taxa	Species number	% of total species number
Mesotaeniaceae	**7**	**6.0**
Cylindrocystis	2	1.7
Netrium	3	2.6
Planotaenium	1	0.9
Spirotaenia	1	0.9
Gonatozygaceae	**1**	**0.9**
Gonatozygon	1	0.9
Peniaceae	**2**	**1.7**
Penium	2	1.7
Closteriaceae	**13**	**11.2**
Closterium	13	11.2
Desmidiaceae	**93**	**80.2**
Actinotaenium	5	4.3
Bambussina	1	0.9
Cosmarium	29	25.0
Desmidium	1	0.9
Euastrum	13	11.2
Hyalotheca	1	0.9
Micrasterias	4	3.4
Pleurotaenium	3	2.6
Sphaerozosma	1	0.9
Spondylosum	3	2.6
Staurastrum	18	15.5
Staurodesmus	9	7.8
Teilingia	1	0.9
Tetmemorus	2	1.7
Xanthidium	2	1.7
Total	116	100

Twenty seven species and one variety of the identified desmids were found for the first time in this northern region. Taxons of that kind in the common table of desmids are marked with an asterix (Table 3). The species such as *Cosmarium isthmium* and *Gonatozygon brebissonii* are included in the Red List of St. Petersburg area (Cvelev, 2000) and species *Cosmarium contractum*, *C. nasutum*, *Micrasterias radiosa* are recognized as rare on the territory of Russia.

The species prevalent only in one lake combined 51.7% of the desmid flora, whereas 38.8% of desmid species appeared to be rare and were found in 2–5 samples (Fig. 3). Frequently found species were discovered in 6–15 samples; they belong to *Cosmarium angulosum*, *C. blytii*, *C. botrytis*, *C. regnellii*, *Euas-*

Table 3. Taxonomic list of desmids, their cell measurements, habitats and species distribution in the water bodies of the Khrebtovyi Nature Reserve

