Algae of terrestrial biotopes near the Russian Antarctic scientific station Bellingshausen, King George Island

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Abstract

The biodiversity of algae of anthropogenically and technogenically disturbed terrestrial biotopes at the Bellingshausen Station of King George Island has been revealed. Fifty-three species of algae from five divisions were detected. Representatives of the cyanobacteria division dominated in the biotope studied. Almost all species belong to benthic forms, which corresponds well with the nature and origin of the biotopes. Differences in the composition of algocoenoses which developed on ornithogenic, mineral or anthropogenically polluted substrates were noted and characterized. The features of participation of different morphological types of algae in the process of organic mat formation have been emphasized. The biotopes of polar station surroundings were characterized by the dominance of cyanobacteria. Endemic species were not found.

Keywords: Antarctica, King George Island, algae, terrestrial biotopes, algal flora, biodiversity.

Introduction

Algae are one of the most important components of terrestrial ecosystems in polar environments. Due to the fact that in high latitudes the vegetation of higher vascular plants is extremely restricted by climatic factors, it is algae, as well as mosses and lichens, that are the main suppliers of primary organic matter and energy to terrestrial ecosystems. The role of algae in the primary colonization of mineral substrates and primary soil formation is crucial for development of ecosystems in the periglacial landscapes of Antarctica. Colonization of the substrata by algae results in the initiation of the biogeochemical cycle and turnover in lithobiont systems (Shtina and Hollerbach, 1976; Graham et al., 2009). At the initial stages of soil formation, algae take part in the process of rock weathering and in the creation of primary organic matter on lifeless mineral substrates. Cyanobacteria are particularly effective in processes of initialization of biogenic-abiogenic interactions because they are able to fixate atmospheric nitrogen. Under favorable conditions (in fact, at the beginning of the growing season), algae can rapidly increase their population and biomass. Given the short growing season, they are able to create a large number of primary products virtually immediately after the thawing of the snow, and some representatives of chlorococcal algae develop directly on the snow cover (Vasser et al., 1989). Lower heterotrophic organisms exist at the expense of organic matter, synthesized by algae (Hollerbach and Shtina, 1969). Another important function of algae is the binding of the substrate and creation of organo-mineral biogenic-abiogenic formations which can be considered prototypes of primary soils. Microscopic mucous filamentous algae (representatives of cyanobacteria: *Leptolyngbya*, *Microcoleus*, *Phormidium* and others) bind particles of mineral substrate together, assisting to preserve the accumulated

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organic matter and the mineral compounds accessible to algae, and also preventing development of soil erosion (Shtina and Hollerbach, 1976). On the surface of such mats, representatives of such sections of algae as Bacillariophyta, Chlorophyta, Charophyta, as well as heterotrophic microorganisms, can develop intensively.

Despite this importance, the study of polar and especially Antarctic algae is very insufficient in comparison with the algal flora of lower latitudes. The floral stage in the study of algae in Antarctica began with the work of Hooker (1947). Further, in the beginning of the 20th century, the study of Antarctic algae continued on materials collected in expeditions (West and West, 1911; Fritsch, 1912; Carlson, 1913). Further works were resumed in the early 1960s, when the Antarctic stations began to be developed intensively. Various data from works published before the 1960s were reviewed by Hirano (1965) and Koob (1967). Vincent (1988) summarized data on the ecology of Antarctic terrestrial algae. Smith (1984) provided an overview of the algae of coastal and continental Antarctica. He made the conclusion that cyanobacteria, as well as diatom and yellow-green algae, dominated in these communities.

In addition to floristic studies, ecological studies have been conducted (Round, 1981). Research on algae in terrestrial habitats has been particularly intensive (Wynn-Williams, 1992; Davey and Rothery, 1993; Friedmann et al., 1993), including research on the effects of changes in the environment, for example, the effect of climate warming (Wynn-Williams, 1993) and the increase in ultraviolet radiation (Wynn-Williams, 1994).

One of the most comprehensive reports is the work on the study of the Schirmacher Oasis (Pankow et al., 1991), where authors cited data on 217 taxa, which is about one third of the species known for the territory of Antarctica, the number of which at the time of research was about 700. The most species-rich groups were cyanobacteria (100 taxa), diatoms (56 taxa), and green algae (42 taxa).

The questions of algae diversity and distribution were the subject of Broady's publication (1996). According to the author, the role of cosmopolitan species in the biodiversity of various regions is often underestimated because of imprecise identification. The role of endemics in the flora of Antarctica is relatively small. Application of the new generation sequencing methods with the use of 16S rRNA for some biotopes has shown that the majority (79 %) of the investigated algae were cosmopolites (Namsaraev et al., 2010). Only 21 % of the taxa were considered by the majority authors to be potentially endemic to Antarctica. Partially this can be explained by the fact that the last cover glaciation occurred about 18,000 years ago, which by evolutionary standards is quite recent (Convey et al., 2008). So, exchange of flora between Antarctica and other continents was possible in the postglacial period—that is why the flora of maritime islands was not completely isolated from South America, South Africa, Australia and numerous islands of the Southern Ocean.

