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CHECKLIST OF CYANOBACTERIA FROM THE EUROPEAN POLAR DESERT ZONE

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Abstract

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The present study compiles the results of inventory of cyanobacteria species from the polar desert zone of Europe. The checklist includes actualized literature data from Franz Josef Land and Novaya Zemlya archipelagos, most of which are published in Russian, and the data from Svalbard archipelago. After the revision of nomenclature, the current checklist contains 176 species of cyanobacteria. The data on site characteristics, habitats, species frequency are provided. The study is the first generalization of the biodiversity of cyanobacteria in the European polar deserts, and it is important for the knowledge about their distribution and biodiversity in the Arctic. The flora analysis showed a decreasing trend of cyanobacterial biodiversity towards high latitude areas.

Keywords: biodiversity, Cyanoprokaryota, European Arctic, polar desert zone.

INTRODUCTION

The polar desert zone is the northernmost marginal zone of their latitudinal distribution. According to Aleksandrova (1980, 1988), we assume that the Arctic includes the polar desert zone and tundra zone. European polar desert zone comprises some islands and three archipelagos of the Arctic Sea: North East Land Island of Svalbard (in the list, abbreviations of archipelagos are in bold – **SV**), Franz Josef Land (**FJLA**) and local part of Zhelaniya cape of Severny (Northern) Island of Novaya Zemlya (**NZA**) and Vize island (Fig. 1).

Extreme ecological conditions include low temperatures, a short growing period, etc., and make the polar desert zone one of the harshest environments on the Earth. Most parts of the landscape lack vegetation. Cyanobacteria are widespread organisms in Arctic ecosystems. The functional role of cyanoprokaryotes in polar biotopes is important, because they are a significant producer of organic matter. Indeed, the cyanobacterial microflora of the polar desert zone is poorly known (Davydov & Patova, 2018). The data on their diversity are still incomplete, due to the remoteness of the region.

The first data on cyanobacteria biodiversity in Franz Josef Land archipelago we can find in the papers of Borge (1899), Kosinskaya (1933), Shirshov (1935), Novichkova-Ivanova (1963). A few algological studies on the polar desert zone of Svalbard archipelago (Thomasson, 1958; Richter & Matuła, 2013; Davydov, 2013, 2016) and Novaya Zemlya archipelago (Shirshov, 1935) have been carried out.

Until the beginning of our study, the list of species from the European polar desert zone included 76 taxa. Partially, the cyanobacteria from the polar desert have been described in previous monographs (Patova et al., 2015), which include the soils and terrestrial habitats only. Therefore, the cited list was incomplete, because it did not include new data on

floras from Innvika coast (Davydov, 2016) and floras from the northern coast of Murchisonfjorden. The aim of the current study was to present all available published data on cyanobacteria from the European polar deserts, and new data on biodiversity of freshwater and terrestrial cyanoprokaryotes in Svalbard.

MATERIALS AND METHODS

We studied cyanoprokaryotes on North East Land Island (Nordaustlandet) (**NI**), Svalbard archipelago from 2006 to 2012 (Fig. 1), namely, on Prins Oscars Land, on the eastern coast of Rijpfjorden Bay (in the list, areas are in italic and underlined – *R*) in 2006; on Gustav V Land, on the northern coast of Murchisonfjorden (*K*) in 2010; on the southern coast of Innvika cove, Fotherbyfjorden Bay (*I*) in 2011; on Orvin Land, on the eastern coast of Sætherbukta cove, Duvefjorden Bay (*S*) in 2012.

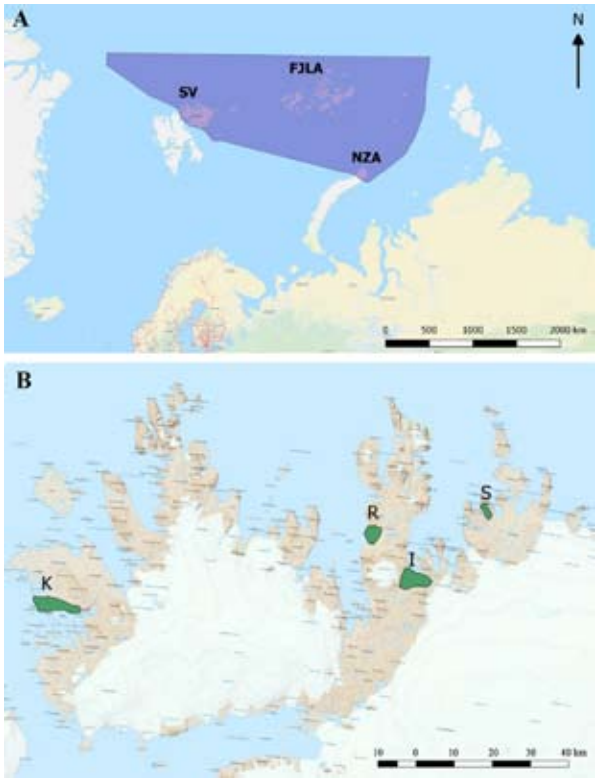

Fig. 1. The area of cyanobacteria studies: **A.** European polar desert zone: FJLA – Franz Josef Land archipelago, NZA – Novaya Zemlya archipelago, SV – Svalbard archipelago; **B.** Svalbard archipelago: *R* – the eastern coast of Rijpfjorden Bay, *K* – the northern coast of Murchisonfjorden. *I* – the southern coast of Innvika cove, Fotherbyfjorden Bay, *S* – the eastern coast of Sætherbukta cove, Duvefjorden Bay. Free products ©Norwegian Polar Institute were used to create the map

All samples were collected by the author, with the exception of some specimens collected by Dr S. Shalygin. A total of 368 samples of cyanobacteria were collected. The samples were collected on the sea coast and sea marshes, in lakes and pools, in streams and waterfalls of different type, minerotrophic mires and seepages, under the bird colonies, on the wet rocks, on soils, on bare permafrost landforms. We followed the approach to the classification of polar habitats (Metting, 1981; Elster, 2002; Wehr & Sheath, 2015) with some changes. From our point of view, the following groups of cyanobacteria habitats could be divided in the polar desert zone: among aquatic habitats we distinguished, specifically, lakes (Fig. 2A) and ponds, fast running glacial streams (Fig. 2B) and waterfalls (Fig. 2C), slow running streams (Fig. 2D). We divided the subaerial types of habitats into coastal habitats, pools, littoral zone of inland surface waterbodies (Fig. 3A), minerotrophic mires, seepages (Fig. 3B). Wet moss-dominated communities (Fig. 3C), wet soils, wet and dripping rocks (Fig. 3D) were referred to aerial types of cyanobacterial habitats.

The specimens are deposited at the Herbarium of Polar-Alpine Botanical Garden-Institute, Kirovsk (KPABG). Information on habitats and description of localities and data from the literature sources is included in the CYANOpro database (Melechin et al., 2013).

Cyanobacteria species are listed alphabetically. The species recorded in Europe's polar desert flora for the first time are marked with an asterisk. The species frequency is defined on the basis of the field observations as follows: *rare* – species recorded 1–3 times, *sporadically* – 4–7, *frequent* – over 7 times, *very often* – more than 10 times. Annotation contains the names of collection sites; the numbers after it designate the specimens in KPABG Herbarium and habitats. More information about specimens include localities, detailed description of habitats, each sample, substrates, and coordinates can be found in CYANOpro database (http://kpabg.ru/cyanopro/?q=seraed). Herbarium numbers are cited together with the names of species in the text below. Komárek & Anagnostidis (1998, 2005) and Komárek (2013) manuals were used for species identification, synonyms of the species are provided in the brackets. Current taxonomic positions of taxa correspond to Komárek et al. (2014).

Fig. 2. Examples of aquatic habitats selected for the study of cyanobacteria flora: A – cyanobacterial mats on the shore of an unnamed lake (the eastern coast of Sætherbukta cove, Duvefjorden Bay); B – a fast stream on the eastern coast of Sætherbukta cove, Duvefjorden Bay; C – a waterfall on the southern coast of Innvika cove, Fotherbyfjorden Bay; D – a slow stream with mat of *Phormidium uncinatum* on the bottom (the southern coast of Innvika cove, Fotherbyfjorden Bay)

Similarity of floras was determined by the Sørensen index (KS) (weighted pair-group method using arithmetic averaging) in the programme module GRAPHS (Nowakowskiy, 2004): KS = 2a/(2a + b + c), where a – number of species common to both sets, b – number of species unique to the first set, c – number of species unique to the set.

