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Polar Ecology Conference 2012

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Abstracts & contact list

Edited by:
Alexandra Bernardová, Jan Kavan, Otakar Strunecký

České Budějovice 2012

Dear Ladies and Gentlemen,

it is my great privilege to welcome all of You here in České Budějovice. Polar Ecology Conference 2012 is supposed to be an ideal place for exchanging knowledge and experiences and also helping us to integrate more into the worldwide scientific community.

Czech Republic has been a member of polar science community from its very beginnings. At the end of the last century, with opening of the borders between East and West and political changes in Central and Eastern Europe, Czech polar research activities started to flourish.

Several expeditions to various parts of the Arctic and Antarctic have been organised by the Masaryk University in Brno, the University of South Bohemia in České Budějovice, the Czech Geological Survey, the Czechoslovak (and later the Czech and Slovak) Academy of Sciences. Since then, Svalbard archipelago and Antarctic Peninsula vicinity were the main regions of our interest. In addition, various research teams have been working in different sub-Arctic localities, for example in the Abisko research station.

Czech research station of J.G. Mendel on James Ross Island (north-east part of Antarctic Peninsula) was opened in 2006. Later on, Czech Republic has participated on several research programmes operated under the auspices of the International Polar Year (IPY 2007 – 2008). One of them, the "Arctic climate and biological diversity" - an interdisciplinary research project, was proposed as a part of the Network for ARCtic Climate and Biological DIVersity Studies (ARCDIV) - a multidisciplinary international research initiative. The main goal of the project was understanding ecosystem diversity at the landscape scale within the Arctic region. Czech research team as a member of this larger initiative has established a small temporary research station in Petuniabukta (central Svalbard). In 2010, the Arctic and Antarctic research programmes were introduced into research infrastructure of the Czech Republic. Czech research infrastructure is nowadays integrating into wide international research network (e.g. IASC, INTERACT) and this will certainly continue with the construction of proper Czech research station in Ny-Ålesund, Svalbard.

The conference is organized by the Centre for Polar Ecology, Department of Ecosystem Biology, Faculty of Science, University of South Bohemia in České Budějovice. I would like to acknowledge the support for this conference from the project "Establishing of working team and conditions for education in the field of polar ecology and life in extreme environments", No. CZ.1.07/2.2.00/28.0190. The project is funded by the European social fund and the government budget of the Czech Republic. The support by the Faculty of Science, University of South Bohemia in České Budějovice is also highly appreciated.

Welcome in České Budějovice, enjoy the Polar Ecology Conference, enjoy Your stay in the beautiful region of South Bohemia!

Josef Elster
head of the Centre for Polar Ecology

CULTIVATION OF ANTARCTIC ALGA TREBOUXIA SP. IN A BIOREACTOR: CHLOROPHYLL FLUORESCENCE-BASED STUDY OF TEMPERATURE-DEPENDENT GROWTH

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KEYWORDS: LICHEN SYMBIOTIC ALGA, USNEA ANTARCTICA, JAMES ROSS ISLAND

Introduction

Species of genus *Trebouxia* are green microalgae, well known as photobionts, *i.e.* photosynthetizing partner in lichen association. *Trebouxia* sp. is present in two thirds of all lichen species. It is frequently found also in extremophilic lichens from Antarctic habitats. It is an unicellular green alga, size of which is about 10 – 15 μm in diameter. In spite of the fact that several species of genus *Trebouxia* are cultivated as stock items in many culture collections, surprisingly little is known about their basic physiological characteristics. Over last few decades, photosynthetic parameters of *Trebouxia* sp. have been scarcely investigated. However, basic knowledge on their photosynthetic responses to osmotic (Váczi et Barták 2006), high light (Showman 1972), oxidative (del Hoyo et al. 2011) and heavy metal-induced stress (Alvarez et al. 2012) is available. The aim of presented study was to evaluate optimal growth temperature of isolated *Trebouxia* sp. when cultivated in liquid medium and changes in photosynthetic performance as dependent on cultivation temperature.

Material and Methods

Trebouxia sp. was isolated from an Antarctic lichen *Usnea antarctica* collected at the James Ross Island (63.81 S, 57.83 W). After isolation the alga was cultivated on agar medium at 5 °C. When algal culture was sufficiently developed, it was collected from the surface of agar medium and suspended. Then, it was cultivated in liquid medium (BBM) in a FMT-400 photobioreactor (PSI, Czech Republic) for 33 days. Two different growth temperatures (15 °C, 10 °C) and 16/8 h light/dark period were used. During cultivation, optical density (OD at 680 nm) of *Trebouxia* sp. culture, and effective quantum yield (Φ_{II}) of photosynthetic processes in photosystem II were measured repeatedly. Finally, OD and Φ_{II} were plotted against the time of cultivation, so that temperature-induced differences in growth rate and photosynthetic efficiency could be distinguished.

Results and Discussion

Time course of OD showed that faster growth of *Trebouxia* sp. was achieved at 10 °C than 15 °C. At 10 °C, the OD of culture showed typical S curve, with maximum growth rate found after 420 h of cultivation. At 15 °C, however, the OD values exhibited rather constant growth rate (see Fig. 1). Final culture density was higher when cultivated at 10 °C (OD = 0.45) than 15 °C (OD =0.35) indicating that optimum cultivation temperature for *Trebouxia* sp. is definitely below 15 °C. Such conclusion is supported also by fluorometric data. While effective quantum yield (Φ_{II}) reached relatively low value ranging from 0.5 to 0.7 at 15 °C, it was much higher at 10 °C (0.6-0.8). Moreover, Φ_{II} showed increasing values with cultivation time indicating progressive acclimation to cultivation conditions (10 °C), highly effective performance of photosynthetic apparatus at such more favourable temperature. At 15 °C, contrastingly, Φ_{II} exhibited slightly decreasing trend with cultivation time. This finding supports the conclusion that 15 °C is suboptimal cultivation temperature.

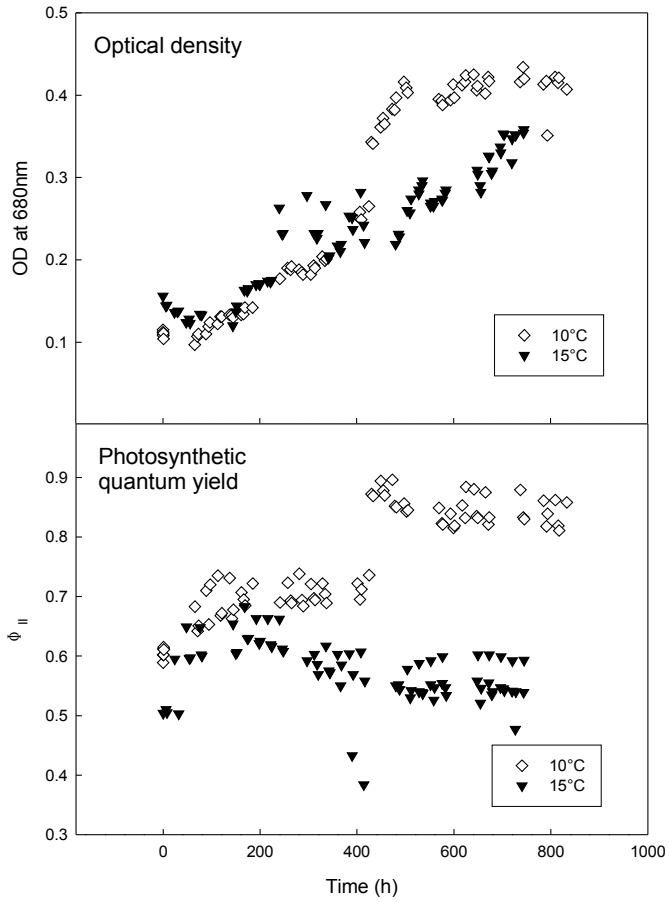

Fig. 1. Time courses of optical density (OD) and effective quantum yield (Φ_{II}) in *Trebouxia* sp. cultivated at two growth temperatures (10, 15 ºC).

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THE ROLE OF MOSSES FOR ECOSYSTEM DEVELOPMENT IN A PROGLACIAL AREA OF SE-ICELAND

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KEYWORDS: FACILITATION, PRIMARY SUCCESSION, ECOSYSTEM DEVELOPMENT, TRANSPLANT EXPERIMENT, SURVIVAL

Facilitation and positive interactions are now widely recognized processes that shape plant communities. They are expected to be especially important in harsh environments (e.g. Callaway, R.M et al. 2002). On the vast glacial outwash plain of Skeiðarársandur in subarctic SE Iceland, a mosaic of early successional communities is developing with minimal human interference. Although the physical environment appears highly homogeneous, diverging successional processes are clearly operating on the sandur. In the uppermost part, mosses (mostly *Racomitrium* spp.) form discrete patches of varying size on an otherwise sandy/gravelly plain. Moss patches may influence vascular plant establishment and growth by 1) acting as physical barrier and therefore trapping seeds more effectively than barren ground, 2) creating safe sites for germination, 3) improving growth conditions through ameliorated microlimate, and 4) increasing substrate nutrient status by trapping wind-borne particles. We propose that moss patches may function as habitat islands for vascular plants and facilitate vascular plant establishment and direct ecosystem development along a different path from moss-free areas.

To examine the potential roles of moss, we compared seed rain and seed bank in moss patches and surrounding barren areas. To test the effect of moss on vascular plant germination, establishment and survival we transplanted homogeneous *Racomitrium ericoide*s moss mats on two sites with different substrate type (fine and coarse) in the barren central part of Skeiðarársandur in 2010. A seedling transplant and sowing experiment with locally collected seeds started in spring 2011 to compare germination rates, seedling establishment and plant survival for five selected species (*Silene acaulis*, *Campanula rotundifolia*, *Luzula multiflora*, *Rumex acetosella* and *Betula pubescens*). A third experimental site was established 100 km further east in June 2011 due to an eruption of Grímsvötn volcano in May 2011 that affected the original site by ash deposition.

There was no significant difference in seed rain and seed bank size between moss patches and bare ground. Germination rate on the experimental sites was significantly higher in bare ground than in moss. In general, germination rate in the different treatments varied a lot between species, ranging from 0% to 56% of the sown seeds. Soil samples from outside the experiment had however almost exclusively viable seeds below moss patches. Substrate type clearly affected winter survival of seedlings which was highest on coarse substrate.

Our results indicate facilitation effects of the moss due to better seed preservation in winter. Germination increases, resulting in higher density and diversity of vascular plants growing in moss. Frost heaving does not appear to be strong, it may however be the most important factor for seedling survival as moss cover reduces this effect by stabilising the surface. Our study both shows the importance of facilitation in plant succession and emphasizes the widely underestimated role of mosses in ecosystems. In a changing climate with increasing glacial retreat and expanding primary successional areas, mosses might become increasingly important for ecosystem development.

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CH_4 AND CO_2 FLUX MEASUREMENTS AT FOUR CONTRASTING VEGETATION TYPES AT DISKO, WEST GREENLAND

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KEYWORDS: CH_4 OXIDATION, CO_2, GREENLAND, ARCTIC

Introduction

Methane (CH_4), carbon dioxide (CO_2) and water vapor are important greenhouse gasses with respect to climate change. Total annual CH_4 emissions from natural sources has been estimated to be around 145-260 Tg (IPCC, 2007). CH_4 is produced by methanogenic bacteria during anaerobic decomposition of soil organic matter (LeMer, 2001) and CH_4 can be oxidized by methanotrophic bacteria in aerobic soil types. Oxidation rates from these soils are estimated to be around 30-40 Tg yr^{-1} (Reay, et al. 2005) but are poorly described under Arctic field conditions. This study aims to verify net CH_4 production and consumption rates in a high arctic environment under different vegetation types.

Methods and materials

The study area is situated in a high arctic environment at Flakkerhuk, Disko Island, Greenland (69°N, 53°W). The study site is placed on a young marine terrace. Four main but contrasting vegetation types have been identified.

Fen1: is a very heterogenic area with 40% of the area dominated by hummocks (Fen1Hum, n=10) and 60% of the area dominated by standing water table (Fen1WT, n=10). Vegetation cover on Fen1Hum is very diverse including the growth of *Salix Arctophila, Salix Arctica, Pyrola Grandiflora, Carex L., Deschampsia Alpine* and some *Sphagnum*. Fen1WT is primarily dominated by *Carex L* and *Sphagnum.*

Fen2: has a permanent high water table. Several stones and pebbles are visible on the ground. The area is dominated by grasses such as *Eriophorum Vaginatum* and *Arctophila Fulva*. *Sphagnum* is also found.

Salix a.: is dominated by *Salix Arctica* and *Salix Glauca* and bare soil is present in a mosaic pattern and big stones make the area rugged.

Betula n.: coveres a much more regular plane and is dominated by *Betula Nana* yet also *Cassiope Tetragona* and *Empetrum Hermaphroditum* are present.

CH_4- and CO_2 flux measurements were conducted in a two week period in July 2010 at the five sites. Four campaigns were measured at Fen1 (n=20), Fen2 (n=10) and Salix a. (n=5) and three campaigns at Betula n. (n=5).

Measurements were made using a mobile unit equipped with a LGR-DLT100 (Los Gatos Research, http://www.lgrinc.com) for measuring CH_4 and a LICOR 840 to measure CO_2 concentration. Two Teflon tubes (5 metres long and with an air volume of 141 cm^3) were connecting the analysers to lid which was placed on top of preinstalled dark cylindrical chambers with a diameter of 31 cm during measurements of 15 min. Chambers were inserted 15-20 cm into the soil. A fan was installed to ensure ventilation during measurements. A blanket was used to minimize heating effect from the sun. Soil water content was measured with a Theta Probe. Temperatures were measured in the ground (5 cm), in the chamber and in the air during measurements.

A one-way ANOVA test has been conducted on data in GraphPad to verify significant differences ($P<0.05$) of CH_4 and CO_2 emissions between sites.

Results

Fen1WT, Fen1Hum and Fen2 are wet sites with water content close to 100%. Salix a. and Betula n. represent well-drained sites with soil water content of 40% and 30%, respectively.

Figure 1 below shows the measured CH_4 and CO_2 fluxes in µmol m^{-2} hr^{-1} and mmol m^{-2} hr^{-1}. Fen1WT, Fen1Hum and Fen2 show a clear net CH_4 production whereas Salix a. and Betula n. are consuming CH_4 from the atmosphere. Fen1Hum (CH_4) was significantly different from Fen2. No other significantly differences were found within sites. All sites produced CO_2, with Salix a. having a significantly higher production compared to the other sites ($P<0.05$).

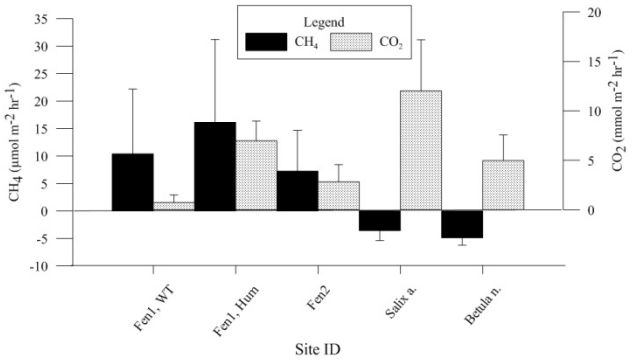

Figure .CH_4 and CO_2 emissions measured on different vegetation types at Flakkerhuk, Disko, West Greenland.

Discussion

Further analysis of the quality of the organic matter, availability of nutrients, bacterial composition, pH and temperature could help explain the spatial variations which are found within wet and dry sites, since those are controlling factors of CH_4- and CO_2 production and CH_4 consumption. These analyses are still ongoing.

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NEW TECHNIQUES FOR ANALYSING THE EVOLUTION AND DYNAMICS OF LANDFORMS ON SVALBARD

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KEYWORDS: SVALBARD, LIDAR, ERT, HORNSUND, PETUNIA, MORPHOMETRY, RELIEF DYNAMICS

In recent years, many novel research techniques started to be applied in landform analyses. Among these, near surface geophysics and laser scanning (LiDAR) are used to obtain precise information about the structure and morphology of terrain. However, their application for studies in Polar Regions is still limited.

Using the ground laser scanning, a very precise morphology of the landforms was measured. This is very useful in the landform analysis, but crucial for the assessment of the dynamics of these landforms. By repeated measuring of the same form, even small-scale changes (in the scale of millimetres) can be observed.

The ERT measurements are extremely useful for the deciding on the validity of the hypotheses, based upon field mapping, morphology analysis and means of remote sensing. Underground structures, such as fault planes or underground ice bodies, are thus helping to pinpoint the particular landform origin and history.

In this contribution, the application of ground laser scanning and ERT profiling is presented on several different case studies in Svalbard, showing its wide applicability and potential. Firstly, application in the research of tectonic structure is presented, followed by analysis of morphology of a rock glacier/rock avalanche. Last cases present application of laser scanning on the dynamics of an outwash plain and debris cone/fan.

This study was supported by the Grant No. LM2010009 CzechPolar (MSMT CR), and CZ.1.07/2.2.00/28.0190 (EU).

DENDROCHRONOLOGICAL ANALYSES OF HIGH AND LOW ARCTIC TUNDRA SHRUBS (SPITSBERGEN, WESTERN GREENLAND)

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KEYWORDS: TREE-RINGS, SERIAL SECTIONING, MISSING RINGS, ANNUAL GROWTH ALLOCATION

Both High and Low Arctic shrubs are long-living woody plants reaching age of more than 100 years. This feature gives a unique chance for dendrochronological studies in the high latitudes which might provide a high-resolution proxy with broad applications in polar studies. At the same time. Arctic shrubs are known to often experience the complete or partial absence of growth during years with limiting conditions for cambium activity which complicate the sampling and cross-dating of their annual rings.

With the aim of having a better insight on intra- and inter-plant sampling strategy, we performed a detailed intra-plant growth allocation study on two tundra species from the High and Low Arctic region. As High Arctic species we sampled the dwarf shrubs *Salix polaris* in central Spitsbergen (78ºN), and as Low Arctic representative we collected the semi-erect shrubs *Betula nana* in Disko Island, in Western Greenland (69ºN). Tree-rings were crossdated and measured within both the above-ground (two dominant shoots) and below-ground (main root) part of the shrubs using the serial sectioning method. Annual radial growth was visually inspected on digital images taken from complete microsections of the stem (if avaiable), root and branches (Fig. 1). Growth curves were compared between the sections of the plant organs and the individual shrubs and the visual cross-dating was performed. This step allowed the detection and following analysis of the distribution and frequency of partially and completely missing rings in relation to the environmental conditions.

Results indicated that the growth of Arctic shrubs is strongly tempearture limited. The High Arctic dwarf shrub Salix *polaris* was found to be highly limited by thermal conditions of the growing season. High positive correlation ($r=0.70$; $P<0.01$) between mean annual growth rate of *Salix polaris* and mean June-July-August (JJA) temperature was observed. This relationship was confirmed by high negative correlation ($r=-0.53$; $P<0.01$) between the years whitout radial growth and the average JJA temperature. In contrast, the *Betula nana* form the Low Arctic presented significantly lower ratio of missing rings in single years. However this species displayed a different growth allocation strategy where a sequence of missing othermost rings might occured in the below-ground compartments.

These results strongly suggest that Arctic shrubs growth is characterized by an high intra-plant as well inter-annual allocation variability which is principally determined by harsh environmental conditions. The presence of partially and completely missing rings is most likely due to a limited ability of cambium to divide in such cold conditions. Our results also show that the two species examined have different growth allocation startegies. This differing characteristic does not allow generalization for a common sectioning protocol of woody plants in the Arctic. We therefore conclude that dendrochronological studies of tundra shrubs should require an additional effort to verify the correct cross-dating, especially within the location missing reference chronologies for calibration.

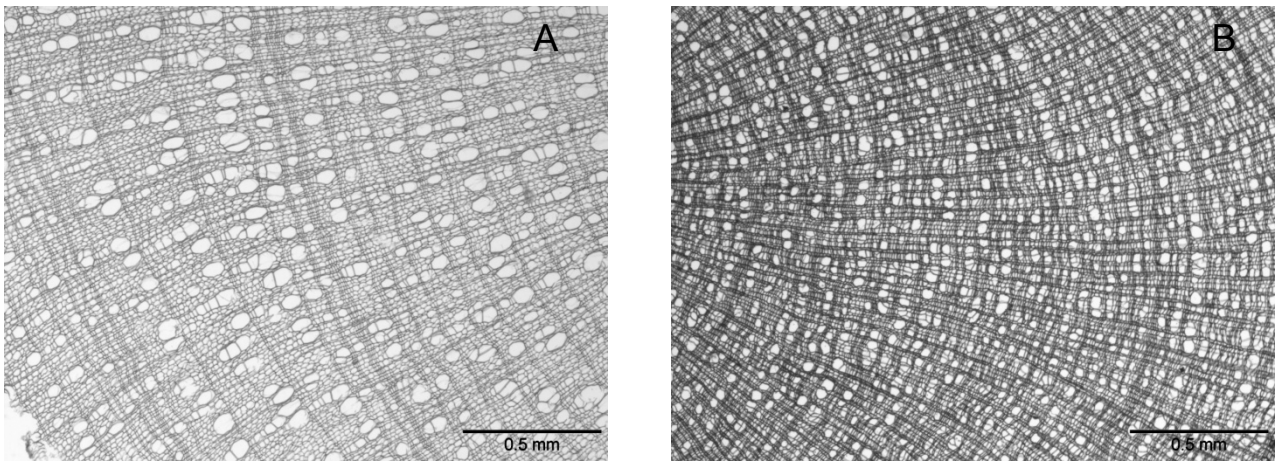

Fig. 1. Part of the cross-sections with annual tree-rings of (A) *Betula nana* root (Disko Island, Western Greenland) and (B) *Salix polaris* stem (Ebbadalen, central Spitsbergen). Note the common radial growth irregularitues and year-to-year variations in ring withds sequence

The research leading to these results has received funding from (i) the European Community's Seventh Framework Programme INTERACT under grant agreement No.262693 (ii) Sciex project ArcDendro No.09.045 and (iii) Polish Ministry of Science and Higher Education No. N N306 009139

LAKES OF THE BILLEFJORDEN REGION, CENTRAL SVALBARD

Denisa Čepová[1], Jan Kavan[2,3], Linda Nedbalová[2,3]

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KEYWORDS: BILLEFJORDEN, SVALBARD, LAKE ECOSYSTEMS, DEGLACIATION,

Billefjorden is the most distant part of the Isfjord pointing towards the central part of the Spitsbergen archipelago. Systematic research of the lake ecosystems in the study area has started in 2011, when the first overview of lakes has been made during the summer field-campaign on the Czech research station in Petuniabukta. The goal of the study is to bring new information about dynamics of the lake ecosystems, describe its morphology, physico-chemical characteristics and last but at least also phyto and zooplankton diversity.

Billefjorden and its surroundings is rather a heterogeneous region with different types of landforms to which different types of lakes are related. According to the origin and development of lakes, it is possible to distinguish several types of lakes. Most of them are related to glacial dynamics of the area especially within the deglaciation after Little Ice Age in last 150-200 years (Rachlewicz et.al.,2007).

- proglacial lake dammed by the front moraine (Ragnar lake)
- kettle lakes on the recently deglaciated areas (Sven, Hoerby and Nordenskiold moraines)
- lakes on the marine teracces (Ebbadalen, Brucebyen)
- karst lakes (Mathiessendalen)
- landslide related lake (Garmaksla) (Geological map of Billefjorden, 2004)
- tectonic determined (eroded area in front of Nordenskiold glacier)
- snow related depressions (high altitude areas in Mimerdalen)

Basic physico-chemical parameters were measured on most of the investigated lakes. Measured characteristics were water temperature, oxygen content, conductivity and pH. Table 1 summarizes all measured parameters in different morphological types of lakes. Ragnar lake represents the proglacial lake (largest in the area), Sven and Nordenskiold lakes stand for kettle lakes on moraines. Brucebyen is relatively old lake originated on the old marine terrace. Mathiessendalen lake located in karstic region is quite a unique locality in Svalbard. Garmaksla and Mimer lakes are examples of lakes of high altitude with relatively short ice-free period – Garmaksla is situated in the fault zone lateral to the major Billefjorden fault zone and fills a depression after an approximately 35 vertical meters landslide. The other one situated more inland is placed in nival depression surrounded by mountain crests. Its water level is highly unstable and diminish slowly as the snow melts down during summer.

The most significant differences in measured parameters can be seen in case of conductivity and temperature. Large lakes with higher volume of water have relatively low temperatures during the beggining of summer season due to its high thermal inertia (Ragnar, Mathiessendalen). Garmaksla and Mimer lake are situated in high altitude and the temperature is rather low as well. Conductivity generally express the ion concentration in the water and can be interpreted as the amount of dissolved material. Mathiessondalen 1 has the highest value of conductivity very likely because of its hydrological regime and specific location in karstic region. The reason for high conductivity in Brucebyen 1 is the presence of nesting birds bringing large amount of organic substances to the system. Nordeskiold 1 and Sven 5 are relatively small kettle lakes with similar morphological characteristics and thus also its physico-chemical parameters are similar.

LAKE	date	temperature (°C)	Oxygen content mg/l	conductivity ($\mu S \cdot cm^{-1}$)	pH	area (ha)	maximum depth (m)
Brucebyen1	7.8.2012	8,7	13,2	866	8,48	2,1	1,3
Nordenskiold1	7.8.2012	9	11,33	325	8,48	0,1	6,5
Sven 5	8.8.2012	9,1	13,1	236	8,55	0,1	6
Garmaksla	4.8.2012	5,3	12,73	103	9,23	3,2	5
Mimer lake	26.8.2012	4,8	no data	132	8,5	3-0.7	2.5-1.5
Mathiessendalen 1	12.8.2012	3,6	13,82	989	8,76	4	13
Ragnar	10.8.2012	4,6	13,66	113	8,57	46,5	17,5

Table 1. - basic physico-chemical parameters of selected lakes in Billefjorden region

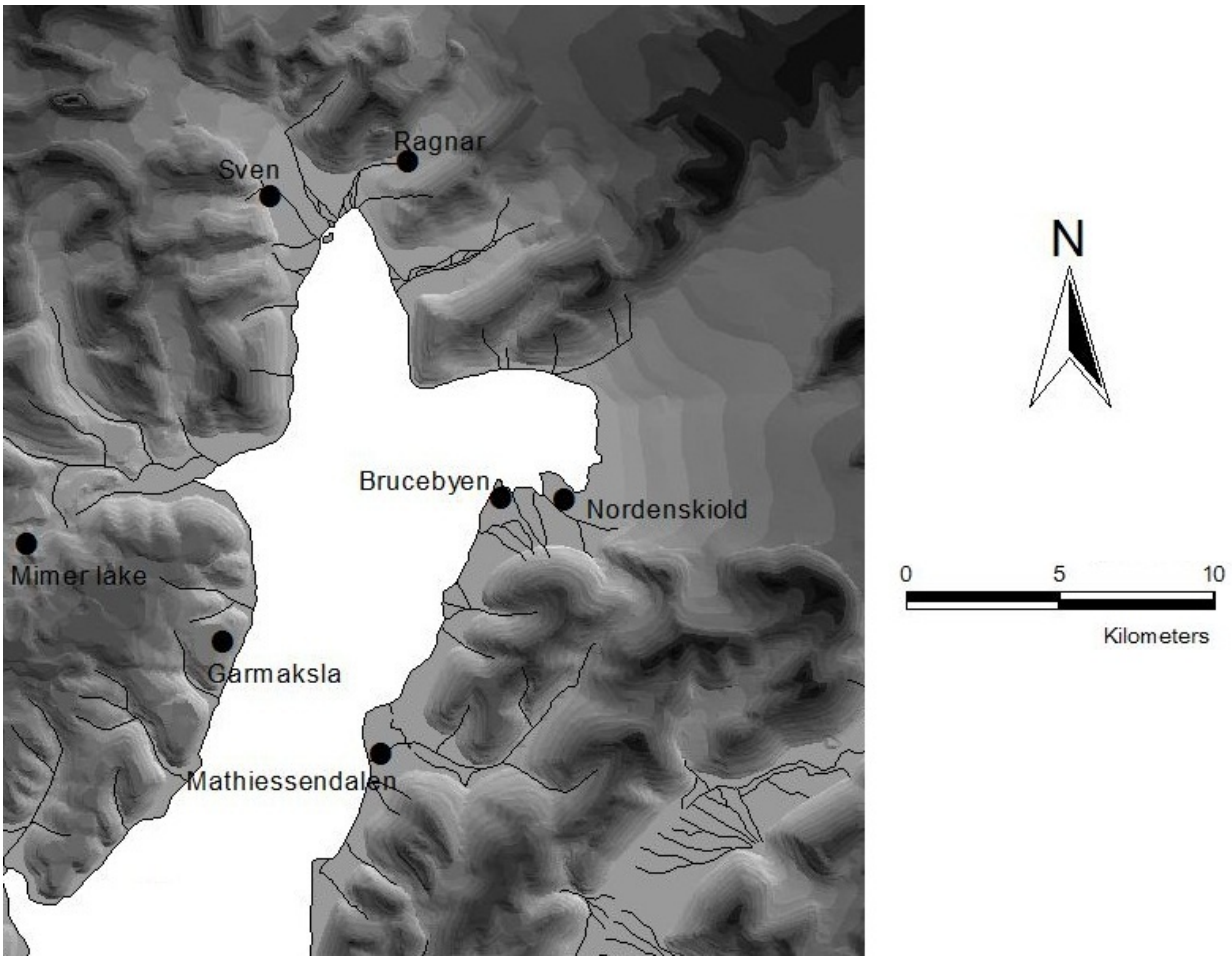

Fig 1 – study area of the Billefjorden and its surroundings with location of lakes listed in Table 1.

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GEOLOGICAL MAP OF BILLEFJORDEN, 2004, Norsk Polarinstitutt

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SEARCH FOR ARBOVIRUSES ON SVALBARD

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KEYWORDS: ARBOVIRUS, SVALBARD, PCR, ALPHAVIRUS, BUNYAVIRUS

In Arctic, a few months of a relatively warm and humid summer and presence of proper hosts allows reproduction of large numbers of blood sucking arthropods such as ticks and mosquitoes. These arthropods can serve as an effective vectors for many arthropod-borne viruses (arboviruses). Various arboviral species were described in many arctic regions such as Canada, Alaska, northern Russia and Scandinavia. These arboviruses belongs to five different genera: Orbivirus (family *Reoviridae*) Bunyavirus, Phlebovirus (both family *Bunyaviridae*), Flavivirus (family *Flaviviridae*) and Alphavirus (family *Togaviridae*).