However, several authors have expressed different opinions. Many algae can be erroneously assigned to cosmopolitan species, since taxonomic keys for species from the temperate and tropical zones were used to determine them (Komárek, 1999). The hypothesis of the endemicity of many local algae is supported by the fact that Antarctica has been geographically isolated for many millions of years (Vincent, 2000), and because the free distribution of algae between various ice-free biotopes or between other geographic regions is very difficult (Broady, 1996). Terrestrial ecosystems of Antarctica are made up not only of islands and oases, but also of isolated patches of ground surrounded by ice and snow. These environments can be considered as specific Holocene or even Pleistocene refugiums of some species. Moreover, for algae surviving in a such severe conditions adaptive strategies should result in active speciation. Komárek (1999) suggested that most species are presumably endemic to the Antarctic.

Singh et al. (2008) suggested that the most important fact for cyanobacteria development is the pH values and related acidity values. In total, they have found 109 species, and only 14 species were found in acid soils. The maximum number of species developed in neutral to alkaline soils (pH 6.0–8.3). The soils of the Antarctic were represented mainly by acid soils in the Antarctic peninsula and by alkaline soils in coastal and interland parts of the continent. The air temperature and soil composition did not show a high correlation with the diversity and distribution of cyanobacteria. The work of Komárek and Elster (2008) is devoted to the study of the role of the ecological background in the distribution of cyanobacteria in the northern part of James Ross Island. Five main types of habitats with dominant cyanobacterial assemblages were analyzed (soils, seepages, streams, wetted rocky walls and lakes), and the main ecological variables were measured (pH, temperature, intensity of soil surface insolation, electric conductivity and nutrients) as a background for further ecological and ecophysiological studies.

A comparative study of the biodiversity of algae in the mineral and ornithogenic soils of Cierva Point, Antarctic Peninsula was carried out by González Garraza et al. (2011). Seven samples of soils (four ornithogenic and three mineral) have been investigated in terms of the influence of abiotic factors (temperature, pH, organic carbon, nitrogen in NO_3, and NO_4 forms, phosphorus and chlorophyll a) on the taxonomical composition of algoceniosis and biodiversity levels. In total, 140 taxa were found: 34 % Chlorophyceae, 29 % Bacillariophyceae, 29 % Cyanobacteria and 8 % Xanthophyceae. In the mineral soils 103 taxa were found, (34 of them Chlorophyceae, 32 Cyanobacteria, 28 Bacillariophyceae and 9 Xanthophyceae). In the ornithogenic soils 72 taxa were found, including 28 Chlorophyceae, 21 Bacillariophyceae, 19 Cyanobacteria and 4 Xanthophyceae. The algal flora of ornithogenic soils is almost 1.5 times poorer than the algal flora of mineral soils.

The Bellingshausen Scientific Polar Station was founded in 1968 on King George Island. In the following few decades Petrov and Nikolaev (1975) performed a number of algological studies. It was noted that cyanobacteria, as well as green and diatom algae, dominate in the benthic algal communities of the inland waters of the island. In terrestrial habitats cyanobacteria form independent communities or live as a part of moss and lichen-algal biocenoses (Nikolaev, 1975). In overmoistened places, representatives of the orders Nostocales and Oscillatoriales were more abundant (Petrov, 1984). In 1987 a paper was published by Belyakova (1987) on the blue-green algae of King George Island based on materials from the 18th, 21st, and 25th Soviet Antarctic expeditions. She described 31 species of cyanobacteria from various habitats. O. Komárek and J. Komárek (2010) conducted research on the island from 1996 to 2005 in the vicinity of the Polish Antarctic station H. Arktovsky using both traditional morphological methods of determination and molecular genetic methods of cyanobacterial analysis. In addition to identifying the species, they established the species composition and structure of algal mats. In total, they identified 26 cyanobacterial taxa on King George Island. In 2009 a study was published on communities of diatom algae that live in the moss of the Potter Peninsula (Vinocur and Maidana, 2010). Also, there has recently been a publication on soil and aerophilic immobile green microalgae near the Bellingshausen Station; namely, 25 species of algae were detected. (Andreeva, 2011; Andreeva and Kurbatova, 2014). Of interest is the work devoted to the study of soil algae of the Clemens Massif, Prince Charles Mountains (Chaplygina et al., 2017). The study of algae cultures showed the presence of 34 species from three divisions: Green — 16, Cyanobacteria — 13, Ochrophyta — 5. Five species were first noted for soils of the Antarctic region.

In order to preserve the local biota, data on the distribution and development of vegetation, including terrestrial algae, are required (Ebott and Beninghov, 1990; Russell and Smith, 1993). It is also of great importance for the control of invasive species and with the aim to elaborate station management plans.