RESULTS

Total list of cyanobacteria from the European polar desert zone comprises 176 species that occupy water, sub-aerial and aerophytic habitats. The highest number of cyanoprokaryotes (132 species) was detected in the flora of North East Land Island (Sval-

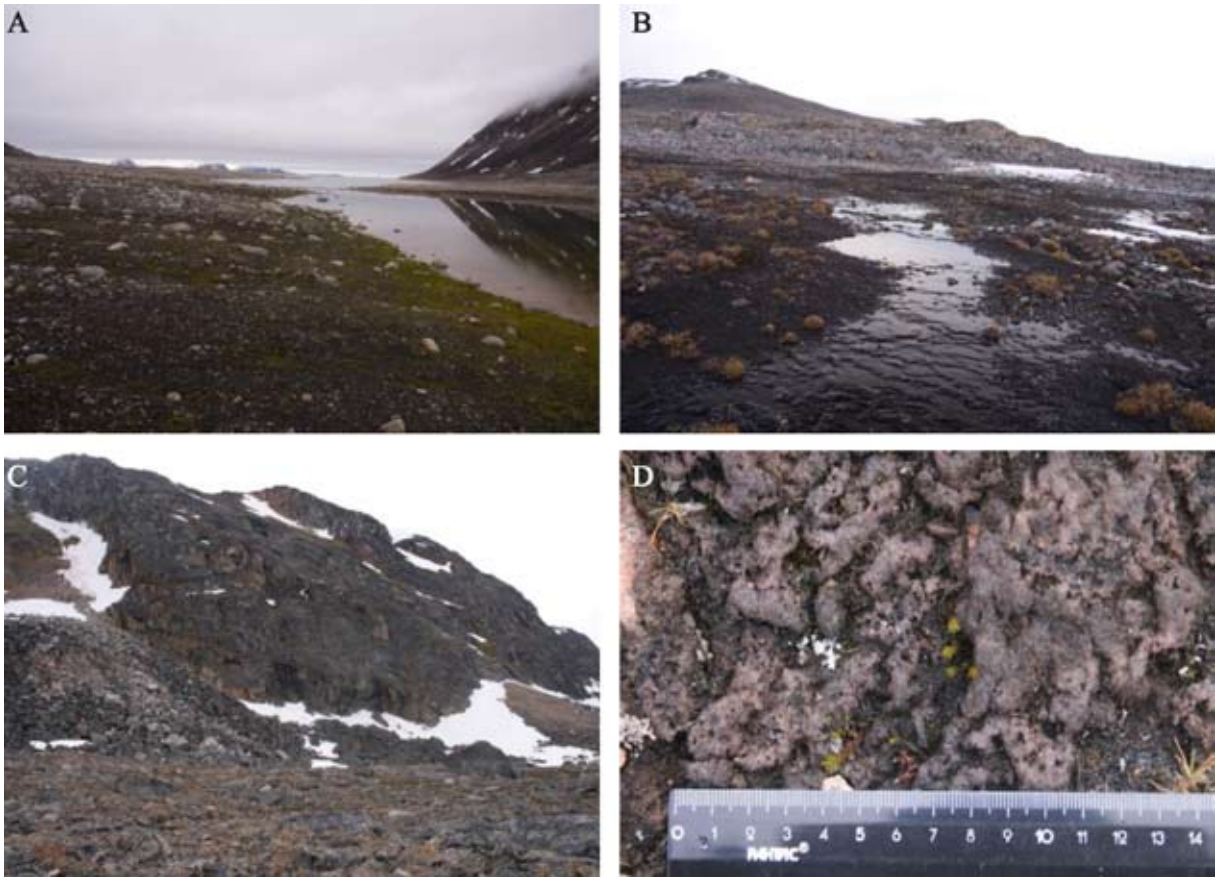

Fig. 3. Examples of subaerial habitats: A – a bank of lake on the eastern coast of Sætherbukta cove, Duvefjorden Bay; B – a seepage on the eastern coast of Sætherbukta cove, Duvefjorden Bay; and aerial habitats: C – a wet rock on the southern coast of Innvika cove, Fotherbyfjorden Bay; D – a biocrust with *Microcoleus vaginatus* in upper layer

bard archipelago). In the floras of polar deserts, only 35 species were common and dominant, whereas most species were rarely (102 species) or sporadically recorded (32 species). Most diverse in species were the genera *Gloeocapsa* (15 species), *Chroococcus* (13 species), *Phormidium* (12 species), *Aphanocapsa* (11 species), *Leptolyngbya* (10 species) (Table 1, Fig. 4).

Almost all species were found in aquatic habitats (172 taxa). In lakes, 81 species inhabited, in fast streams and waterfalls – 28, in slow streams – 63 species. There were 119 species in subaerophytic types of habitats. On the sea coast occurred 19 species, in pools – 61, on banks of water bodies – 48, in a few mires – 2, on seepages – 50. The aerophytic types of habitats comprised 136 cyanobacterial species, a lot of these species were growing on rocks (76) and soil (46) and a few species were discovered on moss community (9) and permafrost polygons (8).

DISCUSSION

The total species diversity in the European polar desert zone is significantly less studied than in the European tundra zone, which includes 401 species, and the European Hypoarctic zone comprises 472 species (own unpublished data). We can assume that it is an obvious trend, which represents a general character of cyanobacterial biodiversity and their decrease towards high latitude areas.

At the same time, the European polar desert zone exceeds the Siberian province of the polar desert by the number of investigated areas and by the number of identified species. The Asian part of polar desert zone comprises Severnaya Zemlya archipelago and the northern part of Taymyr, where only 45 species have been found (Patova et al., 2015). For comparison, the Canadian part of the polar desert has a single occurrence and four species have been found (Dick-

Table 1. Taxonomic structure of cyanobacterial flora of the European polar desert zone

Subclass	Order	Family	Genus
Gloeobacterophycidae (1)	Gloeobacterales (1)	Gloeobacteraceae (1)	*Gloeobacter* (1)
Nostocophycideae (35)	Nostocales (35)	Nostocaceae (9)	*Anabaena* (2)
			Nostoc (7)
		Rivulariaceae (8)	*Calothrix* (3)
			Dichothrix (3)
			Microchaete (1)
			Rivularia (1)
		Scytonemataceae (7)	*Petalonema* (4)
			Scytonema (3)
		Stigonemataceae (4)	*Stigonema* (4)
		Tolypothrichaceae (7)	*Coleodesmium* (1)
			Tolypothrix (6)
Oscillatoriophycidae (80)	Chroococcales (47)	Aphanothecaceae (7)	*Aphanothece* (4)
			Gloeothece (3)
		Chroococcaceae (33)	*Chroococcus* (13)
			Cyanosarcina (1)
			Gloeocapsa (15)
			Gloeocapsopsis (4)
		Cyanobacteriaceae (1)	*Cyanobacterium* (1)
		Entophysalidaceae (2)	*Entophysalis* (1)
			Siphononema (1)
		Gomphosphaeriaceae (3)	*Gomphosphaeria* (3)
		Microcystaceae (1)	*Microcystis* (1)
	Chroococcidiopsidales (1)	Chroococcidiopsidaceae (1)	*Chroococcidiopsis* (1)
	Oscillatoriales (31)	Coleofasciculaceae (1)	*Geitlerinema* (1)
		Cyanothecaceae (2)	*Cyanothece* (2)
		Homoeothrichaceae (2)	*Ammatoidea* (1)
			Phormidiochaete (1)
		Microcoleaceae (9)	*Kamptonema* (2)
			Microcoleus (5)
			Symplocastrum (2)
		Oscillatoriaceae (17)	*Lyngbya* (1)
			Oscillatoria (4)
			Phormidium (12)
	Pleurocapsales (1)	Xenococcaceae (1)	*Xenococcus* (1)
Synechococcophycideae (60)	Synechococcales (60)	Chamaesiphonaceae (4)	*Chamaesiphon* (2)
			Clastidium (1)
			Geitleribactron (1)
		Coelosphaeriaceae (6)	*Coelospherium* (2)
			Snowella (1)
			Woronichinia (3)
		Leptolyngbyaceae (17)	*Leptolyngbya* (10)
			Nodosilinea (1)
			Phormidesmis (1)
			Planktolyngbya (1)
			Trichocoleus (4)
		Merismopediaceae (20)	*Aphanocapsa* (11)
			Eucapsis (2)
			Limnococcus (1)
			Merismopedia (6)
		Pseudanabaenaceae (6)	*Jaaginema* (2)
			Pseudanabaena (4)
		Schizotrichaceae (4)	*Schizothrix* (4)
		Synechococcaceae (3)	*Anathece* (2)
			Synechococcus (1)