Taxa	Measurements of the cells (length × width), of isthmus and apex, μm	Lake number and habitat type abbreviations	Frequency category
DESMIDIALES			
Mesoteniaceae			
Cylindrocystis brebissonii Menegh.	28.2–77 × 12.4–33	2a, 6b, 8b, 12b, 13b	Common
Cylindrocystis crassa de Bary	15 × 55	1a	Single
Netrium digitus (Bréb. ex Ralfs) Itzigs. et Rothe	26–214.5 × 22–121.4	1a, 2a–b, 3a, 4a–b, 6b, 10a, 11b, 12a–b	Common
* *Netrium naegelii* (Bréb. ex W.Archer) West	110–115.5 × 22–33	10a	Single
Netrium oblongum (de Bary) Lütkem.	95.14 × 22.3	13b	Single
Planotaenium interruptum (Bréb. ex Ralfs) Petlovany et Palamar-Mordvintseva	143 × 38.5	3b	Single
Spirotaenia condensata Bréb.	214.5 × 33	4b	Single
Gonatozygaceae			
Gonatozygon brebissonii de Bary	115 × 8	4b	Single
Peniaceae			
Penium margaritaceum Bréb.	68–185 × 14–22	1a, 13b	Single
Penium polymorphum Perty (Perty)	60 × 25	13b	Single
Closteriaceae			
Closterium baillyanum (Bréb. ex Ralfs) Bréb.	385 × 44; I. 16.5	6b	Single
Closterium costatum Corda ex Ralfs	240.1 × 25.8; Ap. 7.1	8b	Single
Closterium dianae Ehrenb. ex Ralfs	196.7 × 18.2	1a, 2a–b	Rare
Closterium ebrenbergii Menegh. ex Ralfs	172.5–225.5 × 34.5–46; Ap. 6.8–12.3	1a, 3a, 8b	Rare
Closterium kuetzingii Bréb.	368 × 23	7a	Single
Closterium lineatum Ehrenb. ex Ralfs	308 × 27.5; Ap. 11	2b, 3a, 4b, 7a, 8b	Rare
Closterium moniliferum Ehrenb. ex Ralfs	203.3–214.5 × 38.5–45.4; Ap. 11	3b, 8a–b	Rare
**Closterium porrectum* Nordst.	232.6–311 × 16.1–26.5	2a, 3a	Rare
Closterium pronum Bréb.	198.3 × 8.6	5a	Single
Closterium ralfsii Bréb. ex Ralfs	247.5–264 × 27.5; Ap. 5.5–11	2a, 7a	Rare
Closterium tumidum L.N. Jonhson	170.5 × 33	3b	Single
**Closterium turgidum* Ehrenb. ex Ralfs	467.5 × 49.5; Ap. 22	2b	Single
Closterium venus Kütz. ex Ralfs	59.2–95.7 × 17.4–15.7	1a, 2b	Rare
Desmidiaceae			
**Actinotaenium crassiusculum* (de Bary) Teiling	56 × 15.7	13b	Single
Actinotaenium cucurbita (Bréb. ex Ralfs) Teiling	22–49.5 × 12–22	6b, 13b	Rare
Actinotaenium cucurbitinum (Bisset) Teiling	49.5–60.5 × 22 × 27.5	12b	Single
**Actinotaenium diplosporum* (P.Lundell) Teiling	29.4 × 15.6; I. 8.9	6b, 14b	Rare
Actinotaenium rufescens (Cleve) Teiling	44–60.5 × 22–27.5	6b, 12b, 13b	Rare
Bambusina borreri (Ralfs) Cleve	20–33 × 16.5–27.5	6b,11b, 12a–b	Rare
Cosmarium abbreviatum Racib.	23.2 × 27.5	4b	Single
Cosmarium amoenum Bréb. ex Ralfs	49.5–60.5 × 23–27.5; I. 8.9–15.7	2b	Single
Cosmarium angulosum Bréb.	12.6 × 12.1; I. 3.1	1a, 2b, 4b, 8a, 10a–b	Common
Cosmarium biretum Bréb. ex Ralfs	104.5 × 44; I. 27.5	1a, 2a, 11a	Rare
Cosmarium blytii Wille	23.2 × 23.2; I. 20.3	1a, 3a, 7a, 8b, 10a, 13b	Common
Cosmarium botrytis Menegh. ex Ralfs	31.7–104.5 × 22–72.5; I. 10.3–38.5	1a, 2a–b, 3a–b, 4a–b, 6b, 7a, 8a–b, 9a, 10a–b, 11a–b, 12a, 13b, 14b	Common
Cosmarium botrytis var. *subtumidum* Wittr.	44–55 × 44–55; I. 22–33	6b	Single
Cosmarium circulare Reinsch	55 × 49.5; I. 14.5	1a	Single
Cosmarium constrictum Delponte	33 ×27.5; I. 16.5	7b	Single
Cosmarium contractum Kirchn.	27.5–43.5 × 26.6–33; I. 5.8–11	1a, 2b, 4a–b	Rare
Cosmarium depressum (Nägeli) P.Lundell	37.8–42.3 × 35.7–36.8; I. 10.8–13.4	1a	Single
Cosmarium difficile Lütkem.		2a	Single

