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Original research paper

Cyanobacteria and algae of selected tundra habitats in the Hornsund fiord area (West Spitsbergen)

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Abstract

Samples of the Cyanobacteria and algae flora of the tundra surrounding the Hornsund fiord were collected from various types of habitats, differing in terms of moisture content, trophy, soil type and vegetation.

Over 150 species of Cyanobacteria and algae were identified, including 72 species never observed before in Svalbard. The character and prevailing species compositions for particular habitat types were formulated, e.g. eutrophic habitats – *Prasiola crispa* (Lightf.) Menrgh. and *Phormidium autumnale* (Agardh.) Trevisan ex Gomont, for oligotrophic sites – *Nostoc commune* Vaucher and *Nostoc punctiforme* (Kützing) Hariot.

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INTRODUCTION

The flora of blue-greens and algae of Svalbard's terrestrial ecosystems has been poorly investigated so far considering the fact that they are the richest in the species group (Skulberg 1996) of the phycoflora of these ecosystems compared to other systematic groups (Elvebakk, Prestrud 1966). Research into the phycoflora of the Svalbard archipelago (Skulberg 1996; Matuła et al. 2007) has concerned mainly taxonomic analysis, while there is a lack of algae and blue-green algae analysis with respect to environmental conditions. The work of Plichta and Luścińska (1988) is an exception, characterizing the cyanobacteria with respect to soil types.

The present study demonstrates the preliminary studies on algae biodiversity, especially blue-green algae, in habitats (soil, water courses, moist mossy tundra) diversified as regards the content of mineral nitrogen compounds for the area around Hornsund fiord. Samples for analysis were collected during the two 'Scientific Expeditions Spitsbergen' in 2003 and 2005, financially supported by Wrocław University of Environmental and Life Sciences.

MATERIALS AND METHODS

The study took place in July and August of 2005. Algae for analysis were collected in Spitsbergen, around the Hornsund fiord, taking into consideration habitats situated on a slope of the Ariekammen mountain ridge featuring colonies of little auks (*Alle alle*), on a slope of Gnalberget cliff colonized by guillemots (*Uria lomvia*) and black-legged kittiwake (*Rissa tridactyla*), and the Fuglebersglett and Gnalodden plains of raised marine terraces. The associations from the dry lichen and lichen-moss tundra, through moderate peat-bogs mosses, to permanently overflow mosses around small ponds, lakes and water holes, were present in the studied area. Among the analysed habitats, special attention was paid to those distinctly differentiated as regards the trophy, and especially the nitrogen compound content.

The Ariekammen and Gnalberget slopes (sites 1, 2 and 4) are characterised by a considerable slant: 30-35^{o} and 45-50^{o}, respectively.

Site 1 covers the strongly nitrophilous area beside the foot of the Ariekammen slope, an area under the direct influence of bird excrement.

Site 2 was located by the foot of the Gnalberget cliff. This is also a site under the direct influence of bird excrement; hence the soil features a considerable amount of nitrogen and phosphorus compounds.

In the case of both sites algae were collected from the soil surface, between widely spread *Prasiola crispa* thallus and single clusters of *Cochlearia groenlandica* and *Poa alpina* var. *viviparia*.

Site 3 covers eutrophic and mesotrophic moist moss-tundra near the foot of the Arikammen slope. Algae were collected in moss areas and from streams spilling through the tundra.

Site 4, mesotrophic one, situated on a slope of the Gnalberget cliff, covers habitats with communities of *Saxifraga cespitosa* and *Deschampsia borealis* with *Plagomnium ellipticum* and *Pohlia nutans.* Algae were collected from the soil surface and from the turf of the predominant mosses.

Site 5 is the most hydrated and oligotrophic, it includes the moist plains of the Fuglebersglett raised marine terraces under Ariekammen, and is also supplied with water from melting snow, streams and surface water effusions. The site is overgrown by a *Saxifraga oppasitifolia* community. Algae were collected from the soil surface and mosses.

Site 6 is located on the plains of raised marine terraces under Gnalberget, moss also an oligotrophic site with a community of *Saxifraga oppositifolia* with *Sanionia uncinata* and *Aulacomnium palustre*. Samples of algae were collected directly from the soil and from mosses covering the tundra.

RESULTS

A total of 150 species of blue-greens and algae were identified, including as many as 72 species being newly recorded for the Svalbard archipelago (e.g. *Aphanothece caldariorum* P. Richter, *Calothrix gelatinosa* (Böcher) V. Poljanskij, *Leptolyngbya faveolarum* (Raben. ex Gom.) Anag. et Kom., *Leptolyngbya treleasii* (Gomont) Anagnostidis et Komárek, *Phormidium granulatum* (Gardnem) Anagnostidis*, Schizothrix fragilis* (Kützing) Gomont, *Schizothrix calcicola* (Ag.) Gomont, *Borodinellopsis texensis* Dykstra, *Excentrosphaera viridis* G.T. Moore, *Keratococcus mucicola* (Hust.) Hind.) (Matuła et al. 2007). Some communities of blue-green algae and algae that occur on particular sites are shown in Table 1.