In our research, we investigated 1671 larva and 388 adult *Aedes nigripes* mosquitoes and one adult female of *Ixodes uriae* tick all collected in Petunyabukta, Spitzbergen, Svalbard. Samples were pooled for 40 (larva) or 20 (adults) individuals. Pooled samples were homogenized, viral RNA was extracted, and one-step RT-PCR using genus specific primers was carried out. Bands produced by PCR were sequenced to verify virus identity.

We detected one Bunyavirus positive sample from our mosquito collection and the tick sample was positive for Alphaviruses. To our best knowledge these viruses poses the northern most arboviruses ever found. Exact identification and phylogenetic relationship to other members from genera Bunyavirus and Alphavirus as well as possible impact of these viruses to the arctic ecosystem will be discussed.

PRELIMINARY ANALYSIS OF SURFACE WIND CONDITIONS AROUND THE PETUNIABUKTA (BILLEFJORDEN, SVALBARD)

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KEYWORDS: WIND SPEED, WIND DIRECTION, WAsP MODEL, WIND MAP

The data and results of this paper were obtained during the summer expedition at the Czech polar station in Petuniabukta (Billefjorden) in Svalbard in the period 17. 7. – 31. 7. 2012. During this period wind speed and wind direction were measured at 3 meteorological stations at different types of terrain. The first meteorological station was situated on the beach at the altitude of 15 m above sea level (AWS 1). The second one was situated at the exposed place at the top of the Pyramiden Peak at the altitude of 935 m a. s. l. (AWS 6) and the last one near Mumien Peak at 475 m a. s. l. (AWS 4). The wind characteristics and wind map of the Petuniabukta were computed using the WAsP model.

The wind conditions around the Petuniabukta were calculated by the WAsP model (Troen and Petersen, 1989). Wind data from the three meteorological stations were used as an input to the WAsP model. The calculation was performed individually for each of the positions, the resulting mean wind field at the Petuniabukta has been determined as an average of those three calculations. For graphical representation of the wind map, the ESRI ArcMap software was used.

The Figure 1 shows the mean wind rose at AWS 1 (left) and at the AWS 6 (right). The wind from northeast and southwest direction was typical for coastal area (AWS 1) during the measured period. At the Pyramiden Peak (AWS 6) the wind rose is different, the prevailing winds were from northeast and southeast directions. The wind map of northern part of Petuniabukta will be presented at the poster. According to model WAsP the wind speed at the highest peaks (800–930 m) is typical between 7 and 12 m/s, whereas in coastal areas the typical wind speeds are only between 2.5 and 3.5 m/s at the height of 10 meters above terrain.

It is well known that WAsP model performs well in flat or moderately hilly terrain, however the model errors increase in complex terrain with steep slopes. In general, the model overestimates the orographic effects of steep orographic features, such as the wind speed-up at the top of the Pyramiden Peak. On the other hand, it can underestimate the wind speed in orographic depressions. This effect also leads to general underestimation of the model results if the input measurement was taken at highly exposed position – and vice versa. In my calculation, the possible bias is reduced by averaging results based on measurements from three sites located in very different orographic conditions.

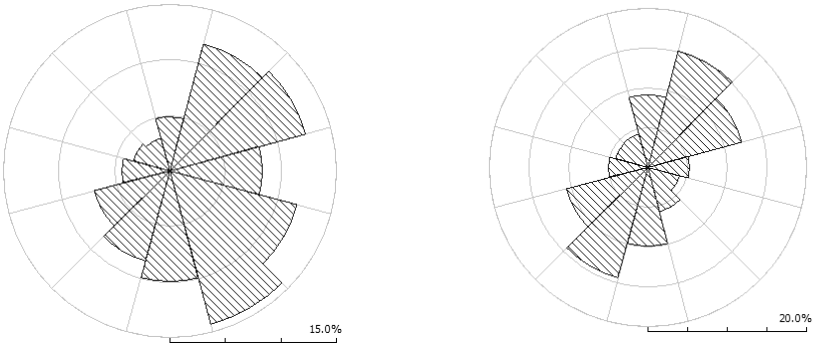

Fig. 1 The wind rose at the coastal AWS 1 position (left) and at the Pyramiden AWS 6 (right).

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EFFECTS OF LIFE FORM AND SUBSTRATE DIFFERENCES OVERTICAL DISTRIBUTION OF SOIL HYDROBIONTS (ROTIFERA, TARDIGRADA, NEMATODA) IN SOIL CRUSTS OF CENTRAL SVALBARD (PETUNIABUKTA BAY, BILLEFJORDEN)

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The changes of soil hydrobiont populations along vertical transect of coastal mountains have been studied in Petuniabukta Bay (Billefjorden, central Svalbard). Populations of Rotifera, Tardigrada and Nematoda have been studied with respect to different stage of soil crust development, populations of other invertebrate groups as well as microbial populations. However the range of altitudes is less than 750 m, extremity of arctic environment cause very different conditions in case of temperature and water availability.

Nematods as most abundant group reached abundance from 100 to 3000 10^3 ind m^{-2}, rotifers from 0 to 174 10^3 ind m^{-2} tardigrades from 0 to 82 10^3 ind m^{-2}. Quantitative analyses of populations show, that both transects are different. Although soil crusts of Løvehovden mountain rotifers as well as nematodes are most abundant in second position from the top, tardigrades preffered lover positions, in Wordiekammen mountain rotifers and tardigrades preffered medial positions and nematodes were most abundant on the top. In total 23 species of bdelloid and monogont rotifers were found if most abundant was *Encentrum arvicola*, *Adineta gracilis*, *Macrotrachela* cf. *musculosa* and *Philodina rapida*. Rotifer species diversity increased with decreasing altitude in general.

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TREMATODES (DIGENEA) FROM MOLLUSCS AND FISH IN PETUNIABUKTA (SVALBARD)

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KEYWORDS: TREMATODA, OPECOELIDAE, GYMNOPHALIDAE. HEMIURIDAE, ARCTIC FISH, MARINE MOLLUSCS

During summer periods 2008–2012, a total 1717 molluscs belonging to 22 species and 814 fish belonging to 13 species were examined for helminths. Sampling of molluscs has been performed by scuba diving in the Petunia bay and near Brucebyen, fishes have been sampled using gill nets in the same localities.

Larval stages of three species belong to different groups of trematodes have been found in molluscs:

- i) Unidentified cercariae from the family Opecoelidae in Buccinum undatum, B. glaciale and Colus kroeyeri (Gastropoda, Caenogastropoda, Buccinidae). Their occurrence is dependent on the season and in the end of August the prevalence reached almost 40 %. The definitive hosts are fishes, most probably sculpins.
- ii) Cercariea belonging to the genus Gymnophalus (Gymnophalidae) was found in Mya truncata and Hiatella arctica (Bivalvia, Myoidea). The prevalence in M. truncata reached over 70 %. The larvae of this trematode most probably manipulate the behaviour of its intermediate hosts to increase the probability of their predation by definitive hosts that are most probably the common eiders (Somateria mollissima).
- iii) Cystophorous cercariae resembling Derogenes varicus (Hemiuridae) was found in Euspira pallida (Gastropoda, Caenogastropoda, Naticidae) with prevalence almost 20 %. The definitive hosts of this species is fish and progenetic metacercariae found in arrow worms Eukrohnia hamate (Chaetognata) may belong ti its life cycle, too.

Three unidentified species of trematodes belonging to the family Opecoelidae (probably genera Helicometra and Neohelicometra) have been found in the intestine of 2 species of sculpins (Myoxocephallus scorpius and Gymnocanthus tricuspis) in high prevalence.

The morphology of larval stages and adults has been described using light and scanning electron microscopy. The molecular analyses are performed and will probably enable to associate larval stages with adults.

This study was supported by the Grant No. LM2010009 CzechPolar (MSMT CR), and CZ.1.07/2.2.00/28.0190 (EU).

EVALUATION OF WEATHER CONDITIONS AND CLOUD TYPES IN PETUNIABUKTA (BILLEFJORDEN, SPITSBERGEN) IN JULY 2012

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KEYWORDS: SVALBARD, CIRCULATION TYPE, CLOUD COVER, CLOUD TYPE

The paper deals with the evaluation of synoptic situations, weather conditions and cloud types in Petuniabukta (78°40´N, 16°30´E) in July 2012. The study area is located in the region of Billefjorden in the central part of the Spitsbergen, Svalbard archipelago. The study period (17 July 2012 – 31 July 2012) covers the stay of the climatological group which was a part of Svalbard 2012 Expedition organized by Centre for Polar Ecology, University of South Bohemia, Czech Republic.

During the study period, we distinguished several typical synoptic situations as previously described by Baranowski (1975) and Niedźwiedź (2007). They were evaluated with the help of reanalyzed maps of surface air pressure field and air pressure at various levels derived from NCEP/NCAR reanalysis data. Each of these synoptic situations was reflected in typical weather conditions and diurnal variation of meteorological parameters. Therefore, both cyclonic and anticyclonic circulation types were analyzed separately using hourly values of global solar radiation, 2-m air temperature and relative humidity, wind speed, wind direction and precipitation measured by the automatic weather station (EMS Brno, Czech Republic). The example of diurnal regime of the selected meteorological parameters on a day with anticyclonic circulation (July 19-20 2012) is shown in Fig. 1.

Consequently, the obtained results have been compared with the observations carried out at other stations in the area of Svalbard archipelago: Barentsburg, Edgeøya, Hopen, Hornsund, Longyearbyen, Ny-Ålesund and Verlegenhuken in particular. These findings were supplemented by means of hourly observations of cloudiness, cloud type, cloud height and visibility that were accomplished by the members of climatological group. A further aspect covered by this paper was acquiring the extensive photo-documentation of cloud types and processes that would describe both large-scale circulation pattern and topographic effects over the Spitsbergen mountains.

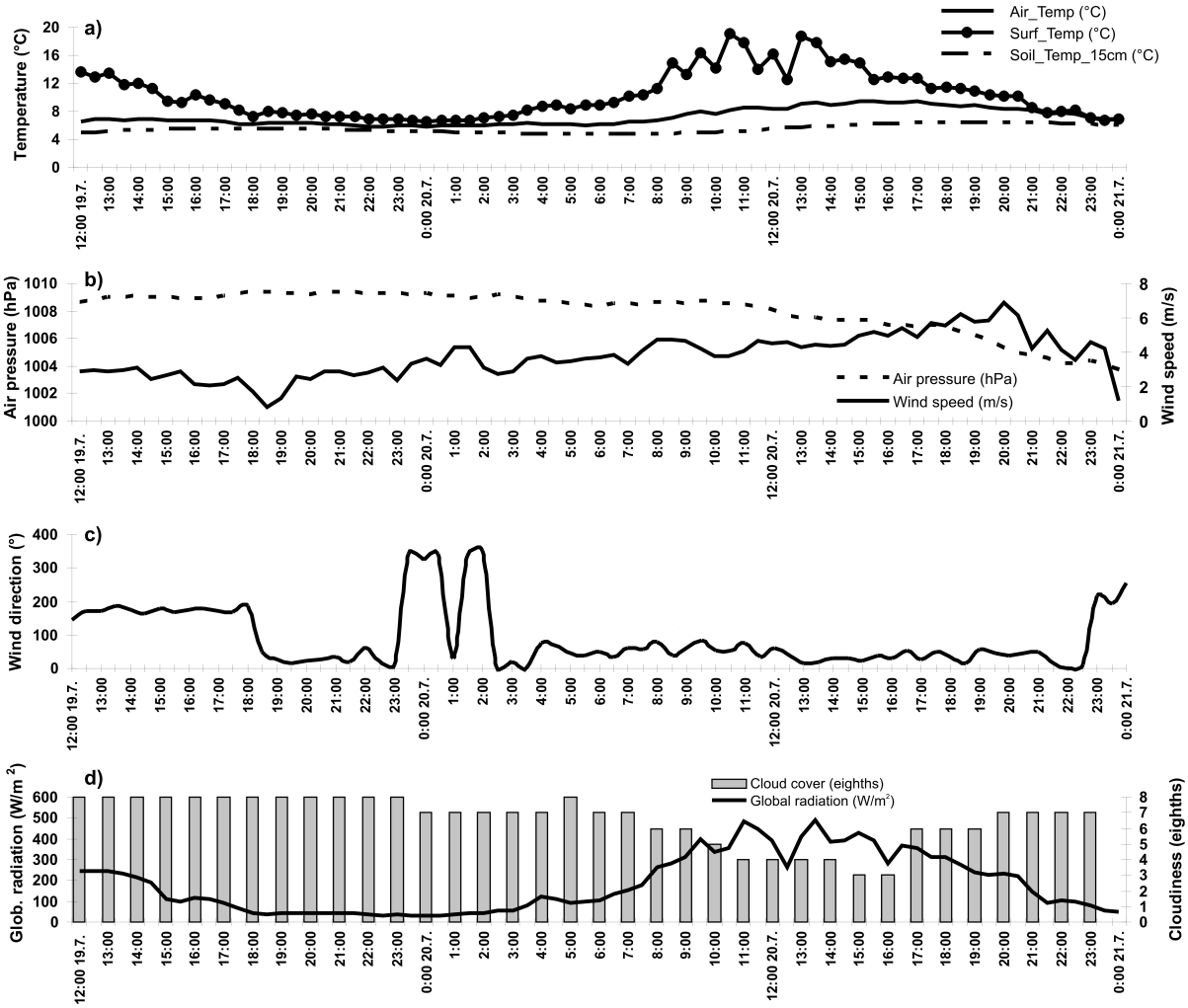

Fig. 1 Diurnal regime of the selected meteorological parameters at Petuniabukta (Billefjorden, Spitsbergen) in the period July 19-21, 2012. Time axis in UTC (Coordinated Universal Time).

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This study was supported by the Grant No. LM2010009 CzechPolar (MSMT CR), and CZ.1.07/2.2.00/28.0190 (EU).

IMPACT OF WARMING ON NOSTOC COLONIES (CYANOBACTERIA) IN A WET HUMMOCK MEADOW, SVALBARD

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In order to simulate the warming effects on Arctic wetlands, three passive open-top chambers (OTCs) and three control cage-like structures (CCSs) equipped with soil temperature and soil volumetric water content (VWC) probes for continuous microclimatic measurements were installed in a wet hummock meadow, Petuniabukta, Billefjorden, Central Svalbard, in 2009. The warming effects on primary productivity were investigated in cyanobacterial colonies of Nostoc commune s.l., which plays an important role in the local carbon and nitrogen cycles, during summer seasons 2009 and 2010. The microclimatic data indicated that the effect of OTCs was dependent on microtopography. During winter, two short-term snow-thaw episodes occurred, so that liquid water was available for Nostoc communities. Because of the warming, the OTC hummock bases remained unfrozen three weeks longer in comparison to the CCSs and, in spring, the OTC hummock tops and bases exceeded 0°C several days earlier than CCS ones. Mean summer temperature differences were 1.6°C in OTC and CCS hummock tops, and 0.3°C in OTC and CCS hummock bases. The hummock tops were drier than their bases; however the VWC difference between the OTCs and CCSs was small. Due to the only minor differences in the microclimate of OTC and CCS hummock bases, where the Nostoc colonies were located, no differences in ecophysiological characteristics of Nostoc colonies expressed as photochemistry parameters and nitrogenase activities were detected after two years exposition. Long-term monitoring of Nostoc ecophysiology in a manipulated environment is necessary for understanding their development under climate warming.

This study was supported by the Grant No. LM2010009 CzechPolar (MSMT CR), and CZ.1.07/2.2.00/28.0190 (EU).

CHARACTERIZATION OF SMALL-SCALE VEGETATION PATTERNS BY TOPOGRAPHY-SOIL-VEGETATION-TRANSECTS IN HIGH-ARCTIC GREENLAND

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KEYWORDS: MICRO/MESOTOPOGRAPHY, SOIL ANALYSES, VEGETATION PATTERNS, MONITORING, NORTHEAST GREENLAND

Vegetation patterns at arctic-alpine sites point to a complex interplay of limiting factors that needs to be understood to assess climate-induced vegetation changes. Not only microclimate (temperature and precipitation), but also relief characteristics, redistribution of snow, snow melt and drainage conditions are likely to influence (and limit) the establishment of vegetation and soil (Elberling et al. 2008), and often may change over small distances.

To possibly unravel these interdependencies, we recorded topography, soil moisture and other physical and chemical soil features along three transects in different elevations (90, 470 and 605 m a.s.l.; 95, 30 and 85 m length) near Zackenberg, Northeast Greenland (ca. 74°30'N/21°00'W, mean temperature June-August 4.3°C, mean annual precipitation 261 mm). All transects were located in the vicinity of GLORIA (Global Observation Research Initiative in Alpine Environments, www.gloria.ac.at) long-term observation summits. They were positioned to represent several topographical units relevant for vegetation distribution within their elevation. We recorded composition and abundance of vascular plant species and in situ soil moisture along these transects, collected soil samples and analyzed grain sizes, loss on ignition, pH and C/N.

Vegetation types covered those typical for each elevation/vegetation zone, i.e. *Cassiope tetragona* heath and fen communities at 90 m, open *Dryas-Salix arctica* communities at mid elevations, and fell-fields with very low plant cover (e.g. *Papaver radicatum*) at the uppermost site, but also 'resource-driven' plant communities of dry and wind-blown areas, as well as late-melting snowbeds.

The values from soil analyses (excluding peat) showed great variations, e.g. 0 to >80% stone content, 30 to 80% sand content in the fine soil (<2 mm), <1 to >25% loss on ignition, pH <4.5 to >7.5. The accumulation of wind-borne fine material and humus below dense vegetation greatly improves the water regime of the soils. Distinct differences in soil characteristics following the composition of vegetation became particularly apparent along the lowermost transect (Fig. 1), whereas the soils at higher and more exposed sites were more homogeneous with less pronounced differences in the content of fine material and organic matter. Vector fitting of environmental variables using permutation tests on a DCA (Detrended Correspondence Analysis) ordination of the vegetation samples revealed soil moisture, pH and inclination as the factors best explaining vegetation patterns at the lowermost transect. We further identified several correspondences: slopes around 20° inclination are dominated by coarse debris almost without vegetation. Vegetation patterns in less steep areas are driven by moisture from snow melt and slope water. As a result of aeolian deposition, and therefore dependent on topography and vegetation density, soils lose or gain fine material and nutrients.

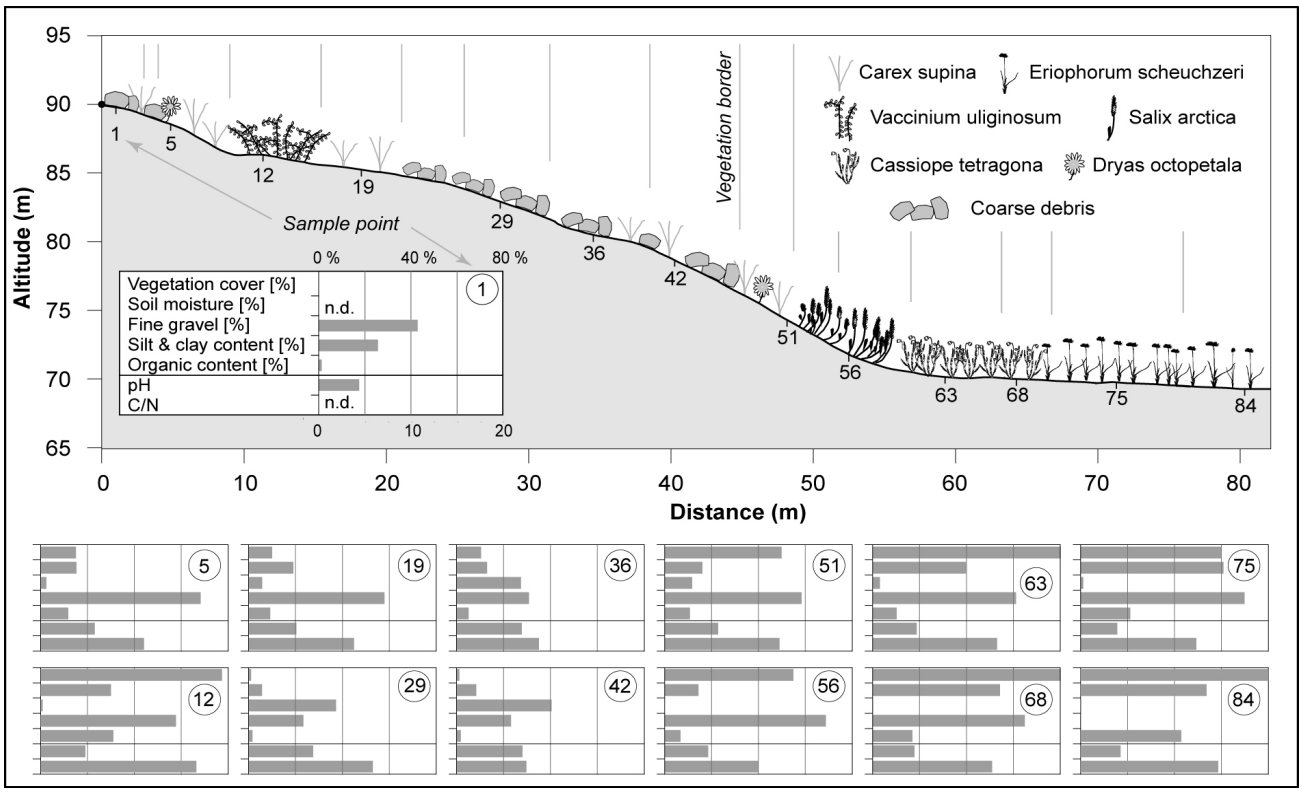

Figure 1. Profile of transect 1 at 90 m a.s.l. with vegetation borders, soil sampling points and results of soil analyses, in situ soil moisture and vegetation cover (Design: Clemens Geitner, Graphics: Kati Heinrich).

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NENETS IN TUNDRA ECOSYSTEMS OF THE YAMAL: EFFECT OF REINDEER OVERGRAZING

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KEYWORDS: REINDEER, OVERGRAZING, TUNDRA, VEGETATION, ANIMAL

Currently in the Yamal-Nenets Autonomous Area (North of the Western Siberia) over 700 thousand head of reindeer are grazing - about 40% of the world total number. Of these, 380 thousand (21% of the world number) are concentrated in the Yamal peninsula on pasture area of 106 km^2. The sharp increase in the number of reindeer began in 1990-s, after the «perestroika» reforms, when most of the reindeer became private. We analyzed a unique situation in the tundra when pasture pressures prove to be extremely high on a vast area. The impact of overgrazing on vegetation and vertebrates of Yamal are examined. Attention is concentrated only on the key points that though simplifies the overall picture, but makes it more distinct.

The results of own investigations 1980-2009 were compared with the published materials 1930-s. The researches of vegetation were done on landscape profiles by describing plots of 10×10 m (total about 2000). The species composition, projective cover, height of grass and thickness of moss and lichen mat were revealed here. Aboveground phytomass was determined by mowing on the plots of 25x25 cm in 5-10-fold replication. Level of abundance of rodents was determined in scores using own and published complex data: trapping, with a dog catching, visual counting on the routes. Birds were counted by method of mapping on large plots with rechecking (plots for passerines and waders 1-15, other species - up to 50 km^2, in total 1750 km^2) and during the observations on the routes.

Overgrazing has resulted in a substantial transformation of vegetation. The worst affected lichen tundra. Compared with the 1930s their area decreased 3.5-4 times, mass of lichens - from 3-6 to 0,01-0,43 t/ha, the dominant height - from 3-4 to 0.5-1.5 cm, forage species (*Cladina*) were replaced by inedible (*Sphaerophorus, Alectoria, Flavocetraria, Thamnolia* etc., foliose and crustose lichen forms). Total supplies of phytomass decreased for grasses by 1.5-2 times, low shrubs - almost 8 times, tall shrubs - 2 times. In the tundra often 90% herbaceous vegetation has been eaten. This tundra looks “shaven” as newly mown lawn.

Vegetation degradation furthers to formation of the sandy outcrop, which increasing due to wind erosion. Desertification of the peninsula is going. Now the area of sand is on average about 5.5% of the land, in the Middle Yamal locally to 19%.

Overgrazing affected the animal populations too. On the Yamal before 1990 there used to be the lemming peaks (200-400 ind./ha) at intervals of 3-4 years that typical for tundra. They covered the vast area of one or more subzones. After 1990, the peaks never reached former high values, only twice to the middle level, although their cyclicity remained. The peaks became local and patchy. While on the Bely island, where domestic reindeers are not, the significant peaks of the lemmings have continued.

The reducing of the lemmings number affected the predators. Specialized predators (snowy Owl *Nyctea scandiaca* and pomarine Skua *Stercorarius pomarinus*) have almost ceased to nest. Nesting density of the less specialized predators has decreased: rough-legged Buzzard *Buteo lagopus* into 2,5 times, long-tailed Skua *Stercorarius longicaudus* into 3 times.

The number of other tundra birds decreased too: geese almost into 2 times, hygrophilous waders into 3 times, Lapland bunting *Calcarius lapponicus* almost into 5,5 times on watershed and 2,5 times in floodplain, long-tailed Duck *Clangula hyemalis* into 2 times on watershed. At the same time, due to desertification of the landscape the number of a typical inhabitant of mineral arenas -

Ringed Plover *Charadrius hiaticula* increased more than 2 times.

Nenets are increasing head of reindeers not to create marketable products and profits, but because that according to their cultural tradition the reindeer is a criterion of wellbeing. Reindeer as the basis of Nenets life-support satisfies all their demands, making their lives isolated from the economic of the rest society. This made it possible for the Nenets to thrive in the period of economic disturbances after the collapse of the Soviet Union.

A situation is such that, on the one hand, the Nenets are not economically dependent on the society, on the other hand, the society promotes the maintenance of their traditional economy, as the aboriginal. Veterinary disease prevention eliminates natural factors on the regulation of the reindeer number. Conditions for the increase in the Nenets number were created, and this creates the necessity to increase the reindeer number. This vicious circle is not infinite. Natural ecosystems are able to function in wide conditions, but in extreme climates, an overexploitation always pushes them beyond sustainability. Nenets with their tough attitudes to unrestrained breeding of reindeer are destroying the natural basis of their traditional lifestyle.

The work was performed as part of the projects № 12-P-47-13 and 12-4-3-012-ARCTIC of the Presidium of the Ural Branch of the Russian Academy of Sciences.

LONG-TERM CHANGES OF AN AVIFAUNA IN THE NORTH OF WESTERN SIBERIA

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KEYWORDS: CHANGES, AVIFAUNA, ARCTIC, WESTERN SIBERIA

Introduction

It analyzed long-term changes in distribution and abundance of birds that have occurred over the last 70 years in the Lower Ob and the Yamal Peninsula (North of Western Siberia).

Materials and methods

I used my materials for the 30-year period and published data from other researchers. In order to avoid distortions due to an increase in the intensity of ornithological studies in recent years have taken into account only visible species (active, loud, large, etc.). Present registrations of inconspicuous species taken into account only when comparing with the old publications, in which the species composition was accurately revealed.

For the estimate of climate change the data on the average air temperature for the spring-summer period (May-August) in Salekhard weather station, since 1883, were used.

Results and discussion

List of species with pronounced changes in number of and distribution is rather impressive - about 44% of all avifauna of the Lower Ob and Yamal.

For some species reasons for the changes are not clear. The examples are the Siberian species, advancing to the west and to the north (such as Arctic warbler *Phylloscopus borealis*, bluetail *Tarsiger cyanurus*, Indian tree pipit *Anthus hodgsoni*). The reasons for changes, that reflect general trends occurring simultaneously in different parts of the species' area, are not also quite clear. Examples are Taiga Bean Goose *Anser f. fabalis*, Lesser white-fronted goose *Anser erythropus*, Scoter *Melanitta fusca*, Great Snipe *Gallinago media*, Starling *Sturnus vulgaris* with widespread declines of their numbers.

Changes of some species are explained by long-term cyclical fluctuations in numbers. For example, the Red-breasted goose *Rufibrenta ruficollis* regained western borders of the area on the Yamal when the next rising stage 12-14 year cycle in the end 1990-s. Changes in the number of Bewick's swan *Cygnus bewickii* are also cyclically from high numbers in 1935-1955 (22,5 ind./10km in the coastal part) to a decline in 1980-s (0,2 ind./10km) and to a next rise in 2000-s (4,2 at a distance and 10,0 ind./10km of river valley close to the sea). In the late XIX century Greylag Goose *Anser anser* nested in the Lower Ob under 66°48'N. In the 1930-1940, in the phase of the low water in the steppe zone, its total number declined and after the mid-1960-s it stopped nesting in the Lower Ob. Since the early 1980-s, in the phase increasing of water in the steppe, the total number of the geese began to increase and its visitations in the north became ordinary, right up to 68°28'N.

Anthropogenic factor had to cause the number and distribution changes in more than a third of species. The appearance of suitable habitat or additional food sources contributed to the increase of the number and spreading of the Black-headed Gull *Larus ridibundus*, Ringed Plover *Charadrius hiaticula*, Magpie *Pica pica*, Hooded Crow *Corvus cornix*, Rock-pigeon *Columba livia*, sparrows *Passer domesticus* and *P. montanus* and Snow buntings *Plectrophenax nivalis*.

Owing to extermination, the number of Gyrfalcon *Falco rusticolus* and capercaillie *Tetrao urogallus* have dramatically dwindled, in the former case because it is being fowled for smuggling, in the latter - it was shooted when its number decreasing into a cold period.

Because of the vast transformation of habitats and reducing of lemmings number owing to overgrazing of reindeer the decreasing of the typical tundra species has taken place. Such predators

as Snowy Owl *Nyctea scandiaca* and Pomarine Skua *Stercorarius pomarinus*) have almost ceased to nest. Nesting density of other predators has decreased: Rough-legged Buzzard *Buteo lagopus* into 2,5, long-tailed Skua *Stercorarius longicaudus* into 3 times. The number of geese decreased almost into 2, hygrophilous waders into 3, Lapland bunting *Calcarius lapponicus* almost into 5,5 on watershed and 2,5 in floodplain, long-tailed Duck *Clangula hyemalis* into 2 times on watershed.

About a third of the “changed” species are new, “southern” birds, whose emergence is explained usually owing to climate warming. However, over the last 100 years (since 1908) a significant increase in temperature of the spring and summer months were not observed. Over the past 75 years on the north of Western Siberia, there were 4 periods of the emergence of southern species, but without a clear relation with brief warm periods. After emergence in the north almost all new species stay here for years and nest without whether warm or cold are the following seasons. Perhaps the emergence of southern species has not relation with short-term cycles of warming but with long-term ones. The vanishing of the "new" species occurs only in single instances, and for reasons not related to the weather. The ratio of the vanishing and the emerging species is about 1:9.

Thus, there is a constant process of faunal restructuring. At that, there is a gradual increase in the total number of species. The causes and mechanisms of this process are not clear entirely.