Taxa	Measurements of the cells (length × width), of isthmus and apex, μm	Lake number and habitat type abbreviations	Frequency category
**Cosmarium galeritum var. subtumidum* Borge	49.5 × 44; I. 16.5	1a	Single
Cosmarium humile Nordst. ex De Toni	27,5–33 × 16.5–27.5; I. 5.9–11	5a	Single
Cosmarium isthmium West	33–38.5 × 22 – 27.5; I. 11	10a	Single
Cosmarium laeve Rabenh.	8.5 × 33; I. 11	3b	Single
Cosmarium meneghinii Bréb. ex Ralfs	18 × 14	2a	Single
**Cosmarium moniliforme* Ralfs	21 × 11.2; I. 5.9	2b, 3b	Rare
Cosmarium nasutum Nordst.	35 × 49.5; I. 16.5	13b	Single
Cosmarium phaseolus Bréb. ex Ralfs	35 × 28; I. 11.2	2b	Single
**Cosmarium polygonatum* Halász	15–16.5 × 14; I. 5.5	1a, 5a	Rare
Cosmarium pseudopyramidatum P. Lundell	38.5–44 × 27.5; I. 11	8b	Single
Cosmarium punctulatum Bréb.	27.5–34.5 × 22; I. 6,3–9.3	2b	Single
Cosmarium pyramidatum Bréb. ex Ralfs	38.5–60.5 × 22–55; I. 9.6–16.5	4b, 9a, 11a, 13b	Rare
Cosmarium quadratum Ralfs ex Ralfs	60.5 × 38.5; I. 16.5	13b	Single
Cosmarium regnellii Wille	12.5–15.5 × 12.9–13; I. 3	1a, 2a–b, 4b, 12b	Rare
Cosmarium subcostatum Nordst.	22–27.5 × 19.1–23.2	1a	Single
Cosmarium subprotumidum Nordst.	23.2– 37.7× 20.3–29; I. 8.7–9.5	1a, 4b	Rare
Cosmarium subtumidum Nordst.	27.5 × 22; I. 16.5	3b	Single
Cosmarium undulatum Corda ex Ralfs	29 × 20.2; I. 8.7	1a	Single
Desmidium swartzii C.Agardh ex Ralfs	11–16.5 × 33	1a, 12a–b	Rare
Euastrum ansatum Ehrenb. ex Ralfs	44–121 × 23.2–55; I. 11–22; Ap. 16.5–22	4a–b, 9a, 10a–b, 14b	Common
Euastrum bidentatum Nägeli	38.5–55 × 27.5–38.5; I. 5.5–22	4b, 6b, 8a–b, 9a, 10a	Common
Euastrum binale Ehrenb. ex Ralfs	12.9–27.5 × 12.9–22; I. 4.6–7.9; Ap. 12.5–13.2	1a, 2b, 4b, 7a, 8b, 10a, 12a, 14b	Common
Euastrum denticulatum F. Gay	26.1–27.5 × 21.7–22	1a, 2b, 8b, 10a	Rare
Euastrum elegans Ralfs	17.4–38.5 × 14.5–38.9; I. 2.9–13.6	2a–b, 7a–b, 10a, 12a, 15b	Common
Euastrum gemmatum Ralfs	55–60.5 × 44–46; I. 14.5	4a–b, 9a	Rare
Euastrum insulare (Wittr.) J.Roy	19.1–27.5 × 14.5–22; I. 5	1a, 4a–b	Rare
Euastrum intermedium Cleve	66 × 38.5; I.33	4b	Single
Euastrum oblongum Ralfs	157 × 77; I. 22	4a	Single
**Euastrum pulchellum* Bréb.	27.5–55 × 16.5–38.5; I. 5.5–16.5	2b, 3a, 7a–b, 8b, 10a, 12a, 15b	Common
**Euastrum subalpinum* Messik.	16.5–22 × 11–16.5	4a, 10a, 14b	Rare
Euastrum turneri West	34.8–37.7 × 26.1; I. 8.7–14.5	2a–b	Rare
Euastrum verrucosum Ehrenb. ex Ralfs	92.5–121 × 80–110; I. 22–27.5	1a, 2a–b, 9a	Rare
Hyalotheca dissilens Bréb. ex Ralfs	13.8–19.8 × 18.6–21.7	1a, 2a, 7a–b	Rare
Micrasterias crux-melitensis Ralfs	137.5–143 × 115–126.5; I. 34.5–55	4b, 10b, 11b	Rare
**Micrasterias furcata* C.Agardh ex Ralfs	176 × 115.5; I. 22	4b	Single
Micrasterias papilifera var. *glabra* Nordst.	121 × 137.5; I. 16.5	2b	Single
Micrasterias radiosa Ralfs	137.5–143 × 115.5–132; I. 16.5	2b	Single
**Pleurotaenium maximum* (Reinsch) P.Lundell	495 × 38.5	11b	Single
Pleurotaenium trabecula Nägeli	291.5–506 × 27.5–46; I. 27.5; Ap. 16.5	7a, 11a–b, 12a, 15b	Rare
**Pleurotaenium trabecula* var. *crassum* Wittr.	319 × 27.5	10b	Single
Pleurotaenium truncatum (Bréb. ex Ralfs) Nägeli	360.8–363 × 57.3–60.5; I. 38.5–39.5; Ap. 22.1–27.5	2a, 4a	Rare
**Sphaerozosma aubertianum* West	15 ×22.1; I. 5.9	2b, 12b	Rare
**Spondylosium ellipticum* West et G.S.West	20.3 × 20.3; I. 5.3	10b	Single
**Spondylosium moniliforme* var. *compressum* Grönblad	38.5–44 × 27.5; I. 11	2b	Single