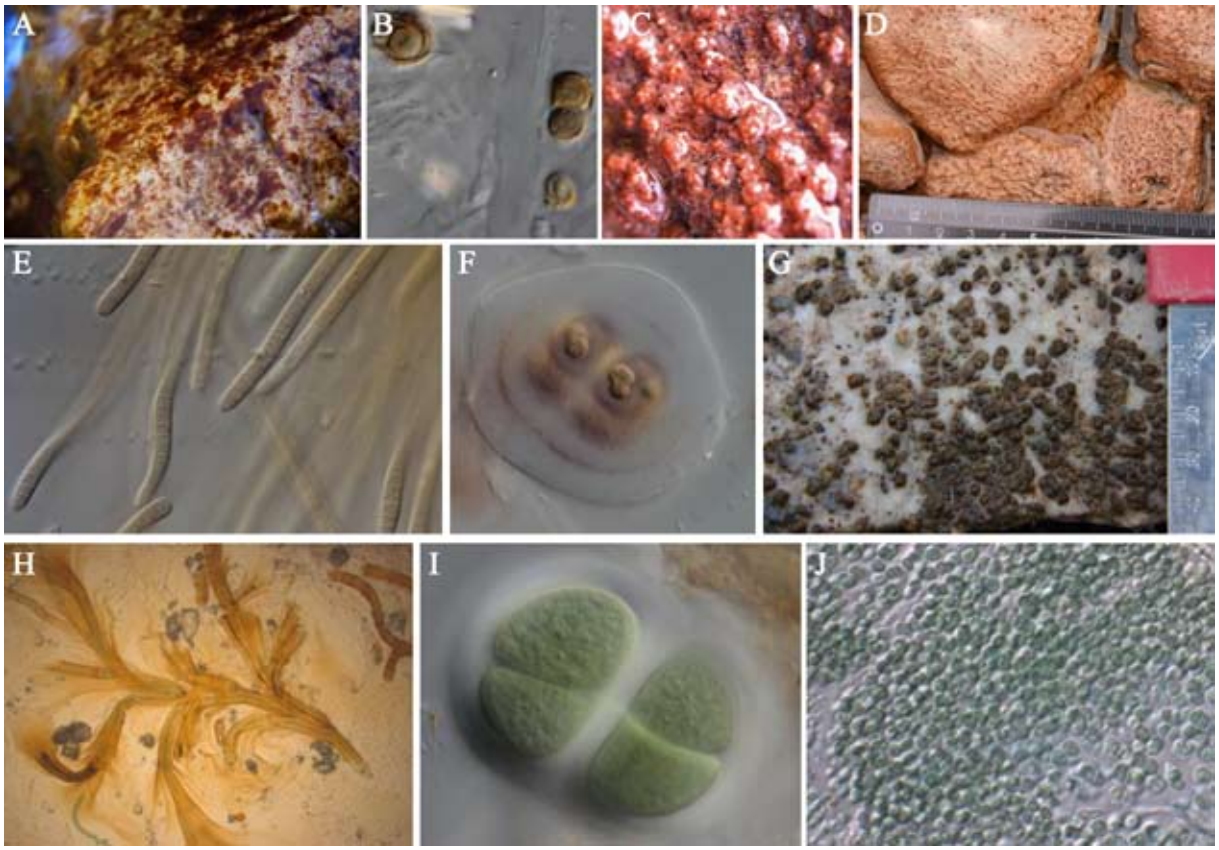

Fig. 4. Some cyanobacteria from the polar desert zone: A–B – colonies of *Chamaesiphon polonicus* growing on a boulder in a fast stream (A) and the species micrograph (B); C–D – *Phormidium uncinatum* growing on a stony bottom of lake (C) and the species micrograph (D); E–F – colonies of *Dichothrix gypsophila* growing on a pebble in a slow stream (E) and the species micrograph (F); G–H – colonies of *Gloeocapsa ralfsii* growing on a wet rock (G) and the species micrograph (H); I – micrograph of *Chroococcus subnudus*; J – micrograph of *Aphanocapsa fonticola*

ie, 1880). Other high Arctic regions have a different level of studies. Basically, cyanobacterial diversity has been investigated in tundras zone of Svalbard archipelago (Davydov & Patova, 2018), Greenland (Kristiansen, 2003) and local parts of Canadian Arctic Archipelago (Croasdale, 1973; Sheath et al., 1996; Sheath & Muller, 1997; Vézina & Vincent, 1997; Elster et al., 1999; Dickson, 2000; Villeneuve et al., 2001; Bonilla et al., 2005; Jungblut et al., 2010). Although flora of cyanobacteria from the European polar desert zone contains a small number of species, their abundance is not extremely low and can be compared to the flora of tundras of Svalbard archipelago (264 species) or Greenland (127 species). Perhaps future investigations employing the molecular analysis will increase diversity of some floras, because genetic approach allows to detect cryptic species. Previously it has been shown that molecular approach enables to identify more different cyanobacterial OTUs than light microscopy only (Pushkareva et al., 2015).

Currently, the Polar desert zone of Antarctic probably is the richest in cyanobacterial diversity (Akiyama, 1967; Smith, 1984; Pankow et al., 1991; Vincent et al., 1993; Broady, 1996; Broady & Weinstein, 1998; Cavacini, 2001; Singh et al., 2008; Komárek & Komárek, 2010; Michaud et al., 2012). Distribution of the studied areas shows that only North East Land Island (Svalbard archipelago) is particularly well investigated, while other regions of the European polar deserts still have not received enough attention. High number of cyanoprokaryotes (132 species) has been detected in the flora of North East Land Island (Table 2). Franz Josef Land archipelago has been only partially studied and has lower numbers of species (69).

Table 2. Number of cyanobacterial species in the areas of the European polar desert zone

Locality	North East Land Island of Svalbard archipelago				Franz Josef Land archipelago	Novaya Zemlya archipelago	Vize Island
	R	K	I	S			
Species number	37	64	74	63			
Total species number in the locality	132				69	10	4

R – the eastern coast of Rijpfjorden Bay, K – the northern coast of Murchisonfjorden, I – the southern coast of Innvika cove, Fotherbyfjorden Bay, S – the eastern coast of Sætherbukta cove.

Floristic similarity between all the studied localities is low (Table 3). Only 25 common species mainly typical hydrophytes occur in the floras of Franz Josef Land and North East Land Island.

Evidently, a more detailed study of terrestrial cyanobacteria from Franz Josef Land could result in a lower floristic difference. The flora of Novaya Zemlya polar deserts includes 12 species only and at the current situation, we had no reason to discuss the similarity between this flora and floras of other areas.

Almost all species (127, see the list of species) detected in the polar deserts grow in tundra also. Most species, which are absent in tundra zone, are widely distributed on the Earth and aren't specific of polar deserts (*Chamaesiphon minutus*, *Coelosphaerium dubium*, *Merismopedia hyalina*, *Tolypothrix fasciculate*, *Woronichinia elorantae*). The species found in polar deserts don't occur in the tundra zone, but grow in the southern part of Hypoarctic, particularly *Ammatoidea normannii*, *Anabaena sedovii*, *Aphanocapsa conferta*, *Chroococcus obliteratus, Gloeocapsa fusco-lutea*, *G. novacekii*, *Gomphosphaeria cordiformis*, *Microcoleus paludosus Phormidiochaete nordstedtii Phormidium deflexoides, P. lividum*, etc.).

The most part of polar desert species have a worldwide distribution (*Aphanocapsa grevillei*, *A. incerta*, *Aphanothece castagnei*, *Limnococcus limneticus*, *Merismopedia glauca*, *M. punctata*, *Microcoleus amoenus*, *M. autumnalis*, *M. paludosus*, *Nostoc commune*, *Phormidium uncinatum*, *Pseudanabaena frigida*, *Scytonema hofmannii*, *Stigonema minutum*, *Tolypothrix conglutinata*, etc.). Probably, among these can be genetically different cryptic species. Some species occur in similar Arctic and Antarctic habitats (*Ammatoidea normanii*, *Gloeocapsa kuetzingiana*, *G. ralfsii*, *Microcoleus autumnalis*) (Broady & Weinstein, 1998).

Table 3. The Sørensen similarity index of cyanobacteria flora between the studied localities

Locality	FJLA	NZA	VI	SZA
SV	14	6	2	16
FJLA	–	14	4	21
NZA	–	–	7	6
VI	–	–	–	5

SV – North East Land Island of Svalbard archipelago, FJLA – Franz Josef Land archipelago, NZA – Novaya Zemlya archipelago, VI –Vize Island, SZA – Severnaya Zemlya archipelago (Patova &Belyakova, 2006).

Reservoirs have a few planktonic species. *Aphanocapsa conferta*, *A. elachista*, *Chroococcus minutus*, *Ch. tenax*, *Ch. turgidus*, *Coelosphaerium kuetzingianum*, *Cyanothece aeruginosa*, *Gomphosphaeria aponina*, *G. cordiformis*, *Limnococcus limneticus*, *Merismopedia glauca*, *M. punctata*, *Woronichinia naegeliana* are the typical ones. The benthos communities are more diverse and forming large mats in shallow lakes. *Aphanocapsa grevillei*, *Phormidium uncinatum*, *Pseudanabaena frigida*, *P. minima* are the dominant species there. In some lakes, on the bottom, *Ammatoidea normannii* and *Nostoc kihlmanii* are found. Fast streams have poor cyanobacterial floras. Only few species inhabit there: *Ammatoidea normannii*, *Chamaesiphon polonicus*, *Phormidium aerugineo-caeruleum*, *P. uncinatum*, *Schizothrix simplicior*, *Trichocoleus delicatulus*. Slow streams have a lot of specific taxa such as *Calothrix parietina*, *Chroococcus cohaerens*, *Dichothrix gypsophila*, *Microcoleus autumnalis*, *Tolypothrix distorta*. In coastal habitats, *Chroococcus helveticus*, *Ch. tenax*, *Gloeocapsa ralfsii*, *Microcoleus autumnalis*, *Nostoc commune*, *Oscillatoria tenuis*, *Pseudanabaena minima* are found. The typical species that occur on the bottom of pools are *Calothrix parietina*, *Chroococcus pallidus*, *Ch. turgidus*, *Ch. varius*, *Gloeocapsa compacta*, *G. ralfsii*, *G. sanguinea*, *Nostoc commune*. The banns of streams and lakes have the abundant species composition. The

more frequent are *Aphanocapsa grevillei*, *A. rivularis*, *Dichothrix gypsophila*, *Leptolyngbya* cf. *gracillima*, *Oscillatoria tenuis*, *Petalonema crustaceum*, *Pseudanabaena frigida*, *Tolypothrix distorta*. The minerotrophic mires have no specific taxa, *Cyanothece aeruginosa*, *Merismopedia arctica*, *Nostoc commune* are found there. The seepages are a common type of habitats with many cyanobacteria species growing there, for example *Aphanocapsa muscicola*, *Aphanothece microscopica*, *A. saxicola*, *Calothrix parietina*, *Chroococcus pallidus*, *Gloeocapsa alpina*, *G. kuetzingiana*, *G. sanguinea*, *Leptolyngbya sieminskae*, *Nostoc commune*, *Phormidium uncinatum*. Cyanobacterial community of wet rocks have different species, particularly typical are *Aphanothece castagnei*, *Calothrix parietina*, *Gloeocapsa ralfsii*, *G. violascea*, *Gloeocapsopsis magma*, and *Stigonema ocellatum*. The bare soils and permafrost polygons have the following composition of species: *Aphanocapsa muscicola*, *Microcoleus vaginatus*, *Nostoc commune*.