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MODIFICATION OF SEDIMENTARY ROCK CLASTS IN HIGH ARCTIC POLYTHERMAL VALLEY GLACIER ENVIRONMENT: CASE STUDY FROM THE BERTILBREEN, CENTRAL SVALBARD

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KEYWORDS: SEDIMENTARY ROCK CLASTS; CLAST STRIATION, SHAPE AND ROUNDNESS; MORAINES; PROGLACIAL GLACIOFLUVIAL STREAM; SVALBARD

Bertilbreen is a 3–3.5 km long valley glacier located NW of the Pyramiden town on the Spitsbergen Island. High lateral and frontal moraine ridges places ~2 km down the present glacier front have been deposited during its last maximum extent during the Little Ice Age. The terminoglacial zone is made of ice-cored moraines (ablation moraines of Bennett & Glasser 2010). A till plain is located behind the frontal moraine ridge. Glaciofluvial stream flowing from the glacier front is cutting through the frontal moraine ridge. The stream is downcutted to the solid bedrock in the immediate forefield of the frontal moraine. A braided outwash fan is created by the glaciofluvial stream at the mouth of the incised valley. Bertilbreen could be characterised as a polythermal glacier basing on the landforms and sedimentary sequences (Hambrey & Glasser 2012) and our field observation.

Bertilbreen is located in the valley made exclusively of solid sedimentary rocks. Strongly tectonically tilted Devonian Old Red sandstones are located on the valley floor and on the lower parts of the slopes. The upper valley slopes and the surrounding summits are made of Carboniferous and Permian limestones. Terrestrial Carboniferous sandstones and siltstones are present only locally. All these rocks are present as clasts in different glacial deposits. The most common are limestones and Old Red sandstones. Carboniferous sandstones are mostly present only as an accessory.

The research was focused on the clasts shapes in morainic material and on the clasts modification during the proglacial glaciofluvial transport. The fraction of 64–256 mm in the b-axis was studied, each sample contained 100 clasts. A comparison was made for the two most abundant petrotypes - limestone and Old Red sandstone.

The clasts in the moraines have typical shapes, as described from numerous glaciers (e.g. Benn & Ballantyne 1994, Bennett et al. 1997, Hambrey & Ehrmann 2004). Clastic material of the lateral moraine has high values of both RA and C_{40} indices, as it was nearly not modified by glacier movement. Slightly lower values of both indices are typical for the frontal and ice-cored (ablation) moraines and the till plain. The sediments of these landforms should contain actively modified material by the glacier, as it is characterized by an average to high roundness values and by isometric shapes. However, these shapes may also originate from subglacial or englacial glaciofluvial transport. Moraines might also contain material reworked from older glaciofluvial deposits; which did not undergo an active transport in a glacier despite the higher roundness values.

Striation is a clasts' superficial signature originating exclusively from an active sliding at the glacier base. It is very common on the surfaces of the sedimentary rocks clasts, while it is much rarer on the crystalline rocks clasts' surfaces (Bennett et al. 1997, Hambrey & Glasser 2012). Approx. 40–50% of the clasts is striated in the frontal and ice-cored (ablation) moraines and the till plains of the Bertilbreen. We can assume that at least half of clasts creating these landforms initially underwent an active transport at the glacier base.

The striation could thus be used to determine the minimum amount of actively transported clasts at the glacier base in sediments with abundant sedimentary rocks clasts. This phenomenon could not be use when crystalline rocks are dominant, because striation is created much less on the surface of the crystalline rocks.

Clast shapes correspond to the source sediments (diamictons of an ablation moraine and a till plain) in the proglacial glaciofluvial stream between the glacier front and the LIA frontal moraine. The glaciofluvial transport is not effective to modify the material in this zone. In the section of the stream between the incised valley and the subsequent braided outwash fan the limestone and sandstone clasts shapes differ. This is probably caused by the primary rock conditions influencing strongly the clast modification during the glaciofluvial transport. This might be seen in a trend of changing the limestone clasts towards the more isometric ones and to the predominance of subrounded projections (in the distal part of the fan ~40–60% of limestone clasts is subrounded). Sandstones create clast with lower sphericity and that are clearly more angular than limestone clasts (Old Red sandstone clasts are predominantly subangular in the distal part of the fan). Lower roundness values of sandstone clasts are influenced by an admixture of angular debris originating from the outcrops in the canyon. At the same time the actively modified (striated) sandstone clasts broke apart during glaciofluvial transport, which is suggested by a high number of striated angular clasts. Breakages of sandstone clasts towards more angular platy clasts before and during the transport were probably affected by the primary bedding and jointing of these rocks. Limestones were, however, rounded and did not break apart. A clear trend of gradual diminishing of clast striation with an increasing glaciofluvial transport distance was not found here. Only for limestone a visible decrease of the striated clasts shares could be seen in the distal part of the fan. The proglacial glaciofluvial transport was not long enough here to wipe off the signs of the glacier scouring processes from the surface of the clasts (Bennett et al. 1997).

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THE ROLE OF MOSSES IN ICELANDIC SUBARCTIC TUNDRA

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KEYWORDS: MOSS DEPTH, MOSS-VASCULAR PLANTS INTERACTIONS, SOIL MICROBIAL BIOMASS, SOIL TEMPERATURE, SUBARCTIC TUNDRA.

Mosses are an important component of many ecosystems of the subarctic tundra in Iceland and these fragile ecosystems are expected to be affected by changing climate. However, the role of mosses in ecosystem functioning and their interaction with vascular plants is poorly studied in Iceland. To improve our understanding we ask: How does the moss cover effect different soil properties and the survival, growth and reproduction of vascular plants?

Relationships between variable moss depth and different soil properties (soil temperature, moisture, respiration, pH, microbial biomass and available NO3- og NH4+) were examined in 30 plots (30x30cm) in relatively dry dwarf birch heath community (Auðkúluheiði, 65°N, 480 m elevation), in which moss cover averaged 90% and the dominant bryophyte species was *Racomitrium lanuginosum*. To study the interaction between moss cover and vascular plants, a moss removal experiment was set up in June 2011 where four target species: *Betula nana*, *Empetrum nigrum*, *Silene acaulis* and *Carex rupestris* were present in each plot (50x50cm, total of 27). Three treatments were applied, 1) all moss cover removed, 2) moss cover thinned 50% and 3) no moss removed. Target species responses were measured in August 2012.

With increasing moss cover the soil temperature decreased and daily temperature fluctuations were reduced. Soil moisture increased with moss depth and soil microbial biomass increased with increased moisture. The target species responses differed depending on treatments. All four species had higher reproduction (flowering) with the moss cover removed, while survival and growth during the study period varied between growth forms and treatments.

These results show that the *Racomitrium lanuginosum* cover plays an important and complex role in Icelandic subarctic tundra. It acts as an insulator for soil temperature and retains moisture, which is a key factor in ecosystem processes in harsh environment such as Auðkúluheiði. Although the moss cover may reduce flowering, its effect on the vascular plants appear to vary and not to be entirely negative.

THE BIOGEOCHEMISTRY OF ARCTIC GLACIAL ECOSYSTEMS: EXAMPLES FROM SVALBARD

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KEYWORDS: BIOGEOCHEMISTRY; POLYTHERMAL GLACIERS; RUNOFF; GLACIAL ECOSYSTEMS

Contemporary cryospheric change in the Arctic is marked, and in the case of glaciers, associated with glacier thinning, thermal change, large runoff fluxes and ice marginal retreat. These processes have the capacity to impact upon the often sensitive ecosystems that are found beyond the ice limit. However, while the likely physical changes to ice marginal ecosystems are known (at least from a conceptual perspective), the biogeochemical impacts of cryospheric change are ratherly poorly understood. This talk therefore combines a description of how glaciers in Svalbard are responding to climate change with an assessment of the biogeochemical consequences that result from it. Particular emphasis will be given to Svalbard glaciers, and the microbial ecosystems found in glacial habitats, ice marginal sediments and coastal waters. Two key aspects of the connections between glaciers and their downstream ecosystems will be made clear: first glaciers are ecosystems in their own right, and so nutrent release downstream is not a simple function of ice loss. Second, ice mass losses from low elevations are causing glaciers to freeze onto their substratum, with very significant consequences for microbial processes at the glacier bed and the transfer of nutrients to ice marginal environments.

Examples of habitat characteristics in glacial ecosystems across Svalbard will be presented, giving particular emphasis to autotrophic processes at the glacier surface and heterotrophic bacterial processes at the glacier bed and along its flanks. These characteristics will then be linked to the composition of glacial runoff and it will be shown how microbially-mediated processes virtually dominate the anionic composition of glacial runoff. This offers the best means of demonstrating the marked impact of glaciation and deglaciation upon the biogeochemical cycling of carbon, sulphur and nitrogen in polar environments.

CLIMATE CHANGE RESEARCH IN NY-ÅLESUND

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KEYWORDS: CLIMATE CHANGE, NY-ÅLESUND, NITROGEN DEPOSITION

Climate research in Ny-Ålesund has been a primary actitivity already from the early establishment of scientific investigations. This presentation will give a brief presentation of the wide range of knowledge accrued during the past four decades. Examples include the trends in snow melt in the spring, trends in glacier mass balance, and trends in green-house gases. The observed changes are consistent with what is expected as a result of human induced perturbations of radiatively active species in the atmosphere.

In an ecological perspective the climatic trends themselves will clearly induce changes. Recent results will be presented regarding how shifts in wind patterns and deposition can further perturb the environment for terrestrial biology through shifts in deposition of nutrients and pollution. This will be exemplified with studies of deposition of nitrogen from the atmosphere.

PASSIVE WARMING STUDIES IN ARCTIC AND ANTARCTIC: DIFFERENCES AND SIMILARITIES IN THE EFFECTS OF OPEN TOP CHAMBERS ON THE MICROCLIMATE

Ad H.L. Huiskes [1], Stef F. Bokhorst[2] and many others

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Organisms in polar terrestrial ecosystems are close to their distribution limits, while biological processes are already known to be limited by the twin constraints of water availability and chronically low temperatures. The magnitude of change being experienced by polar terrestrial ecosystems, combined with the sensitivity of their component biota to these changes, leads to the prediction that biological consequences will be relatively larger and easier to detect in these simple ecosystems, compared to lower latitude counterparts. During the IPY, studies on these consequences were brought together in the IPY TARANTELLA project (Terrestrial ecosystems in Arctic and Antarctic: Effects of UV Light, Liquefying ice, and Ascending temperatures). To study the effect of climate warming experimentally (infra red) lamps and warming cables in the soil can be used, but this is often not possible in the polar regions were infrastructure is sparse. Hence passive warming chambers were developed and used both in the Arctic and the Antarctic.

In the Antarctic various designs of chambers have been used over the years and in this presentation we will compare the effects of the different designs. In the Arctic warming studies were mainly executed using Open Top Chambers, developed by the participants in the International Tundra Experiment in which most of these studies were combined.

Passive chambers are mainly used to examine the impacts of summer warming in the Polar Regions. However, impacts occurring outside the growing season, or related to extreme temperatures, have hardly been reported, despite their potentially large biological significance. In this presentation we synthesize and discuss the microclimate impacts of passive warming chambers (especially Open Top Chambers - OTCs) commonly used in Antarctic and Arctic terrestrial habitats, paying special attention to year-round effects, seasonal warming, extreme temperatures, freeze-thaw events and effects on moisture availability.

We conclude from the combined studies that:

- The warming effect of screening techniques, to simulate temperature changes brought about by climate change, is based on the effect in the summer season. In other seasons the different designs show different effects.
- Especially the effects on degree-day sums and frequency of freeze-thaw cycles are ecologically significant
- Spring is the most important season for terrestrial organisms. Especially in this season research should be intensified, choosing the right chamber.
- OTC effects on snow depth is often regarded an artifact but may not be. Especially in the Antarctic Peninsula, snowfall is increased in winter, followed by earlier snow melt. An increase in snow cover by accumulation in OTC's can be simulated, but not the earlier snow melt.
- OTC's in Arctic, Antarctic, and Alpine environments show similar effects on microclimate parameters

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ALIENS IN ANTARCTICA, QUANTIFYING SEEDS INADVERTENTLY CARRIED INTO THE ANTARCTIC

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The impact of alien (non-native, non-indigenous, introduced) species poses a major threat to many of the ecosystems of the world, Antarctic ecosystems included. In the Antarctic Continent two vascular plant species (*Poa pratensis* and *P. annua*), an enchytraeid worm (*Christensenidrilus blocki*), and a chironomid midge (*Eretmoptera murphyi*) have successfully established, a much larger number of plant, invertebrate and vertebrate species have invaded many of the subantarctic islands. The Southern Ocean effectively isolated the Antarctic from other biomes (when we use the term 'the Antarctic' we refer to the region around the South Pole: Antarctica, its surrounding waters and the sub-Antarctic islands. 'Antarctica' is the term we use for the continent proper.). However, this barrier has been broken since human influence in the Antarctic began, the presence of a number of species, originally absent, supports this. Visitor numbers have increased since the beginning of the 20th century, because a large number of research stations has been established, visited yearly by scientists and support personnel, and by an increase in the number of tourists visiting the Antarctic (from 6700 in the 1992/93 summer season to about 46,000 in the 2007/08 summer season, effecting an astonishing number of 222,418 landings in Antarctica and on the surrounding islands).

Until quite recently there was a complete absence of information about the frequency with which propagules were imported, and the number of species represented by these propagules. We sampled visitors to the Antarctic, in order to quantify the propagule load they carried; we focused in this study on seeds. In addition we collected information about the regions people visited before they came to the Antarctic, and about the use of clothing and equipment they brought with them.

Our results show that (a) about one third of the 850 visitors sampled, carried plant seeds (4288 from over 250 different species) with them, that (b) ships and aircraft crew and tourists carried seeds less frequently, but field scientists and tourist support personnel more frequently than other categories of visitors, and that (c) camera bags, backpacks, and footwear showed a higher frequency of harbouring seeds, than other items of clothing or personal gear. The behaviour of the visitors and their travel patterns prior to their journey to the Antarctic modulated these findings.

The protected status of Antarctica requires visitors to refrain from introducing alien organisms. By reducing the propagule number being carried into the Antarctic the probability of new biological invasions will be reduced. Our data will make it possible to devise an efficient and effective way of assuring that the transport of alien propagules to the Antarctic is minimized.

EFFECTS OF LIFE FORM AND SUBSTRATE DIFFERENCES ON WATER AVAILABILITY FOR ARCTIC LICHENS DURING SNOW-FREE SUMMERS IN THE HIGH ARCTIC GLACIER FORELAND

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KEYWORDS: LICHEN, HIGH ARCTIC, WATER AVAILABILITY, LIFE FORM, SUBSTRATE, PHOTOSYNTHESIS

We investigated the photosynthetic activity and water relationships of five dominant lichens, which were distributed in a glacier foreland, by focusing on differences in their life form and attached substrates using observational and experimental analyses in the High Arctic, Ny-Ålesund, Svalbard (79°N) during snow-free seasons in 2009 and 2010. After rains ceased, lichens and their attached substrates quickly dried up, while the photosynthetic activity in lichens gradually decreased. Water content (WC) of all lichens uniformly decreased from 100% to 20–40%, while levels of <20% were obtained in some cases. The in situ photosynthetic activity was estimated based on the electron transportation rate (ETR) in four fruticose lichens and it approached zero around noon, although ETR of a crustose lichen remained positive. WC and photosynthetic activity of the four fruticose lichens showed diel increases after rehydration from the surrounding air during the night and the maximum ETR was recorded in the early morning. By contrast, WC of a crustose lichen grown on humus remained at about 20% throughout the day and even during a desiccation period, while ETR was highest around noon. The humus substrate retained significantly more water than the other substrates (moss litter, vascular plant and mixture of both). The crustose lichen could acquire water from the humus and retain its WC to perform positive photosynthesis. The light-ETR relationship curves of the five well-watered lichens were characterized into two types, i.e. shade-adapted with photoinhibition for fruticose lichens and light-adapted with no photoinhibition for crustose lichens. The maximum ETR was expected to occur when they could acquire water from the surrounding air or substrates during the desiccation period. Our results suggest that Arctic lichens have different water availability among species due to their morphological characteristics and/or attached substrates, which affected their photosynthetic active periods during the summer.

SVALBARD'S CLIMATE SYSTEM (PAST, PRESENT AND FUTURE)

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KEYWORDS: SVALBARD, SPITSBERGEN, CLIMATE, LONG-TIME VARIABILITY, WARMING, TEMPERATURE

Results of the study long-term variability of temperature and radiation conditions in the atmosphere, ocean and ice conditions in the fjords of Svalbard based on data obtained at the Russian Hydrometeorological Observatory "Barentsburg" are presented. Time series of air temperature, incoming global solar radiation, cloud amount, temperature and salinity, ice characteristics were analyzed. A number of characteristics (downward long-wave radiation of the atmosphere) were estimated using original techniques, verified by data of direct instrumental observations. In particular, the method of "*Konig-Augstein*" developed at the Alfred Wegener Institute for Polar and Marine Research (Bremerhaven, Germany) was applied. Direct measurements of the characteristics of the long-wave balance from Norwegian research station ("*Sverdrup*" station, Ny-Alesund, Svalbard) were also used.

Monthly and annual estimates of surface air temperature, cloud cover, and incoming global solar radiation for station Barentsburg, and oceanographic and ice data for the fjords of the archipelago were obtained from Russian and Norwegian archives and databases.

The analysis of the cloud characteristics for individual steps (clear and overcast sky) was executed. The distribution functions of cloud amount for various seasons of the year were estimated. A generalization for conditions of polar night and polar day was made as well.

The long-term variability in temperature and salinity of intermediate Atlantic waters as one of the main external factors that determine ice conditions in the Svalbard's fjords was estimated. The long-term variability of ice conditions was assessed based on more than 20 standard ice characteristics observed instrumentally and visually at the Barentsburg research station. The regularities and features of the above characteristics variability on different time scales and statistically significant trends were evaluated.

A determining role of increasing frequency of overcast conditions in lowering of the average annual incoming global radiation, increasing of the downward long-wave atmospheric radiation and increasing of the surface air temperature was shown.

The long-term trend of an increase of the intermediate Atlantic water temperature and softening of the ice conditions in the fjords were observed.

The conclusion about overall "warming" of Svalbard climate in the second half of the twentieth century was made on the basis of the study carried out.

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PHOTOTROPHS IN SUBNIVAL SOIL

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KEYWORDS: PHOTOTROPHS, SUBNIVAL SOIL, HIMALAYAN MOUNTAINS, CHRONOSEQUENCES, MICROBIAL COMMUNITY

Introduction

Soil environments in high-altitude ecosystems provide habitats for numerous microorganisms, despite being subject of environmental stress. The diversity knowledge about these communities are still very poor, especially in the mountains, despite mountains create 12.3% of terrestrial land outside Antarctica and host a larger proportion of the Earth's biodiversity (Kőrner et al. 2011). Most of the available studies, have been based on data from Europe, while the largest and highest mountainous areas are located in Asia. On the Tibetan Plateau, which covers almost 14 times larger area than the European Alps, the subnival and alpine climatic zones host a unique and relatively species-rich flora (Miehe *et al.*, 2011) and well develop biological soil crusts (BSC) with complex microbial communities (Řeháková *et al.*, 2011). One member of BSCs are phototrophic microorganisms - cyanobacteria and eukaryotic microalgae. They play several important roles in soil environment, such as soil stabilization, water retention and infiltration, and help with the establishment of vascular plants.

Aims of the investigation

Elucidate diversity of phototrophic soil community and understand their role in BSCs and bulk soil in the subnival and alpine zone of Ladakh.

Study sites and sampling

Fieldwork was conducted on the W-slope of Chamser Kangri Peak above TsoMoriri Lake. It is located on the Tibetan Plateau in Ladakh, India. The sampling was done at four locations along an elevational transect from 5300 to 5900 m asl., to cover the different major vegetation types of steppes, alpine screes, alpine meadows and the subnival zone. Two types of soil were collected for analyses-BSCs and uncrusted soil.

Methods

Quality and quantity of phototrophs were done according protocol Kaštovská et al. 2005. Physico-chemical analyse of soil were determined by Řeháková et al. (2011). Nitrogenase activity was estimated as acetylene-ethylene reducing activity (Hardy et al. 1973).

Results

The both types of investigated soils were mainly inhabited by cyanobacteria. The phototrophs from BSCs did not differ from that living in uncrusted bulk soil in terms of the species composition, but the biomass was three-to-five times higher. An increasing trend with elevation was observed in the cyanobacterial biomass from the biological soil crusts, with the genera *Nostoc* spp., *Microcoleus vaginatus* and *Phormidium* spp. contributing to this increase. The genus *Chroococcus* identified in the Tibetan Plateau soils have not been previously reported to be associated with BSCs. Because Cyanobacteria created dominant part of phototrophs, the nitrogenase activity was determined in collected soils. Based on the laboratory experiments, the highest nitrogenase activity was recorded in the middle elevations, and the rate of nitrogen fixation was not correlated with the cyanobacterial biomass.

Discussion

BCSs harbored higher biomass of cyanobacteria than uncrusted soils; even the species composition was very similar. The interesting trend of increasing cyanobacterial biomass in BSCs

with altitude was observed, even the concentration of macronutrinets was higher in uncrusted soil. Here must be other factor causing the development of biomass, than soil chemical properties. The trend may be caused by several factors. Firstly, lower competition with vascular plants for resources. At the highest elevation studied is negligible cover of plant, less than 10% . Secondly, the temperature profile during the vegetation season provides better growing conditions for the microorganisms than for plants. The vegetation season lasts 1,5 months at 5900 m asl and during these days the temperature often drops below freezing for more than 8 hours. The short growing season and shortage of water are conditions, which microorganisms are resistant to. Phototrophic microorganisms have a much quicker metabolism and a shorter generation time than plants. In addition to this, the low amount of accessible water primarily activates the crust rather than the uncrusted soil where the evaporation is much quicker due to lower retention of water, which is better in BSC. The nitrogenase activity was highest in the middle elevation, but reason why was it are still unclear. From the presented results is visible, that the remote mountains of the World need to be studied more for the complex understanding of the mountain ecosystems.

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DEHYDRATION-DEPENDENT INHIBITION OF PHOTOSYNTHETIC PROCESSES IN TWO LICHEN SPECIES FROM SVALBARD: A FLUOROMETRIC STUDY.

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KEYWORDS: UMBILICARIA, QUANTUM YIELD OF PHOTOSYSTEM II, DEHYDRATION, WATER POTENTIAL, PHOTOSYNTHESIS

Introduction

Lichens are poikilohydric symbiotic organisms exhibiting maximum photosynthetic rate at optimum hydration that is species-specific. If hydration of lichens decrease below such optimum due to progressive desiccation, photosynthetic processes are gradually inhibited. Initial phase of desiccation is typical by partial water loss from a thallus but no reduction of photosyntehic rate is apparent. More pronounced water loss, however, leads to fast decrease of photosynthetic processes. At severe dehydration of thalli, full inhibition of photosyntehsis occurs. Within last couple of years, the dependence of photosynthesis of numerous Arctic and Antarctic lichens on thallus dehydration expressed as water potential has been investigated in our laboratory (see *e.g.* Barták et al. 2005). Representatives of genus *Umbilicaria* typically show substantial photosynthesis even at strong dehydration, *i.e.* within water potential (WP) range from -15 to -20 MPa. In this study, we investigated two lichens form Svalbard (*Umbilicaria cylindrica* and *Umbilicaria decussata*) during gradual desiccation using measurements of chlorophyll fluorescence, effective quantum yield of photosynthetic processes in photosystem II (Φ_{PSII}) of symbiotic alga in particular. The other aim of this study was to evaluate critical water potential (WP) at which photosynthetic processes are fully inhibited and compare to existing data from other lichen species.

Material and Methods

Typical foliose thalli of lichens *Umbilicaria cylindrica* and *Umbilicaria decussata* were collected in central part of Spitsbergen in the vicinity of Petuniabukta during field campain in Arctic summer of 2012. Under laboratory conditions, inhibition of photosynthetic processes in dependence on gradual dessication was investigated using two techniques simultaneously. Thalli were naturally desiccated at room temperature. During desiccation, water potential (WP) of thalli was determined repeatedly by a WP4T (Decagon, USA) water potential meter. Simultaneously, effective quantum yield of photosynthetic processes in photosystem II (Φ_{PSII}) was measured by a FL1 fluorometer (OptiScience, USA) using saturation pulse method on light-adapted samples (for definition see Roháček et Barták 1999) . Thus, dependence of Φ_{PSII} on WP was obtained for both experimental species.

Results and Discussion

At full thallus hydration, suprasaturation effect on photosynthesis was observed in *U. cylindrica* but not in *U. decussata* (see Fig. 1, the Φ_{PSII} values at WP=0). Either no or mild decrease of Φ_{II} was observed in both species within the WP range of 0 to -10 MPa which reflects initial phase of thallus dehydration. Further decrease of water potential (below -10 MPa) led to substantial and rapid decrease of Φ_{II} in both experimental lichen species. Significant limitation of photochemical processes in PSII appeared at WP below -20 MPa. Critical WP at which Φ_{PSII} was close to zero differed between species. Full inhibition of photosyntehtic processes was reached at about -31 MPa in *U. decussata* while the same was apparent at lower values of about -34 MPa in *U. cylindrica.*

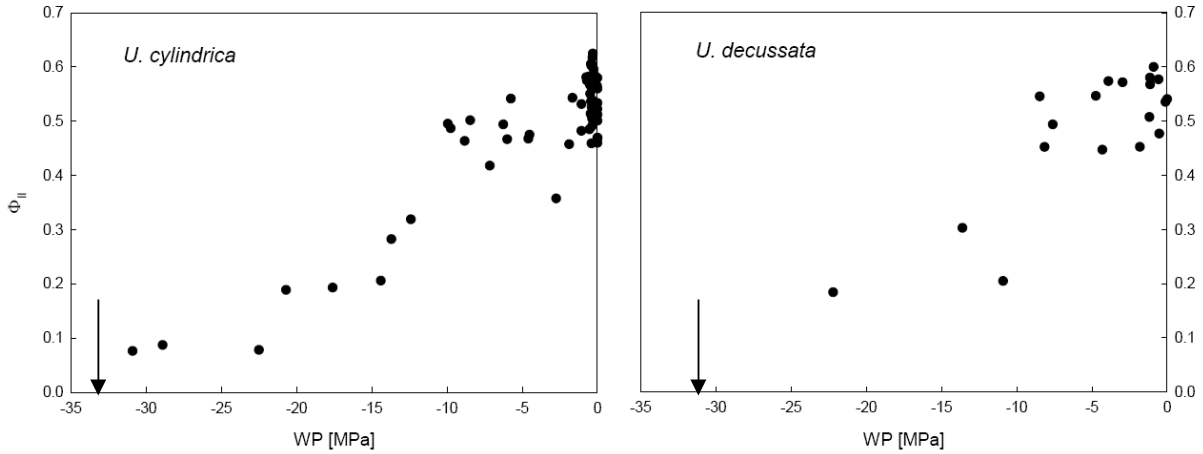

Fig. 1. Relation of effective quantum yield of photosynthetic processes (Φ_{PSII}) to water potential (WP) recorded during gradual desiccation form full thalli hydration (WP=0 MPa) to fully dehydrated thalli (critical water potentials are found within the range from -30 to -35 MPa as indicated by arrows).

The results indicated high degree of tolerance of genus *Umbilicaria* species to water stress and their ability to photosynthesize even under substantial water loss from their thalli. Moreover, critical water potential values were below -30 MPa which indicates the ability of the two lichen species to perform photochemical processes of photosynthesis at strongly desiccated state of a thallus as well (Jupa et al. 2012). We may, therefore conclude that *U. cylindrica* and *U. decussata* may thrive well in polar ecosystems with limited water availability and short period of thallus hydration.

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INVESTIGATION OF RUNOFF SOURCES DUE TO CHANGES IN WATER ISOTOPIC COMPOSITION - ELSA RIVER, CENTRAL SVALBARD

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KEYWORDS: SVALBARD, ISOTOPES, WATER FLOW RATE, HYDROGRAPH SEPARATION

Two investigations of hydrologic regime and isotopic changes of $\delta^{2}H$ and $\delta^{18}O$ were carried out in the Elsa river catchment (fig. 1) during the field campaign in August 2012. Elsa River originates from the Elsabreen glacier in the area of Petuniabukta in Svalbard archipelago (78.6969°N, 16.4101°E). Elsa river channel is approximately 3 km long with quite high elevation gradient. This represents an example of braided river typical for this region. This means that the river flows in unstable channel/channels and carry large amounts of sediment load. Two sampling and measuring campaigns were carried out to study the flow rate changes and diurnal regime of the river flow.

The largest changes in discharge in the catchment are related to precipitation events. Significant changes - especially strong diurnal regime - are however related to air temperatures and radiation level. Ice and snow melt stands for the main contributor to runoff. Melt water originating from Elsabreen glacier and adjacent snow fields as well as the melting permafrost layer are main sources of water available for runoff during summer season.

Investigating the ratio of melt water added by glacier and melt water added by the snow fields was the main task of the survey. Best way to investigate the amount of contribution of different sources was to analyse stable isotopes ^{2}H and ^{18}O naturally presented in terrestrial water system as a part of a water molecule. Concentration of these isotopes is expressed as $\delta^{2}H$ and $\delta^{18}O$, which is defined by VSMOW (Vienna Standard Mean Ocean Water) and mainly depends on the temperature when the precipitation fell down. This isotopic hydrograph separation is commonly used for separation of a melt water ratio from the total outflow bringing very valuable results.

Figure 1. - Elsa river catchment in Petuniabukta, central Svalbard

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THE EFFECT OF TOPOGRAPHY AND LANDCOVER ON SURFACE TEMPERATURES IN SVALBARD

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KEYWORDS: SURFACE TEMPERATURE, THERMAL REFUGIA, TOPOGRAPHY, VEGETATION COVER

Surface temperature (ST) is a function of weather condition, topography, water supply, soil properties and vegetation cover. Complex topography and various biotopes result in broad scale of ST. Heterogenic mosaic of ST may represent resilient system in condition of climate change. The aim of our project was to test the influence of topography and vegetation cover on ST in the polar area. We hypothesize that ecosystems, where temperature is one of the most limiting factors, will form heterogenic mosaic of ST patches due to complex topography and water supply. Patches with highest ST may create thermal refugia for thermophilic vegetation and those "hot spots" may be potential source of seeds in the climate warming. On the other hand the thermal refugia may protect vegetation in cold climate periods.

The area of interest is located in Dickson Land, in the central part of Svalbard. We focused on the area near the bay Billefjorden, primarily in Petuniabukta and Skansbukta. This area has rugged terrain with heterogeneous geology.