The analysis of the species composition at the investigated sites revealed significant diversification of blue-greens and algae flora, dependent on the ground trophy.

Observed at Site 1 was Nitrophilous, as a dominant *Prasiola crispa* (Lightf.) Menrgh. species, creating a light-green and patchy thallus covering a considerable part of the soil surface. It was accompanied by blue-green algae in the form of crusty, gelatinous compact colonies. *Phormidium autumnale* (Agardh) Trevisan ex Gomont was especially visible, forming large, dark-turquoise thallus between large patches of *Prasiola crispa.* Also the thallus were observed of *Pseudanabaena frigida* (Fritsch) Anagnostidis accompanied by *Leptolyngbya fragilis* (Gomont) Anagnostidis & Komárek, *Schizotrix calcicola* Brébisson and *Schizotrix fragilis* (Kützing) Gomont.

Table 1

List of selected species typical for particular habitats.

Number of habitats / Species	Eutrophic sites		Mesotrophic sites		Oligotrophic sites	
	1	2	3	4	5	6
Aphanothece caldariorum P. Richter					2	
Aphanothece saxicola Nägeli					2	
Aphanothece minutissima (W. West) Komárková-Legnerová & Cronberg					1	
Aphanothece nebulosa Skuja					1	
Gloeocapsa biformis Ercegovič					2-3	
Gloeocapsa sanguinea (Agardh) Kützing					2	
Gleocapsa novacekii Komárek et Anagnostidis					2	
Calotrhrix gypsophila (Kützing) Thuret					3	
Chlamydomonas nivalis (Chod.) Hoham et al.		2		4		1
Microcoleus vinatus Gomont ex Gomont					2	
Nostoc commune Vaucher					3-5	
Nostoc calcicola Brébisson					2	
Nostoc minutum Desmazières					1	
Nostoc minutissimum Kützing					1	1
Anabaena varabilis Kützing						2
Scytonema crustaceum Agardh					3	
Nostoc paludosum Kützing				2	1-2	2
Nostoc punctiforme (Kützing) Hariot				2-3		4-5
Excentrosphaera viridis G. T. Moore				1		2
Borodinellopsis texensis Dykstra				2		1
Ulothrix variabilis Kützing		4		2		
Pseudanabaena minuta Skuja		2			1	
Phormidium granulatum (Gardner) Anagnostidis & Komárek		1-2				
Oscillatoria rupicola Hansgirg		3				
Phormidium uncinatum (Agardh) Gomont		2				
Gloeocapsopsis magma (Brébisson) Komárek et Anagnostidis		2				
Schizotrix lacustris A. Braun					2-4	
Leptolyngbya margaretheana (Schmid) Anagnostidis et Komárek				1		
Planktothrix clathrata (Skuja) Anagnostidis et Komárek				1-2		
Jaaginema gracile (Böcher) Anagnostidis et Komárek				1-2		
Phormidium subcapitatum Boye-Pet Geitler				2		
Leptolyngbya treleasii (Gomont) Anagnostidis et Komárek				1		
Tolypothrix tenuis Kützing				2		
Planctolyngbya limnetica (Lemmermann) Anagnostidis & Komárek				1		
Pseudanabaena galeata Böcher				2		
Anabaena affinis Lemmermann				1		
Anabaena spiroides Klebahn				1		
Chroccocus turgidus (Kützing) Nägeli				1	1-2	
Schizotrix calcicola Brébisson	1-2					
Schizotrix fragilis (Kützing) Gomont	1-2		1		1	
Leptolyngbya fragilis (Gomont) Anagnostidis & Komárek	1-2		1		1	
Phormidium autumnale (Agardh) Trevisan ex Gomont	4-5	3	5	2		
Pseudanabaena frigida (Fritsch) Anagnostidis	2-3	2	2		1	

1-the species occurred sporadically, 2-the species occurred individually in 50% of the visual field, 3–the species occurred in every visual field, 4-5 the species formed a bloom on the surface of the soil and water, visible to the naked eye (in masses).

At Site 2 nitrophilous *Prasila crispa* was a dominant, and its light-green spread out thallus covered almost 80% of the soil surface. It was accompanied by filiform blue-green algae (*Phormidium autumnale* (Agardh) Trevisan ex Gomont, *Pseudanabaena frigida* (Fritsch) Anagnostidis*, Phormidium uncinatum* (Agardh) Gomont, *Ph. granulatum* (Gardner) Anagnostidis & Komárek*, Oscillatoria rupicola* Hansg.,); coccales (*Gloeocapsopsis magma* (Brébisson) Komárek et Anagnostidis) and green algae, including *Ulotrix varabilis* Kützing and *Haematococcus pluvialis* Flotow em Wille (in the form of duplicating spores).