In conclusion, cyanobacteria in the polar desert zone occupy a lot of different habitats. The floras of polar deserts have a few numbers of dominant species. Commonly distributed and very often observed species are as follows: *Nostoc commune*, *Phormidium uncinatum*, *Oscillatoria tenuis*, *Microcoleus autumnalis*, *M. vaginatus*, *Aphanocapsa grevillei*, *A. muscicola*, *Calothrix parietina*, *Tolypothrix tenuis*, *Trichocoleus sociatus*, *Dichothrix gypsophila*, *Gloeocapsa ralfsii*, *G. sanguinea*, *G. violascea*.

We can also assume that the future studies of cyanobacterial diversity in the polar deserts will increase the number of species, but a total quantity of taxa will not exceed the tundra's diversity and the polar desert zone will have the poorest cyanobacterial species composition in the world.

List of species

***Ammatoidea normannii* W.West et G.S.West –** very often; **SV**, **NI**; *R*: 201; *I*: 3439, 3608, 285, 3594, 3577, 3576, 2964, 3628, 2962; *S*: 3673, 3671, 3668; at the bottom of lakes and pools, in fast and slow streams, on seepages, crust on wet soil, in clefts of wet rocks.

***Anabaena laxa* (Rabenh.) A.Braun ex Born. et Flah. –** rare; **FJLA**, Northbrook Island (Shirshov, 1935), Alexandra Land Island (Novichkova-Ivanova, 1963); moss tundra, on bare soil.

***A. sedovii* Kosinsk. –** rare; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933).

***Anathece clathrata* (W.West et G.S.West) Komarek et al.** (=*Aphanothece clathrata* W.West et G.S.West) **–** rare; **SV**, **NI**; *K:* Heimbukta Bay, Third Lake (Thomasson, 1958); in plankton.

***A. minutissima* (W.West) Komarek et al.** (=*Aphanothece saxicola* Näg. f. *minutissima* (W.West) Elenk.) **–** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); moss desert, moss-lichen desert, on the soil.

***Aphanocapsa conferta* (W.West et G.S.West) Kom.-Legn. et G.Cronb.** (=*Aphanocapsa elachista* W.West et G.S.West var. *conferta* W.West et G.S.West) **–** rare; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933), Scott Keltie Island (Kosinskaya, 1933; Shirshov, 1935); in plankton of lakes and on seepages.

***A. elachista* W.West et G.S.West.** (=*Microcystis pulverea* f. *elachista* (W.West et G.S.West) Elenk.) – rare; **SV**, **NI**; *K*: Little North Lake (Thomasson, 1958); **FJLA**, Scott Keltie Island (Shirshov, 1935), Hooker Island, Tikhaya cove (Shirshov, 1935); in plankton of lakes and in pools.

****A. fonticola* Hansg.** (Fig. 4 J) **–** rare; **SV**, **NI**; *S:* 3644; on mosses.

Fig. 11. Micrographs of Aphanocapsa. fonticola (a) and Chroococcus subnudus (b).

****A. fusco-lutea* Hansg. –** rare; **SV**, **NI**; *K:* 3899; on wet rocks.

****A. grevillei* (Berk.) Rabenh. –** very often; **SV**, **NI**; *R:* 210, 212; *K:* 3755, 3870–3875, 3819, 3864, 3865, 3867, 3868, 3879, 3883, 3886, 3887, 3921; *I:* 2861, 3594, 3598; *S:* 3660, 3697, 3662, 3601, 3604, 3606, 3609; at the bottom of lakes and pools, in slow streams and on the shores of streams, on seepages, on wet rocks.

***A. incerta* (Lemm.) G.Cronb. et Komarek** (=*Microcystis pulverea* (Wood.) Migila f. *incerta* (Lemm.) Elenk.) – rare; **FJLA**, Hooker Island, Sedov cape; Scott Keltie Island (Kosinskaya, 1933); on seepages and in pools.

****A. muscicola* (Menegh.) Wille –** very often; **SV**, **NI**; *R:* 205; *K:* 3933, 3750, 3863; *I:* 3624, 3581, 3608; *S:* 3649, 3654, 3662, 3952, 3686, 3679, 3670; at the bottom of slow streams and on the shores of streams, on seepages, on wet rocks, on permafrost polygons.

***A. parietina* Näg. –** rare; **SV**, **NI**; *R:* 227; stony wet desert, on boulder.

***A. rivularis* (Carm.) Rabenh.** – rare; **SV**, **NI**; *K:* 3747, 3745; on the shore of lake.

***A. testacea* Näg. –** sporadically; **SV**, **NI**; *R:* 207, 197, 225, 191; on wet rocks.

***Aphanocapsa* sp. –** very often; **SV**, **NI**; *K:* 3852, 3860, 3862, 3864, 3866-3868, 3870, 3872, 3888, 3906, 3915, 3916, 3930, 3932; *S:* 3953, 3954, 3956, 3951, 3943, 3942, 3940; on sea marsh in small pools, an endolithic and an epilithic on pebbles, on the shores of lakes, on seepages, on wet rocks.

***Aphanothece castagnei* (Breb.) Rabenh. –** frequent; **SV**, **NI**; *K:* 3933; *I:* 2969; *S:* 3649; **FJLA**, Hooker Island, Sedov cape, MacKlintok Island, Dillon cape (Kosinskaya, 1933), Scott Keltie Island (Kosinskaya, 1933; Shirshov, 1935); on wet rocks, on the shore of a slow stream, on seepages.

***A. microscopica* Näg. –** sporadically; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963), **SV**, **NI**; *S:* 3943, 3941, 3940, 3942; on the shores of lakes.

- *Aphanothece* cf. *microscopica* Näg. – sporadically; **SV**, **NI**; *I:* 3581, 3439, 3174, 3171; in pools and on seepages.

***A. saxicola* Näg. –** frequent; **SV**, **NI**; *I:* 3601, 3628, 2969, 3605, 2859, 3180, 3629; *S:* 3700; at the bottom of pools, on seepages, on wet rocks, on the shores of lakes.

***Aphanothece* sp. –** frequent; **SV**, **NI**; *I:* 3610, 3609; *S:* 3954, 3953, 3649; at the bottom of pools, on seepages, on wet rocks, on the shores of lakes.

***Blennothrix* sp. –** rare; **SV**, **NI**; *K:* 3880; in a slow stream.

***Calothrix breviarticulata* W.West et G.S.West –** rare; **SV**, **NI**; *I:* 3605; at the bottom of pool.

***C. elenkinii* Kosinsk. –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); a moss desert, on the soil.

***C. parietina* Thur. ex Born. et Flah. –** very often; **SV**, **NI**; *R:* 210, 213-215; *K:* 3826-3828, 3830, 3860, 3864, 3868, 3872, 3874, 3878, 3881, 3883, 3886, 3888, 3890, 3891, 3893, 3897-3900, 3904, 3913, 3918, 3919, 3925, 3926, 3928; *I:* 3807, 3624, 3578, 3580, 3621, 3593; *S:* 3650, 3657, 3689, 3661, 3684; in a slow stream, in pools, on seepages, an epilithic at the bottom of lakes and on the shores of lakes, on sea marsh, on wet rocks.

***Chamaesiphon minutus* (Rost.) Lemm. –** rare; **FJLA**, Scott Keltie Island (Shirshov, 1935); in a slow stream.

***Ch. polonicus* (Rost.) Hansg**. (Fig. 4 A–B) **–** very often; **SV**, **NI**; *K:* 3751, 3828, 3833, 3843–3849, 3852, 3859, 3862, 3888, 3912–3915, 3919, 3921, 3928, 3931; *I:* 3178, 3170, 3586, 3175, 3568, 2963, 2857, 3570, 3168, 2964, 3576, 3577, 3172; *S:* 3637, 3680, 3688, 3638, 3636, 3682; in fast and slow streams and pools, on the shores of lakes, on seepages, on wet rocks.

***Chroococcidiopsis* sp. –** rare; **SV**, **NI**; *K:* 3827; *I:* Shalygin S. 3807; in a cleft of rocks.

***Chroococcus cohaerens* (Breb.) Näg. –** very often; **SV**, **NI**; *R:* 201, 207, 205, 224; *K:* 3886, 3874; *I:* 3615, 2959, 3166, 3581, 3173, 3591, 3601, 3177; *S:* 3655, 3941; in slow streams and pools, on the shores of lakes, on seepages, on wet rocks.