Local level of surface temperature

The local scale is focused on a land cover and topography influence on the ST in range of several meters. We measured the ST using thermal dataloggers (COMET) regularly every half an hour. Four dataloggers were installed on 7th July for approximately two weeks with four probes for each of it: 1) Petuniabukta- hummock tundra with wet or dry vegetation and mosses; 2) Petuniabukta - the hill with slope orientation on the east, south and north; 3) Petuniabukta-Brucebien- tundra with dry and wet vegetation; 4) Skansbukta- the scree southern slope with rocks, mosses and vegetation.

We studied three influences on the ST: 1) the effect of slope orientation (aspect) was measured on the small local hill in Petuniabukta, where each of the four probes was placed in the vegetation of Dryas octopetala with a different slope orientation., 2) the effect of the land cover unit (wet, dry, rocky, hummock covered by vegetation and covered by lichenous crust substrate) and 3) the topoclimatic comparison of ST (dry vegetation) in Skansbukta and Petuniabukta .

Regional level of surface temperature

Second level covers ST variability in regional scale with the aim to investigate more general effects including higher differences in topography and precipitation.

Satellite imagery from Landsat 4-5 and Landstat7 were used for ST calculation. The spatial resolution of the 6th thermal channel of Landsat 5 TM and Landsat 7 ETM+ is 120 x 120m and 60 x 60m, respectively. Because of lack cloud free satellite scenes, we selected three images from years 2001-6-17, 2002-6-22 and 2006-7-23. DN (digital number) values were transformed to temperature values by applying ATCOR2_T (Geomatica Algorithm Reference, 2003). To avoid the ST differences due to weather condition we used the Z-transformation. In Multiple regression were data from DEM and Slope united in Hillshade. For Resulting map show ST distribution in the area of interest.

When we compared the influence of local topography on the ST, the south slopes expressed the highest values (27,4°C) and lowest values (2,2°C) of ST and largest amplitude. While the northern slope has the smallest amplitude (3,5 -13,5°C). The difference between the eastern slope and the 0°horizon plane was not significant. The wetness has a strong impact on surface heating in

hummock tundra. The median values of surface temperature on the wet hummock and dry hummock varied by 0,8°C. The difference between hummock tundra and lichenous cruist was 0,3°C, thats means it is not significant. The highest ST (30°C) and the largest ST amplitude (26,4°C) were measured in Skansbukta in stones. The median value of ST in Skansbukta was 8,9°C and in Petuniabukta 10,1°C when we compared measurements on the south slope with dry vegetation. In this case higher ST was in Petuniabukta 20,8°C and the difference between maximums was 4,2°C. The significant difference was confirmed. The ST of wet hummock showed lower values in compare to other substrates with vegetation. The difference of the surface temperatures between dry hummock with vegetation and dry tundra vegetation was not significant. In Skansbukta, where we tested surface temperature on the southern slope, the lowest amplitude probe was in vegetation. The temperature increase in vegetation has the same dynamic (speed) as in stones, but ST in the vegetation reached the minimum.

The considered topography influence on surface temperature between Skansbukta and Petuniabukta was also accepted. Multivariate regression shows the dependence of surface temperature on altitude and slope orientation. Satellite data confirmed to us that Petuniabukta is warmer than Skansbukta. This regional model of altitude and hillshade explained 0,18; 0,21; 0,11of variability for three scenes years 2001, 2002, 2006 respectively. Probability is in all cases lower than 0,000 and the hypothesis refuse on the zero level of significance.

Both local and regional ST temperatures showed similar effect of topography on ST, where despite the expected low diurnal ST changes during polar day, the south slopes reached highest mean values of ST and the northern slopes the lowest ones. Finding consequences among surface temperature, topography and land cover can be useful for delineating areas as a potential refugees.

THE ANTARCTIC PART OF THE CZECHPOLAR PROJECT INTRODUCTION: JOHANN GREGOR MENDEL CZECH ANTARCTIC STATION, JAMES ROSS ISLAND, ANTARCTICA

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The unique scientific infrastructure of J.G. Mendel Czech Antarctic Station on James Ross Island (Antarctica) is owned and run by the Masaryk University in Brno. Specialized biological research laboratory for extreme polar conditions - EEL (Extreme Environmental Laboratory) is the part of the CzechPolar project as well.

James Ross Island is about 2.600 square kilometres in area and only the northern part is deglaciated; in any case, it is one of the biggest "Antarctic coastal oases". James Ross Islands is surrounded by numerous small islands that can be considered potential areas for future research. James Ross Island is located on the Eastern side of the Antarctic Peninsula. The clash of two air masses with differing temperatures and moisture levels (oceanic and continental air masses) over the Antarctic Peninsula leads to considerable climatic variability in the vicinity of the Czech Antarctic Station. The process of deglaciation is geologically relatively young (it has taken about 6.000 years) and is still continuing in the northern part of James Ross Island, which gives scientists the opportunity to study past and present glacier mass balance changes (shelf glacier and continental glacier), gradual relief transformation and subsequent colonization of recently deglaciated areas by biota (consequences of global warming for biological diversity).

Czech Antarctic Research Programme at the J.G. Mendel Antarctic Station

The research programme carried out at the station is intended to be long-term and multidisciplinary. The multidisciplinary character of the research programme is determined by its focus on a complex study of one of the largest deglaciated area in Antarctica (the coastal Antarctic oasis with significant research potential). Both its abiotic and biotic components are studied.

Biology related topics

- Biodiversity of lichen flora of JRI (taxonomy)
- Stress in photosynthetis in poikilohydric autotrophs of JRI
- Microbial communities (taxonomy, physiology, ecology)
- Fungi of JRI (field and lab-based work)
- Advanced chlorophyll fluorescence techniques to assess lichen vitality
- Invertabrates associated with moss cushions and biological mats
- Cryoprotective mechanisms in extremophilic autotrophs
- Avian biodiversity
- Lake ecosystems biodiversity
- Parasitological diversity of Antarctic fish, birds and mammals (taxonomy)
- Plant ecology

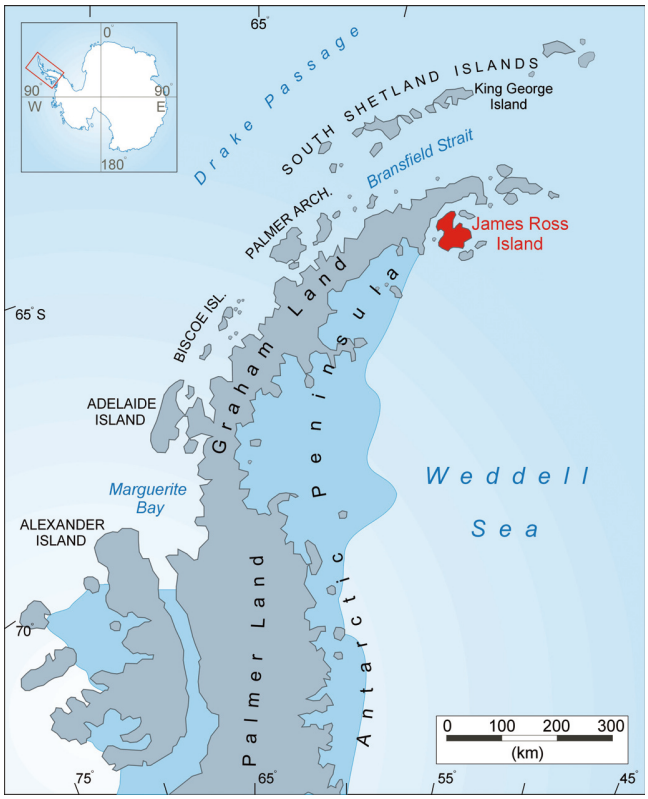
Meteorology and glaciology related topics

- Study of continual variability of UV radiation depending on atmospheric factors
- Long-term monitoring of all basic weather characteristics
- Permafrost and periglacial environment changes due to recent climate change
- Mass balance changes and sensitivity of land-terminating glaciers of James Ross Island to recent climate change

Geology related topics

- Tectonic evolution of Fuegian Andes and Antarctic Peninsula – a key to understand causes of Gondwana Pacific margin breakup

– Genesis and tectonic setting of Mesozoic igneous rocks in the NE Antarctic Peninsula and S Patagonia as markers of Gondwana breakup
– Environmental and climate change impact on high latitudes communities during the Cretaceous: An example from the James Ross Basin
– Thermochronological constraints of the James Ross and Austral/Magallanes Basins evolution since the Mesozoic
– Cenozoic sub-glacial back-arc volcanism in the Antarctic Peninsula
– Palaeoclimatic and palaeoenvironmental conditions in changing Neogene high latitudes of Antarctic Peninsula
– Geological mapping of deglaciated areas of the James Ross Island
– Geochemical and isotopical research of regolith, streams and lakes at the James Ross Island
– Lake sediment records of Holocene climate and environmental changes at the James Ross Island archipelago
– Glacial, paraglacial and periglacial geomorphology of the James Ross Island
– Impact of environmental changes since the Little Ice Age on lake ecosystems at the James Ross Island archipelago



IS THE LIFE HISTORY THE MAIN CONSTRAINT SHAPING THE POPULATION STRUCTURE OF SPECIES BEING REPETITIVELY AFFECTED BY CLIMATE CHANGE?

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KEYWORDS: ECHINODERMATA, STERECHINUS ANTARCTICUS, STERECHINUS NEWMAYERI, LIFE HISTORY, LGM

Introduction:

Antarctica, the most remote and isolated continet, possess the insight into the „in situ" evolution of ecosystems not affected by immigrants from the North. In order to understand the impact of on-going climate changes on polar communities, we used a retrospective approach based on simultaneous population genetic analysis of two species with different ecological requirements (life histories).

We perform comparative analysis of demographic histories within two echinoid species (Echinoidea) : *Sterechinus antarcticus*, a relative deep-sea form from outer shelf areas (below 450 m), and *Sterechinus neumayeri*, , which resides in the inner, shallow shelf areas (down to 450 m depth). These two high Antarctic closely related (morphologicaly similar, having planctonic larvae) buspecies have contrasted depth ranges and might have had different life histories as well.

In the Antarctic, shelf species were more impacted by grounded ice than those living beneath (Thatje, 2005). Where they survived? In refugies (Allcock, 2012, Janko, 2011). Who was less affected and why? Here , we state that species restricted to shallow high Antarctic areas had been much more vulnerable to the recurrent ice sheet advances during the last glacial maxima.

Material & Methods:

Samples were collected at ANT23/8 of the Polarstern (PS stations) Cruise, JR230 of the James Clark Ross Cruise and at station, 2012. Fragment of COI gene was amplified by nested PCR using primers described by Lee (Youn-Ho Lee et al. 2004) and further ourself developed primers LCOI 1523_E (5´- GCT AGC ACA ACC AGG CTC TC -3´), RCOI_E (5´-AGT GGC GGC AGT AAA GTA CG-3´).

To infer population past changes minimum spanning network (TCS), neutrality tests (Tajima ´s D, Fu´s Fs, R_2) were performed. Comparable time estimates of population expansions were assessed by τ. Allele richness were described by haplotype diversity (Hd), and nucleotide diversity (π).

Results &Conclusions:

The longer population have evolved without disturbances the higher genetic diversity gained (Hd, π). We conclude that populations of the deep-sea *S. antarcticus* are older (more developed haplotype networks, older expansions (τ) than the shallow *S. neumayeri*. Picking up the threads of the previous work on Notothenioid fishes (Kasparova et al., in prep.) generalizes the hypothesis: „Life history is the prominent trait forming the population response to LGM". Marine species living either in pelagic or in the deep-sea are less affected by glacial advances than those restricted to shellow shelf areas.

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PATTERNS OF LITTLE AUKS COLONY DISTRIBUTION ON THE WEST COAST OF SPITSBERGEN

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KEYWORDS: LITTLE AUKS, COLONY DISTRIBUTION, SPITSBERGEN

Little auk as the most numerous Arctic bird, is a key-stone species for Arctic ecosystems functioning both, terrestrial and marine environment. Its population is estimated over one million pairs on Spitsbergen, while the world's population is assessed between 12 and 20 millions of pairs.

It is considered, that deciding feature that affects placement of colony is a distance from a foraging area. Nevertheless, topographic factors like slope angle, aspect elevation above sea level or lingering of snow cover, ground temperature etc. seems to be important too.

Study area is located on the West coast of Spitsbergen in fjords Hornsund and Belsund. Fieldwork was conducted during breeding season (July-August) 2010-12 with good weather conditions supplying good visibility. Colonies observations with binocular helped discriminating the borders of the colony patches, which coordinates were noted. All spatial analysis were made with GIS software ArcGIS.

The results showed, that only for Hornsund, population of Little Auks reaches over 500000 pairs what is equal to Barents Sea region population. Going further, research conducted in Bellsund showed, that big concentration of Little Auks are present only on the northern coast of this fjord, on the slopes of Ingeborgfjellet, while believed to be inhabited by birds southern coasts are abandoned, with no evidence of birds activity.

Two different types of colony were observed. First, with high nest density, very numerous (at least 250 pairs) placed in the lower parts of the slopes, less steep (30deg), with nests hidden between rocks and second, build up by maximum 50 pairs, scattered on the vertical slopes in the top parts of mountain peaks, with nests hidden in the rock crevices. The latter states for less than 1% of Little Auks population on Spitsbergen, however it is regularly observed along the western coast of Spitsbergen.

Having recognition in the highest concentrations of breeding Little Auks on Spitsbergen (southern and northern end of West Spitsbergen, Fig.1, Norsk Polarinstitutt), it's possible to fill gaps in the subject of Little Auk biology, that is still under intensive research due to its importance for nutrient flow between sea and land ecosystem in the context of climate changes and environment protection.

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FISH PARASITES BEYOND THE ARCTIC CIRCLE: MYXOZOA

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KEYWORDS: MYXOZOA, MARINE FISH, PHYLOGENY

Myxozoa are microscopic metazoan parasites that have reverted to unicellular morphology and possess a complex life cycle. Their morphological simplification has puzzled scientists about their phylogeny. Placement of Myxozoans in Metazoa was confirmed by the first molecular SSU rDNA analysis (Smothers et al. 1994). Myxosporea are common parasites in a large number of freshwater and marine fish, as well as amphibians, reptiles, waterfowl and some terrestrial mammals. Myxozoa infect various organs in vertebrate hosts and can be split into two groups according to the site of infection. Coelozoic species replicate in the cavities of body organs (gall bladder, urinary tract, renal corpuscles etc.) whereas histozoic species are intercellular in various tissues (liver, skin, kidney, testes). Most myxozoan infections are benign, but a few species can cause serious disease with important economic and conservation implications.

To determine the diversity of myxozoan parasites, we dissected 234 fishes belonging to the 7 species (*Myoxocephalus scorpius*,*Clupea harengus*, *Mallotus villosus*, *Gymnocanthus tricuspis*, *Boreogadus saida*, *Hippoglossoides platessoides*, *Lumpenus lampretaeformis*) in Petunia Bay in Svalbard. We found 8 myxosporean species: *Ceratomyxa* cf *longispina*, *Myxidium gadi* and *Sinuolinea* sp. in *Myoxocephalus scorpius*, *Parvicapsula* sp. in *Gymnocanthus tricuspis*, *Zschokkella hildae* in *Boreogadus saida*, *Parvicapsula* sp. and *Shulmania aenigmatosa* in *Hippoglossoides platessoides* and *Latyspora* sp. in *Clupea harengus*.

Four taxonomically undescribed species: Latyspora sp., Sinuolinea sp. and two species of genus Parvicapsula were morphologically characterized by light microscopy.

The phylogenetic positions of *Z. hildae* and *M. gadi* are already known. We add new molecular data to four species collected from the urinary bladder and confirm their position within the marine urinary clade according to their tissue tropism. Two different *Parvicapsula* spp. and *Latyspora* sp. cluster within *Parvicapsula* subclade and *Shulmania aenigmatosa* clusters within *Zschokkella* subclade.

Shulmania aenigmatosa is the first sequenced species of the genus *Shulmania,*in addition, we provide novel data about its ultrastructure. *Latyspora* sp. is the second discovered species of its genus; however, its distant relation to the type species *L. scomberomori* causes the genus *Latyspora* to be paraphyletic. The low number of discovered myxosporean species in comparison to the abundance and diversity of fish is an interesting contrast to myxosporean diversity in tropical or subtropical fishes.

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THE GEOGRAPHIC DISTRIBUTION OF POLAR CYANOBACTERIA AND THEIR RELATION TO MICROFLORA OF HIGH MOUNTAIN HABITATS

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KEYWORDS: CYANOBACTERIA, POLAR REGIONS, HIGH MOUNTAINS, ECOLOGY, DISTRIBUTION

The dependence of various cyanobacterial taxonomic units (genera, species, OTU´s) on the specific ecological characters is indicated by all modern studies, based on the polyphasic evaluation of the world cyanobacterial diversity. The various genotypes are ecologically limited and their geographic distribution depends on the frequency of convenient habitats; the ubiquitous types were not found. The cosmopolitan types can occur, but only these ones, growing in widely distributed habitats with similar ecological conditions.

This problematic concerns also the problem of origin and ecology of cyanobacterial populations in polar ecosystems and their relations to other habitats, particularly to the communities in high mountains with similar ecological conditions. The origin of microflora of isolated and ecologically extreme Antarctica is particularly specific and the cyanobacterial vegetation must be considered as autochtonous, forming in each vegetation season the characteristic communities with specific species composition and specific structure (Komárek 1999; Komárek & Elster 2008; Komárek et al. 2008; Komárek et al. 2012; Strunecký et al. 2012). The number of species, which is possible to designate as Antarctic endemites, increases every year. On the other hand, the easy transport of cyanobacterial diaspores to Antarctica by wind and other physical and antropogenic impacts, and particularly to Arctic habitats, which are more open to the influence from southern areas, is the preposition of occurrence of cosmopolitan types also in polar regions. The occurrence of several cyanobacteria in both polar regions and in Alpine zones of various high mountain ridges in other parts of the world, is therefore probable. It concerns mainly the species from subaerophytic communities from wetted rocky walls, from wetlands with character of seepages, from shallow cold and stenotherm water habitats and from cryoseston. In similar habitats were already registered also the most similar morphospecies. To genera commonly recorded from both Antarctic and Alpine habitats belong especially members of the genera *Gloeocapsa, Phormidium, Nostoc* and few others. However, the genetic identity of all these similar populations must be revised in future, the precise studies in this field are only at the beginning. It is interesting that Arctic habitats and the High Arctic microflora seem to be related more to near tundra ecosystems (North Canada, North Scandinavia, Siberia) than to more distant high mountains.

The important question is also the relatedness of cyanobacterial microflora of both polar ecosystems one to another and the possibility of refugia of the common species in high mountain habitats in other continents. Also solution of this problematic is still at the beginning, but it follows from up to date results that the number of common genotypes is surprisingly low. On the colonization of similar habitats in both polar regions and in high mountains participate evidently the similar eco- and morphotypes of the microvegetation, but their genetic identity was not quite confirmed up to now. This problem is evidently connected with the specific diversification strategy of cyanobacteria.

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DIVERSITY AND BIOGEOGRAPHY OF FRESHWATER DIATOMS FROM TWO CONTRASTING ANTARCTIC LOCALITIES

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It is widely accepted that climate change will have significant effects on polar ecosystems. Because of their (bio-)geographically interesting location, the study of Antarctic environments currently receives considerable attention. Diatoms (Bacillariophyta) form one of the principal algal components of the freshwater and terrestrial ecosystems of the Antarctic Region.

Several years ago, a detailed study of non-marine diatoms focuses on the taxonomy and ecological characterisation of aquatic diatom communities of two different islands was started. Both islands are located close to the Antarctic Peninsula: James Ross Island and Livingston Island. Although located close to each other, their geographical position on different sides of the Antarctic Peninsula makes them interesting localities to explore the differences in the environmental impact on their diatom communities.

Until recently, most of the non-marine diatom species were believed to have a cosmopolitan nature, mainly due to the use of non-appropriate taxonomic literature. Only a very low percentage of the listed species in the literature showed an Antarctic distribution. However, the results of our study contradict entirely this statement.

The present poster discusses the results of the taxonomical and biogeographical study of the diatom communities living in various freshwater habitats such as lakes and seepage areas in relation to ecological factors determining their composition and diversity. In this study, more than 150 diatom taxa have been identified during the survey. A detailed revision based on scanning electron microscopy observations was therefore necessary to clarify the taxonomic position of most taxa resulting in the description of more than 20 new taxa such as *Eolimna jamesrossensis* Kopalová & Van de Vijver, *Luticola truncata* Kopalová & Van de Vijver and *Luticola tomsui* Kopalová (Kopalová et al. 2009, 2011) The poster shows some of the interesting endemic species of both islands.

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FOUR NEW SMALL-CELLED NAVICULOID TAXA FROM THE MARITIME ANTARCTIC REGION

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The Maritime Antarctic Region comprises the Antarctic Peninsula and several adjacent archipelagos and islands, such as the South Shetland Islands. In 2008, a detailed taxonomic and ecological study of the limno-terrestrial diatom flora of Livingston Island (South Shetland Islands) and James Ross Island was begun to improve our understanding of the biodiversity and biogeography of the Antarctic diatom flora. The revision of several genera, such as Pinnularia, Luticola and Hantzschia has already resulted in the description of more than 20 new species with a restricted Antarctic distribution. During the survey, several unknown, small-celled naviculoid taxa were also found. Based on detailed scanning electron microscopy, these four taxa could not be identified using the current Antarctic literature and will be described as new to science.

Adlafia sp. A is characterized by its small dimensions, and separated from similar taxa, such as A. muscora, A. suchlandtii or A. minuscula, by its valve outline, which lacks subrostrate or capitate apices, and by its striation density. Chamaeapinnularia sp. A shows some resemblance to C. australomediocris but can be separated by the lack of a well-defined fascia, smaller valve dimensions and a more narrowly-lanceolate outline. Mayamaea sp. A is related to M. agrestis but has less acutely rounded apices, clearly curved striae and larger central area due to the presence of shorter central striae.

The taxonomic position of Microcostatus sp. A is rather unclear as this taxon posseses several features that conflict with its position within the genus, such as the presence of a conopeum, and striae composed of one large elongated areola. However, the structure of the raphe, axial area, valve outline and valve dimensions justify its position within Microcostatus.

All four new taxa are illustrated using both LM and SEM. Details of their morphology and ecology are included, and their relationships to the most similar taxa discussed.

THE CHANGES IN GEOCHEMICAL PROPERTIES OF SOILS AND DIFFERENCES IN THE SOIL MICROBIAL COMMUNITY STRUCTURE ALONG ALTITUDINAL GRADIENTS IN ARCTIC MOUNTAINS SURROUNDING PETUNIABUKTA, SVALBARD

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KEYWORDS: PLFA, MICROBIAL COMMUNITY STRUCTURE, ALTITUDINAL GRADIENT

The four altitudinal soil transects were sampled during the summer season in 2012 in the offshore area near Petuniabukta, Svalbard (78°N, 16°E) to understand how the biogeochemical properties of soils changes with increasing altitude. Main goals of this study are: 1) describe geochemical properties of soils in different altitudinal levels (pH, the availability of nutrients) and 2) understand how the microbial diversity and community structure changes with increasing altitude. Transects consists of 4 altitudinal levels at 50, 250, 500 and 750 m above sea level. Sampling was conducted as follows: three soil subsamples taken by corer were combined to obtain one of three mixed samples representing each altitudinal level. Samples were homogenized by sieving and frozen as soon as possible. Moreover, part of each sample was conserved by RNA later immediately after processing. For the characterisation of the microbial community composition both phenotypic and genotypic diversity will be evaluated. The latter determined by 16 sRNA gene analysis using PCR-DGGE, the former by PLFA profiling.

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ECOLOGICAL AND GEOGRAPHICAL CHARACTERISTICS OF PHYTOPLANKTON IN THE EASTERN LAPTEV SEA (ATUMNAL SEASON 2008)

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KEYWORDS: PHYTOPLANKTON, LAPTEV SEA, DIATOMS, DINOFLAGELLATES, TRANSDRIFT

The Laptev Sea constitutes the central part of the wide Siberian Arctic shelf. It is considered to be one of the key regions where the changes of the marine environments as a result of the climate variability are the most pronounced (Kassens et al. 1999, 2009). The phytoplankton communities and their structure are directly affected by the changes of the temperature conditions, sea-ice cover extend, water masses circulation, riverine outflow and other parameters. Therefore, comprehensive analysis of the present state of the pelagic ecosystem and theirs interannual dynamics will allow indicating the direction of biological feedback process in the Laptev Sea.

The previous reported evidences for the autumnal phytoplankton in the Laptev Sea related mainly to the end of the past century (Gogorev 1994, Heiskanen & Keck 1996, Sorokin & Sorokin 1996, Tuschling et al. 2000), and give evidences for the heterogeneous phytoplankton distribution largely depended on the prevalent hydrography and hydrodynamics. Our research of autumnal phytoplankton 2008 years is the contribution to the environmental monitoring of the Laptev Sea ecosystem, which is carried out in the frame of the multidisciplinaly Program “Laptev Sea System”. The main aims of our researches were: (1) to study the species composition of phytoplankton communities, (2) to reveal the spatial-temporal peculiarities of phytoplankton biomass and species abundances in dependence of local hydrological conditions during the investigated period.

The phytoplankton samples were collected during the joined Russian-German expedition “TRANSDRIFT XIV” in September 2008. Phytoplankton abundances were determined by cell countings, which provided the basis for biomass calculations according to taxon-specific carbon values. The Shannon index was applied to describe the species diversity.

In total 62 species were identified (Dinophyceae – 36 taxa, Bacillariophyceae – 24 taxa, Chlorophyceae – 1 taxon, Chrysophyceae – 1 taxa). The overall abundance of algae in the water column ranged from 190 to 5 040 cell $\times$ l^{-1}. Total phytoplankton biomass in the water column varied from 0.15 to 9.65 µg C $\times$ l^{-1}. The highest values of algal abundance and biomass were observed in the vicinity of the Lena Delta. In general total abundance and biomass gradually decreased northward. The obtained results indicated that we observed a late stage of a seasonal succession pattern of the phytoplankton community. Diatoms were dominated by species of *Chaetoceros* and *Thalassiosira* genera (*Thalassiosira baltica, T. hyperborea, Chaetoceros diadema, C. socialis, C. wighamii*). Dinophysis were mainly represented by *Dinophysis acuminata, D. rotundata, Gonyaulax spinifera, Preperidinium meunierii, Protoperidinium bipes, P. pallidum, P. pellucidum*. Heterotrophic and mixotrophic forms were characteristic of dinoflagellate communities during the investigated period. The highest species diversity was found at the stations in the vicinity of the Lena delta. Ecological analysis showed that algal flora was represented mainly by marine and brackish species (71% и 21% respectively). The contribution of freshwater species was negligible. In terms of geographical analysis arctic-borel, arctic-boreal-tropic, cosmopolitan and tropical-boreal species were characteristic of algal communities. Tropical-boreal species are considered to be an indicator of Atlantic water masses. The obtained results generally agree with previously published data on phytoplankton composition and its distribution in the eastern Laptev Sea during autumn

(Gogorev 1994, Heiskanen & Keck 1996, Sorokin & Sorokin 1996, Tuschling et al. 2000).

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MASSIVE, SIMULTANEOUS FLOATATION OF PHYTOBENTHIC MICROBIAL ASSEMBLAGES UNDER THE LOWER ICE SURFACE OF A FROZEN ANTARCTIC LAKE

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KEYWORDS: ANTARCTIC FROZEN LAKES; MICROBIAL ASSEMBLAGES; SOLAR RADIATION; INVERSE STRATIFICATION; PHOTOSYNTHESIS

In spring, massive, floating fragments of phytobenthic assemblages were found under the ice of a frozen lake on the Sôya Coast, East Antarctica. These assemblages occupied 77% of the area beneath the ice and were found in the period between 11 and 21 October 2010, when the daily averaged solar radiation increased to more than 200 W m^{-2}, which was 50% of the yearly maximum. Photosynthetically active radiation (PAR) that reached the benthic surface was at least 10 µmol photons m^{-2} s^{-1}. These seasonally increased radiations may accelerate photosynthetic activity in the phytobenthos, leading to oxygen bubble formation and positive buoyancy. Increased solar heating of the lake water led to disruption of the inverse thermal stratification in the water column and enhanced vertical mixing. This combination of physiological and physical changes may have triggered formation of massive floating phytobenthic assemblages that were released from the lake bottom.

MEASUREMENTS OF SOLAR UV RADIATION AT THE MENDEL STATION, JAMES ROSS ISLAND, ANTARCTICA

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KEYWORDS: UV RADIATION, OZONE, CLOUDINESS, ANTARCTICA

In the last few decades interest in ultraviolet (UV) radiation has increased within the scientific community as it has been found a broad variety of environmental and health effects. To estimate the trends of incident UV radiation, depending on the evolution of the ozone layer and cloudiness in Antarctica, the requirement on accuracy of solar radiation and ozone measurement have increased. Total ozone content (TOC) and solar UV radiation can be obtained either from ground observation (Dobson or Brewer spectrophotometers) or from satellite-based measurements. However, in the high-latitude regions the satellite-derived UV data show a significant inaccuracy due to errors in determination of surface albedo and cloud cover. Therefore, it is important to carry out both measurements of incident solar UV radiation using ground-based radiometers and satellite data validation (Láska *et* al. 2010).

The paper presents the measurements of solar UV radiation and the other meteorological observations at the Czech J.G. Mendel Station situated on the northern tip of James Ross Island, Antarctica (φ = 63° 48´ S; λ = 57° 53´ W; 7 m above sea level). Since 2006, there are installed the following instruments: CM11 pyranometer (Kipp-Zonen), CUV3 broadband UV radiometer (Kipp-Zonen), UVSABT radiometer (Kipp-Zonen), and UV-Biometer Robertson Berger Model 501A (Solar Light Co.) **(Fig.1)**. The measurements are taken at a sampling interval of 10 s (Láska *et* al. 2011). From this basic dataset 10-min average values are calculated and recorded on the MiniCube VV/VX Data Logger (EMS, Czech Republic). In order to examine spatiotemporal differences between the satellite-derived UV radiation and ground-based measurements, daily mean values and residuals are calculated and compared. The validation of the UV time series showed that satellite-derived surface UV data was underestimated by ~20% due to the snow cover and low cloud occurrence. Moreover, seasonal variation of the sea ice extent around James Ross Island affected both surface albedo and biases of satellite-derived UV radiation. Therefore, the residuals of UV radiation varied between 9% (December-January) and 30% (September-October).

Fig. 1 The set of radiometers equipped with the Kipp-Zonen ventilation units installed on a special platform at the J.G. Mendel Station (photo K. Láska).