The aim of this work was to characterize the species composition and ecological peculiarities of natural and anthropogenic terrestrial biotopes in the vicinity of the Bellingshausen Station (Fildes Peninsula, King George Island, Western Antarctic region). To achieve this aim the following objectives were formulated: (1) to reveal the complex of dominant species which are constituent for cyanobacterial mats, (2) to investigate the trends of algocoenosis formation, and, (3) to assess the resemblance of algae of Maritime Antarctica with other regions of Antarctica.

Material and Methods

In the field season 2015–2016 during the 61st Russian Antarctic Expedition, key terrestrial biotopes in the vicinity of the Antarctic Russian Station Bellingshausen, Fildes Peninsula, King George Island, Western Antractica (Fig. 1) were surveyed. Samples were collected from terrestrial habitats, but the specific conditions of the Antarctic region do not allow a clear boundary between terrestrial and aquatic habitats. This is due to the fact that the degree of hydromorphism of many biotopes varies greatly during the growing season. Soils in the studied biotopes were mainly Fluvisols, Lithosols, Cryosols, and Histosols, and many of them are covered by water in the beginning of summer and become air-drained in the end of Antarctic summer (Abakumov et al., 2017).

The surveyed area was largely susceptible to anthropogenic impact.

King George Island (1400 $km^{2)}$ is the largest archipelago in the South Shetlands. Only about 5 % of its area is free of ice (Rakusa-Suszczewski, 2002). The Fildes Peninsula and Ardley Island together (around 33 km^2) comprise the second largest ice-free area of the South Shetland Islands and the largest on King George Island. Relatively flat topography dominates the Fildes Peninsula with a wide central plain and several other plains at different altitudes. It is a tableland made up of old coastal landforms with numerous rocky outcrops and an average height of 30 m a.s.l. (Michel et al., 2014).

According to Smellie et al. (1984) this area mainly consists of lavas with small outcrops of tuffs, volcanic sandstones, and agglomerates. The climate here is cold, moist and maritime with mean annual air temperature of –2.2 °C and mean summer air temperatures above 0 °C for up to four months (Wen et al., 1994). The mean annual precipitation is 350–500 mm/yr. The Fildes Peninsula and Ardley Island are among the first areas in Maritime Antarctica to become ice-free after the last glacial maximum (Birkenmajer, 1989). The Fildes Peninsula was covered by glaciers from 8000 to 5000 years BP (Mausbacher et al., 1989; Haus et al., 2014). The basins of most lakes are over-deepened glacial basins, and the valleys of the largest streams are glacial troughs—both are located along fractures. After the glacial erosive phase glacial retraction led to the Holocene glacioisostatic and tectonic uplift and favored the occurrence of paraglacial and periglacial processes such as frost weathering, gelifluction, cryoturbation and nivation (Simonov, 1977; Navas et al., 2008; López-Martínez et al., 2012).