Taxa	Measurements of the cells (length × width), of isthmus and apex, μm	Lake number and habitat type abbreviations	Frequency category
Spondylosium planum (Wolle) West et G.S.West	10.1–16.5 × 11–16.5; I. 3.5–11	2b, 3a, 4a–b, 5a, 7a–b, 15b	Rare
**Staurastrum anatinum* Cooke et Wills	44 with processes × 55; I. 11	9a	Single
Staurastrum arctiscon (Ehrenb. ex Ralfs) P.Lundell	82.5–115.5 with processes × 82.5–99; I. 22–38.5	2a–b, 3b	Rare
Staurastrum boreale West et G.S.West	29 × 43; I. 7.5	8a	Single
Staurastrum brachiatum Ralfs ex Ralfs	15–27.5 × 27.5–38.5; I. 5.5	5a, 6b	Rare
**Staurastrum cristatum* (Nägeli) W.Archer	36 × 43,5; I. 17.4	1a	Single
Staurastrum furcigerum (Bréb.) W.Archer	63.8 with processes × 43.5 × 72.5; I. 26.1	1a	Single
Staurastrum hexacerum Wittr.	27.5 with processes × 33; I. 11	10a	Single
**Staurastrum hirsutum* Ehrenb. ex Ralfs	34.5–38.5 × 29–31 with processes; I. 11	2b, 4b	Rare
**Staurastrum manfeldtii* Delponte	38.5 × 55; I. 11	2b	Single
Staurastrum margaritaceum Menegh. ex Ralfs	22–27.5 with processes × 22–27.5; I. 5.5–11	7b	Single
Staurastrum paradoxum Meyen ex Ralfs	27.5 with processes × 44; I. 16.5	2b	Single
**Staurastrum pelagicum* West et G.S.West	32.7 × 34.5 × 51.9 with processes; I. 17.4	2b	Single
**Staurastrum polytrichum* (Perty) Rabenh.	49.5 × 38.5; I. 16.5	12b	Single
**Staurastrum proboscideum* (Bréb.) W.Archer	33 × 33; I. 11	7a	Single
Staurastrum sebaldii Reinsch	66–99 with processes × 71.5–93.5; I. 17.4–27.5	2a-b	Rare
Staurastrum sexcostatum Bréb. ex Ralfs	40.6–60.5 with processes × 38.5; I. 16.5–17.4	2a–b, 7a–b	Rare
**Staurastrum tohopekaligense* Wolle	55–87 with processes × 33–66.7 × 44–92.4 with processes × 23.2–43.5; I. 16.5–20.3	2b	Single
Staurastrum vestitum Ralfs	23.2–43.5 × 60.5–66.7 with processes	10a	Single
Staurodesmus convergens (Ehrenb. ex Ralfs) S.Lill.	44–55.1 × 40.6–44 ×58–60.5 with processes × I.: 11.6–16.5	2a–b, 15b	Rare
Staurodesmus dejectus (Bréb.) Teiling	44 × 38.5; I. 11	3a, 10a	Rare
Staurodesmus dickiei (Ralfs) S.Lill.	38.5 × 38.5–44 ×55–60.5 with processes, I. 16.5–27.5	2b, 9a	Rare
**Staurodesmus glaber* (Ralfs) Teiling	38.5–44 × 49.5–71.5 with processes; I. 16.5	2b, 4a–b, 7a–b	Rare
Staurodesmus incus (Hassal ex Ralfs) Teiling	11 × 16.4; I. 5	7b	Single
* *Staurodesmus octocornis* (Ehrenb. ex Ralfs) Stastny, kaloud et Neustupa	16.4 × 23.6; I. 5.7	2a–b	Rare
Staurodesmus patens (Nordst.) Croasdale	27.5–38.5 × 26.5–27.5; I. 5.5	7a, 8b	Rare
Staurodesmus spetsbergensis (Nordst.) Teiling	38.5 × 27.5–38.5; I. 16.5	9a	Single
**Staurodesmus subpygmaeus* (West) Croasdale	27.5 –33 × 33; I. 11	3b	Single
**Teilingia quadrispinata* (Scott et Grönblad) Kurt Först.	7.5 –10.7 × 8.7–11.5; I. 4.1–5.7	2b, 4b, 12b	Rare
Tetmemorus brebissonii Ralfs	66–115.5 × 11.5–34.5	8b	Single
Tetmemorus laevis Ralfs ex Ralfs	71.5–76.8 × 16.5	13b	Single
Xanthidium antilopeum Kütz.	33–116.2 with processes × 27.5–94.5 × 33–86.9 with processes × 27.5–76.8; I. 11–34.2	1a, 2a–b, 6b, 7b, 11b, 15b	Common
Xanthidium cristatum Bréb. ex Ralfs	60.5 with processes × 49.5 × 55 with processes × 38.5; I. 27.5	2a, 3a, 11b	Rare