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DIVERSITY AND ECOPHYSIOLOGICAL PERFORMANCE OF CYANOBACTERIA IN WET MEADOW, PETUNIA BAY, CENTRAL SVALBARD

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Diversity, abundance and ecophysiological performance of *Nostoc commune* s.l. and metaphyton attached to mosses in wet meadow, Petuniabukta, Central Svalbard (N 78°43'49" E 16°26'41") were studied during the months of July and August 2012, 2012. According to ecological conditions (water level, vegetation cover and composition) the wet meadow was divided into five different areas. In these meadow *Nostoc commune* s.l., organic carbon, photochemical performance (evaluated as variable chlorophyll fluorescence parameters) and nitrogenase activity (acetylene reduction assay) were measured. Simultaneously, diversity (species richness and abundance), biovolume and carbon of metaphyton together with nitrogenase activity were performed as well as. The comparison of areas composing the meadow will define which area and/or component (methaphyton or *Nostoc commune* s.l.) are more variable in respect of cyanobacterial diversity/abundance and ecophysiological performances (productivity) to give us overview of ecological role of cyanobacteria in this special habitat. Introduced results will inform us about ecological functioning of wet meadow in high Arctic ecosystem.

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CSI: SVALBARD* – EXPLORING RELATIONS BETWEEN PLOIDY, GROWTH FORM AND HABITAT IN *SAXIFRAGA OPPOSITIFOLIA*

(*CURRENT *SAXIFRAGA* INVESTIGATIONS IN HIGH-ARCTIC SVALBARD)

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KEYWORDS: ARCTIC FLORA, CYTOTYPES, MORPHOTYPES, PURPLE SAXIFRAGE, SPITSBERGEN

The vascular plant flora of northern high latitudes is rich in polyploids, especially in previously glaciated areas (e.g. c. three quarters of Svalbard's vascular plant species).

Saxifraga oppositifolia L. (Saxifragaceae), a widely distributed species in many north-hemispherical mountain ranges, is also one of the most common and widespread species in the circumpolar Arctic and a rather well-investigated model organism. Although the flora of Svalbard is one of the best known among all arctic floras, the ploidy status of *Saxifraga oppositifolia* in this high-arctic archipelago was not entirely clear until recently. Furthermore, this species displays considerable morphological variation throughout its range, and several subspecies have been suggested for the Arctic. In Svalbard two divergent main growth forms (cushion and prostrate, but also intermediate forms) have long been known, but support for correlation of growth form with ecology and/or ploidy level was found to be vague and inconsistent, which leaves taxonomic separation problematic.

Only recently, Müller et al. (2012) found two distinct genetic groups in Svalbard, mainly representing diploids and tetraploids, with few intermediate triploids. These were frequently growing intermixed and it was hypothesized that diploids and tetraploids have different, but largely overlapping, ecological amplitudes. However, the study by Müller et al. (2012) did neither report growth form nor ecology associated with single individuals. The aim of the present study, therefore, is to investigate the ploidy levels of *Saxifraga oppositifolia* present in Svalbard, and to unravel potential relations with growth forms and micro-habitat characteristics.

Leaf material of 193 individuals of *Saxifraga oppositifolia* was collected as living material or dried in silica gel at 20 sampling sites (15 locations, Fig. 1) in Svalbard for ploidy level determination via flow cytometry. The sampled habitats covered all three arctic bioclimatic subzones present in Svalbard (middle and northern arctic tundra zone as well as arctic polar desert zone). Minimum distance between sampled individuals at each site was 10 m. The individuals were assigned to one of three growth form types: cushion, intermediate and prostrate. Additionally, environmental data (soil temperature and moisture on site, soil samples for determination of pH, conductivity and loss on ignition) and vegetation data (vascular plant species and surface types using point frame intercept method with a 0.25 m² frame and 25 equidistant points) were collected in immediate vicinity of 138 of the sampled individuals. Multivariate statistical techniques were

applied to determine possible relationships among growth forms, ecological factors and different cytotypes.

Out of the 193 individuals, 106 were diploid, eight triploid and 79 tetraploid (Tab. 1). The diploids displayed all three growth forms, whereas tetraploids almost exclusively showed prostrate growth. After excluding non-significant and correlated data, the principal component analysis (PCA) suggested a shifted and broader realized ecological niche of the tetraploid than the diploid type. The micro-habitat of tetraploid individuals was characterized by higher soil pH and higher cover of vascular plants, whereas sites with lower pH and less vascular plant cover, but higher bryophyte cover, appeared to be more suitable for the diploid type.

The present study reconfirms the presence of three ploidy levels in *Saxifraga oppositifolia* in Svalbard, with a majority of diploids and tetraploids (cf. Müller et al. 2012). Triploid individuals seem to be a rare exception. Although individuals with different ploidy levels were found intermixed at most sampling sites, at some sites only diploids or tetraploids occurred. This could be a sign of ecological differentiation as Müller et al. (2012) inferred from genetic data that dispersal capability is not restricting the occurrence of either the diploid or tetraploid form in certain habitats. Moreover, this is the first study that demonstrates a significant correlation between ploidy level and growth form. This relation is not mutually exclusive as diploid individuals mainly formed cushions, but also showed intermediate and prostrate growth. With the exception of two individuals, tetraploid individuals never formed cushions. It can be assumed that the growth form is at least partly determined genetically, but the data suggest genetic-environmental interactions particularly in the case of diploids.

Analyses of environmental and vegetation data indicate largely, but not completely (cf. sites with exclusively diploid or tetraploid individuals, see above), overlapping niches, which could explain the observed co-existence of diploids and tetraploids in close proximity. In addition, the results confirm the frequently observed pattern that polyploids possess wider ecological amplitudes, which is in line with the predominance of polyploids in the Arctic.

Fig. 1

Tab. 1

		Ploidy			
Growth form		diploid	triploid	tetraploid	*sum*
	cushion	64	0	2	66
	intermediate	20	2	4	26
	prostrate	22	6	73	101
	sum	106	8	79	*193*

Fig. 1: Map of the high-arctic archipelago of Svalbard with the 15 sampling locations at the islands of Hopen, Spitsbergen and Nordaustlandet (c. 76°30'N – 80°02'N).

Tab. 1: Distribution of ploidy levels and growth forms of 193 individuals of *Saxifraga oppositifolia* in Svalbard.

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ROLE OF BRYOPHYTES IN STRUCTURING PLANT COMMUNITY DIVERSITY IN ICELAND

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KEYWORDS: BIODIVERSITY, BRYOPHYTE, GRAZING, LANDSCAPE SCALE, PRODUCTIVITY

The term biological diversity or biodiversity is relatively new, perhaps being used for the first time in 1968 by Raymond F. Dasmann (Dasmann 1968). It was not widely used in the natural science community until the 1980s, and has since become a principal term. It is now actively used in many groups including everyone from biologists and ecologists, to political and social leaders. Biodiversity is an extremely complex term and in order to research it one must analyze each component. A first step would be to identify the research community and begin to define biodiversity at that level. For the sake of this study a well-organized plan was carried out to analyze biodiversity in the target community and at multiple scales in the landscape. This included a close examination of six valleys in Iceland. Each valley was broken into three zones dependent on distance from the sea. Within each zone the two faces of the valley were explored using various methods. Because biodiversity is scale sensitive it was imperative that the methods of this research follow a strict guideline and allow for biodiversity measures at these different scales. One of the aims of this project is to gain knowledge on the factors that shape community biodiversity. Another aim is to see how this diversity can differ among communities located at different scales in the landscape. Bryophyte diversity will be focused on and specifically how large herbivores might influence this diversity and the species pool size. An investigation of the role bryophytes play in structuring the overall plant community diversity will also be carried out. The aim of this poster is to explain the study design and give a good case where biodiversity was measured at multiple scales throughout the landscape in a subarctic region.

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VEGETATION DEVELOPMENT IN GLACIER FORELANDS OF SPITSBERGEN

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KEYWORDS: PRIMARY SUCCESSION, ARCTIC, LICHENS, GLACIER FORELANDS

Introduction

Rapid glacier recession in polar regions, observed in recent decades due to global climate change, leads to occurrence of new areas, devoid of vegetation. This creates a unique opportunity to follow colonization process from the very beginning. Several comprehensive studies focused on different aspects of primary succession were performed in the High Arctic (e.g. Hodkinson et al. 2003; Moreau et al. 2005). However, there is still need for further information, particularly concerning cryptogams – lichens and bryophytes. They had been often treated collectively, despite being a significant component of tundra.

The study was focused on colonization and succession of vascular plants, bryophytes and lichens in two High Arctic glacier forelands. Sequence of appearance of different groups and species was analyzed, and main succession stages were distinguished. Relationships between succession patterns and abiotic factors, e.g. substratum age and properties, terrain relief, were explored. Part of the results was published in Olech et al. (2011).

Materials and Methods

Fieldwork was carried out in 2008-2009 on Spitsbergen, Svalbard. Gåsbreen (Sørkapp Land, S Spitsbergen) and Longyearbreen (Nordenskiöld Land, Central Spitsbergen) forelands were investigated, using the chronosequence method. In each foreland a continuous transect of 1x1 meter phytosociological relevés (Braun-Blanquet method) was led from the glacier front to the oldest moraines. Additional study sites outside the transects were also selected, to obtain overall information about the study area. Soil samples were collected for analyses of pH, macroelements, and heavy metals. Statistical analyses were performed to assess impact of abiotic factors on vegetation.

Results

Vascular plants were first to colonize fresh morains in both studied glacier forelands, with species such as Cerastium arcticum, Saxifraga spp. and graminoids as early colonizers. These were quickly followed by mosses, mainly of the genus Bryum. Lichens were the latest group along the chronosequences. First came small epilithic species, mainly from the genus Polyblastia and Verrucaria, supported later by species with larger thalli, e.g. Aspicilia spp. Epigeic lichens occurred in the oldest parts of the chronosequences. In Gåsbreen foreland vascular plants dominated, whereas in Longyearbreen foreland lichens were the most abundant and species-rich group. Species exchange along the chronosequence was observed in the Gåsbreen foreland, but not in Longyearbreen.

The age of the substratum proved to be the main factor determining vegetation development in the study area, but terrain relief and microhabitat differences – mainly in substratum grain size – influenced species richness and cover of different groups. Abundance of lichens depended mainly on deposits stability. Chemical properties of the substratum were responsible for differences in species composition between these two forelands. Human impact had little influence on the studied processes.

Discussion

In general, the results correspond with observations from other parts of Spitsbergen (Hodkinson et al. 2003, Moreau et al. 2005). Some differences in species composition of vegetation and in colonization speed were observed. Last observed stages of succession were far from final.

Stereocaulon spp. which is an indicator of late successional stages (Moreau et al. 2009) was found only at the end of the marginal zones; species composition differed from mature tundra communities, e. g. no Cassiope tetragona and Dryas octopetala was present in Longyearbreen foreland. Some common regularities of primary succession in northern and southern polar regions were recorded. A moss Bryum pesudotriquetrum is a common pioneer colonizer in both Arctic and Antarctic (Olech et al. 2011). The results of the project will not only contribute to the general knowledge on primary succession and the role of cryptogams, but also create a background for a long-time monitoring.

Acknowledgements:
Fieldwork in Sørkapp Land was carried out within the Polish national project N-N305-035634.

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RECENT PROGRESS IN GLACIOLOGICAL INVESTIGATIONS IN PETUNIABUKTA AREA, SVALBARD

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Glaciological investigations in arid Petuniabukta region (Dickson Land, Svalbard) have been primarily conducted by Soviet and Russian researchers from Pyramiden town. After the settlement has been abandoned in 1997, geomorphological research with some glaciological elements have been performed by Adam Mickiewicz University (AMU) in Poznań, Poland. Since 2009 glaciology of Dickson Land is investigated by AMU dil*ice project (*Dickson Land Ice Masses Evolution*) which cover a broad range of glacial research, including mass balance, geometry changes, meteorology, energy balance, hydrology, thermal regime and dynamics. Here we briefly share some preliminary mass balance and geodetic balance results.

Direct mass balance measurements

The object of the most detailed works is Svenbreen (3.8 km^2) - a small valley glacier west of Petuniabukta. Its mass balance is measured with direct glaciological method. In summer of 2010 a network of 14 stakes has been drilled into glacier ice for 8 m and in 2011 two additional stakes have been installed. The stake network is the basis for measuring ablation during summer periods. Winter snow accumulation is measured in the end of winter, in April/May by 150-200 snow depth probings and snow density measurements. The preliminary net mass balance estimates for Svenbreen are -0.7 w. eq. (water equivalent) for 2010/11 and -0.3 m w. eq. for 2011/12, with equilibrium line altitudes ~550-600 m and ~450-500 m respectively. Most of mass was accumulated as superimposed ice rather than as snow/firn.

Geometry changes and geodetic mass balance balance

From several different sources of topography data (maps and digital elevation models) one can measure not only area change or retreat of glaciers, but their elevation and volume changes as well. We have analyzed seven glaciers from Petuniabukta region and conclude that they all are in negative mass balance mode and that their rates of thinning, volume loss, area loss and retreat are rising. The overall, area-weighted geodetic balance of non-surging glaciers in this region has been estimated to be -0.36 m w. eq. a^{-1} for 1960-1990 and -0.64 m w. eq. a^{-1} for 1990-2009 with roughly 36% volume loss since 1960. The area of all glaciers has significantly decreased since their maximum phases: in the end of Little Ice Age (around 100 years ago) the total area of Dickson Land ice masses (~130 glaciers and ice patches) was 322 km^2, while in 2007 it was only 207 km^2 (35% decrease).

Summary remarks

The project's aim is to better understand Dickson Land ice masses and investigate if their functioning differs from other Svalbard regions. At the current state of works it is clear that they are experiencing fast wastage, enhanced especially in the last two decades what we link to an abrupt increase in summer temperature in Svalbard after 1990. The mass balance of Petuniabukta glaciers lying ~100 km from the open seas potentially suffers from limited moisture transport and higher summer temperature. Geometry changes of local ice masses suggests however that their high elevation above sea level offsets unfavourable climatic conditions, so their geodetic balance is on

the similar order of magnitude as glaciers in more maritime Svalbard regions. The research of interactions between local climate and glacier behaviour will be continued in the coming years.

Acknowledgements

The project is funded by Polish National Science Centre as grant N N306 062 940. Special thanks are dedicated to member of 16th and 17th AMU expedition to Petuniabukta and others who greatly helped in the fieldworks, especially S. Faucherre and S. Lewis. Support of D. Benn and University Centre in Svalbard is also deeply appreciated.

WILD REINDEER (RANGIFER TARANDUS L.) RESOURCES USE IN AN ASPECT OF THE PRINCIPLE OF ECOLOGICAL JUSTICE

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KEYWORDS: INDIGENOUS PEOPLE, WILD REINDEER, ECOLOGICAL JUSTICE

The modern industrial expansion on Taimyr Peninsula together with the changing environmental conditions has caused observable disruption of the resources of living for the indigenous people of Taimyr. Many problems are eliminated by existing environmental laws, research and educational activity, which should be developed and advanced.

Taimyr population of wild reindeer (Rangifer tarandus L.) is focused on as the main component of the resources for the indigenous people. As a preprocess within the period of 1984-2002 field work of 500 hours of ground and 600 hours of air survey for reindeer have been conducted with the territory cover of the Taimyr Peninsula. As a post process data from all over Russia on Research, Laws and Education have been are systemized and investigated.

Taimyr population of wild reindeer (Rangifer tarandus l.) is one of the most popular wildlife species in Taimyr and one for the most important for subsistence and recreational hunting, and for viewing. In spite of the remoteness of the region two specific human industrial developments occur here: construction of gas line complex and a railroad and an extended autumn navigation period in the Yenisei River. In order to understand these human-induced alterations, and to be better prepared to prevent their occurrence the wild reindeer resources using is redefined both as an aspect of ecological justice: justice for animals, living beings and living ecological systems, as well as humans environmental protection, -as a basic right of indigenous people to protect their health and welfare. The environmental justice, research and education have set out clear goals of eliminating unequal enforcement of environmental, civil rights and public health laws, faulty assumptions in calculating, assessing and managing risks, exclusionary policies and practices that prevent the indigenous people from participating in decision making. As some examples could be done: “Priority directions of science development, technologies and techniques in Russian Federation” approved by the decree of the President of the Russian Federation of July 7, 2011, № 899 (№4. The science about life. № 6.Rational using of natural resources). The decree of the President will be a guide to the action for allocation of funds for science. Legal documents and laws of the Russian Federation represented in: the Legislation about small indigenous peoples from the North. The ecological doctrine of the Russian Federation.M., 2001. «Hunting rules in the Russian Federation». Resolution of the RSFSR Ministers Council of 19 December 1978, № 592 «About the procedure of a reindeer pastures damage compensation». In the period from 1996 to 2000, a project was launched and Russian training center for indigenous peoples was opened as some assistance to small indigenous peoples of the North for practical training of specialists, keeping and development of traditional industries. Some generic and family enterprises were opened, particularly, for products processing and using of wild reindeer. (Sulyandziga R., Krikunenko E. “Catalogue for Production, Goods and Services of the Indigenous Peoples of North, Siberia and Far East of the Russian Federation-Russia”. Issue № 1. 2004.115p.). In the Taimyr Autonomy district, the Charter (Basic Law) of the Taimyr Autonomy provides additional rights for indigenous peoples as assistance in the development of traditional branches of the economy, training of national personnel and etc. In this fact, there are following laws: «About nomadic tribal community of the indigenous peoples of the North»; «About specially protected natural territories»; «About legal status of indigenous people of the North»; «About hunting». One could note good example of the Autonomy districts. In Yamal-Nenets, Khanty- Mansi and Yamal Nenets autonomy regions there are some democratic procedures

for participation of indigenous people as a quota of representation in local Parliament which gives the opportunity for the participation in the funds distribution process in programs of social-economic development of the indigenous peoples to determine the status of territories, which belong to indigenous people of these regions, and to negotiate with mining companies. Educational programs: Malygina Natalia 2010. Textbook for secondary schools of Far North and High school "The Arctic Territories Socio-Ecology-Economics Space Learning with the Gradual Foreign Language Cover as a Module System".Marzekha A.V. 2009 guidelines: «Veterinary-sanitary examination of meat products of wild reindeer». Many problems of ecological justice for animals, living beings and living ecological systems as well as humans are eliminated by existing environmental, health, housing and civil rights laws, research and educational activity, which should be developed and advanced.

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ECO-PHYSIOLOGICAL CHARACTERISTICS OF THE COASTAL PLANTS IN THE CONDITIONS OF THE TIDAL ZONE ON THE COASTS OF SVALBARD

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KEYWORDS: HIGHER PLANTS, PLASTID PIGMENTS, SVALBARD

Salt marshes and coastal beaches with the lowest abundance of species within habitats are the intrazonal communities at the Western Spitsbergen. The lowest alpha-diversity was recorded for halophytic communities and mineral fens, which is saved on all their circumpolar area (Koroleva et al., 2007). Therefore, investigation of morphological and eco-physiological plasticity of coastal species on the gradient of environmental factors has the specific importance in determination the plants' reactions in extreme conditions of inhabitation. The aim of investigation – the revelation the content and the ratio of plastid pigments for general salt marsh species on the east coast of Grøn-fjord at the Western Spitsbergen.

The pigments content was studied in 17 species from 7 families on transect (300 m length) from the line of mean low water at neap tide (MLWNT) to the shore. Halophytic meadows on the seashore marshes belong to ass. *Puccinellietum phryganodis* Hadaĉ 1946 and ass. *Caricetum ursinae* Hadaĉ 1946. Fragments of community type *Mertensia maritima* were found on the pebble beach on Grøn River. The pigments content was determined on the SF-26 and PD-303S SF.

Ass. *Puccinellietum phryganodis* Hadaĉ 1946 includes unspecific, oligodominant, closeless communities with simplified vertical structure. Diagnostic species: *Puccinellia phryganodes, Phippsia algida, P. concinna, Dupontia psilosantha, Stellaria humifusa, Carex subspathacea, C. ursina*. Individual herbs and grasses are firmly pressed to the substrate. Influence of tidal water has led to the definite zonation of vegetation. Almost all these species have the arctic circumpolar areas. *P. phryganodes* is the first, who appears on the mud at distance of 40 m from MLWNT in the form of single towers of dirty-brown color. At the distance of 90 m, the *P. phryganodes* has a projective cover up to 70% and looks like an orange-colored belt. These changes are related to changes in the pigments content. The content of chlorophylls increased from 0.71 to 2.11, and carotenoids from 0.43 to 0.82 mg/g dry mass. The ratio of chlorophyll (a/b) is 2.6 – 2.72, the ratio of chlorophylls/carotenoids is increasing: from 1.6 in plants closer to the sea till 2.6 in plants from orange belt. The volume of the light-containing complex is not changed (60%). At distance 70 m *Carex subspathacea* appears, the content of chlorophylls is 4.0, carotenoids – 0.89 mg/g dry mass, the ratio of chlorophyll (a/b) is 1.7, the ratio of chlorophylls/carotenoids increases up to 4.5. *Carex urzina* appears at a distance of more than 100 m from the water's edge. It pigment's content is similar to the *Carex subspathacea*. *Dupontia psilosantha* occupies the depressions with ditch-water. On the pigment content this species closer to the sedge, but differ in the ratio of chlorophylls/carotenoids, which is lower (2,5), than in sedges, and this testifies the growing role of carotenoids. At distance of 100 m. from the water *Stellaria humifusa* appears, it bright green sprouts are covered by gray dead vegetative organs, protecting the green leaves from the excess of Sun. The pigment content of green leaves has shown the content of chlorophylls – 4,43, carotenoids – 0.91 mg/g on dry mass, the ratio of chlorophylls/carotenoids is 4,9, and this testifies the active assimilating activity of this species..

The *Mertensia maritima* group is the open community, with low abundance *Luzula confusa* and *Poa alpigena* var. *vivipara*. For *Mertensia maritima* the content of chlorophylls is 8.5, carotenoids is 1.8 mg/g on dry mass, the ratio of chlorophylls is 2.1, the ratio of chlorophylls/carotenoids is 4.8, which testifies the high functional activity of this species. For

Luzula confusa, which is similar to the sedges on the pigment content, but there are differences: the high content of chlorophylls in leads to sudden increase in the volume of the light-containing complex (up to 90%).

The range of values of green pigments' content (chlorophyll a+b) at the investigated species varied from 0.5 up to 2.5 mg/g dry mass, of yellow pigments (carotenoids) varied from 0.15 up to 0.44 mg/g dry mass. These values are slightly lower that at the majority of species of higher plants of the West Spitsbergen.

The obtained data suggest that the photosynthetic apparatus of Puccinellia phryganodes' plants in the tidal zone is fairly active, but, judging by the content of pigments, the most activity of photosynthetic apparatus occurs in plants of the orange-colored belt. The increase in the ratio of chlorophylls/carotenoids in plants closer to the water line showed an increase in the functional load of yellow pigments in the adaptation to more severe unstable conditions of tidal zone.

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CORYNOSOMA ACANTHOCEPHALANS FROM PARATENIC HOSTS IN THE WEDDELL SEA, JAMES ROSS ISLAND, ANTARCTICA

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KEYWORDS: JAMES ROSS ISLAND, ATARCTICA, PARASITES, ACANTHOCEPHALA, NOTOTHENIOID FISHES

Palaeacanthocephala have a complicated life cycle involving more than one host. They use crustaceans as intermediate host which can infect both paratenic and definitive hosts. Definitive hosts of Antarctic palaeacanthocephalan species include fishes, birds or marine mammals. Our material contains cystacanths of species *Corynosoma pseudohamanni* Zdzitowiecki, 1984. Its acanthor (first larval stage) hatches from the egg and passes through two subsequent stages (acanthella and cystacanth) within an intermediate arthropod host (amphipods). It may also use a paratenic host (fish) in which the cystacanth gets encapsulated in the mesentery without further development. Schema of its life cycle documents figure 1.

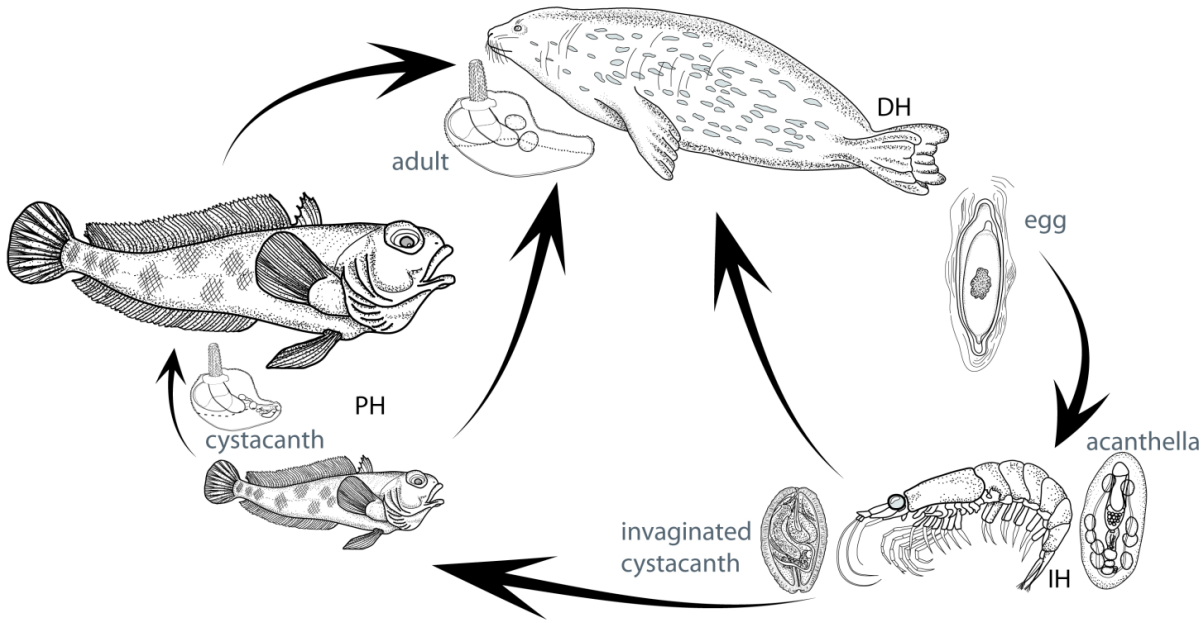

Figure 1. Life cycle of *Corynosoma* species. *Abbreviations*: DH - definitive host, IH - intermediate host, PH - paratenic host.

Field investigations were carried out during expedition Antarctica 2012 from January to March. Fifteen specimens of 5 notothenioid fishes were examined for parasites (prevalence 60%, intensity of infection 3–144, abundance 24, mean intensity of infection 41). They were caught with gillnets in sites in the Prince Gustav Channel in depth about 30 m. Examinations of fresh fish were carried out using a dissecting stereo-microscope. Cystacanths of species *Corynosoma pseudohamanni* were collected from *Trematomus bernacchii*, *Gobionotothen gibberifrons* and *Notothenia coriiceps*. *Trematomus eulepidotus* and *T. newnesi* were not infected. Encapsulated acanthocephalans occurred at the surfaces of internals and in the tissues of mesentery. Some cystacanths were liberated from cysts using entomologiacal needles. To studying structural details of external morphology and internal anatomy, scanning electron microscopy (SEM) was used.

Morphological and morfometrical study is based on relaxed specimens of cystacanth with

evaginated or partly evaginated proboscis and on encysted cystacanth from the body cavity. Males and females are similar in size and shape. Proboscis cylindrical with retractor muscle, armed with 20 longitudinal rows of generally 13 hooks each. In each row, posterior 2 (rarely 3) basal hooks without roots, shorter, thinner and less recurved than normal ones. No record of differences between sexes was found. The longest are the 3rd to 5th hook from the top. In the distal part of proboscis the hooks are more slender having thorns longer than roots. Towards the base of proboscis the root length increases simultaneously with thickening of the hooks. Truncated-cone neck, wider than longer, often retracted into foretrunk. Pipe-like body; foretrunk expanded in form of ellipsoidal swelling near the junction with neck, bent to some extent ventrally, with dorsal surface more prominently inflated than ventral surface. Anteriormost foretrunk with 4 groups of specialized longitudinal disk muscles arranged as roughly semitubular bundles. Trunk spines asymmetrically distributed, covering entirely evenly foretrunk and extending to ventral hindtrunk. Spines surrounding genital pore present, follow anterior hindtrunk spines as continuous field, their range and distribution differs in both sexes. Lemnisci rounded, quite broad, leaf-shaped, shorter than level of proboscis receptacle. Dorsal neck retractor muscle divided into 2 fan-shaped bundles, not associated with lemnisci. Each bundle fans out to attach along the dorsal trunk. Single ventral neck retractor fans out and attaches to both sides of the ventrolateral hindtrunk. Retinacula arising near the middle of ventrolateral proboscis receptacle. Genital vestibule muscles surround the genital opening.

Acanthocephalans in cystacanths stage have usually wide spectrum of paratenic hosts. According to Zdzitowiecki (1984a, b, 1986, 1990, 1996, 2001), Zdzitowiecki and Laskowski (2004), Zdzitowiecki et al (1999), and Laskowski et al. (2012), *C. pseudohamanni* have been reported in 19 fish species, 9 from the family Nototheniidae, 2 from Bathydraconidae, 6 Chaenichthyidae and 2 from Harpagiferidae. Our material contains specimens from 3 host species from Nototheniidae: *T. bernacchii*, *G. gibberifrons* and *N. coriiceps*. All 3 species already have been reported as paratenic host before. The aims of the study were to redescribe and illustrate relaxed *C. pseudohamanni* cystacanths with everted proboscis in detail and create description of external morphology, morphometry, internal anatomy and meristics. This amends current data with information on intraspecific determinative features. The next step will be DNA sequencing for obtaining new molecular data about this *Corynosoma* species.

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STRONTIUM ISOTOPIC SIGNATURES OF THE TORRENT VALLEY STREAMS AND PHORMIDIUM LAKE ON JAMES ROSS ISLAND, ANTARCTICA

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KEYWORDS: STRONTIUM, ISOTOPES, ANTARCTICA

The Antarctic Peninsula and adjacent islands hold some similarity to sub polar glacial systems (such as coastal Greenland, Svalbard, Patagonia, and Alaska), and are known to be more sensitive to atmospheric warming than the ice sheets covering the rest of the Antarctic continent (Vaughan, 2006). Historical temperature records indicate that the Antarctic Peninsula region is the third-most warming site worldwide and the fastest warming in the Southern Hemisphere (Thomas and Dieckmann, 2002). Most glaciers in the Antarctic Peninsula region have been in retreat over the past half century (Cook et al., 2005). Retreating glaciers are leaving fresh rock surfaces preserved from an ancient ages exposed to extreme weather conditions. Global warming is not affecting only a retreat of glaciers but also the rate of rock weathering. In order to understand weathering processes we are using strontium isotopes ($^{87}Sr/^{86}Sr$) that are routinely used to determine sources and mixing relationships in geochemical studies. Their isotopic variations provide natural fingerprints of rock-water interactions and have been widely utilized in studies of weathering and hydrology. The $^{87}Sr/^{86}Sr$ ratio is not fractionated by low temperature geochemical reactions (e.g., mineral dissolution and precipitation) or biotic processes, and may thus be used to investigate mineral weathering reactions. The advantage of using Sr isotopes over major elements as proxies of chemical weathering is that Sr-isotopic ratios are not sensitive to the processes that may concentrate or dilute concentrations of solutes, and therefore can be used as a conservative tracer to determine water-flow paths and mixing relations (Shand et al., 2007).