***Ch. dispersus* (Keissl.) Lemm.** (=*Gloeocapsa minor* f. *dispersa* (Keissl.) Hollerb.) **–** rare; **FJLA**, Hooker Island, Scott Keltie Island (Shirshov, 1935); in pools.

***Ch. helveticus* Näg. –** sporadically; **SV**, **NI**; *K:* 3884, 3879, 3750, 3876; in pools, on sea marsh.

***Ch. minutus* (Kütz.) Näg.** – frequent, **SV**, **NI**; *K:* Little North Lake (Thomasson, 1958); 3872, 3866, 3867, 3873; *I:* 3174; **FJLA**, Hooker Island, Tikhaya cove (Shirshov, 1935), Sedov cape, MacKlintok Island (Kosinskaya, 1933), Scott Keltie Island (Kosinskaya, 1933; Shirshov, 1935); in plankton of lakes and pools, in slow streams, on seepages.

***Ch. obliteratus* P.G.Richt. –** sporadically; **SV**, **NI**; *K:* 3865, 3864; *I:* 3614, 2962; in slow and fast streams.

***Ch. pallidus* (Näg.) Näg. –** very often; **SV**, **NI**; *R:* 224; *K:* 3752, 3815, 3881, 3903, 3930; *I:* 3439, 3627, 3593, 3597; *S:* 3693; on the shores of slow streams, in pools, on seepages, on wet rocks, crust on the soil, on sea marshes.

***Ch. spelaeus* Erceg. –** sporadically; **SV**, **NI**; *K:* 3815; *I:* 3598, 3176, 3581; *S:* 3673; on seepages, on the shore of a small slow stream, crust on wet soil.

***Ch. subnudus* (Hansg.) G.Cronb. et Komarek** (Fig. 4 I) **–** rare; **SV**, **NI**; *I:* 3630, 3603; in a slow stream and on the shore of a fast stream.

***Ch. tenax* (Kirchn.) Hier. –** frequent; **SV**, **NI**; *K:* Ice-eye Lake (Thomasson, 1958); 3876, 3826, 3828, 3832, 3874, 3879; *S:* 3954, 3956; in plankton and on

the shore of lake, on sea marsh, in slow streams, on wet rocks.

***Ch. turgidus* (Kütz.) Näg. –** very often; **FJLA**, Hooker Island, Sedov cape, MacKlintok Island (Kosinskaya, 1933), Scott Keltie Island (Kosinskaya, 1933; Shirshov, 1935), **NZA** (Shirshov, 1935), **SV, NI;** *K:* Little North Lake, Third Lake (Thomasson, 1958); 3867, 3868, 3872; *R:* 213, 214; *S:* 3942; in plankton and on the shore of lake, at the bottom of small pool and in a slow stream.

****Ch. turicensis* (Näg.) Hansg. –** rare; **SV**, **NI**; *K:* 3933; *S:* 3649, 3647; on the shore of a slow stream and on wet rocks.

****Ch. varius* A.Braun –** very often; **SV**, **NI**; *K:* 3826, 3872, 3749, 3867, 3823, 3829; *I:* 3166, 3626, 2964; *S:* 3649, 3671; in slow streams and small pools, on wet rocks, crust on permafrost landforms.

***Chroococcus* sp. –** sporadically; **SV**, **NI**; *K:* 3832. *I:* 3179; *S:* 3688, 3635; at the bottom of a fast stream, in slow streams, on wet rocks.

***Clastidium setigerum* Kirchn. –** rare; **FJLA**, Scott Keltie Island (Shirshov, 1935); in a slow stream.

***Coelosphaerium dubium* Grun. –** rare; **FJLA**, Scott Keltie Island, Rumyantsev lake (Shirshov, 1935); in plankton.

***C. kuetzingianum* Näg. –** sporadically; **FJLA**, Hooker Island, Tikhaya cove, Scott Keltie Island (Shirshov, 1935), **SV**, **NI**; *S:* 3657; in pools, on wet rocks.

****Coleodesmium wrangelii* ([C.Ag.] Born. et Flah.) Borzi ex Geitl. –** rare; **SV**, **NI**; *I:* 3568, 3570; on wet rocks.

***Cyanobacterium* sp. –** rare; **SV**, **NI**; *I:* 2861; in a slow stream.

***Cyanosarcina* sp. –** sporadically; **SV**, **NI**; *S:* 3954; *K:* 3868, 3867, 3751; *I:* 2964; at the bottom of slow streams and pools, on seepage.

***Cyanothece aeruginosa* (Näg.) Komarek** (=*Synechococcus aeruginosus* Näg.) **–** very often; **FJLA**, Hooker Island, Sedov cape, Scott Keltie Island, Aagaard Island (Kosinskaya, 1933), **SV**, **NI**; *K:* Third Lake (Thomasson, 1958), 3867; *R:* 224; *I:* 3626, 3173, 3603, 2962; *S:* 3641, 3696, 3645, 3673; in plankton of lake and pools, on moist tundra bogs, on seepages, on wet rocks, at the bottom and on the shores of fast and slow streams.

***C. major* (Schröt.) Komarek** (=*Synechococcus aeruginosus* Näg. var. *maximus* Lemm., *S. major* Schröt.) **–** sporadically; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933), Scott Keltie Island (Shirshov, 1935), **NZA** (Shirshov, 1935); in pools.

***Dichothrix compacta* Born. et Flah. –** rare; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933).

****D. gypsophila* (Kütz.) Born. et Flah.** (Fig. 4 E–F) **–** very often; **SV**, **NI**; *R:* 207; *K:* 3823, 3756, 3757, 3931; *I:* 3177, 3602, 3601, 3599, 3598, 3591, 3582, 3172, 3573, 3572, 2968, 2967; *S:* 3942, 3956, 3957, 3647, 3649, 3953, 3941, 3701, 3943; at the bottom and on the banks of slow and fast streams and pools, on seepages, on the shores of lakes, on wet rocks.

****D. orsiniana* (Kütz.) Born. et Flah. –** rare; **SV**, **NI**; *S:* 3646, 3653, 3687; on wet rocks.

***Entophysalis* sp. –** rare; **SV**, **NI**; *K:* 3859; *I:* Shalygin S., 3807; at the bottom of small slow streams.

***Eucapsis alpina* Clements et Shantz –** sporadically; **FJLA**, Aagaard Island, Hooker Island, Sedov cape, Scott Keltie Island (Kosinskaya, 1933); in pools and on seepages.

***E. minor* (Skuja) Elenk. –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963), on the soil.

***Geitleribactron* sp. –** rare; **SV**, **NI**; *I:* 3179; in a fast stream.

***Geitlerinema splendidum* (Grev.) Anagn.** (=*Oscillatoria splendida* Grev.) **–** rare; **FJLA**, Scott Keltie Island (Shirshov, 1935); in pool.

****Gloeobacter violaceus* Rippka et al. –** sporadically; **SV**, **NI**; *K:* 3881; *I:* 3180; *S:* 3940, 3161, 3701, 3687; in small pools, on the shores of lakes, on wet rocks.

***Gloeocapsa alpina* (Näg.) Brand –** very often; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933), **SV**, **NI**; *K:* Ice-eye Lake (Thomasson, 1958); 3830, 3863, 3831, 3828, 3827, 3860, 3832; *R:* 199; *I:* Shalygin S., 3807; in plankton of lake, on wet rocks, on seepages.

****G. atrata* Kütz. –** rare; **SV**, **NI**; *R:* 211; *K:* 3749; on the shore of lake, crust on the stone ring (permafrost landforms).

****G. biformis* Erceg. –** sporadically; **SV**, **NI**; *K:* 3898, 3827, 3883, 3884, 3919; *I:* 3167; on wet rocks, in small pools.

****G. compacta* Kütz. –** very often; **SV**, **NI**; *K:* 3884, 3905, 3904, 3874, 3750, 3876, 3748, 3883,

3752; *I:* 3606, 3621, 3624; in small pools and slow streams, crust on the soil and permafrost polygons, on sea marsh, on wet rocks.

***G. fusco-lutea* (Näg.) Kütz. –** rare; **SV**, **NI**; *R:* 205; *K:* 3874; *I:* 2968; in slow and fast streams, on wet rocks.

***G. kuetzingiana* Näg. –** very often; **SV**, **NI**; *R:* 210, 212, 214, 196; *K:* 3827, 3749, 3828, 3923, 3928; *I:* 3182, 3177, 3627, 3618, 3605, 3601, 3574, 3573, 3572, 3571; *S:* 3671, 3660; on the shores of lakes, in slow and fast streams, at the bottom of pools, on seepages, on permafrost polygons, on wet rocks.

***G. novacekii* Komarek et Anagn. –** rare; **SV**, **NI**; *I:* 2959; on wet rocks.

***G. punctata* Näg. –** rare; **SV**, **NI**; *R:* 229; on seepage.

***G. ralfsii* (Harv.) Kütz.** (Fig. 4 G–H) **–** very often; **SV**, **NI**; *K:* 3905, 3832, 3898, 3902, 3932; *I:* 3572; Shalygin S., 3807, 3176, 2969, 3620, 3574; *S:* 3650, 3651, 3661, 3657, 3689; in pools, on sea marshes, and on wet soil under a bird colony, on wet rocks.