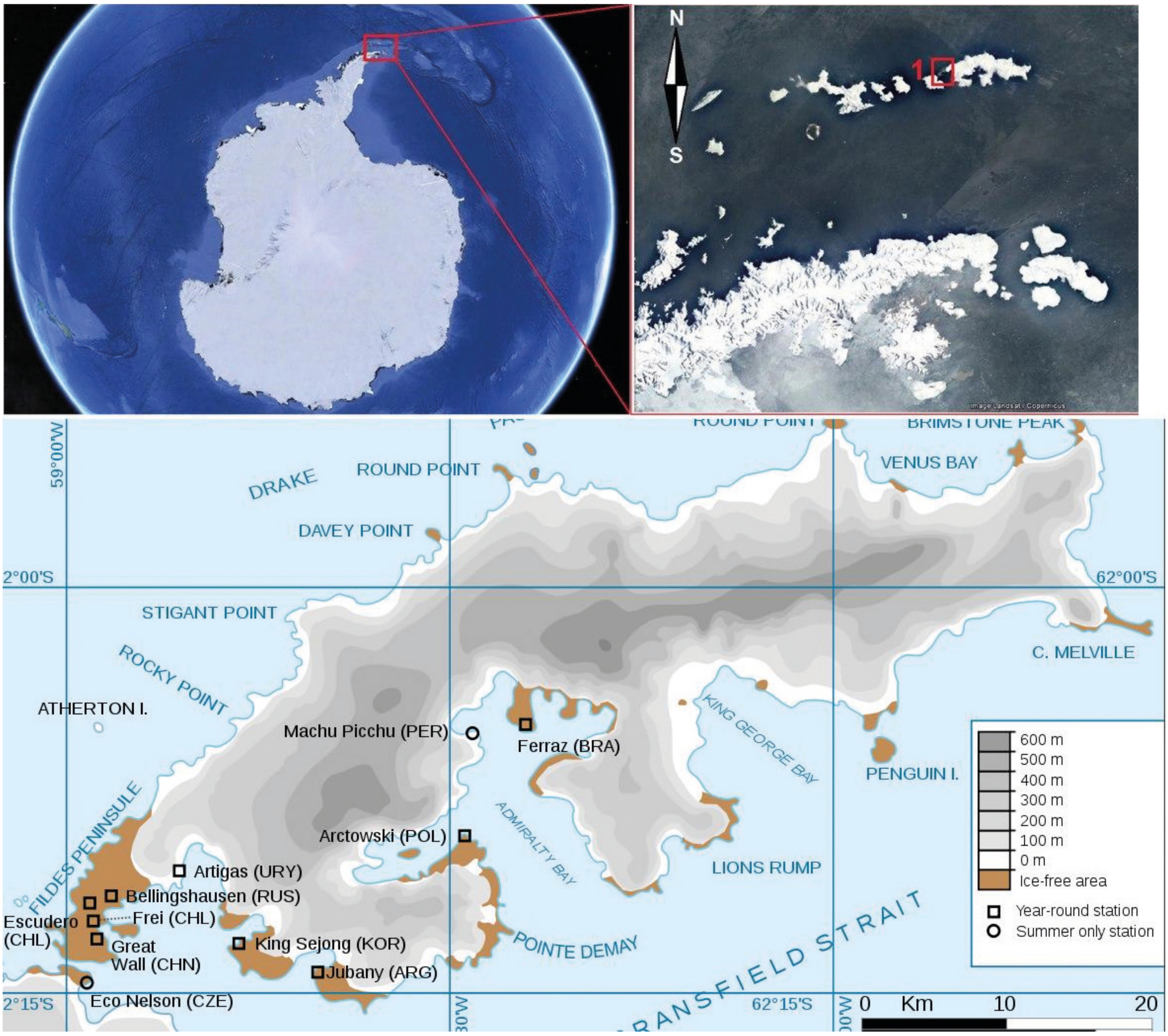

Fig. 1. Location of the Fildes Peninsula

The patterned ground in this region dates from 720 to 2640 years BP (Jeong, 2006). In the South Shetland Islands permafrost is sporadic or non-existent at altitudes below 20 m a.s.l., and occurs more or less discontinuously in altitudes from 30 to 150 m a.s.l. (Bockheim et al., 2013). Mosses, lichens and algae are common here, along with two vascular plants (*Deschampsia antarctica* Desv. and *Colobanthus quitensis* (Kunth) Bartl.). Penguins, seals, and seabirds are common in coastal areas and have significant effects on soil development. Major cryogenic surface-forming processes here are frost creep, cryoturbation, frost heaving and sorting, gravity and gelifluction (Michel et al., 2014). Eight separate sites on the Fildes Peninsula have been collectively designated an Antarctic Specially Protected Area (ASPA 125) mainly because of their paleontological significance (Management Plan…, 2009).

Samples of algal mats were collected at the locations of soil incisions in sample jars, filled with water from the same mats or with distilled water and fixed with formalin (Fig. 2). The species and ecological composition of algal flora of algal mats developed on the soil surface was studied.

The following samples were collected on the territory of the Fildes Peninsula in January 2016.

Point 88 (Fig. 2-1).

Date — 19.01.2016. To the southeast of Bellingshausen Station. 62-10-590 S, 058-58-30 W. Sampling of algal mat.

Point 89 (Fig. 2-2).

Date — 19.01.2016. 62-10-590 S, 058-58-288 W. Sampling of the detected cyanobacterial mat.

Point 92 (Fig. 2-3).

Date — 20.01.2016. 200 meters to the north of the tank farm at the foot of a high hill on a sea terrace be-