Mesotrophic sites were characterised by significantly wider biodiversity compared to nitrophilous ones. Numerous species of filiform blue-green algae like *Leptolyngbya margaretheana* (Schmid) Anagnostidis et Komárek,

Planktothrix clathrata (Skuja) Anagnostidis et Komárek, *Phormidium granulatum* (Gardner) Anagnostidis & Komárek, *Jaaginema gracile* (Böcher) Anagnostidis et Komárek, *Phormidium subcapitatum* Boye-Pet Geitler, *Leptolyngbya treleasii* (Gomont) Anagnostidis et Komárek, *Pseudanabaena galeata* Böcher, *Planctolyngbya limnetica* (Lemmermann) Anagnostidis & Komàrek, *Totypothrix tenuis* Kützing were observed at Site 3. The dominant was *Phormidium autumnale,* creating very large areas of clearly observable turquoise thallus alternating with the whitish areas of *Pseudanabaena frigida,* while *Prasiola crispa* did not have such a significant participation as in the case of Sites 1 and 2.

The participation of *Prasiola crispa* green algae at Site 4 was minimal, while *Haematococcus pluvialis* was a dominant. The following species were also present: *Borodinellopsis texensis* Dykstra, *Excentrosphera viridis* G.T. Moore (for the first time reported for Svalbard) and *Ulotrix varabilis* Kützing, which was characterized by its significant participation. Also a number of blue-green algae was observed (e.g. *Anabaena affinis* Lemmermann*, A. spiroides* Klebahn*, Chroccocus turgidus* (Kützing) Nägeli), where the largest participation was noted for *Nostoc* species (*Nostoc paludosum* Kützing*, N. punctiforme* (Kützing) Hariot*,* and which were abundant on uplifted mosses clusters.

Nostoc commune Voucher was a dominant at oligotrophic Site 5. On the soil surface, between the mosses, it created clearly visible, spherical colonies covered with skin-like, dark-olive periderm or rope-like, black thallus in older stadium, while on moist areas it was present in the form of widely spread, patchy, dark-olive thallus. It was also accompanied by other abundant species: *Nostoc*: *N. calcicola, N. minutissimum, N. minutum*. Species of *Gloeocapsa* kind (*G. biformis* Ercegović, *G. sanguinea* (Agardh) Kützing, *G. navacekii* Komárek et Anagnostidis). There was a significant participation by species like: *Scytonema crustaceum* Agardh, *Calotrix gypsophila* (Kützing) Thuret, *Microcoleus vinatus* Gomont ex Gomont, while on highly hydrated sites were small colony species like: *Aphanothece cardariorum* P.Richter, *Aphanothece saxicola* Nägeli*, A. nebulosa* Skuja, *A. minutissima* (W. West) Komárková-Legnerová & Cronberg,

Site 6 was also an oligotrophic one, and the definite dominant was *Nostoc punctiforme* (Kützing) Hariot, and *N. paludosum* Kützing (adominant), creating clearly visible, black or dark-blue spherical thallus on the soil and between mosses. Also *Anabaena varabilis* Kützing and *Excentrosphaera viridis* G.T. Moore were characterised by fairly significant participation.

Prasiola crispa green-algae were not observed on either oligotrophic Sites (5 and 6).

CONCLUSIONS

The preliminary study underlines the specific dependence of the algae flora of the investigated area on the content of mineral nitrogen compounds. On both eutrophic sites *Prasila crispa* green algae were predominant, as this is a strongly nitrophilous species. It created large, compact patches of light-green thallus covering a considerable part of the area. It was accompanied by *Phormidium autumnale* blue-green algae forming a blue-green patchy thallus, and by *Pseudanabaena frigida* characterized by a wider ecological spectrum.

On mesotrophic sites, however, *Prasiola crispa* green algae were present in significantly smaller amounts, while at the same time the widest blue-green algae biodiversity was observed. Species composition of both of the mesotrophic sites differed significantly due to the differences in the fertility of both sites. Algae communities that occur on the Gnalbaerget slope are distinguished by the larger green algae participation (such as *Haematococcus pluvialis, Borodinellopsis texensis,* or *Excentosphaera viridis),* indicating the greater soil fertility of these site in comparison to those situated on the Ariekammen slope.

On the most oligotrophic sites the distinct domination by blue-green alga of *Nostoc* kind was observed, but in the case of the site on the Ariekammen slope the dominants were mainly *Nostoc commune* and *N. calcicola*, while on a site on the Gnalberget slope *Nostoc punctiforme* and *N. paludosum* were predominant.

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