Geochemical mapping of the major rivers and lakes on the Northern part of the James Ross Island was performed during the 2011 expedition by small team of Czech Geological Survey. Sampling sites were selected in respect to lithology of bedrock, which is a key nutrient resource of the study area due to weathering processes. The bedrock on James Ross Island consists of two main geological domains (volcanic and sedimentary) with different geochemical and isotopic composition. Thus, the chemistry and physical parameters of surface waters is likely variable because of these contrasting source lithologies. Sampling on selected sites consisted of collecting water, stream sediments and further materials influencing the streamwater chemistry such as rocks, snow, glaciers etc. Basic hydrochemical parameters were measured onsite (pH, conductivity). Isotopic analyses were performed at Czech Geological Survey in two steps, one comprising the column ion exchange chromatography, the second instrumental ratio determination. The separation of Sr from rock and water samples was done using ion-specific resin according to Míková and Denková (2007). Sr isotope determinations were performed on solid-source thermal ionization multicollector mass spectrometer (Finnigan MAT 232).

Data for water samples from Torrent Valley and Brandy Bay (Phromidium lake and its surroundings exactly) together with data from literature are presented in Fig.1. Water samples from above mentioned sites on Jamess Ross Island fall within two isotopicaly distinct groups. Previously published data were used for estimation of overall trends (as we do not have finished our isotopic analyses for end members of mixing lines yet), although the samples were not collected on the same locations. Water samples taken within Torrent Valley have lower (less radiogenic) $^{87}Sr/^{86}Sr$ ratios than samples from Brandy Bay, with exception of one sample, which fits the Brandy Bay values. In Torrent Valley the $^{87}Sr/^{86}Sr$ ratios of the stream profile from the glacier to the sea shore become less radiogenic with increasing distance from the glacier. Torrent Valley is dominated by volcanic rocks and the isotopic composition of waters is close to its isotopic data, thus implying major contribution of volcanic source of the Sr in the water. The only exception from this trend is one

sample from the middle part of the main stream, where small creek with abundant suspended material enters the stream. This suspended material presence (probably from Cretaceous marine sediments) could be an explanation of such outlier value from the overall trend.

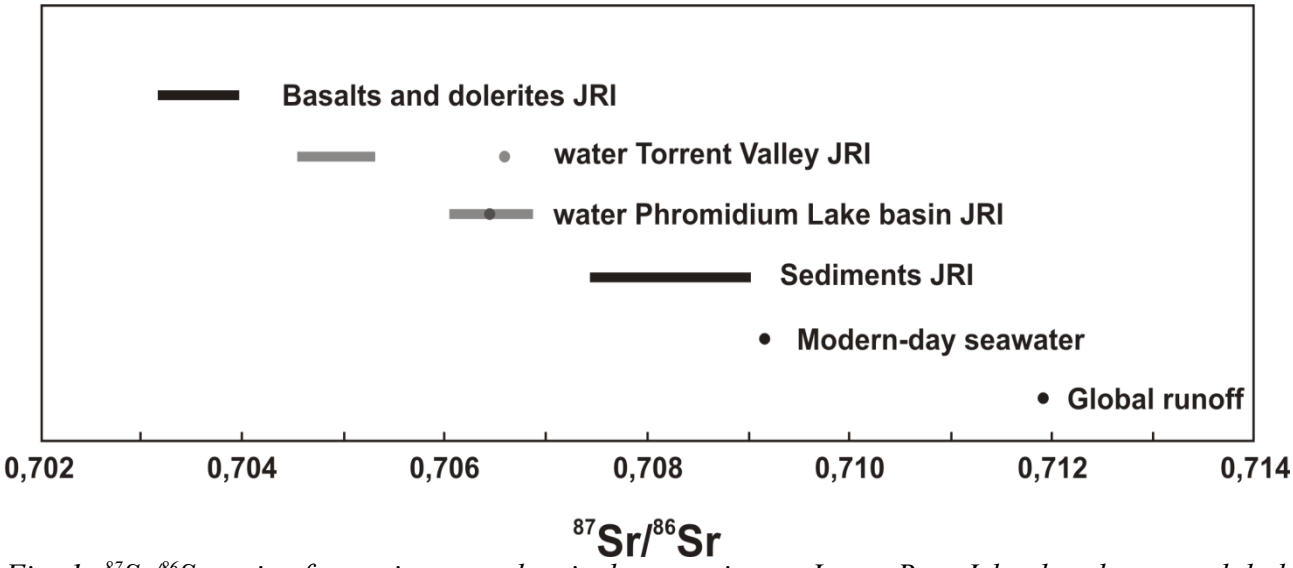

Fig. 1: $^{87}Sr/^{86}Sr$ ratios for various geochemical reservoirs on James Ross Island and recent global values. Data presented in grey are from presented study (errors are within symbols); data in black are taken form literature(Lyons et al., 2002, Košler et al., 2009 and Nývlt et al., 2011). The darker dot in the line of "water Phromidium Lake basin JRI" represents the value of the lake itself.

Water samples collected within Phromidium Lake basin have $^{87}Sr/^{86}Sr$ ratios close to marine sediments which are in good agreement with the geological situation on site. There are significant isotopic variations in the stream data. Some of the small streams entering Phromidium Lake are more radiogenic and some are less radiogenic than the waters of the lake itself. The $^{87}Sr/^{86}Sr$ ratio of the Phromidium Lake lies on the mixing line between the stream waters. If the assumption that the $^{87}Sr/^{86}Sr$ ratio of the sea water in Brandy Bay is equivalent to the modern-day seawater composition value (Lyons et al., 2002) is true, it seems that the sea spray aerosol contribution is not significant here, even the Phromidium Lake is in the close proximity to the bay shore.
Our preliminary results imply that strontium isotopic composition can be successfully used as a tool to discern the proportions of geological materials undergoing chemical weathering.

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HOW DOES DISTURBANCE BY SHEEP GRAZING AFFECT PLANT DIVERSITY IN SUBARCTIC ICELAND? - AN APPROACH ON DIFFERENT SPATIAL SCALES

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KEYWORDS: INTERMEDIATE DISTURBANCE, PRODUCTIVITY, ALPHA DIVERSITY, BETA DIVERSITY

One of the major challenges we currently face is the conservation of biological diversity. The role of the scientific community is hereby to discover the factors and processes which are shaping biodiversity and to assess the patterns of biodiversity over spatial scales which range from local phenomena to the entire globe. Disturbances and Productivity have been found to be two of the key factors in shaping biological diversity but some authors clearly highlight the importance of interaction effects between these two factors (see e.g Proulx & Mazumder 1998). Another important issue is the scale at which biodiversity is assessed and if one considers diversity within (alpha) or between (beta) communities.

Studies from northern Norway investigated the effects of grazing by semi domesticated reindeer on plant communities on different spatial scales. Bråthen et al. (2007) found that reindeer might cause a homogenization between plant communities by reducing the abundance of certain plant groups under fertile conditions. Ravolainen et al. (2010) found no grazing effect on alpha diversity, but an indication of decreased beta diversity on a landscape scale. Domestic sheep grazing is a traditional land use form in Iceland where plant productivity is similar to northern Norway. Although the effects of grazing on alpha and beta diversity have not been explicitly studied in Iceland, it is expected that the sheep grazing has similar effects on species diversity as in Norway.

In this study we conducted a large-scale vegetation survey in Iceland during summer 2012. We stratified our sampling to typically U-shaped glacial valleys around abandoned sheep farms which are free from sheep grazing for periods between ~30 and ~60 years. We contrasted these areas to comparable valleys with ongoing sheep grazing. We expected that plant community differentiation is following typical gradients in moisture and snow deposition and therefore stratified our sampling according to the topography. To avoid bias by subjective choice of certain vegetation types in the field, we used Geographical Information Systems (GIS) to guide us to sampling sites. This procedure further enabled us to balance the sampling with respect to exposure and to stretch it over the whole valley. We conducted vegetation sampling at different elevations (60 m intervals, termed “macro topography”) where we recorded vegetation along 15 m transects across convex and concave landforms perpendicularly to the slope (termed “meso topography”). We placed 40 x 40 cm plots in fixed distances of 3 m within each entity of convex and concave land forms and recorded topography in a one meter surrounding of the plot (termed “micro topography”). We used point intercept method to record plant species abundance within each plot and recorded species richness of each plot in addition. To control for site fertility we measured Normalized Difference Vegetation Index (NDVI) on a plot scale and sampled the soil on a meso topographical scale.

First impressions from the survey indicated that the abundance of shrub species and plant biomass was considerably higher in non grazed valleys. Whether this effect leads to reduced diversity of plant communities (*alpha*) or a reduction of community differentiation (*beta*) needs to be further analysed.

The results are of major importance when conserving plant diversity in Iceland and controlling the effects of traditional sheep farming. Our survey is the first that assesses patterns of

plant diversity in Iceland over different spatial scales which range from plots (40 x 40 cm) to entire valleys. We have to consider many effects when dealing with macro ecology, but the stringent survey design that avoids bias from choosing certain vegetation types subjectively, enables us to conduct similar surveys in other places where topographical conditions are similar. By controlling for grazing contrasts and productivity, we have the potential to compare the outcome of studies throughout the Arctic and can potentially assess the effects of large herbivores in areas with different plant species pool as well.

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SHORELINE VEGETATION OF THE COAST OF BAYDARATSKAYA BAY (YAMAL-NENETS AUTONOMOUS DISTRICT, RUSSIA) IN THE SOUTHERN TUNDRA SUBZONE

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KEYWORDS: SHORELINE VEGETATION, LAIDA, MARSHES, MARITIME MEADOW, YAMAL

In the North of European Russia and on Chukotskiy Poluostrov shoreline vegetation of the northern seacoasts has been relatively well studied (Leskov, 1936; Korchagina, 1937; Sergienko, 1985: by Rebristaya, 1997), while those along the Siberian Arctic and Subarctic coast have not. On the flora and vegetation of the Siberian Arctic coastal ecotypes known only from brief descriptions of shoreline vegetation in intertidal zone, presented in the papers on the flora and vegetation of the Arctic. But in all of these works only briefly list the main plant dominant of coastal ecotypes, most of which are found everywhere.

Intertidal zone are drawn strip along the coast, reaching a width of several kilometers. These seaside landscapes supporting a number of shallow streams and small round-oval ponds with salt or salty water. The depths of these reservoirs are usually up to 1 m, more often – smaller diameter from 1 to 20 m. Lakes on laida take up to 40% of the area. All ponds and lakes are connected to each other by numerous streams.

Shoreline vegetation composed mainly by grasses and herbs and characterized as marches or tamps. Tamps are meadow vegetation type (Gorodkov, 1935). This is a special coastal meadows, formed specific halophytic grass species. In the elevated parts appear tundra and wetland species with wide ecological amplitude. Tamps often swamped, but it is passable, but the coast ponds and streams are often quite boggy.

Shoreline vegetation was investigated on six stations along Kara sea costs in southern subarctic tundra subzone. Vegetation of laida investigated on the Yamal Peninsula and the Urals coast of Baydaratskaya Bay. For comparison was used the data on the flora and vegetation of the Kara Sea coasts in northern subarctic and arctic tundra of the Yamal and Gydan Peninsulas.

Vegetation forming in intertidal zone from the line of surf begins gradually, usually presented several successional stages evolved visually as zones extending along the coast. Plant groups and communities begin in 50-250 m from surf and to typical marshes vegetation released several zones of width from 2 to 10 m:

1. The sandy beach is usually devoid of vegetation, although it can occur even single individuals and small patches of *Puccinellia phryganodes and Honkenia peploides.* Less common *Tripleurospermum hookeri*. This zone especially in the delta of large rivers characterized by large deposits of silt, sand is very wet, sometimes marshy.

2. Sparse groups on the slope of sea bar, facing the sea. Typical sparse single-species groups, often *Honkenia peploides*. The width of zone is 2-4 m and total projective cover (TPC) 10-20%. Patulent rosettes of *Honkenia* often covered with a thin layer of sand. Additionally it can occur sporadically small shrubs of *Salix reptans*.

3. Sparse grass-herb plant groups on sea bars. TPC = 30%. *Honkenia peploides* is dominant. *Fe stuca cryophila, Dupontia psilosantha, Rumex graminifolius, Stellaria humifusa*, *Tripleurospermum hookeri, Armeria maritima, Cerastium arvense, Salix reptans, Carex rariflora, C. subspathacea, C. ursina* present sporadically and diffusely.

4. Sedges-grass plant groups on the slope of sea bar, facing from the sea, provides by high abundance of *Festuca cryophyla.* Constant species of groups is *Carex mackenziei, Calamagrostis deschampsioides*; sol – *Deschampsia borealis, Pedicularis sudetica* s.l., *Salix reptans,*

Dendranthema arctica, Rumex graminifolius, R. aureostigmaticus, Armeria maritima, Tanacetum bipinnatum. Sporadically mosses of *Polytrichum* genus are occurred.

5. Sedges-grass plant groups with *Salix reptans* characteristic for the bottom of sea bars. TPC = 60%. *Salix reptans* and *Carex mackenziei* are dominant.

6. Typical tamps (marshes). This is the widest (from a few tens of meters to several kilometers) and the comman zone. TPC = 90-100%. The main dominant species - *Carex subspathacea*, *Carex mackenziei, Carex ursina, Carex rariflora, Carex concolor, Calamagrostis deschampsioides, Dupontia fischeri, Puccinellia phryganodes. Potentilla egedii, Rhodiola arctica, Dendranthema arctica, Stellaria humifusa, Cochlearia groenlandica* are sporadically abundant. In the coastal zone of the deep and shallow ponds *Hippurus tetraphylla* is abundant, on small puddles - *Ranunculus tricrenatus*.

In different part of intertidal zone the ratio of main dominant species varies with moisture and saline groundwater. When the level of relief is increased on 30-40 cm, marshes replaced by the typical tundra vegetation – grass-moss tundras and bogs. Significantly increased the abundance of cotton grass (*Eriophorum polystachion, E. scheuchzeri, E russeolum, E. vaginatum*).

Species diversity of investigated shoreline vegetation of of Baydaratskaya Bay is 57 species vascular plants, 15 mosses and 5 lichens.

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RECOVERY OF LICHEN TUNDRA VEGETATION AFTER OVERGRAZING IN THE NORTH OF WESTERN SIBERIA

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KEYWORDS: LICHEN TUNDRA, REINDEER PASTURES, RESTORATION, LICHEN GROWTH, YAMAL

The lichen-rich tundra communities on Yamal Peninsula (North of Western Siberia, Russia) are overexploited by reindeer grazing and trampling (Golovatin et al., 2010). In 1993-1995 in the northern subarctic tundra subzone on Yamal 5 pairs of experimental plots (5x5m) were established with the aim to evaluate restoration rate of lichen-rich tundra vegetation after ceasing the grazing stress in grass-dwarf shrub-lichen-moss tundra. Each plot of every pair was isolated from the pasture by a metal fence. The research was supported by AMOKO EURASIA PRODUCTION Co in collaboration with Harvey Martens and Associates Inc, to whom we express our sincere thanks. During the period of monitoring the detailed description of species composition, ground cove, frequency, structure of synusiae and aboveground productivity was regularly registered at the small plots (20x50cm), 12 times for each (Magomedova, Morozova, 1997). The first collecting of data was made in 2006, i.e. after 12-13 years from isolation of experimental plots. In the fenced territory (RE - “enclose”) in comparison with grazed pastures (RN - “not enclose”) visible changes in the species composition and synusiae structure of lichens were obtained.

Species diversity. The number and species composition of lichens is very dynamical, strongly depends from patchiness of vegetative cover and micro habitats. As a whole the species diversity on all encloses plots was higher than under impact of reindeer grazing. The tendency of an increase in the number of constant species was outlined. In this group species, which frequence above 50%, on enclose plots the tendency to occurrence increasing of “reindeer lichens” species and foliose lichens is to be observed. On the grazing sites, the opposite trend – decrease in frequency of fodder species and increase of crustose lichens is looked through.

Cover. For 12-13 years after removal of grazing pressure the total cover of lichens has not changed. However, it is possible to note some changes in structure of a lichen cover. The cover increasing of some morphological type of lichens (fruticose-furcated, filiform, subulate, foliose) is revealed. Fruticose-lociniated and crustose morphotypes have considerably lowered it cover. As a whole for tundra under the influence reindeer grazing for 12 years there was a significant decrease in the cover of fruticose-lociniated and filiform lichens and on the other hand, the cover of subulate and crustose species has increased.

Mat height. In the moment of monitoring plots organization the lichen mats were reduced by grazing to a thin layer of fractured lichens and the general height of fruticose species (*Cladina* ssp.) everywhere was 0,5-1,5-2 cm, on the average – 1,25 cm (Magomedova, Morozova, 1997).

For 13 years of recovery the increase in podetium height of fruticose lichens on the enclosed plots is revealed in comparison with the data for 1993-1994 years and the areas under reindeer grazing pressure. For the last period the general height of lichens has increased to 3-5 cm. The height of lichens on not enclosed plots for the last period remained without change.

Lichen mass. Its volume depends from height of thalii, density of the lichen cover and the total area occupied by lichens (Andreev, 1954). On the enclosed plots a significant increase in a cover of three morphotypes of fruticose lichens and increases in height of podetium the growth in total mass from 40-65 to 80-155 g/m^2 is revealed too. The necromass of lichens is about 25% from the total mass. On the plots under impact of reindeer grazing some changes of lichen mass is not

discovered.

Recovery rate. Using techniques of simulation modeling and based on the data of thalii height and lichen mass change for thirteen years was calculated an average recovery rate of lichens. So in grass-dwarf shrub-lichen-moss tundra in the subzone of Northern Subarctic tundra at Yamal peninsula the average rate of increment of fruticose lichens in the first 12-13 years after removal of reindeer grazing has made 1,3 mm/year. The rate of the biomass increase of lichens for this period has made 3,8 g/m2/year that makes 3,6% from mass in the year.

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PARASITES OF TERRESTRIAL VERTEBRATES IN SVALBARD

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KEYWORDS: PARASITES, SVALBARD, TERRESTRIAL VERTEBRATES

Although warmer areas are the main centre of diversity of parasites they are nothing rare in polar areas. Arctic regions are characterized by extreme conditions including photoperiods of markedly varying length, short cool summer and long cold winter. Animals living in such inhospitable conditions must have adaptations to help them survive, so do their parasites by finding own ways to transport through this environment.

The study was aimed to extend our knowledge about the distribution of terrestrial vertebrates parasites in Svalbard (Petuniabukta, Billefjorden). The excrements of chosen members of mammals and birds were collected during two summer seasons and one winter season. The samples were examined for the occurrence of intestinal parasites by using both microscopic and molecular methods. The molecular diagnostics of cryptosporidia, microsporidia and giardia was done using the polymerase chain reaction (PCR). The positive detection was followed by the sequential analyses which proved the presence of cryptosporidia. Also the presence of *Encephalitozoon* was proved. Another recognized kind of microsporidia was *Enterocytozoon bieneusi* in *Rangifer tarandus platyrhynchus* and *Anser brachyrhynchus*. Both findings present new genotypes of microsporidia. These findings proved that the extreme conditions of high Arctic on Svalbard enable spreading of intestinal unicellular parasites, cryptosporidia and microsporidia.

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SENSITIVITY OF ECOSYSTEM CARBON CYCLE TO CLIMATE CHANGE IN A HIGH ARCTIC GLACIER FORELAND

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KEYWORDS: HIGH ARCTIC, CARBON CYCLE, SENSITIVITY ANALYSIS, GLACIER FORELAND

Global circulation models predict warming and increased precipitation in Arctic regions throughout the 21st century. Since large amounts of organic matter accumulate in soils, we need to know how carbon flows in the Arctic terrestrial ecosystem will respond to projected climate change. In this study, we construct a process-based model for simulating stand-level photosynthesis, root respiration and heterotrophic respiration at Svalbard in the High Arctic (Fig. 1). Using this model, responses of net ecosystem production (NEP) to temperature and precipitation increases and to lengthening of growing season are examined.

The study site was in the glacier foreland of Austre Brøggerbreen near Ny-Ålesund in Kongsfjorden, Svalbard. A mixed community of *Salix polaris* and the moss *Sanionia uncinata* was selected for study, because it is the dominant vegetation of the late successional stage of the glacier foreland. The model was composed of six carbon pools: aboveground and belowground biomasses of vascular plants, biomass of cryptogams, organic layers of vascular plants and cryptogams, and mineral soil layer. Responses of each carbon flow to environmental factors were expressed by functions determined in previous studies (Nakatsubo et al. 1998; Muraoka et al. 2002; Uchida et al. 2002; Bekku et al. 2003).

To evaluate model calculations and determine model coefficients, we selected three study plots (A, B, C) with different coverages of *S. polaris* in the glacier foreland. In the 2001 summer season, NEP was measured in these plots using a portable photosynthesis system with an assimilation chamber. Carbon pools in each plot were investigated after this measurement.

In situ NEP values in the growing season varied widely among the three plots, ranging from 17 to 110 mg CO_2-C m^{-2} h^{-1}. Seasonal variation within a plot was also considerable, but there was close correlation between model-estimated values and those determined in the field. This shows that the model effectively simulates NEP in the growing season at the plot level. Model-estimated NEP values for the plots (A–C) were from 6.2–27.0 g C m^{-2} growing $season^{-1}$. The NEP variations may be caused by a difference in *Salix* leaf biomass, because a significant correlation was observed between leaf biomass and NEP.

We used the model to examine NEP response to temperature, precipitation and lengthening of the growing season. Effects of temperature increases of +2°C, +4°C and +6°C on NEP were calculated. It was shown that NEP decreases rapidly with increasing temperature. In two of the three plots, NEP became a CO_2 source to the atmosphere with an increase by 2°C. All three plots became such a source with a 4°C increase. The effect of precipitation increase was examined by 5, 10 and 15% increases. Our result suggests that this effect on NEP was extremely small. On the other hand, lengthening the foliage period of *S. Polaris* significantly increased NEP, partially compensating the negative effect of temperature increase.

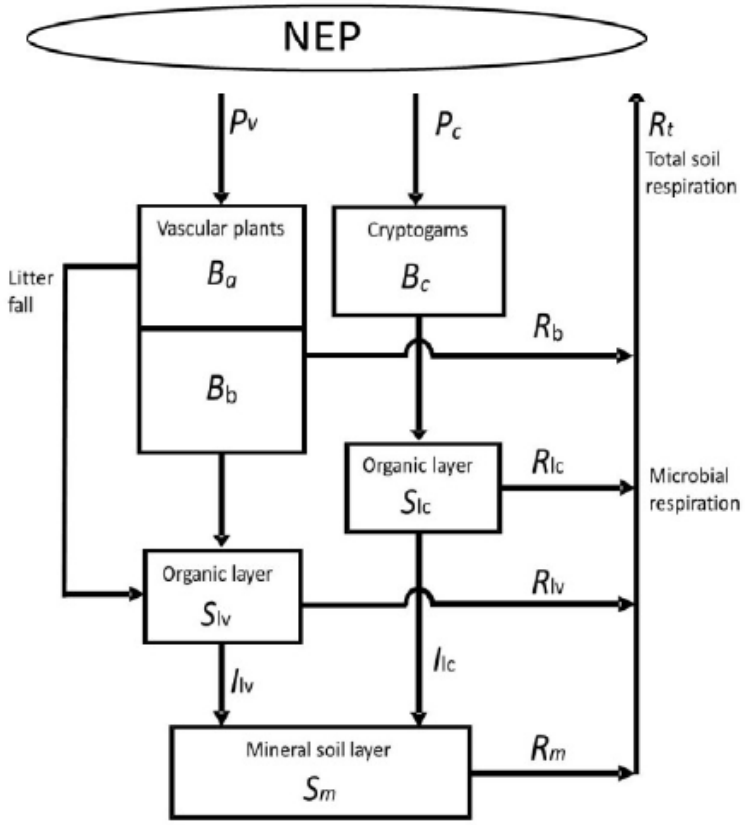

Fig. 1. Compartment model showing major carbon pools and flows on the glacier foreland at Svalbard.

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THE PRESENT AND THE PAST RATE OF THE MECHANICAL DENUDATION IN THE SMALL GLACIATED ARIE CATCHMENT

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KEYWORDS: GLACIATED CATCHMENT, DENDROCHRONOLOGY, SUSPENDED SEDIMENTS, SPITSBERGEN,

The fluvioglacial processes in the High Arctic environment differ than in the another regions. Hydrologic regime of the rivers is connected not only with precipitation or snow and glacial melts during summer season but also with thawing of permafrost and thermo-erosional phenomenon. Understanding of the present and past rate of the mechanical denudation allows to determine direction of development of partly-glaciated valleys.

Our investigation focused on Ariedalen valley (Fig. 1), which is located in the South - West part of the Spitsbergen island, 2.5 km from Hornsund fjord and Polish Polar Research Station (PPS) (77°00'N 15°33'E). The study area is a small mountain catchment (2.04 km2) situated between Skoddefjellet (783 m a.s.l) and Ariekammen (514 m a.s.l.) massifs. According to Pulina (2004), Ariedalen belongs to glaciated basins in residual stage that include valleys and coastal mountains.

The ice-cored moraine, located in the middle of the basin, divides valley on two parts. Upper part with small cold body cirque Ariebreen glacier (0.36 km2) and the marginal zone in the South (Nawrot, 2011). Szponar (1975) suggest that the part, which contains an end moraine, is a lateral moraine and present-day Ariebreen glacier is younger than older zone of Arie Valley. The latter zone is 850 m length and contains lateral moraine and has existed back to the period in the Ariebreen glacier front was outside Ariedalen valley (Nawrot, 2011).

Szponar (1975) suggest also that present day marginal zone should be assigned to the time of the Holocene transgression that occurred in the 18th and 19th centuries. In this time ice-cored moraine located in Arie valley was build by the Ariebreen glacier. Proglacial and pronival waters are creating Arie river. Since end of the 20th centuries and end of the Little Ice Age (LIA), Arie river bed was changing the shape and length as well as suspended sediment concentration.

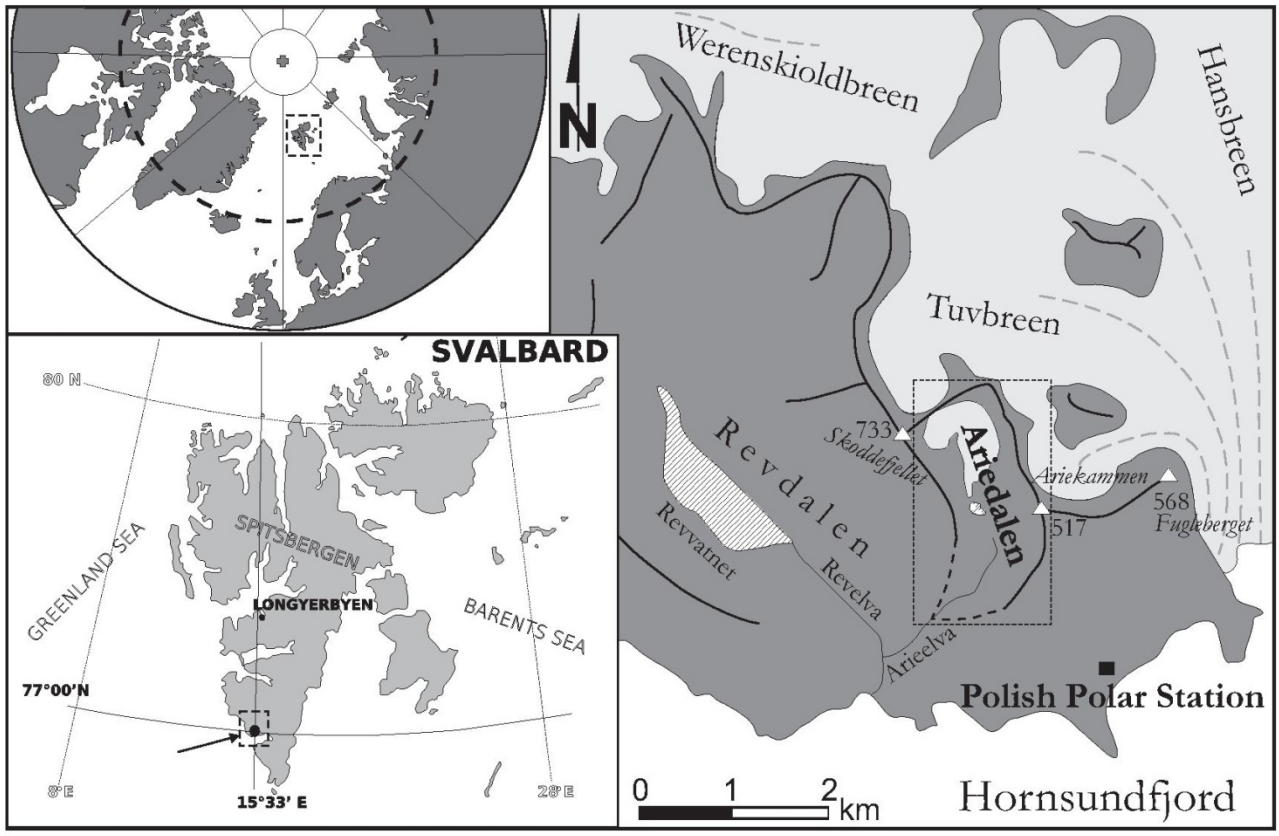
To recognize present and past rate of the mechanical denudation we had to use several field and laboratory methods:

1. Dendrochronology – to analyze the age of fluvioglacial forms. Two species of dwarf shrubs, which belong to Willow family (*Salicaceae*), *Salix polaris* and *Salix reticulata,* were collected from two levels of fluvioglacial terraces and lateral moraine of the Arie glacier;
2. Water samples for suspended sediment transport from Arie stream were collected from July to October in 2008 and 2009. Autosampler ISCO System was automatically taken samples to 1000 ml prerinsed polyethylene bottles, in 2008 four times per day at 06, 12, 18 and 24 UTC and in 2009 once per day at 18 UTC. In the Polish Polar Station laboratory, water was filtered with 0.7µm GF/F Whatman glass microfibre filters. Afterwards filters were dried for 30 minutes at 105oC and stored in an exsiccator to chill. Filters weighting was done on a Radwag analytical balance with a precision of 0.1 mg.
3. Geodetic survey - at summer 2009 additional measurements of river bed location, river terrace altitude and old fluvial channel located on ice-cored frontal moraine of Ariebreen glacier was appointed. Each point was measured with geodetic resolution using two Differential GPS Leica 1200 System. One as a rover and second as a base station. In the field the Stop&Go method with measured time for each point > 2 minutes was used.
4. Geographical Information System (GIS) – geomorphic analysis using ArcGIS Software;

In the light of dendrochronological analysis can be distinguish tree stages of the Arie Valley development during last 100 years: (1) before 1930 - aggradation phase – development of higher level of fluvioglacial terrace, (2) form the turn of 1930 and 1940 – intensive erosion phase, connected with Arie glacier retreat, (3) from the 1970-1975 – stabilization of the valley bottom and development of the lowest part of the valley.