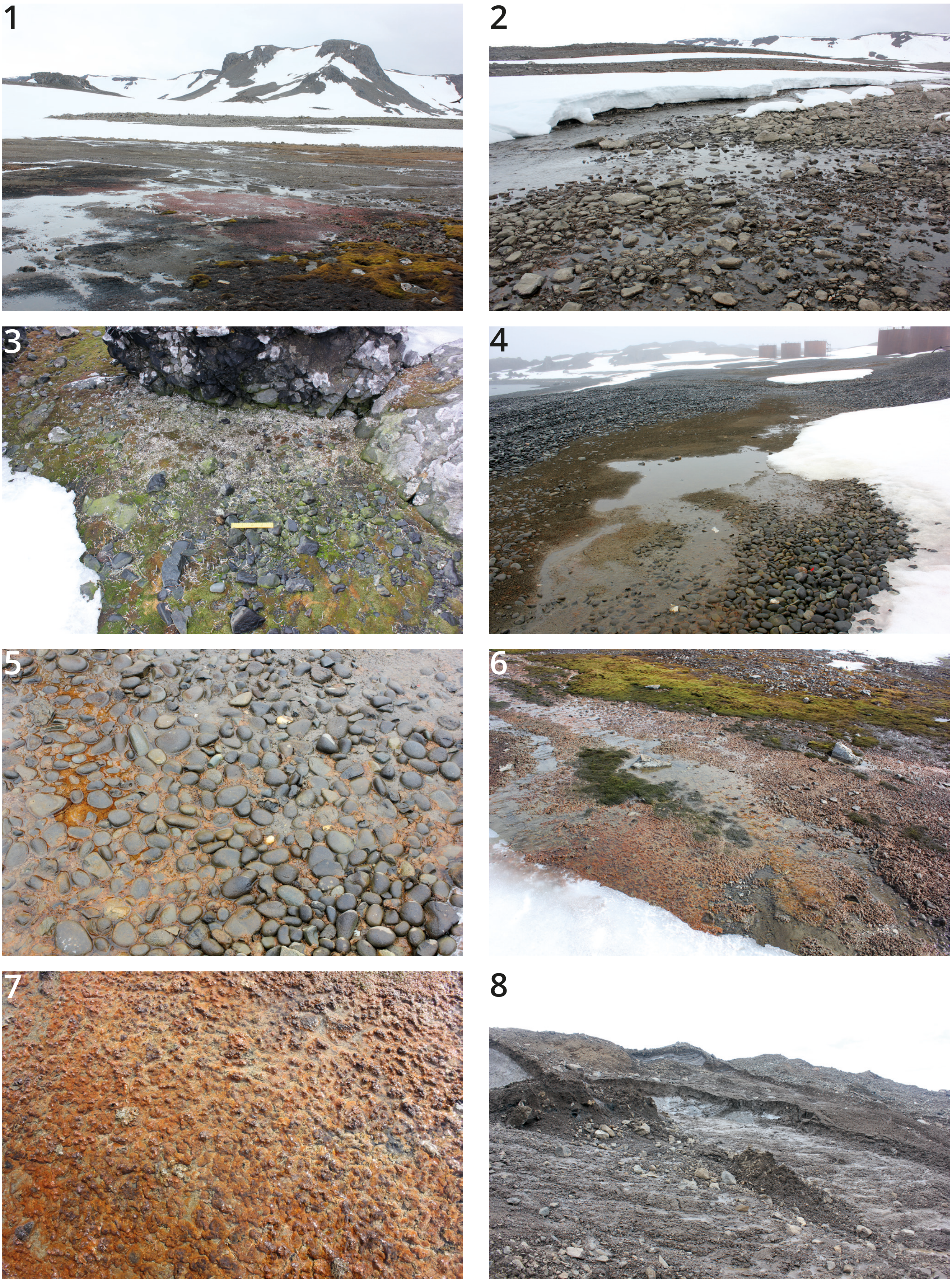

Fig. 2. Photos of sampling sites

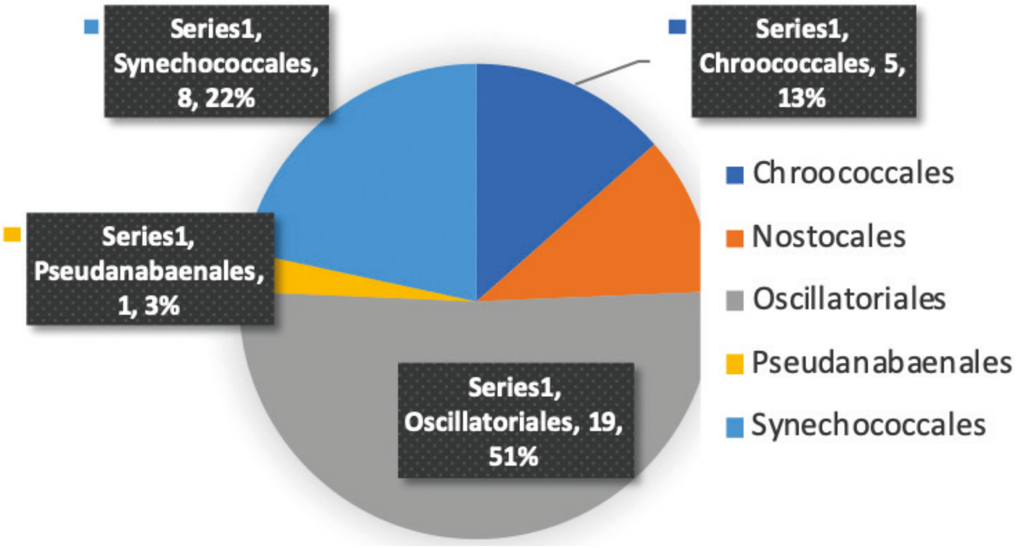

Fig. 3. The ratio of the orders of cyanobacteria in the revealed algal flora

tween two small rocks where an ornithogenic habitat with a large number of penguin feathers is located. The growth of alga *Prasiola crispa* on an organogenic substrate.