***G. rupestris* Kütz. –** rare; **SV, NI**; *K:* 3827; on wet rocks.

***G. rupicola* Kütz. –** rare; **SV**, **NI**; *I:* 2959; *S:* 3939; on wet rocks and on the shore of lake.

***G. sanguinea* (C.Ag.) Kütz.** (=*Gloeocapsa magma* (Breb.) Kütz. var. *itzigsohnii* (Bern.) Hansg.) **–** very often; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933), **SV**, **NI**; *K:* 3757, 3829, 3925; *I:* 3182, 2967, 2868, 3166, 3179, 3573, 3180; *S:* 3700, 3684; at the bottom of pools and on fast and slow streams, on the shores of lakes, on wet rocks, on seepages.

***G. tornensis* Skuja –** rare; **SV**, **NI**; *I:* 2968; at the bottom of a fast stream.

***G. violascea* (Corda) Rabenh. –** very often; **SV**, **NI**; *K:* 389, 3815, 3889, 3891, 3893–3895, 3897–3900, 3902, 3913, 3918, 3925, 3926, 3928, 3930, 3932; *I:* 2967, 3572, 3573, 3574, 3166, 3605, 3167, 3180, 3176, 2859; *S:* 3647, 3952, 3657, 3957, 3700, 3654, 3653, 3954, 3693, 3684, 3687, 3689, 3661, 3646; on wet rocks, in small pools, in slow streams, on sea marshes, on wet soil under a bird colony, on seepages, on the shores of lake.

***Gloeocapsa* sp. –** rare; **SV**, **NI**; *K:* 3913; on wet rocks.

***Gloeocapsopsis cyanea* (Krieg.) Komarek et Anagn. –** rare; **SV**, **NI**; *K:* 3920; on wet rocks.

***G. magma* (Breb.) Komarek et Anagn. –** very often; **SV**, **NI**; *R:* 229, 207, 199; *K:* 3893; *I:* 3621, 2578, 3166, 3623, 3624, 3595, 3608, 3598, 3577, 2859, 3167, 3627, 3628, 2966, 3618, 3616; *S:* 3654, 3687, 3939, 3699, 3645, 3684, 3669, 3668, 3647, 3937, 3646; on wet rocks, in slow and fast streams, on seepages, on the shores of lakes.

***G. pleurocapsoides* (Novacek) Komarek et Anagn. –** rare; **SV**, **NI**; *I:* Shalygin S., 3807, 3577; on wet rocks.

***Gloeocapsopsis* sp. –** rare; **SV**, **NI**; *K:* 3751; in a slow stream.

***Gloeothece confluens* Näg. –** rare; **SV**, **NI**; *K:* 3827, 3828, 3863; on wet rocks, on seepage.

***G. palea* (Kütz.) Rabenh. –** rare; **SV**, **NI**; *S:* 3651; on wet rocks.

***G. violacea* Rabenh. –** rare; **SV**, **NI**; *S:* 3669; in a slow stream.

***Gomphosphaeria aponina* Kütz. –** sporadically; **FJLA**, Scott Keltie Island, Rumyantsev Lake (Shirshov, 1935), **NZA** (Shirshov, 1935), **SV**, **NI**; *K:* Little North Lake, Ice-eye Lake, Home Lake Third Lake (Thomasson, 1958); in plankton.

***G. cordiformis* (Wille) Hansg. –** rare; **SV**, **NI**; *K:* Third Lake (Thomasson, 1958); in plankton.

***G. natans* Komarek et Hind. –** rare; **SV**, **NI**; *K:* 3867; in a small pool.

***Jaaginema pseudogeminatum* (G.Schmid) Anagn. et Komarek** (=*Oscillatoria pseudogeminata* G.Schmid) **–** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963), **SV**, **NI**; *R:* 201; in the soil, in a slow stream.

***Jaaginema* sp. –** rare; **SV**, **NI**; *K:* 3753; crust on the soil of permafrost landform.

***Kamptonema animale* (C.Ag. ex Gom.) Strunecky et al.** (=*Oscillatoria animalis* C.Ag.) **–** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***K. formosum* (Bory ex Gom.) Strunecky et al. –** sporadically; **SV**, **NI**; *R:* 222, 227, 218, 217, 209, 221, 216; on wet rocks, on the soil, at the bottom of pools.

***Leptolyngbya aeruginea* (Kütz. ex Hansg.) Komarek –** rare; **SV**, **NI**; *R:* 201; on seepage.

***L. compacta* (Hansg. ex Hansg.) Komarek –** rare; **SV**, **NI**; *I:* 3592; *S:* 3640; on the shore of slow stream and near waterfall.

***L. foveolarum* (Rabench. ex Gom.) Anagn.**

et Komarek (=*Phormidium foveolarum* (Mont.) Gom.) – rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963), **SV**, **NI**; *I:* 2963; in a small fast stream and on the soil.

L. gracillima **(Hansg.) Anagn. et Komarek** (=*Plectonema gracillimum* (Zopf) Hansg.) – very often; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963), **SV**, **NI**; *I:* 2959, 3174, 3608, 3597, 3593, 3591, 3582, 3581, 3580, 3439; *S:* 3660, 3662, 3663; in the soil, on wet rocks, on seepages, at the bottom of lakes.

- *Leptolyngbya* cf. *gracillima* (Hansg.) Anagn. et Komarek – frequent; **SV**, **NI**; *S:* 3957, 3956, 3954, 3953, 3951, 3943, 3942, 3941, 3940; on seepages, on the shores of lakes.

L. nostocorum **(Born. ex Gom.) Anagn. et Komarek** (=*Plectonema nostocorum* Born.) – rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

****L. notata*** **(Schmidle) Anagn. et Komarek** – sporadically; **SV**, **NI**; *R:* 212, 210, 215, 196, 207; on the shores of lakes, crust on the soil, on wet rocks.

L. sieminskae **Richter et Matula** – very often; **SV**, **NI**; *K:* Snowbed (Richter & Matula, 2013); 3928, 3926, 3913, 3891, 3897, 3886; *S:* 3954, 3942, 3941, 3953; on seepages, crusts on soils, mats at the bottom of lakes and on the shores of lakes, on sea marshes, on wet rocks.

L. tenuis **(Gom.) Anagn. et Komarek** – rare; **FJLA**, Alexandra Land Island (Borge, 1899).

****L. valderiana*** **(Gom.) Anagn. et Komarek** – rare; **SV**, **NI**; *I:* 3594, 3603; at the bottom of slow stream.

Leptolyngbya **sp.** – sporadically; **SV**, **NI**; *K:* 3904, 3888, 3875, 3832; *I:* 3168; *S:* 3635, 3940; on wet rocks, an epilithic on pebbles in lake, in slow streams and on the shores of lakes, on sea marshes.

Limnococcus limneticus **(Lemm.) Komarkova et al.** (=*Chroococcus limneticus* Lemm.) – sporadically; **FJLA**, Hooker Island, Tikhaya cove, Scott Keltie Island (Shirshov, 1935), **NZA** (Shirshov, 1935), **SV**, **NI**; *R:* 215, 213, 214; on the shores of lakes and pools.

Lyngbya fritschii **Anagn.** (=*Lyngbya aestuarii* (Mert.) Lieb. var. *antarctica* Fritsch.) – rare; **FJLA**, Aagaard Island (Kosinskaya, 1933), Alexandra Land Island (Novichkova-Ivanova, 1963); crust on the soil, in plankton of lakes.

Merismopedia arctica **(Kosinskaja) Komarek et Anagn.** (=*Merismopedia punctata* Meyen f. *arctica* Kosinskaja) – sporadically; **FJLA**, Hooker Island, Sedov cape, Scott Keltie Island (Kosinskaya, 1933); in pools, on seepages and on bogs.

M. glauca **(Ehrenb.) Kütz.** – very often; **FJLA**, Hooker Island, Tikhaya cove (Shirshov, 1935), MacKlintok Island (Kosinskaya, 1933), Bell Island, Scott Keltie Island (Shirshov, 1935), **NZA** (Shirshov, 1935), **SV**, **NI**; *K:* Celsius Ice Lake (Thomasson, 1958); 3872, 3865, 3867, 3903, 3873, 3874, 3876; in plankton of lake, in small slow streams and small pools, on sea marshes, on wet rocks.

****M. hyalina*** **(Ehrenb.) Kütz.** – rare; **SV**, **NI**; *I:* 3601; on seepage.

M. punctata **Meyen** – sporadically; **FJLA**, Hooker Island, Tikhaya cove (Shirshov, 1935), **NZA** (Shirshov, 1935), **SV**, **NI**; *K:* Third Lake, Dead Lake, Little North Lake (Thomasson, 1958); in plankton of lakes.

M. tenuissima **Lemm.** – rare; **NZA** (Shirshov, 1935); in pools.

M. thermalis **Kütz.** – rare; **FJLA**, Hooker Island (Shirshov, 1935), **NZA** (Shirshov, 1935); in pools.

****Microchaete calothrichoides*** **Hansg.** – rare; **SV**, **NI** ; *R:* 230; on wet rock.

Microcoleus amoenus **(Kütz. ex Gom.) Strunecky et al.** (=*Oscillatoria amoena* Kütz. ex Gom.) – rare; **FJLA**, Aagaard Island (Kosinskaya, 1933); in lakes.