The total mechanical denudation rate for 2008 was only 5.0 t/km2 and the 75% of total suspended matter flux discharged was recorded in August and only 1% in October. Measurements also confirms that suspended sediment concentration decrease between inflow to and outflow from the Arie ice-moraine even up to 16 times. The fact that ice-cored moraines have influence on the suspended matter concentration is not new in geosciences, but Arie moraine is shows reverse effect. The low concentration of the suspended sediments in the proglacial Arie river comply with the generally accepted fact that due to unstable sediments and poor vegetation cover, sediment recycling is high during early deglaciation and decreased with ice recession (Ballantyne, 2002). This also verify our dendrochronological results.

This interdisciplinary research gave us possibility to recognized past fluctuation of the Arie river valley morphology and geomorphic processes, to estimate rate of the present-day mechanical denudation and determine direction of development of partly-glaciated valleys.



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WHICH ENVIRONMENTAL FACTORS CONTROL DWARF SHRUBS GROWTH IN THE HIGH ARCTIC AREA?

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KEYWORDS: DWARF SHRUBS, DENDROCHRONOLOGY, CLIMATE CHANGES, MASS MOVEMENTS,

Arctic vegetation are very sensitive for environmental changes. Variations of climatic conditions, mainly related to the microtopography and the influence of the ocean and glaciers, thickness of snow cover, geology, bird colonies and activity of periglacial processes determine the growing of the Arctic plants. The studies carried out on the Spitsbergen Island have shown great potential of wooden dwarf shrubs in geomorphological research (Owczarek 2009). The aim of this study is to present variability of growth ring width of the Arctic dwarf shrubs depending on climatic and non-climatic factors.

Three research areas located in the south-western part of the Spitsbergen (Svalbard) were selected to detailed study: (1) slope in the vicinity of the seabird colony, (2) lowland with distinct microtopographic relief and (3) flat marine terrace. Granulometric characteristics of the soil and the concentration of selected chemical compounds (nitrates, nitrites, ammonia) were identified in the research sites. Two species of wooden dwarf shrubs, which belong to the Willow family (*Salicaceae*), were analyzed: *Salix polaris* and *Salix reticulata*. They are creeping plants usually less than 8 cm tall which commonly form mats. The samples were collected during four summer season (2007 - 2011) in the vicinity of the Polish Polar Station in Hornsund. Complete specimens of dwarf shrubs, including their root and branch systems, were collected in the field. Each individual was documented by digital photo and sectioned with GSL 1 sledge microtome. We have taken 15-20 μm cross-sections every 0,5-1,5 cm along each individual: from 4 to 7 different locations (depending on the shrub length). After staining with 1% solutions of safranin and astrablue dyes, digital photographs of the micro-sections were taken for tree-ring analyses (in search for scars and reaction wood) and measurements (in order to determine the age of shrubs and their growth pattern, along with ring reductions). Ring widths were measured along two or three radii using OSM 3.65 and PAST4 software. We construct two chronologies which were used to distinguish climatic and non-climatic factor.

S. polaris and *S. reticulata* have well-defined growth-rings which ranged from 0.2 mm to less than 0.01 mm in width (Fig. 1 AB). We found other interesting features of wood anatomy, like tension wood (Fig. 1C) and scars (Fig. 1D).

Site (1): The research results indicate that the dwarf shrubs form wider growth rings in areas, where the highest concentration of inorganic nitrogen in the soil is observed. These small flat areas in the upper and middle part of the analyzed slope are occupied by bird colonies (Little auk, Bernacle goose).

Site (2) On the lowland with with distinct microtopographic relief, where the impact of seabirds is smaller, the increase of growth of dwarf shrubs depends on microtopography and the granulometric composition of the soil. The widest and the best development growth rings have plants growing on the patterned grounds and the stony areas with poor vegetation cover. Relatively narrow rings are formed in small depressions filled with fine-grained sediment. These areas is covered mainly by moss-tundra communities.

Site (3) Research have shown considerable variation the growth-ring width. Average width of annual rings has increased significantly in the last two decades. These changes highly correlated

with the growth of temperature and sum of summer and fall precipitation observed for the region (Polish Polar Station, Hornsund). The dendrochronological/dendroclimatological data well describe general state of tundra and indicate events of extreme weather, which force mass movement processes, e.g. debris flows.

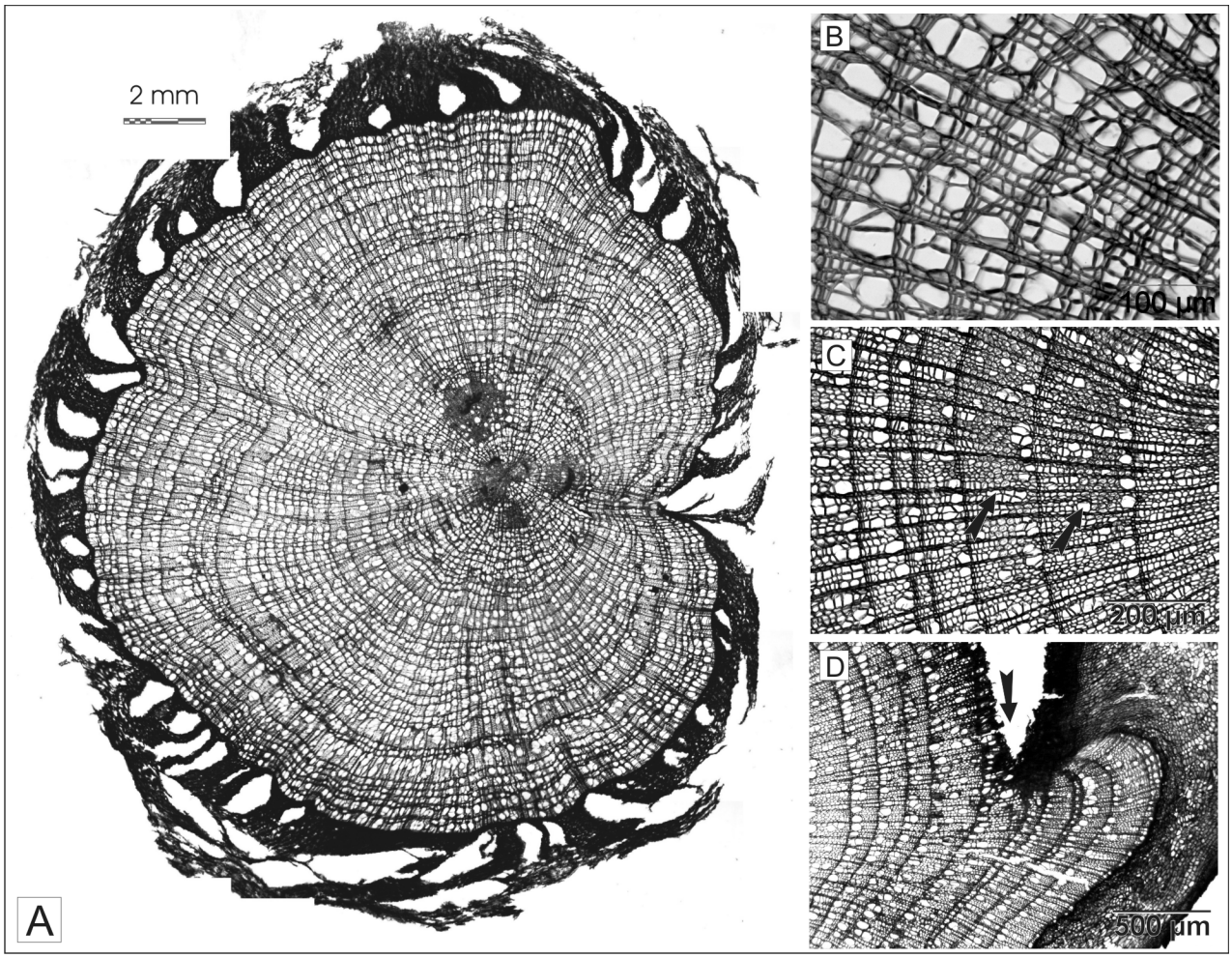

Figure 1. Wood anatomy features of studied shrubs: A – microtome section of the stem of *Salix reticulata* (whole diameter, 46 growth rings) with visible discontinuous growth rings; B – ring boundaries of *Salix polaris* composed of two or more cell rows; C – tension wood in *Salix polaris* (irregular gelatinous fibers marked by arrows); D – a scar in the *Salix reticulata* sample developed 9 years ago.

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DIVERSITY AND DISTRIBUTION OF *PRASIOLA* (PRASIOLALES, CHLOROPHYTA) IN SPITSBERGEN (SVALBARD ISLANDS)

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KEYWORDS: CHLOROPHYTA, *PRASIOLA*, SPITSBERGEN, TAXONOMY, TERRESTRIAL ALGAE.

Prasiola is one of the most common genera of green algae in polar and cold-temperate regions. Members of this genus are found in a wide range of habitats, including moist soil, natural rocks, fast-running streams, slow-flowing water from melting ice and rocks at high water mark on marine shores. *P. crispa* is reported as the most common species of *Prasiola* in polar regions, where it is usually associated with habitats rich in organic nitrogen (particularly, ground hosting penguin rookeries in Antarctica). Recent molecular studies on the systematics of *Prasiola* have placed new emphasis on the genetic diversity of this genus; Móniz et al. (2012) showed that Antarctic populations assigned to *P. crispa* subsp. *antarctica* represent a complex of three different cryptic species that are morphologically indistinguishable (*P. antarctica*, *P. crispa*, *P. glacialis*). This highlights the necessity of a taxonomic reassessment for collections of *Prasiola* from other regions with cold climate. In August 2012 we travelled to Spitsbergen and we investigated the distribution of *Prasiola* in a range of different habitats in part of the Billefjorden region. Populations of *Prasiola* from this island have been used for physiological and biochemical studies (Graeve et al. 2002, Holzinger et al. 2006). However, they have not been the subject of recent taxonomic investigations and molecular data are currently lacking for them. We collected samples from 7 sites (1 freshwater, 1 upper intertidal and 5 terrestrial) and we determined two species of *Prasiola*. *P. fluviatilis* was found in the freshwater sample; it formed a dense population attached to a stone in a fast-flowing stream. Some specimens with large blades were reproducing sexually; gametangial portions of the blades showed a mixture of dark and green patches similar to those of the marine species *P. stipitata*. *P. crispa* was found in the terrestrial samples; it occurred on bare soil, concrete and rocks at the upper tidal line. This alga is probably widespread in Spitsbergen, but it is best developed and most visible at sites with eutrophic characteristics. Although the typical leafy form was found at some sites, this species occurred mostly in the filamentous form, consisting of a mixture of uniseriate filaments and narrow ribbons formed by a few cell rows. Compared to populations from temperate regions and Antarctica, *P. crispa* from Spitsbergen produced much larger numbers of akinetes. The identity of the populations collected will be confirmed using molecular markers (*rbc*L and *psa*B gene sequences), for which the samples are currently being processed. With the help of molecular data, we will also address questions regarding the biogeography and distribution of *Prasiola* in polar regions.

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DESICCATION TOLERANCE AND OSMOTIC POTENTIAL OF *ZYGNEMA* ON SVALBARD

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KEYWORDS: CHLOROPHYLL A FLUORESCENCE, DESICCATION, GREEN ALGAE, OSMOTIC POTENTIAL, PLASMOLYSIS

Zygnema is a filamentous green alga belonging to the class Zygnematophyceae (Streptophyta). It typically occurs in shallow pools, streamlets or on the surface of wet soil and therefore it is subjected to a range of environmental stresses, including desiccation. In spite of that, *Zygnema* is quite abundant and easy to find on Svalbard which shows its high tolerance and resistance to the extreme ambient conditions. The aim of our study was to investigate the desiccation tolerance of *Zygnema* in the field conditions.

Six natural populations in different stages of desiccation were selected – from wet biomass floating in water to dried paper-like films. Morphology and viability of the cells was observed with light and epifluorescence microscopy, physiological state was estimated by measuring chlorophyll a fluorescence parameters. Moreover, osmotic potential (Ψ_s) of the cells at the turgor loss ($\Psi_{t=0}$), was estimated as the osmotic potential of sorbitol solution in which plasmolysis occurs. Furthermore, the algae were stressed with 2M sorbitol and then their recovery in water was studied.

We found out that the moist populations plasmolysed sooner (at 450 mM sorbitol) than populations in various stage of desiccation (750 mM or more). Moreover, a significant decline in the steady-state PSII quantum yield in light with increasing sorbitol concentration was proven in both moist and half-desiccated samples. On the other hand, not even 750 mM sorbitol does not represent strong stress for the photosynthesis in naturally desiccated cells. Furthermore, 2M sorbitol (Ψ_s=−5.87 MPa) represented rather high osmotic stress. The moist populations showed high mortality after this treatment and also the recovery of fluorescence parameters was slower.

Our results show that *Zygnema* is well adapted to the field desiccation during the season. As the cells are subjected to reduced water potential during slow desiccation, they are becoming more resistant (hardened) to severe desiccation stress. Nevertheless, also the wet biomass contained cells with quite negative osmotic potential for plasmolysis showing that this alga is well adapted to life in a hydroterrestrial environment.

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ECOLOGICAL TYPIFICATION OF SOIL CRUST ECOSYSTEM IN PETUNIABUKTA, SVALBARD

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In polar desert soil algae can produce distinct visible biotic crust layers on the ground surface which are called cryptogamic crusts. They consist of water-stable, surface soil aggregates held together by algae, fungi, lichens and mosses. Therefore, biological soil crusts are important to maintain ecosystem structure and functioning in dry lands. The objective of this study was to describe various types of arctic soil crust that were collected in Petuniabukta, Svalbard. The fluorescent area of different samples was estimated by Fluorescence imaging camera FluorCam 700MF (Photon Systems Instruments, Czech Republic). Biodiversity of cyanobacteria and microalgae from collected soil crusts was studied using binolupa analyses and light microscopy observation. In most cases cryptogamic crusts were dominated by cyanobacteria as *Gloeocapsa, Nostoc, Microcoleus, Scytonema, Komvophoron* and green algae as *Coccomyxa, Hormotila.* There was a high amount of *Trebouxia* in soil covered by lichens which have this alga as photobiont. Soil crust that is located in conditions with high humidity, usually was covered by Nostoc. By these methods soil crust from studied area can be divided on three types: black-brown soil crust (with low diversity of algae), brown soil crust (with high diversity of algae) and gray-brown soil crust (with low diversity of algae). Also the same types of soil crust were compared in different gradients. The result has shown that various heights don't affect on biodiversity of algae.
However, amount of them increases with increasing of altitude.

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CYANOBACTERIA AND ALGAE COLONIZING MAMALIAN BONES REMAINS IN SVALBARD, ARCTIC

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KEYWORDS: CYANOBACTERIA, ALGAE, BONES, ARCTIC

The bone remains are frequent dispersed everywhere in polar regions. Such bone substrate served to organisms protection against physical and biological stress factors, e.g. high radiation, low temperature, low content of biogenic nutrients etc. It is a specific natural habitat which is colonized by cyanobacteria and algae in epiostioic (epi - attached; osteo - bone) and euendolithic occurrence, as we also know on stone substrates. These photosynthetic microorganisms grow on bones as biofilms and also co-participate in their decomposition. However, these habitats are not included in the ecological studies of polar regions, though the biota is intensely available everywhere in open nature (Davis 1997, Jans 2008). The study was done on the bone remains from mammals sampled in Petuniabukta, in Svarbard Archipelago in summer season 2011, during a course of polar ecology organized by South Bohemian University in Česke Budějovice. In total we have observed and detaily studied the existence of 14 taxa of cyanobacteria and algae which were isolated as laboratory strains from the natural samples. In comparison to the actual literature data published from Svalbard so far (Table), we confirmed the occurrence of 4 taxa (*Leptolyngbya foveolarum*, *Chlorella vulgaris*, *Pseudococcomyxa simplex*, *Stichococcus bacillaris*). Five more taxa were on genus level only or not in species level as we have observed (i.e. *Phormidium subfuscum*, *Nostoc* sp., *Chlorella miniata*, *Klebsormidium klebsii*, *Coccomyxa* sp.) and 5 taxa were described as a new for Svalbard region (*Synechocystis pavelekii*, *Heterococcus papilosus*, *Pseudodyctiochloris* multinucleata, *Tetracystis pulchra*, *Xanthonema debile*).

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Table: List of cynobacteria and algae observed in present work in comparision to the previous records.

REFERENCES: / Taxa	Matula 1982	Skulberg 1996	Kaštovská et al.2005	Matula et al. 2007	Kim et al. 2008	Richter et al. 2009	Kim et al. 2011
Synechocystis pavelekii	NO	NO	NO	NO	NO	NO	NO
Leptolyngbya foveolarum	NO	NO[3]	YES	YES	NO[11]	NO[14]	YES
Phormidium subfuscum	NO[1]	NO[4]	NO[4]	NO[4]	NO[4]	NO[4]	NO[4]
***Nostoc* sp.**	YES[2]	YES[5]	YES	YES[5]	YES	YES[5]	YES
Heterococcus papilosus	NO	NO	NO	NO	NO	NO	NO
Xanthonema debile	NO	NO	NO	NO	NO	NO	NO
***Coccomyxa* sp.**	NO	NO	NO	YES[9]	NO	NO	NO
Pseudodyctiochloris multinucleata	NO	NO	NO	NO	NO	NO	NO
Tetracystis pulchra	NO	NO	NO	NO	NO	NO	NO
Chlorella miniata	NO	NO	NO[7]	NO[10]	NO[12]	NO	NO[12]
Chlorella vulgaris	NO	NO	YES	YES	YES	NO	YES
Pseudococcomyxa simplex	NO	NO	YES	NO	NO	NO	NO
Stichococcus bacillaris	NO	NO[6]	YES	NO	NO	NO	NO
Klebsormidium klebsii	NO	NO	NO[8]	NO	NO[13]	NO	NO[15]

Comments:

1 – instead reported *Phormidium autumnale, P. presley, P. favosum, P. frigidum, P. tenue*, 2 – reported *Nostoc comunne*, *N. kilhmanii, N. funciforme*, 3 – instead reported *Leptolyngbya limnetica* and *L. vacuolifera*, 4 – reported several species of *Phormidium* except *P. subfuscum*,

5 – reported several other *Nostoc* species, 6 – instead reported *Stichococcus nivalis* and *S. scoplinus*, 7 – reported several species of *Chlorella*, but not *Ch. miniata*, 8 – reported *Klebsormidium flaccidum*, *K. montanum* and *K. scopulinum*, but not *K. klebsii*, 9 – reported *Coccomyxa confluence*, 10 – reported *Chlorella luteoviridis*, 11 – reported two species of *Leptolyngbya*, 12 – reported *Chlorella minutissima*, 13 – reported *Klebsormidium flaccidum*,

14 – reported *Leptolyngbia margaretheana***,** *L. treleasii* and *L. fragilis*, 15 – reported *Klebsormidium flaccidum* and two other species of this genus.

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HIGH ARCTIC LANDSYSTEM CHANGES IN VARIOUS TIME SCALES – EXAMPLES FROM BILLEFJORDEN, SVALBARD

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KEYWORDS: GLACIATIONS, SEA LEVEL CHANGES, RELIEF ALTERATIONS, GEOMORPHOLOGICAL PROCESSES, CENTRAL SPITSBERGEN

The complexity of high Arctic terrestrial environment functioning is the effect of regional setting (geographical situation, geology, oceanographic influences) as well as surface energy and climate related geomorphic processes, that effects from the past and present-days, recorded in landforms and sedimentary sequences. They reflect the action of long-term glacial cycles, considered as main land shaping agent, recurring in periods of hundreds to tens thousands years (ka), with periglacial and paraglacial relief adjustment over deglacierized areas. In the centennial time scale, secondary landform assemblages, connected to minor climatic oscillations, like Little Ice Age (LIA), left an overprint in the slope and valley systems, followed by effects of contemporary warming, causing widespread glaciers decay and increased frequency of above average processes activity.

Study area is located in the central, inner-fjord area of Spitsbergen island in Svalbard archipelago. Geological setting is conditioned by the presence of Paleozoic Billefjorden Fault Zone (BFZ), one of the most distinct tectonic features of the region and the existence of various rock types, *i.e.* metamorphic Precambrian basement, Devonian and Carboniferous sedimentary sequences containing limestones, dolomites, anhydrites, siltstones, sandstones and conglomerates with coal intercalations and intrusive rocks, all substantially folded and cut with faults in the edge part of a half-graben.

All rock types particles are found within Quaternary sediment covers, remaining as old as from the Saalian glaciation ("Glaciation A" *sensu* Mangerud et al. 1998), followed by Eemian marine deposits and three Weichselian tills, separated with interstadial deposits in the well elaborated Kapp Ekholm site (Mangerud et al. 1998) and less known one in Hørbyedalen (Karczewski & Rygielski 1989). Primary glacial erosional landscape shape was produced by ice masses that reached over Spitsbergen 800-1200 m of thickness and 800 m of surface elevation, decaying between 12 and 10 ka, as modeled by Landvik et al (1998). Though only isolated nunatak summits that protruded through the ice sheet, remained not glacially reworked and on most of other surfaces glacial erratic material can be found (Rachlewicz 2009a, 2010a,b). Widespread metamorphic boulders, easy to be identified, show distinct traces of age depending weathering activity (Rachlewicz 2010b) studied with the use of Schmidt-hammer and rock surface micromorphology, both helping retrieve deglaciation and post-glacial shoreline emergence history. More advanced techniques as cosmogenic radionuclide and marine shells dating are also applied.

Continuously, after the deglaciation, in periglacial environment, the landscape is adjusted paraglacially to contemporary situation, in conditions of high relief energy and big amount of accumulated loose sediments in several horizontally and vertically developed morphogenetic domains (Kostrzewski et al. 2007). Smaller scale climate oscillations like LIA glaciers advances and present day warming, with their common decay and sudden geomorphic processes, lead to dramatic changes in slope and river realms, with intensive discharge of water and sediments (in dissolved and solid form) outside of the catchments (Rachlewicz et al. 2007, Rachlewicz 2009a,b, 2010a), in the amount not noticed throughout the whole Holocene, as supposed from fjord bottom deposition rate.

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PERMAFROST ACTIVE LAYER TEMPERATURE VARIATIONS IN EBBA VALLEY (CENTRAL SPITSBERGEN) IN THE YEARS 2009-2012

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KEYWORDS: PERMAFROST, ACTIVE LAYER, GROUND TEMPERTURE, SVALBARD

The studies were conducted in order to identify the yearly state and dynamics of perennially frozen ground active layer in Ebbadalen (Ebba valley) between July 2009 and June 2012, that is essential eg. in plant communities development. Analysed area is located in central Spitsbergen where climate is relatively more dry than in the other parts of Svalbard Archipelago.

Ground temperature monitoring was carried out in three different locations. Measuring points were located at: (1) dry tundra surface, (2) wet tundra surface and (3) central part of the valley (with no vegetation). Measurements were conducted automatically with one hour interval. For automatic record TRIX-8 LogTag's temperature recorders were used. Sensors were placed inside the PVC pipes at depths of 5, 10, 25, 50 and 75 cm (except the wet surface where due to technical reasons it was placed only at 5 and 10 cm depths). Sediment samples were collected at all locations for laboratory analysis (standard grain size composition). In summer periods continuous meteorological observations were also made. In addition, using DGPS and surveying, topographical mapping and vegetation cover sketches were made at the all measuring points.

The sediments in the analysed locations are composed of poorly to moderately sorted sands and gravels. An increase of grain size with depth was also observed. Deposits genesis is connected mostly with marine and fluvial activity in Ebbadalen area. Vegetation depends on the terrain type and in lower and more humid parts of the area greater diversity of plant species is observed. Dryas octopetala, Equisetum arvense, Salix polaris, Carex rupestris, Cassiope tetragona, Saxifraga oppositifolia were mostly observed.

Changes in soil thermal structure show a significant dependence on air temperature (declining with depth), while in spatial diversity of ground temperature the most important factors were: the presence of vegetation cover and sediment moisture (poor correlations with soil grain size composition, cloudiness and precipitation were found).

In addition, it has been observed that:
- greater and more frequent temperature variations occur closer to the surface,
- heat pulse reaches the low lying layers of soil with a well-defined delay,
- ground temperature is responding more quickly to increase of the air temperature than to the cooling,
- negative thermal gradient exist during summer periods,
- zero curtain effect occurs during freezing and thawing of soil,
- thermal gradient after total freeze-up (in cold season) keeps reversed: temperature rises with depth.

PRODUCTIVITY AND BIOGEOCHEMISTRY OF TERRESTRIAL ICE-BOUND ECOSYSTEMS OF MARITIME ANTARCTIC

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KEYWORDS: SUPRAGLACIAL, MARITIME ANTARCTICA, GLACIAL NUTRIENT BUDGET, MICROBIAL PRODUCTIVITY

The glacier ice is the most poorly understood terrestrial habitat in Antarctica but it is also a significant microbial resource that collectively constitutes the largest single freshwater reservoir of bacteria on the Earth's surface. The total bacterial cell biomass in the Antarctic ice sheet is thought to amount to ~ 2.44 Tg so mass losses from West Antarctic and the Peninsula mean major biomass and organic carbon fluxes (~ 16 GgC a-1) are taking place whose ecological implications have been completely overlooked. These viable microorganisms during the melting season sequester between 50% and 75% of the inorganic snowpack nutrient reservoir and fix ~ 10 mgC m^{-2} d^{-1} from the atmosphere by photosynthesis. Snow and ice-bound microorganisms transform enormous quantities of inorganic nutrients and CO_2 from the atmosphere into organic biomass while they are in transit to the coast and the glacial and snowmelt runoff can increase marine plankton blooms up to 100 km offshore. This project aims to study the internal production and biogeochemistry of snow and ice habitats in the maritime Antarctic. Microbiology, nutrient economy and productivity of snow and ice surface habitats will be assessed at several transects upon Signy Island (South Orkney Islands) that are representative of the broad range of melting and nutrient gradients found along much of the Antarctic Peninsula's west coast and associated archipelagos. These sites will encompass nutrient-rich, high melt rate coastal snowpacks and nutrient impoverished, cold snowpacks at altitudes where melting is sporadic and typically restricted to the surface. Microbial community structure and biomass will be established throughout the summer and the fate of microorganisms will be tracked as melting removes them from the snow and ice. Nutrients and melt energy fluxes that drive the whole system will also be monitored. The tight integration of physical, chemical and biological process measurements and the range of sites being considered will enable us to calculate first estimates of CO_2, nutrient and microbial fluxes for maritime Antarctica.

MICROBIAL LIFE IN ALPINE AND POLAR ICE CAVES

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KEYWORDS ALPINE AND ANTARCTIC, ICE/GLACIER CAVES, MICROBIAL COMMUNITIES, AEROBIOLOGY

Ice and glacier caves in alpine and polar regions have been lately recognized as microbial habitats. They harbour truncated food webs consisting of viruses, fungi, bacteria and autotrophic organisms such as cyanobacteria and (snow) algae exerting photosynthesis which is mostly limited to the cave entrance. Ice caves in general are understood as rock caves with remaining permanent ice with a seasonal change of thickness providing a relatively stable environment. Contrary to the relatively stable environment of this type glacier caves do not provide a rock bed and are highly dynamic due to the plasticity and movement of the glacier. Hence, caves in glaciers can as well disappear for a while or close up. However, due to limited but still existing transparency of the overlying ice cyanobacteria can still thrive and provide carbon for heterotrophic bacteria.

Here we present the comparison of the two types located in the Austrian Alps (Grubsteinhöhle and Hintertuxer Eispalast) and glacier caves from Antarctica (Novolazarewskaya and Dumar glacier cave) based on chemical characterization of the ice and the consisting bacterial communities. Samples have been taken in the respective ice caves from ice, sediments and air with a Kovacs ice corer and different types of airsamplers. Molecular biological results from the ice cave revealed largely different microbial communities in ice cores, sediment and air. Ice cores of all habitats contained Actino-, Cyano- and Proteobacteria whereas Acidobacteria and Deinococcus-Thermus have only been found in Antarctic caves. Ice samples show considerable amounts of bacterial carbon which is produced by microbes via heterotrophic processes. Surprisingly, also photosynthetic activity is detectable despite the extremely low light levels therein.

Hintertuxer Eispalast is an ice cave built from a crevasse which is currently used as a public site for tourists. Hence, one has to consider as well the anthropogenic impact of humans onto the composition of microbial communities in the ice and air. In the near future, it is planned to set up an *in situ* ice laboratory directly in this particular cave to study microbial processes under the most realistic conditions.

Ice caves are also understood as a refuge for microbial cells and are hence model habitats for astrobiological hypotheses.

L.I.F.E. (LASER INDUCED FLUORESCENCE EMISSION) AS NON-INVASIVE TOOL TO ASSESS PHOTOSYNTHETIC PIGMENTS IN ICE ECOSYSTEMS

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KEYWORDS: LIFE, NON-INVASIVE DETECTION, PHYCERYTHRIN, ICE, CHLOROPHYLL

Laser-induced fluorescence emission (L.I.F.E.) is an *in situ* laser scanning technique to detect photoautotrophic pigments such as phycoerythrin of an ice ecosystem without invasion. The sensitivity of many psychrophiles to even moderate changes in temperature, and the logistical difficulties associated with either *in situ* analysis or sampling makes it difficult to study microbial metabolism in ice ecosystems in a high resolution. In general, the ice habitat has to be disrupted using techniques that usually include coring, sawing and melting. Samples are also often chosen blindly, with little indication of probable biomass. The need for an *in situ* non-invasive, non-destructive technique to detect, localize, and sample cryosphere biomass in the field is therefore of considerable importance.

Surface communities of cold ecosystems are highly autotrophic and therefore ideal systems for L.I.F.E examinations. 532nm green lasers excite photopigments in cyanobacteria and produce multiple fluorescence signatures between 550nm and 750nm including carotenoids, phycobiliproteins which would enable a non-invasive *in-situ* measurement.