Point 95 (Fig. 2-4, 5).

Date — 20.01.2016. It is located in close proximity to the abandoned tanks at the oil depot. There is a runoff of hydrocarbons from the barrels. In the area of the flow of hydrocarbons — algal mat in a puddle, the sample of which is selected for analysis.

Point 100 (Fig. 2-6, 7).

Date — 20.01.2016. To the east of the lake near the Uruguayan station. Algae mats on a moss-lined mountain foot.

Point 104 (Fig. 2-8).

Date — 20.01.2016. Algal mats in puddles on the second large moraine ridge.

Laboratory processing of the obtained material was performed at the Department of Applied Ecology, Saint Petersburg State University, by direct microscopy of fixed samples using a Leica DM 1000 transmitted light microscope with ×10, ×20, ×40, ×63, ×100 magnifications. Micrographs were performed using an EC3 microscope camera. Identification of algal taxa were mainly accomplished with the aid of the following systematics works: Elenkin (1949); Qualifier of Algae of the USSR Vol. 2 (1953), Vol. 3 (1954), Vol. 4 (1951), Vol. 11(2) (1982); Andreeva (1998); Komárek and Anagnostidis (1999, 2005); Komárek (2013); and a taxonomic section from a paper by Pankow (1991).

Results

In the selected samples 53 species of algae belonging to 5 divisions, 7 classes, 17 orders, 28 families and 36 genera were identified (Table 1). The largest number of identified species belongs to the Cyanobacteria (37 species, 70 % of the total number). Based on the results of the analysis of the taxonomic list, a taxonomic table was compiled with the designation of divisions, classes, orders, families and genera of the algae found.

The division of Cyanobacteria was represented by the highest number of species (37 species, 70 % of the total number). The largest floristic wealth was characterized by genera: *Phormidium* (8 taxa), *Microcoleus* (4 taxa) and *Leptolyngbya* (4 taxa). Cyanobacteria were mainly represented by species of the Oscillatoriales order. (19 taxa) (Fig. 3).

Ecological analysis was carried out according to the tables from the work of Barinova et al. (2006). Prevalent species are characterized as benthic, plankton-benthic and soil inhabitants (Table 2). According to rheophilicity, two groups are noted: algae of standing or standing-streaming waters, which correspond to the places of sampling. In relation to the presence of organic matter in algal communities, species belonging to oligo- and mesosaprobic groups are represented. According to geographical distribution, most species were found in the polar regions (algaebase.org) previously.

In the process of growth cyanobacteria produce various metabolites which play an important role in the formation of the substrate structure due to their water-holding, geochemical barrier and soil surface stabilization functions (Shnyukova, 2002). The pricnicpal components of the mats were filamentous cyanobacteria from the orders Oscillatoriales and Synechococcales. The organic matter of mats assists the process of soil surface aggregation and accumulation of primary organo-mineral substrata like a primary soils. It was they that formed mucous covers that help to fix ash and dust particles, cemented the substrate and formed the environment for

Table 1. Table of algae taxa

Division	Class	Order	Family	Genus	Species
Cyanobacteria	Cyanophyceae	Chroococcales	Chroococcaceae	Chondrocystis	1
				Chroococcus	2
			Entophysalidaceae	Chlorogloea	1
			Microcystaceae	Microcystis	—
		Nostocales	Nostocaceae	Nostoc	2
			Scytonemataceae	Scytonema	1
			Stigonemataceae	Stigonema	1
		Oscillatoriales	Homoeotrichaceae	Homoeothrix	—
			Microcoleaceae	Kamptonema	1
				Microcoleus	4
				Symploca	1
			Oscillatoriaceae	Lyngbya	2
				Oscillatoria	1
				Phormidium	8
			Phormidiaceae	Potamolinea	1
		Pseudanabaenales	Schizotrichaceae	Dasygloea	1
		Synechococcales	Merismopediaceae	Aphanocapsa	2
				Synechocystis	1
			Leptolyngbyaceae	Leptolyngbya	4
			Synechococcaceae	Cyanothrix	1
Euglenozoa	Euglenophyceae	Euglenales	Euglenaceae	Trachelomonas	—
Bacillariophyta	Bacillariophyceae	Bacillariales	Bacillariaceae	Nitzschia	—
		Cymbellales	Cymbellaceae	Cymbella	—
			Gomphonemataceae	Gomphonema	—
		Fragilariales	Fragilariaceae	Fragilaria	—
				Synedra	—
		Naviculales	Naviculaceae	Navicula	—
			Pinnulariaceae	Pinnularia	—
		Thalassiophysales	Catenulaceae	Amphora	—
	Mediophyceae	Stephanodiscales	Stephanodiscaceae	Cyclotella	—
Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlorococcaceae	Tetracystis	—
	Trebouxiophyceae	Chlorellales	Chlorellaceae	Chlorella	—
		Prasiolales	Prasiolaceae	Prasiola	1
Charophyta	Conjugatophyceae	Desmidiales	Desmidiaceae	Cosmarium	—
				Staurastrum	—
		Zygnematales	Zygnemataceae	Mougeotia	—
5	**7**	**17**	**28**	**36**	**53**