M. autumnalis **(Trevisan ex Gom.) Strunecky et al.** (=*Phormidium autumnale* (C.Ag.) Gom.) – very often; **Vize Island** (Shirshov, 1935), **FJLA**, Hooker Island (Shirshov, 1935), Alexandra Land Island (Novichkova-Ivanova, 1963), **SV**, **NI**; *K:* 3927, 3930, 3920, 3919, 3880, 3917, 3916, 3915, 3893, 3877, 3896, 3929; *I:* 3440, 3168, 3568, 3586, 3577, 2965, 3576, 3624, 3179, 3569, 3619, 3584, 3612, 3583, 3441, 3182, 3169, 3587; Shalygin S., 3806; *S:* 3665, 3666, 3659, 3643, 3656, 3948; in slow and fast streams and near waterfalls, in pools, on the shores of lakes, on wet rocks, crust on the soil, in the soil, on wet moss tundra, on sea marshes.

M. favosus **(Gom.) Strunecky et al.** (=*Phormidium favosum* (Bory.) Gom.) – sporadically; **FJLA**, Northbrook Island, Flora cape (Borge, 1899), Scott Keltie Island, Hooker Island, Sedov cape (Kosinskaya, 1933); in pools, on seepages.

***M. paludosus* Gom. ex Gom. –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); in the soil.

***M. vaginatus* Gom. ex Gom. –** very often; **Vize Island** (Kosinskaya, 1933), **SV**, **NI**; *R:* 208; *K:* 3912, 3871, 3913, 3898, 3828, 3874, 3865, 3749, 3823, 3830, 3860, 3899, 3866, 3897; *I:* 3582, 3166; *S:* 3688; at the bottom of slow streams and pools, crust on the soil and permafrost landforms, on seepages.

***Microcystis smithii* Komarek et Anagn.** (=*Aphanocapsa pulchra* (Kütz.) Rabenh.) **–** rare; **FJLA**, Bell Island (Shirshov, 1935); in lake.

****Nodosilinea bijugata* (Kongiss.) Perkerson et Kovacik –** sporadically; **SV**, **NI**; *I:* 3568, 3171, 3172, 3609, 2861; on wet rocks, on seepages, in pools, in slow streams.

***Nostoc commune* Vauch. ex Born. et Flah.** (=*Stratonostoc commune* (Vauch.) Elenk.) **–** very often; **Vize Island** (Shirshov 1935), **FJLA**, Alger Island, Aagaard Island (Kosinskaya, 1933), Hooker Island, Sedov cape, Scott Keltie Island (Kosinskaya 1933; Shirshov, 1935), Alexandra Land Island (Novichkova-Ivanova, 1963), Northbrook Island, Flora cape (Borge, 1899), **NZA** (Shirshov, 1935), **SV**, **NI**; *R:* 190, 202, 200, 223, 191; *K:* 3746, 3748–3750, 3752–3754, 3814, 3815, 3817, 3819, 3823–3826, 3830, 3831, 3854, 3858, 3860, 3866, 3868, 3871, 3872, 3874–3878, 3881, 3882, 3884–3887, 3889, 3891–3895, 3897, 3898, 3899, 3900, 3902, 3904, 3905, 3912, 3913, 3918, 3923, 3925, 3928, 3932; *I:* 2858, 2966, 3167, 3172, 3176, 3578, 3585, 3596, 3597, 3599, 3600, 3602, 3605, 3606, 3620, 3622, 3624, 3625; *S:* 3645, 3954, 3953, 3952, 3942, 3941, 3649, 3943, 3940, 3937, 3687, 3684, 3692, 3693, 3695, 3678, 3677, 3657, 3957, 3694, 3675, 3666, 3667, 3701, 3650, 3674, 3700, 3956, 3955, 3661; on wet moss tundra, in pools, crust on the soil and on permafrost landforms, at the bottom and on the shores of slow streams, on seepages, on the shores of lakes and mats at the bottom of lakes, on wet rocks, on sea marshes.

***N. kihlmanii* Lemm. –** sporadically; **FJLA**, Hooker Island, Tikhaya cove (Shirshov, 1935), Scott Keltie Island (Kosinskaya, 1933), **SV**, **NI**; *K:* Little North Lake, Ice-eye Lake, Third Lake (Thomasson, 1958); in pools, in plankton of lakes.

***N. linckia* Born. ex Born. et Flah.** (=*Stratonostoc linckia* (Roth) Elenk.) **–** sporadically; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***N. paludosum* Kütz. ex Born. et Flah.** (=*Amorphonostoc paludosum* (Kütz.) Elenk.) **–** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***N. parmelioides* Kütz. ex Born. et Flah. –** rare; **FJLA**, Hooker Island, Sedov cape (Kosinskaya, 1933); in pools.

***N. punctiforme* (Kütz. ex Hariot) Hariot** (=*Amorphonostoc punctiforme* (Kütz.) Elenk.) **–** sporadically; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); **SV**, **NI**; *S:* 3695; crust among mosses and lichens, on the soil.

***Nostoc* sp. –** sporadically; **SV**, **NI**; *K:* 3933; S: 3954, 3953, 3930, 3916; on seepages, in small pools, on the shores of slow streams, on wet rocks, on sea marshes.

****Oscillatoria anguina* Bory ex Gom. –** sporadically; **SV**, **NI**; *K:* 3921, 3904, 3922, 3903; on wet rocks.

***O. sancta* Kütz. ex Gom. –** rare; **FJLA**, Northbrook Island, Flora cape (Borge, 1899).

****O. tenuis* C. Ag. ex Gom. –** very often; **SV**, **NI**; *K:* 3826, 3853, 3879, 3859, 3874, 3864, 3867, 3876, 3915; *I:* 3629, 3174, 3606, 3580, 2958, 3439; *S:* 3643, 3690, 3663, 3954, 3680, 3644, 3692, 3678, 3672, 3667, 3694, 3691; on wet rocks, in slow streams and pools, on seepages, on the shores and at the bottom of lakes, on sea marshes, crust on the soil.

****Petalonema alatum* Berk. ex Kirchn. –** sporadically; **SV**, **NI**; *S:* 3940, 3161, 3700, 3701, 3941; on the bank of lakes, on the sand.

****P. crustaceum* C. Ag. ex Kirchn. –** frequent; **SV**, **NI**; *R:* 210, 202, 199; *K:* 3831, 3830, 3832; *I:* 3626, 3173; on the shores of lakes, on seepages, on wet rocks.

****P. incrustans* [Kütz.] Komarek –** very often; **SV**, **NI**; *K:* 3871, 3905, 3900, 3902, 3894, 3860, 3891; *S:* 3661, 3952, 3954, 3956; at the bottom of slow streams, on wet rocks, on seepages.

***Petalonema* sp. –** rrare; **SV**, **NI**; *I:* Shalygin S., 3807; in wet cliffs of rocks.

***Phormidesmis molle* (Gom.) Turicchia et al. –** rare; **FJLA**, Scott Keltie Island (Shirshov, 1935); in slow streams.

****Phormidiochaete nordstedtii* (Born. et Flah. ex De Toni) Komarek –** frequent; **SV**, **NI**; *I:* 3617,

3618, 3616, 3620, 3619, 3589; *S:* 3671, 3697; in fast and slow streams, pools, on wet rocks.

***Phormidium aerugineo-caeruleum* (Gom.) Anagn. et Komarek –** rare; **SV**, **NI**; *I:* 2962; in a fast stream.

***P. boryanum* (Bory ex Gom.) Anagn. et Komarek –** rare; **FJLA**, Hooker Island (Shirshov, 1935); in a slow stream.

***P. deflexoides* (Elenk. et Kosinskaja) Anagn.** (= *Oscillatoria deflexoides* Elenk. et Kosinskaja) **–** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); in the soil.

****P. interruptum* Kütz. ex Gom. –** very often; **SV**, **NI**; *R:* 225, 226, 204, 198, 220, 190, 197, 209, 191, 224; *I:* 3178, 2964; on wet rocks, near a waterfall, in a slow stream.

****P. inundatum* Kütz. ex Gom. –** rare; **SV**, **NI**; *R:* 231; in a slow stream.

***P. jenkelianum* G.Schmid –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963), on the soil.

****P. kuetzingianum* (Kirchn. ex Gom.) Anagn. et Komarek –** rare; **SV**, **NI**; *R:* 203, 206; in a slow stream.

****P. lividum* Näg. –** rare; **SV**, **NI**; *R:* 219; on wet rock.

***P. subfuscum* Kütz. ex Gom. –** rare; **FJLA**, Scott Keltie Island (Shirshov, 1935); on wet rocks.

***P. tergestinum* [Kütz.] Anagn. et Komarek –** rare; **FJLA**, Northbrook Island, Flora cape (Borge, 1899).

***P. uncinatum* Gom. ex Gom.** (Fig. 4 C–D) **–** very often; **FJLA**, Scott Keltie Island, Hooker Island (Shirshov, 1935), Alexandra Land Island (Novichkova-Ivanova, 1963), **SV**, **NI**; *K:* 3755, 3845, 3846, 3847, 3848, 3849, 3850, 3856, 3833, 3834, 3857, 3859, 3861, 3923, 3907, 3901, 3818, 3816, 3723, 3724, 3843, 3844; *I:* 2957, 3594, 2857, 3610, 3611, 3613, 3614, 3575, 3567; *S:* 3632, 3682, 3656, 3639, 3637, 3681, 3680, 3642, 3660, 3659, 3635, 3951, 3950, 3949, 3683, 3640, 3662, 3672, 3652, 3663, 3942, 3664; in fast and slow streams and near waterfalls, crust on the soil, at the bottom and on the shores of lakes, in pools, on seepages, on wet rocks.