trum ansatum, *E. bidendatum*, *E. binale*, *E. elegants*, *E. pulchellum*, *Netrium digitus*, *Spondylosum planum*, *Xanthidium antilopeum* (Table 3).

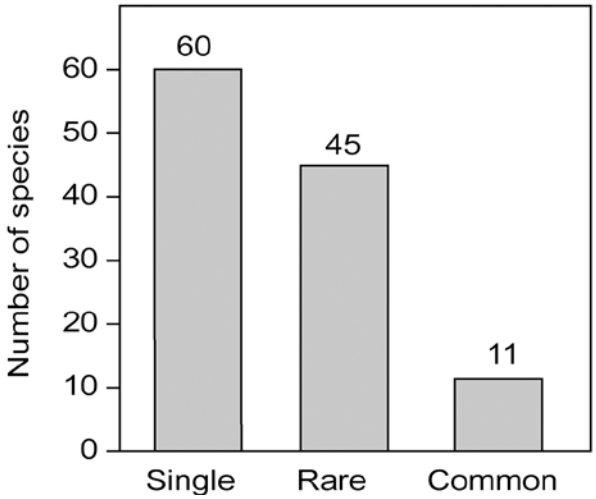

Fig. 3. Distribution of species in the studied water bodies of the Khrebtovyi Nature Reserve

The most diverse group of desmids in the Khrebtovyi Nature Reserve consisted of algae species distributed worldwide – 33% of all desmid species found in the research area, 16.9% of species were distinctly characteristic of the northern algal flora. They belong to Boreal element, namely *Actinotaenium crassiusculum*, *A. cucurbita*, *Cosmarium amoenum*, *Micrasterias radiosa*. There also were a few species representing the boreal-alpine element (6.7%), namely *Actinotaenium cucurbitinum*, *A. rufescens*, *Closterium costatum*, *Cosmarium biretum*, *Cosmarium galeritum*, *Euastrum bidendatum*, *Staurastrum arctiscon*, *Staurodesmus glaber*, *Tetmemorus brebissonii*; and the boreal-arctic (2.5%), namely *Penium polymorphum*, *Staurastrum spetsbergensis*, *Tetmemorus leavis* (Kostkeviciene et al., 2003; Sterlyagova, 2008). These floral elements give evidence that algal flora in the bogs has been strongly affected by the glaciers (Coesel, 1996; Stamenkovič et al., 2008).