Table 2. Table of species with ecological characteristics, geographical spreading and distribution by points

№		Hab	Reo	S	Sap	Geo	Pol geo	1	2	3	4	5	6	7	Points
	Cyanobacteria														
1	Aphanocapsa incerta (Lemm.) Cronb. et Kom.	P-B		2.2	b	k	Arct								89
2	Aphanocapsa cf. muscicola (Menegh.) Wille	B,S				k	Arct, Ant			+				+	92
3	Chlorogloea microcystoides Geitl.	S				Ha,Pt	Arct, Ant			+					92
4	Chondrocystis dermochroa (Nag.) Kom. et Anagn.	B,S				k	Arct, Ant								89
5	Chroococcus cohaerens (Breb.) Näg.	B,S				k	Arct, Ant	+					+		92
6	Chroococcus minutus (Kütz.) Näg.	P		1.8		k	Arct, Ant	+		+			+		92
7	Cyanothrix gardneri (Frémy) Kiselev						Arct								88, 89
8	Dasygloea sp.														95
9	Homoeothrix sp.														88
10	Kamptonema animale (Ag. ex Gom.) Strunecký, Kom. et J. Smarda	P-B,S	str	1.1	o	k	Arct, Ant			+					89, 95
11	Leptolyngbya cataractarum (Rabenhorst ex Hansgirg) Kom. in Anagn.														88
12	Leptolyngbya foveolara (Gom.) Anagn.et Kom.	B,S		1.7	b-o	k	Arct, Ant	+	+	+	+	+		+	88, 89, 95, 104
13	Leptolyngbya laminosa (Gom. ex Gom.) Anagn.et Kom.	P-B,S	st-str	0.1	x	k	Arct, Ant	+		+					88, 89, 95, 104
14	Leptolyngbya subtilissima (Hansgirg) Kom.														92, 100, 104
15	Lyngbya fritschii Anagn.						Arct, Ant						+		89
16	Lyngbya martensiana Menegh. ex Gom.	P-B,S	st-str	1.8	o-a	Ha,Pt,Nt	Arct, Ant		+	+	+		+		95, 100
17	Microcoleus cryophilus G. W. F. Carlson						Ant								95
18	Microcoleus paludosus Gom.	B,S	st	1.0	o	k	Arct, Ant						+		95
19	Microcoleus subtorulosus Gom. ex Gom.	B	st-str	1.5	o-b	Ha,Hn	Ant	+							95
20	Microcoleus vaginatus Gom. ex Gom.	B,S	st			k	Arct, Ant	+	+	+			+		104
21	Microcystis sp.														100
22	Nostoc cf. disciforme Fritsch						Ant						+		92
23	Nostoc paludosum Kütz. ex Born et Flah.	P-B,S	st			k	Arct								95
24	Oscillatoria tenuis Ag. ex Gom.	P-B,S	st-str	2.4	b-a	k	Arct, Ant		+	+			+		89
25	Phormidium ambiguum Gom. ex Gom.	B,S	st-str	2.0	b	k	Arct, Ant			+					95

№		Hab	Reo	S	Sap	Geo	Pol geo	1	2	3	4	5	6	7	Points
26	Phormidium breve (Kütz. ex Gom.) Anagn.et Kom.	P-B,S	st	2.8	a-o	k	Arct, Ant			+			+		95
27	Phormidium cf. corium Gom. ex Gom.	B,S	st-str	1.5	o-b	k	Ant			+					95
28	Phormidium interruptum Kütz. ex Forti						Arct								95
29	Phormidium inundatum Kütz. ex Gom.	B,S	st-str	1.5	o-b	k	Arct								89
30	Phormidium cf. kuetzingianum (Kirchner ex Hansgirg) Anagn. et Kom.						Arct, Ant		+						89
31	Phormidium papyraceum Gom. ex Gom.	B,S	st-str	1.5	o-b	k	Arct								89
32	Phormidium cf. uncinatum Gom. ex Gom.	P-B,S	st-str	2.1	b	k	Arct, Ant			+					95
33	Potamolinea aerugineo-caerulea (Gom.) M. D. Martins et L. H. Z. Branco	P-B,S	st-str			k	Arct, Ant		+	+			+		95, 100
34	Scytonema cf. subtile K. Möbius						Arct								92
35	Stigonema ocellatum Born. et Flah.			2.7	a-o		Ant						+		92
36	Symploca muscorum Gom. ex Gom.	S			x	k	Arct, Ant	+							95
37	Synechocystis aquatilis Sauv.	P		1.2	o	Ha,Pt	Arct, Ant			+			+		92
	Euglenozoa														
1	Trachelomonas sp.*														89
	Bacillariophita														
1	Amphora sp.*														88
2	Cyclotella sp.*														88, 92
3	Cymbella sp.*														88
4	Fragilaria sp.*														88
5	Gomphonema sp.*														88, 89, 92
6	Navicula spp.*														88, 89, 92, 95, 104
7	Nitzschia sp.*														88, 89, 95, 104
8	Pinnularia sp.*														88, 89, 95, 104
9	Synedra sp.*														89
	Chlorophyta														
1	Chlorella sp.*														92
2	Prasiola crispa (Lightf.) Kütz.			0.2 ?	X ?		Arct, Ant								92
3	Tetracystis sp.														92