***Phormidium* sp. –** rare; **SV**, **NI**; *K:* 3870; *I:* 3628, 3179; in pools, on wet rock, in fast stream.

***Planktolyngbya limnetica* (Lemm.) Kom.-Legn. et G.Cronb.** (=*Lyngbya limnetica* Lemm.) **–** rare; **Vize Island** (Shirshov, 1935); in a pool.

***Pseudanabaena frigida* (Fritsch) Anagn.** (=*Phormidium frigidum* Fritsch) **–** very often; **FJLA**, Scott Keltie Island (Shirshov, 1935); **SV**, **NI**; *R*: 222, 209, 203, 216; *I*: 3174, 2962, 3599, 3168; *S*: 3665, 3666, 3664; in pools, on seepages, in fast streams, at the bottom and on the shores of lakes, crust on the soil, on wet rocks.

***Pseudanabaena* cf. *galeata* Böcher –** rare; **SV**, **NI**; *K:* 3723; on the shore of lake.

****P. minima* (G.S.An) Anagn. –** very often; **SV**, **NI**; *I:* 3439, 3175, 3440, 3581, 2961, 3588, 3583; *S:* 3637, 3634, 3633, 3635; in pools, in fast and slow streams, on seepages, on sea marsh.

***Pseudocapsa* sp. – s**poradically; **SV**, **NI**; *K:* 3932, 3876, 3870, 3832, 3826; on sea marsh, in small pools, on wet rocks.

****Rivularia biasolettiana* Menegh. ex Born. et Flah. –** rare; **SV**, **NI**; *I:* 3177; on seepage.

****Schizothrix arenaria* Gom. –** rare; **SV**, **NI**; *I:* 2967; on wet rock.

****S. simplicior* Skuja –** rare; **SV**, **NI**; *I:* 3605; *S*: 3650, 3618; at the bottom of pool, on wet rock, in fast streams.

****S. tinctoria* Gom. ex Gom. –** rare; **SV**, **NI**; *S*: 3687, 3688; on wet rocks.

***Schizothrix* sp. –** rare; **SV**, **NI**; *I*: Shalygin S., 3807; on wet cliffs of rocks.

***Scytonema crispum* [C.Ag.] Born. –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***S. hofmannii* C.Ag. ex Born. et Flah. –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

****S. ocellatum* [Dillw.] Lyngb. ex Born. et Flah. –** rare; **SV**, **NI**; *S*: 3669, 3670; in slow streams.

****Siphononema polonicum* (Racib.) Geitl. –** rare; **SV**, **NI**; *K:* 3922; in the stream.

****Snowella lacustris* (Chod.) Komarek et Hindak –** rare; **SV**, **NI**; *R*: 215; *S*: 3641; in pool, on the shore of lake.

****Stigonema hormoides* [Kütz.] Born. et Flah. –** rare; **SV**, **NI**; *R*: 221; *I*: 2578; in pool, on wet soil.

****S. informe* Kütz. ex Born. et Flah.** – sporadically; **SV**, **NI**; *I*: 3620; *S*: 3645, 3646, 3647, 3689, 3685; on wet rocks, in pools.

***S. minutum* [C.Ag.] Hassall ex Born. et Flah. –** very often; **FJLA**, MacKlintok Island (Kosinskaya, 1933), **SV**, **NI**; *R*: 212, 214, 229, 196, 215,

210, 195, 213, 199; *I:* 2960, 2966, 3599, 2967, 2859, 3166, 3589, 3590, 3625, 3607, 3167, 2868; *S*: 3673, 3671, 3939, 3937, 3670, 3669, 3687; on the shores and at the bottom of slow streams, on the shores of lakes, on seepages, wet crust on the soil, on wet rocks.

***S. ocellatum* [Dillwyn] Thur. ex Born. et Flah. –** very often; **SV**, **NI**; *R*: 213, 211; *I*: 3580, 3578, 2959, 3621, 3623, 3624, 3167, 3180; *S*: 3668, 3699, 3653, 3655, 3684, 3651; on the shores and at the bottom of lakes, in slow streams, on wet rocks.

***Symplocastrum aurantiacum* (Hansg. ex Hansg.) Anagn. –** rare; **SV**, **NI**; *R*: 196; (?) moist bare soil.

***S. friesii* [C.Ag.] ex Kirchn.** (=*Schizothrix friesii* (C. Ag.) Gom.) **–** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***Synechococcus elongatus* (Näg.) Näg. –** rare; **SV**, **NI**; *R*: 228; wet moss-lichen community.

***Tolypothrix conglutinata* Borzi ex Born. et Flah. –** rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***T. distorta* Kütz. ex Born. et Flah. –** frequent; **SV**, **NI**; *K:* 3865, 3872, 3873, 3879, 3885; *I*: 3603, 3606, 3601, 3610; in slow streams and small pools, on the shores of lakes, on seepages, crust on the soil.

***T. fasciculata* Gom. –** rare; **SV**, **NI**; *I*: 3166; in a vertical cleft of rock.

***T. penicillata* Thur. ex Born. et Flah. –** rare; **SV**, **NI**; *I*: 3580, 3581; at the bottom of lake, on seepage.

***T. tenuis* Kütz. ex Born. et Flah. –** very often; **SV**, **NI**; *K:* 3904, 3752; *I:* 3166, 2861; *S*: 3695, 3940, 3679, 3943, 3941, 3693, 3696, 3942, 3700, 3651; on wet rocks, crust on the soil and permafrost polygons, between mosses and lichens, on the shores of slow streams, on sea marshes.

- f. *terrestris* J.B.Petersen – FJLA, Alexandra Land Island (Novichkova-Ivanova, 1963); *I:* 2861; in slow stream among boulders.

***Tolypothrix* sp. –** rare; **SV**, **NI**; *I*: 3625, 3173; *S*: 3698; on wet rocks, on seepages, an endolithic in a boulder on the shore of lake.

***Trichocoleus delicatulus* (W.West et G.S.West) Anagn. –** frequent; **SV**, **NI**; *K:* 3863; *I*: 2968, 3628; *S*: 3676, 3689, 3686, 3680, 3700; on seepages, in fast and slow streams, on the shores of lakes, on wet rocks, wet moss tundra, crust on the soil.

***T. sociatus* (W.West et G.S.West) Anagn. –** sporadically; **SV**, **NI**; *K:* 3892, 3891; *S:* 3693; *I:* 3182; crust on the soil, on sea marshes.

***T. tenerrimus* (Gom.) Anagn.** (=*Microcoleus tenerrimus* Gom.) – rare; **FJLA**, Alexandra Land Island (Novichkova-Ivanova, 1963); on the soil.

***Trichocoleus* sp.** – rare; **SV**, **NI**; *S:* 3650; on wet rock.

***Woronichinia compacta* (Lemm.) Komarek et Hindak** (=*Gomphosphaeria lacustris* (Chod.) var. *compacta* Lemm.) **–** sporadically; **FJLA**, Scott Keltie Island, Hooker Island, Sedov cape, MacKlintok Island (Kosinskaya, 1933); on seepages, in slow streams.

***W. elorantae* Komarek et Kom.-Legn.** – rare; **SV**, **NI**; *S:* 3671; at the bottom of slow stream.

***W. naegeliana* (Unger) Elenk.** (=*Coelosphaerium naegelianum* Unger) – rare; **FJLA**, Northbrook Island, Flora cape (Borge, 1899), **NZA** (Shirshov, 1935), **SV**, **NI**; *K:* Bullet Lake (Thomasson, 1958); in plankton of pools and lakes.

***Xenococcus minimus* Geitl.** – rare; **FJLA**, Scott Keltie Island (Shirshov, 1935); in slow streams.

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EUROPOS POLIARINIŲ DYKUMŲ ZONOS MELSVABAKTERIŲ SĄVADAS

Denis Davydov

Santrauka

Straipsnyje apibendrinti Europos poliarinių dykumų zonos melsvabakterių inventorizacijos rezultatai. Sąvadą sudaro 176 melsvabakterių rūšys, aptinkamos Franco Jozefo Lando ir Naujosios Žemės salose ir Svalbard salyne, minimos mokslinėje literatūroje, paskelbtoje rusų kalba. Straipsnyje pateikiamas šių rūšių aptikimo dažnumas, paplitimui charakteringos vietovės ir biotopai. Tai pirmasis Europos polinių dykumos melsvabakterių įvairovės apibendrinimas, suteikiantis itin vertingą informaciją apie Arkties ekosistemos bioįvairovę ir rūšių paplitimą joje. Melsvabakterių floros analizė atskleidė rūšių įvairovės mažėjimą einant šiaurės kryptimi.