The composition of desmid species in the samples taken from different habitats was analysed by applying the Jaccard index and NMDS technique (Fig. 4). As it could be seen from Scatter plot, sample groups from "a" and "b" habitats were overlapping in 2D space. It can be concluded that complexes of desmid species in those habitats were similar. However, obviously lower diversity of desmid species was in the samples taken squeezing rhizomes and roots of *Carex* or *Equisetum* plants, where altogether 70 species were observed. In comparison, 88 species were identified in the samples taken from *Sphagnum* and other mosses. Differences in the species richness of desmid flora were even more evident when Chao2 estimator was applied: in the "a" habitat, the number of species was 71.8 ± 20.1 and in "b" habitat – 94.9 ± 33.7. Thus, more favourable environment for desmid algae in the studied lakes were habitats with *Sphagnum* and brown mosses, where more rich algal complexes had formed, compared to habitats with rhizomes and roots of *Carex* or *Equisetum* plants. In the further studies on algal flora, it might be possible to find species from the *Micrasterias*, *Staurodesmus* and *Xanthidium* genera since the habitats with *Sphagnum* and brown mosses are suitable for the mentioned groups.

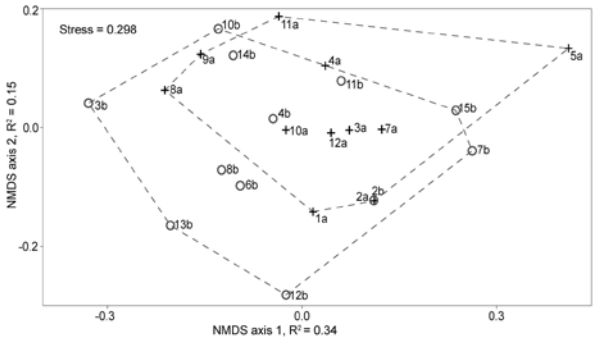

Fig. 4. Non-metric multidimensional scaling (NMDS) technique and the Jaccard similarity index of species composition recorded in the samples from the research area based on the presence/absence data (abbreviations of the number of lakes and habitat types as in Table 1). Dotted line shows convex hulls – the smallest convex polygon containing all points in the group

In the samples taken from the Khrebtovyi Nature Reserve, the species richness was poor and algae were not frequent. However, a large number of desmid species were found for the first time in that territory. Formation of algal flora in the Khrebtovyi Nature Reserve is still poorly understood, mainly because of the remoteness of the area and difficult research conditions. Chao 2 estimated maximum possible species richness was nearly one and a half times higher in the lakes with *Sphagnum* and brown mosses mats on the shores. That presupposes a need of further expeditions and more numerous samples from lakes in the Khrebtovyi Nature Reserve.

ACKNOWLEDGEMENTS

This work is a part of the research project "Diversity, ecology and geography of Cyanophyta/Cyanoprokaryota European sector of the Russian Arctic", which is financed by the Russian Foundation for Basic Research (RFBR), grant No. 07-04-00443-a.

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DVYNIEČIŲ FLORA CHREBTOVYJ DRAUSTINIO EŽERUOSE ŠIAURĖS URALE (RUSIJA)

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Santrauka

Straipsnyje aptariama dvyniečių rūšių įvairovė, jų paplitimas Chrebtovyj draustinio termokarstiniuose ir kalnų ežeruose (Šiaurės Uralas). Rasta 116 dvyniečių rūšių, kurios priklausė *Closteriaceae* (13 rūšių), *Desmidiaceae* (93), *Gonatozygaceae* (1), *Mesotaniaceae* (7), *Peniaceae* (2) šeimoms. Dvidešimt septynios rūšys buvo rastos pirmą kartą šiame regione. Šešiasdešimties rūšių, kurios sudarė 51,7 % visų rastų dvyniečių rūšių, radiniai buvo pavieniai, aptikti tik vienoje tirtoje augavietėje. Didžiausias dvyniečių rūšių skaičius (88 rūšys) rastas vandens mėginiuose, paimtuose išspaudus iš ežerų pakraščių ištrauktus *Sphagnum* spp. ar kitas samanas.