№		Hab	Reo	S	Sap	Geo	Pol geo	1	2	3	4	5	6	7	Points
	Charophyta														
1	Cosmarium sp.														89
2	Mougeotia sp.														89
3	Staurastrum sp.														92

Notes: Hab — habitat; B — benthic in a broad sense, associated with the substrate; S — soil, terrestrial substrates; P-B — plankton-benthic; P — plankton. Reo — rheophilic; st — stagnant waters; st-str — stagnant and streaming waters and / or indifferent. Self-purification zonesaccording to Pantle-Buck in the modification of Sládecek (S) with individual indices of each group of saprobionts (Sap): x — 0.0 — xenosaprobiont; o — 1.0 — oligosaprobiont; o-b — 1.4 — oligo-betamesosaprobiont; b-o — 1,6 — beta-oligosaprobiont; o-a — 1,8 — oligo-alphamesosaprobiont; b — 2,0 — betamesosaprobiont; b-a — 2,4 — beta-alphamesosaprobiont; a-o — 2,6 — alpha-oligosaprobiont. Geographical confinedness (Geo) Melechin et al. (2013); Pt — paleotropic; Nt — neotropical; Ha — Holarctic; Hn — golantarctic; k — cosmopolite. Pol geo — means being in the Arctic (Arct) or Antarctic (Ant) regions according to the Algaebase database. Species were mentioned in the works: 1 — Belyakova (1987); 2 — González Garraza et al. (2011); 3 — Singh et al. (2008), 4 — Mataloni and Pose (2001); 5 — Mataloni et al. (2005); 6 — Pankow et al. (1991), 7 — Chaplygina et al. (2017). * — sensu lato.

the habitation of other species (Shtina, 1985; Shnyukova, 2002; Singh et al., 2008; Komárek and Komárek, 2010). The studied biotopes are represented by areas with a low degree of water cut or a varying degree of humidity. Algocenoses are formed in these peculiar conditions by filamentous cyanobacteria, which have mucous envelopes or a sheath. It is possible to distinguish dense multilayer gelatinous mats, the structure-forming components of which were representatives of the genus Leptolyngbya (*L. foveolara* (Gom.) Anagn. et Kom., *L. laminosa* (Gom. ex Gom.) Anagn. et. Kom.) and leathery dense mats representatives of the genera *Microcoleus* (*M. paludosus* Gom., *M. subtorulosus* Gom. ex Gom.) and *Phormidium* (*P. interruptum* Kütz. ex Forti). Such structures occur as a rule in extreme biotopes (thermal springs, steppes, polar regions) and represent a specific adaptation to harsh environmental conditions (Schwabe, 1933, 1947; Stockner, 1967; Brock, 1978; Nikitina, 1983; Komárek, 2010). Diatoms were most abundant on mats formed by representatives of the genus Leptolyngbya. In some areas diatoms reached a greater proportion of abundance than the structure-forming species of cyanobacteria. Naviculoid forms prevailed.

Conclusions

Data on algae biodiversity in the vicinity of Russian Polar Station Bellinshaused (Fildes Peninsula, King George Island) showed the dominance of the Cyanobacteria division. In total 53 species of algae from 36 genera, 17 orders, 7 classes and 5 divisions were found. In ecological terms all the species investigated belong to benthic forms, which is connected with the pedological and hydrological conditions of the overmoistened territory of the Fildes Peninsula. The great difference has been revealed in the taxonomic composition of algae communities in mineral, ornithogenic or anthropogenic affected soils. The similarity of the species composition between mineral and ornithogenic soils is 21 %, mineral and anthropogenic — 49 %, ornithogenic and anthropogenic — only 6 %. Analysis of the taxonomic diversity of algae, and mainly cyanobacteria, showed high specificity of algae, because only a few species were common for other regions of Antarctica. At the same time, the majority of the algae were represented by cosmopolitan species and only part of the flora comprised circumpolar species. Among the identified species there were no endemics. Probably this is result of strong anthropogenic impact which could be a reason for habitat change, because the vicinity of Bellinshausen Station previously was considered as the most intensively anthropogenically affected in the whole region of the South Shetland Islands.

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