L.I.F.E has already been tested in remote ecosystems like Antarctica (Lake Untersee, Lake Fryxell), but until now no calibration was set to convert the L.I.F.E. signal into pigment concentration. Here we describe the standardization for detection of phycobiliproteins (phycoerythrine) which are found in red algae, cyanobacteria, and cryptomonads. We could relate different concentrations of phycoerythrine with a cerresponding fluorescence signal. Furthermore, the same procedure has been set up to develop a system for a non-invasive detection of chlorophyll$_a$. In order to calibrate the system, various concentrations of standards of phycoerythrin and chlorophyll. Despite the need for a standardization of frozen samples (standards frozen in distilled water) the calibration needed to be done in the liquid phase due to high sensitivity of off the shelf standards. This might most likely produce a shift in the calibration line.

So far the system could be set up for phycoerythrin and chlorophyll$_a$ in a handheld device which can be walked along a virtual grid on the glacial surface to scan the sampling spots in a high resolution.

Similar methods are already used for detection of phytoplankton in liquid systems like oceans and lakes by NASA´s Airborne Oceanographic LIDAR since 1979. The possibility to use L.I.F.E. in ice ecosystems though is a novelty.

SALT MARSH FLORA AND VEGETATION OF THE RUSSIAN ARCTIC COASTS

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KEYWORDS: HIGHER PLANTS, FLORA, VEGETATION, RUSSIAN ARCTIC

The coastal flora of open coasts and the estuaries of rivers, are an important element of the Arctic flora and represents the littoral halophytic floristic complex, possess the unique structural and functional integrity. Salt-marsh communities are sensitive to environmental change, including a rise in sea level and erosion from storm surges. Studies of the interactions between abiotic and biotic processes enable us to determine the state of coastal biogeocenoses (development of the ecosystem) and make predictions of future changes.

The work was performed with the use of a complex route floristic, geobotanical and soils researches methods (Galanin, 1991). The collection of field data was held from 1972 to 2011. Personally, the author has investigated 36 partial local floras, on the shores of the seas: the White, Barents, East-Siberian, Chukchi and Bering. To complete the picture, the herbarium materials (LE, PTZ, O, L) and the published data on the composition and structure of vegetation cover of the above mentioned seas, and Kara and Laptev seas have been used.

Arctic Russian coastal zone spreads for more than 50 000 km. The distribution of the coastal species differs in different parts of the Arctic zone. The total amount of all arctic species of higher plants is 1691, belonging to the 99 families and 435 genuses. The amount of the arctic coastal species is 113 species, belonging to the 32 families and 62 genuses, but the total amount of the coastal species in the different arctic regions is not more than 68 species on White Sea coast, 72 species in Beringian sea, 47 species on the Barents sea, 37, 35, 39 species are on the Kara, Laptev and East-Siberian seas coasts, 57 species are on the Chukchi sea coasts (Sergienko, 2008). In the united partial coastal flora of the Russian Arctic the number of the leading families consists of *Poaceae* (26 species, accounting for 23.4% of the total number of species), *Cyperaceae* (17 species - 15,3%), *Asteraceae* (8 species - 7.2%), and *Chenopodiaceae* (7 species - 6.3%), *Caryophyllaceae* (6 species - 5.4%); 2 families - *Brassicaceae*, *Apiaceae* have 4 species in their structure (3,6%); fam. *Juncaceae, Primulaceae, Rosaceae, Plantaginaceae* have 3 species in its composition. The dynamic changes of salt-marsh plant communities are site-specific: 1) in the initial stages of vegetational development mostly depend on the physical-chemical substrate properties and tidal action; 2) the spatial-temporal processes of successional change over a long time result in the development of the environment and changes in edaphic conditions.

Azonality is the main peculiarity of the halophytic floristic complexes of marshes wetland of the Russian Arctic coasts (Sergienko, 2008). The species are highly adaptable to varying climatic conditions. Only not numerous cosmopolitan circumpolar species such as *Carex subspathacea*, *Eleocharis uniglumis*, *Potentilla egedei*, *Stellaria humifusa* are the kernel and initial pathfinger of the communities. The changes in the biodiversity of the partial floras on the marshes wetlands are related to the historical development of the coenosis, geochemistry of landscape, climate, and, in the modern period, anthropogenous pollutions. The biodiversity the Arctic coastal and salt-marsh communities is directly linked to the geological history of the Arctic. The latitude botanical-geographical structure of the coastal arctic species depends on the zonal region's positions; therefore there is the absence of the species with plurizonal areas in the Kolyma regions, in the Lena and Taimyr regions. During glacial periods the seas were regressed, their level went down; shelves of the seas became a land. During interglacial periods there were seas transgressions, the sea level raised. In the period of warming at the end of the last glacial period, circumpolar arctic plant species became widely distributed over the continental shelf. Other species probably migrated by seed,

dispersed by coastal currents. However, the Taymyr Peninsula and Baffin Land served as barriers against the migration of amphi-atlantic species into the Beringia area. The basic changes of vegetative cover of salt marsh communities connected with the change of level of the Arctic Seas and with the geostatic raising of coasts, are the following: the area of plant communities with domination of boreal – European, and boreal – Eurasian species on the marshes wetland of the Russian Arctic coasts is constantly expanding.

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FUNCTIONAL AND STRUCTURAL COMMUNITIES IN THE SNOW PACK

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KEYWORDS: SNOW COVER, MICROBIAL COMMUNITIES, ION BALANCE, LIPID COMPOSITION

The impact the vast snow covers exerts on the biosphere comprises factors such as light climate, albedo, soil humidity, hydrology and air and water temperatures. Hence, it has been addressed as a physical component. Moreover, due to hostile conditions such as low temperatures, strong wind, low nutrient concentrations, UV radiation etc. the cryosphere has, for long time, been seen as devoid of life. However, the general picture of being a repository for wind-transported and ice-trapped microorganisms has changed dramatically with the improvement of methods and accessibility to cold environments. With increasing awareness that the cold regions of our planet harbour living communities, studies of the cryosphere are not solely restricted to physical aspects anymore but became substantially enriched by e.g. ecological disciplines.

First observations have proofed that snow in polar and high alpine regions presents a habitat for viable communities which are mainly of microbial origin. Hence, most investigations up to date have focused mainly on the characterization of the microbes of various polar und alpine environments. However, there is very sparse information about the composition of the metazoan communities in the snow pack.

During the snow coverage period, snow is undergoing a permanent process of metamorphosis where snow crystals get changed due to temperature variations, snow gets dislocated, compressed and is subject of a distinct hydrology within the pack, depending on the snow and ice layers therein. Hence, the living communities in the snow are mainly influenced by temperature, radiation, availability of liquid water and nutrients.

From what is known so far due to previous observations, not only microbes such as bacteria, viruses, ciliates, flagellates and algae are settling the snow cover but a whole variety of metazoa such as nematodes, larvae, collembola, etc. These communities are underlying the climatic changes within the snow pack substantially, and are also contributing to the nutrient turnover.

Furthermore, studies have shown that the snow melting phase lasting for a relatively short period of time has a great impact on bacterial diversity and biogeochemistry. However, nothing is known so far about the fate of microbial AND metazoan living communities in the snow during the whole snow coverage period which is a novelty. Here, we intend to describe the biological dynamics within the snow cover via the characterization of fatty acid composition.

A CLOSER VIEW ON MOLECULAR DIVERSITY IN AMPHIPODS OF SVALBARD

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KEYWORDS: AMPHIPODS, DNA BARCODING, GAMMARIDEA, PHYLOGENY, SVALBARD

Amphipods are one of the most diverse marine macrofaunal taxa in Svalbard. They occur in a wide variety of freshwater, brackish and marine habitats, where they play an important role in the structure and function of aquatic communities. Amphipods of the genus *Gammarus*, *Onisimus*, and *Anonyx* constitute an important food source for a variety of animals, are widely used in ecotoxicological research, and are also important intermediate hosts of trematodes (family Opecoelidae) and tapeworms (*Diplocotyle olricki*), often found in fish hosts (*Myoxocephalus scorpius, Gymnocanthus tricuspis*). Despite their ecological importance there are still taxonomic uncertainties and problematic species identification within these genera. Molecular markers have seldom been used to resolve phylogenetic relationships within the Amphipoda.

In this study, we established a molecular method to probe the taxonomy of prominent members of marine amphipods of the genus *Gammarus*, *Onisimus*, and *Anonyx*, caught and used for parasitological purposes. The amphipods were collected in a central part of Svalbard (Petuniabukta, Billefjorden), morphologically identified, and their DNA was used for DNA barcoding. This established method uses a short region of the mitochondrial gene cytochrome c oxidase subunit I (COI) for species discrimination. Molecular analysis of these amphipods with other ecological and parasitological data will help us to understand this ecologically important group of crustaceans.

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CHEMICAL CONSTITUENTS AND ANTIOXIDANT POTENTIAL OF ARCTIC VASCULAR PLANTS, LICHENS AND A MUSHROOM FROM SVALBARD

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KEYWORDS: ANTIOXIDANT, ANGIOSPERM, LICHEN, MUSHROOM, NY-ÅLESUND, SELENIUM, SVALBARD.

Environmental stress in the Arctic region causes damage to plant membranes through oxidation. To overcome such stress plants are expected to produce antioxidants. Here, the composition and antioxidative properties of four Arctic flowering plants (*D. Octopetala*, *Carex rupestris, Silene uralensis, Deschampsia alpina*), eight lichen species (*Pseudophebe pubescens, Cladonia amaurocraea*, *Cladonia mediterranea*, *Physcia caesia*, *Flavocetraria nivalis*, *Cetraria fastigata*, *Xanthoria elegans*, *Umbilicaria hyperborea*) and one mushroom species (*Lycoperdon molle* Pers.) were investigated *in vitro* through measurements of the Free Radical Scavenging activity (FRS), Inhibition of Lipid Peroxidation (ILP) and Trolox Equivalent Antioxidant Capacity (TEAC). In all species, the TEAC values were higher than that of the Trolox vitamin E standard. Electrospray ionization tandem mass spectrometric (ESI-MS/MS) analysis of methanolic extracts of vascular plants revealed presence of unusual molecules, some of which are reported as antioxidants. It is likely that the antioxidant activity exhibited by these plants is not only due to phenolics but also due to organoselenides, linear alkylbenzenesulfonates (LAS) and oligosaccharides. The findings provide evidence for the antioxidant potential of the plants examined and suggest that they can be used as nutraceutical sources of selenium and play a role as biomarkers of environmental pollution.

FRS activities of lichen species[1] in various organic solvents such as methanol, ethanol, acetone, and dimethyl sulphoxide (DMSO) were in the range 9.6–51.77%, while ILP activities in these solvents ranged from 32.5 to 82.43%. *Pseudophebe pubescens* showed the highest ILP (82.43%) and FRS (51.77%) activities as compared to other lichen species and the standard antioxidants butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT).

FRS activity of *Lycoperdon molle* Pers[2]. in various organic solvents such as methanol, ethanol, acetone, and Dimethyl sulphoxide (DMSO) were found in range of 44.00 to 89.60% while ILP activities in these solvents ranged from 32.00 to 54.41%. The methanol extract showed the highest FRS (89.60%) and ILP (54.41%) activities as compared to standard antioxidants Buthylated hydroxyanisol (BHA) and butylated hydroxytoluene (BHT). The order of antioxidative activities in *Lycoperdon molle* species in different solvent system was Methanol >Ethanol > Acetone > DMSO. Antimicrobial screening of *Lycoperdon molle* extracts were negative to all of the tested microorganisms. The compounds such as Phosphoethanolamine (PE), Monomethyl arsenic acid (MMA), Phosphatidyl glycerol (PG), phosphoionositol (PI), Phosphoserine (PS), Lysophosphatidyl choline (LPC) were determined by Electrospray ionization mass spectrometry (ESI-MS). Palmitic acid at m/z 255 is the most prominent ion indicating it to be one of the major components.

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EVALUATION OF GENETIC DIVERSITY, PHYLOGENY AND EVOLUTION OF ARCTIC CYANOBACTERIA USING STRUCTURAL AND FUNCTIONAL GENE AS A MARKER

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Cyanobacteria represent an ancient and crucial lineage of photoautotrophic group of organisms. They are one of the most unique and adept group of prokaryotes, possessing the capability of oxygenic photosynthesis. Many species are capable of fixing atmospheric nitrogen, some of which differentiate into specialized cells termed as heterocyst. An intricate machinery and deft regulation of two highly important metabolic pathways i.e., photosynthesis and nitrogen fixation in the same filament is one of the most interesting features that makes cyanobacteria exciting model organisms of study. In the present scenario of climate vulnerability and huge focus on the microbe-climate interactions, we aimed to study the cyanobacteria of one of the most extreme climate zones, the Arctics. The genetic diversity at the structural and the functional levels, the population genetic estimates and finally phylogeny and evolution of *Nostoc* spp. collected from Svalbard, Norway was estimated using molecular techniques and bioinformatics tools. Phylogeny of *Nostoc* spp. using the structural gene 16S rRNA gave some insights into the relatedness of Arctic Cyanobacteria with each other. Analyses of the *nif*H gene that encodes dinitrogenase reductase enzyme further gave some crucial leads into the phylogeny and evolution of the nitrogenase machinery alongwith the relatedness of cyanobacteria. Our population genetics analyses points out towards clear cut evolutionary tendencies of arctic cyanobacteria thus providing substantial proof towards the phylogenetic and evolutionary significance of the cyanobacteria of one of the most extreme environments. The work, thus throws some critical light into the phylogenetic relationship and evolutionary tendencies of arctic cyanobacteria. More elaborative molecular assessment is the needed for further strengthening the current phylogeny and evolutionary status of arctic cyanobacteria.

CZECH POLAR RESEARCH IN MUSEUM EXHIBITIONS AND COLLECTIONS

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Czech polar research, a topic widely known among young nature scientists nowadays, was conceived as a topic of an educative exhibition for public. As a contribution to the 4th International Polar Year 2007-2008, two Czech cultural institutions, Museum of the Krkonoše Mountains National Park in Vrchlabí and the Moravian Museum in Brno prepared in collaboration with a wide deal of polar scientists and explorers the exhibition "North and South - Czech polar research". Both institution have a relationship to this topic: Czech and Polish part of the Krkonoše Mountains is, like the Czech station on Svalbard, incorporated into the international network of monitoring changes in the tundra under the INTERACT project. In Moravian Museum, central Czech phycological collection was found in 1996 and type material from newly described species of cyanobacteria and algae from polar regions are deposited there, similarly as samples from subpolar regions and various extreme habitats. Among important partners in the creation and organization of the exhibition, we can name Masaryk Universitiy in Brno, Institute of Botany in Třeboň, Czech Geological Survey, Speleo Řehák, Czechoslovak Ocean Shipping and others. The main motive was to recall more than a hundred years of Czech share in exploring the polar lands and to acquaint the urgency of current research to the public. Not only historical facts, but also current research were presented: namely building of Czech polar stations both in South and North. During five years of exhibition tour, nine towns (Vrchlabí, Brno, Praha, Bystřice pod Hostýnem, Valašské Meziříčí, České Lípa, Chrudim, Rychnov nad Kněžnou, Novém Město nad Metují) were visited. Results of current expeditions were continually updated. Not only historical and research point of view was presented, but also explanation of urgent problems in ecology.

Large material that was obtained during preparation and course material should be published in the exhibition catalogue, but did not manage to catch his printout during that course of exhibitions. Both exhibition and future catalogue can be awakened if resources would be find. This publication would also be a showcase or a mirror of current Czech polar research including activities of young researches.

Currently we consider the establishment of a museum depositary collections of nature in polar regions, which would gather holistic manner and documented results of Czech polar research from its historical beginning. In addition to recording and cataloging items, that would ensure the preservation, storage and care of collection according to the museum's methodics. Simultaneously, special educational events for schools (primary target group: middle and primary schools) and promotional activities especially in the form of exhibitions are planed, using our potential and experience from museum, exhibitions ecological education programmes. These programmes will be closely joined with Czech Polar Centrum activities.

EPIBRYOPHYTIC AND EPIGEIC LICHENS AS COMPONENTS OF THE ARCTIC TUNDRA IN THE BELLSUND REGION (SW SPITSBERGEN, SVALBARD) – PILOT

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KEYWORDS: LICHENS, TUNDRA, ARCTIC, SPITSBERGEN, BELLSUND

Introduction

Lichens, together with other cryptogams, are a major component of the arctic tundra communities. Although more than 700 lichen species are known from Svalbard (Øvstedal et al. 2009) they are still an insufficiently investigated group, especially in comparison to vascular plants.

The aim of the current project is to investigate biodiversity and distribution of epibryophytic and epigeic lichens in the Bellsund region (SW Spitsbergen). Elaborating historical materials, collected in the 1980s, will provide a basis for comparative studies, and allow to detect possible changes in lichen vegetation of Spitsbergen over the last decades.

Methods and materials

Fieldwork was carried out during two Polish expeditions in 1987 and 1989. Materials were collected by F. Święs, on western shore of Bellsund, using Braun-Blanquet method.

Taxonomical analysis of lichens has employed both classical methods and chemotaxonomy. Identification of lichen secondary metabolites has been done using thin-layer chromatography. All examined specimens have been deposited in the lichenological herbarium of the Institute of Botany of the Jagiellonian University in Kraków (KRA-L).

Preliminary results

Currently, over 35 lichen genera, many of which are rich in species, have been identified from the study area. After the first stage of taxonomical analysis, it can be assumed that species composition and richness of epigeic and epibryophytic macrolichens corresponds with results from other parts of Svalbard (e.g. Olech 1990). Species from genus *Ochrolechia* and *Cetraria* seem to be the most common ones. On the contrary, a few interesting species of microlichens have been identified, e. g. *Biatora subduplex* or *Rhizocarpon expallescens,* which have been recorded earlier only in a few scattered occurences in Svalbard. More findings of rare species are expected during further investigations.

The current studies will result in creating a lichen distribution map of the study area. Lichenological data from this region are still very scarce so the present study allow to fill the blank spots in the map of arctic lichens distribution. Moreover, the dataset will be used for further comparative studies in the future.

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DIVERSITY AND DISTRIBUTION PATTERNS OF SOIL MICROFAUNA IN EDMONSON POINT (NORTHERN VICTORIA LAND, CONTINENTAL ANTARCTICA)

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KEYWORDS: SOIL BIODIVERSITY, ROTIFERS, NEMATODES, TARDIGRADES, ANTARCTIC

Introduction

In the Continental Antarctic, soil habitats belong to the most physically and chemically demanding environments on Earth and were once considered to be adverse to all life. Despite being subjected to extreme environmental stressors (e.i. freezing and desiccation), soils provide conditions for life. With no vascular plants, communities are dominated by microbiota such as algae, cyanobacteria, bacteria and microfungi, but microfaunal taxa including rotifers, nematodes, tardigrades and protozoans are also present (Adams et al., 2006; Smykla et al., 2010). Compared with soil habitats in other parts of the world, the diversity of the Antarctic soil biotic communities is very low. Being taxonomically and functionally simple, they are regarded as bioindicators of environmental change. Increased recognition that climate change and human induced perturbations have substantial impact on the functioning of the Antarctic soil habitats, studies of their biodiversity is critical (Wall, 2005). This work reports data from a survey of soil invertebrates conducted in the Edmonson Point area (Northern Victoria Land) to provide a baseline for comparisons with other Antarctic sites and monitoring impacts of environmental changes on biodiversity of Antarctic soil biotic communities.

Materials and methods

Different soil habitats at Edmonson Point (74°20'S, 165°08'E) located in Wood Bay, Northern Victoria Land, Ross Sea Sector of the Continental Antarctic were investigated for the diversity and abundance of soil invertebrates. Forty-one soil samples were collected from five different soil habitats (barren, moss, cyanobacteria, and active and relict penguin rookeries) during two consecutive austral summers: 2003/04 and 2004/05. The samples were collected from the upper layer of soil (0-10 cm deep), mixed thoroughly in the field and within few hours transported to the Italian Station "Mario Zucchelli" at Terra Nova Bay, where they were frozen by reducing temperature over 48-h period from 1° to -20°C. Then the frozen samples were shipped to Poland and USA for analyses. In the laboratory soil invertebrates were extracted from ca.100-g soil samples by wet-sieving followed by centrifugation. Such treatment allows extraction of alive invertebrates. Extracted invertebrates were counted and identified. Results are given in numbers of particular taxa per 100-g of fresh soil. More detailed description of the investigated area, methods and objectives of the project have already been presented by Smykla et al. (2010).

Results and discussion

Overall, the soil biotic communities were very abundant and relatively complex. They consisted of bacteria, cyanobacteria, algae, microfungi, protozoans, nematodes, rotifers, tardigrades, mites and

springtails. Among soil micro-invertebrates 23 taxa have been identified including: 17 rotifers, 4 nematodes and 2 tardigrades.

Rotifers represented: *Adineta grandis* Murray, 1910, *Encentrum* sp.1, *Habrotrocha constricta* (Dujardin, 1841), *Habrotrocha* cf. *elusa vegeta* Milne, 1916, *Habrotrocha* sp. 1, *Habrotrocha* sp. 2, *Macrotrachela* cf. *insolita* De Koning, 1947, *Macrotrachela* sp.1, *Macrotrachela* sp.2, *Macrotrachela* sp.3, *Macrotrachela* sp.4, *Macrotrachela* sp.5, *Macrotrachela* sp.6, *Mniobia burgeri* Bartoš, 1951, *Philodina gregaria* Murray, 1910, *Philodina* cf. *australis* Murray, 1911, *Rotaria rotatoria* (Pallas, 1766). Rotifer species identified to the genus level did not correspond to any of known descriptions and are considered potentially new for science. With the exception of *Encentrum* sp.1 belonging to Monogononta, all the other rotifers belonged to Bdelloidea. Nematodes represented: *Eudorylaimus antarcticu*s (Steiner 1916) Yeates 1970, *Panagrolaimus davidi* Timm 1971, *Plectus murrayi* Yeates & de Man 1970 and *Scottnema lindsayae* Timm 1971. Tardigrades represented: *Acutuncus antarcticus* (Richters, 1904) and *Milnesium antarcticum* Tumanov, 2006.

While the same nematode and tardigrade species have been reported previously from Victoria Land (Adams et al., 2006), the information about most of the rotifer species and high diversity of their soil communities is novel. Previous studies reported on the occurrence of 11 Bdelloidea and 4 Monogononta species in Victoria Land. However, most of the previously reported rotifers came from aquatic environments with only 4 Bdelloidea species from soil environments. Our results indicate that diversity of soil rotifers may also be high.

In general, soil invertebrate communities in the Edmondson Point area were dominated by rotifers (mean = 981,9 individuals/100g soil) while nematodes (mean = 162,5) and tardigrades (mean = 112,4) were significantly less numerous. Abundances of all invertebrates varied and ranged from 0 to 7 760, 2 312, and 1 824 individuals per 100g of soil for rotifers, nematodes, and tardigrades, respectively. Invertebrates were completely absent in 22% of all soil samples, majority of which represented soils from active and relict penguin rookeries. Although the physical and chemical characteristics of the soil habitats differed, high soil water (>20%) and ornithogenic nutrient contents seemed to be the major factors determining distribution and abundance of invertebrates in the Antarctic soils.

Microinvertebrates have been observed in Victoria Land across a range of habitats and environmental gradients. Results indicate that rotifers are often the most numerous, but in dry soils of McMurdo Dry Valleys soil invertebrate communities are dominated by nematodes (Adams et al., 2006). Invertebrate abundance in the Antarctic soils is very variable, but usually very low (Adams et al., 2006; Wall, 2005). Compare to other studies the abundance values of invertebrates recorded in our study are relatively high and this can be probably explained by relatively high water availability within the investigated soils. Because soil micro-fauna inhabit soil particle water films, it is not surprising that soil moisture appears to be the most important driver of their abundance. However, other environmental factors such as pH, nutrient availability, soil organic matter and elevation were also reported to influence invertebrate abundance.

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EPILITHIC LICHENS AND THEIR ADAPTATIONS IN THE CONDITIONS OF THE COASTS OF WHITE AND BARENTZ SEAS (RUSSIAN ARCTIC)

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KEYWORDS: EPILITIC LICHENS, MORPHOLOGICAL AND PHYSIOLOGICAL ADAPTATIONS, WHITE SEA, BARENTS SEA

Introduction

The paper summarizes the results of the biodiversity's investigations of epilithic lichens and their adaptive capacity to unstable conditions on the coasts of North Seas of the Russian Arctic.

Epilithic lichens are an essential component of coastal ecosystems. They occupy ecological niches which are unsuitable for colonization by higher plants. Lichens are adapted to high insolation, duration of photoperiod, high winds, low temperatures, periodic flooding, storm wave action and other stress factors. It is known that, the morphotype of thallus, ways of reproduction, growth rate, have been reflected to the adaptive capabilities of lichens. The secondary metabolites (lichen acids) are induced by extreme environmental conditions and are involved in these processes.

The purpose of our work - to investigate the biodiversity of coastal lichens and on the examples of *Lecanora intricata* (Ach.) Ach. and *L. polytropa* (Ehrh. ex Hoffm.) Rabenh. to study their structural and functional adaptations.

Materials and methods

During 2008-2012 the cliffs both the Murmansk coast of the Barentz Sea and the southern and western shores of the White Sea have been examined. For the species composition, ecotopic coenotical features of epilithic lichen cliffs the geobotanical methods have been used. The anatomical, morphological and biochemical studies of *Lecanora intricata* and *L. polytropa* have been made in the laboratory of the Department of Botany and Plant Physiology of the PetrSU, and in the bryologycal-lichenological Laboratory and in the Laboratory of Analytical Phytochemistry of the Komarov Botanical Institute RAS.

On the coastal territory epilithic lichens inhabit within the upper littoral and supralittoral zone and in the moving off from the sea shore their biodiversity and projective cover is increasing. In the formation of the coastal lichen cover the influence of the sea (a tidal regime, storms) is a main the abiotic factor among the other environmental factors. Four lichen zones, differing one from other by the lichen species composition and effect of the sea's influence. Halophytic group of lichens: *Verrucaria ceuthocarpa, Hydropunctaria maura, Caloplaca saxicola, Lichina confinis* engage in only the littoral areas and adapted to the periodic flooding of salt water, is general to the shores of two seas. Lichens of supralittoral zones differ according to their species composition, which reflects to the zonal features of the studied territories.

The following morphological-physiological adaptive properties of the coastal lichens, ensure their existence in the tidal zone, have been established: forming the crustose areolate or placodioid thalli types (*Caloplaca marina, Lecania aipospila, Lobothallia melanaspis*), that allows them tightly knit with the substrate hyphae of the core layer; the reproductive organs are the perithecia or apothecia, immersed in the thallus. These morphological features allow species to be adapted to the open habitats with high insolation, strong wind, and irrigation sea water during heavy storms.

Lecanora intricata and *L. polytropa* are among the most widespread coastal epilithic lichens, they are typical inhabitants of acidic mineral, have a circumpolar distribution in the Northern hemisphere and are found everywhere on the coasts of the Northern seas. Such wide distribution of these species is connected with their ability to various morphological, physiological and biochemical adaptations. They have crustose thalli, are propagated by ascospores and conidiospores that can easily be fixed on the rocky substrate on the coasts. However, comparison of

morphological features of these species in the coasts of Barents and White seas has shown the existence of morphotypes, associated with their response to different climatic conditions. Thus, analysis of their anatomical structure has showed that the total thickness of the thalli and the thickness of algal layer significantly higher in samples from the Barentz Sea. However, the ratio algal layer to the total thickness of the thallus in all cases were similar and is approximately 3:1. Chemical analysis has showed the high content of usnic acid in all specimens of both species. This means that regardless of the total amount of thalli, the both lichens content similar quantity of usnic acid on unit of thallus area. This may indicate the protective function of the substance in the body of lichen from UV-radiation and regulate of water exchange and diffusion of CO2.

Discussion

Thus, we have identified structural and functional features of lichens, which allow them to be adapted for living in unstable coastal conditions of the Barentz and White Seas. The crustose, areolate and folded bimorphs are better adapted to the influence of different environmental factors on the coastal territory. Such types of thalli are better adapted to temperature and degree of hydration of thalli in coastal conditions of the Northern seas. Reproductive strategy of the investigated coastal species is consistent with that of various types of epilithic lichens of extreme habitats. The high content of usnic acid in the studied lichen thalli allows them to exist in the open areas and provides the biotic regulation that defines the structure of lichen cover. The optimal ratio of algal and fungal components in the thalli of these species is necessary for maintain their life in extreme environments.

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RECENT LANDSCAPE CHANGES IN TERMINOGLACIAL AREA OF THE NORDENSKIÖLDBREEN, CENTRAL SVALBARD

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KEYWORDS: LANDSCAPE CHANGES, PROGLACIAL STREAM, RIVER PATTERN, ICE-DAMMED LAKE, NORDENSKIÖLDBREEN, CENTRAL SVALBARD

Terminoglacial area of the Nordenskiöldbreen is characteristic by abrupt landscape changes caused by recent recession of the glacier and meltwater release. Post-LIA proglacial river system on the right flank of the glacier passed several flow-pattern changes. According to aerial orthophotos and our field survey, a series of changes from braided to vertically incised channels and vice versa can be recognized. During the ablation season of 2012, the river piracy caused the abandonment of former braided stream to a new perpendicular direction, towards the glacier snout. This has caused the formation of up to >30 m deep ice-dammed lake. The sedimentary sequences documented in the field support the hypothesis of a river prograding into the lake connected with the rise of the lake level during the formation of the lake. The sudden subglacial drainage of the lake was followed by vertical incision of a new high-energetic stream several meters into the glaciofluvial and glaciolacustrine sediments and bedrock. Large amounts of fresh, unconsolidated glacigenic, glaciofluvial and glaciolacustrine material in the vicinity of the glacier allowed excellent sedimentological and geomorphological preservation of these events.

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THE ROLE OF SUBGLACIAL MICROBES IN CARBON CYCLING AND METHANE RELEASE IN THE PAST AND PRESENT

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KEYWORDS: ICE SHEETS, METHANOGENESIS, ORGANIC CARBON, SUBGLACIAL ENVIRONMENT

Subglacial environments are largely anoxic, contain organic carbon (OC) overridden by glacier ice during periods of advance, and harbour active microbial communities. This creates favourable conditions for a variety of microbial metabolisms, including methanogenesis. Yet little is known of the past and present potentials of subglacial microbes to take part in carbon cycling including methane production. Here we present data on the abundance and diversity of prokaryotic microbes, the activity of methanogenic archaea and the amount and character of OC in subglacial sediment and runoff from the Greenland Ice Sheet and compare them to those from other glaciers and ice sheets. The investigated Greenland subglacial sediment was of Holocene-aged soil origin and contained less bioavailable OC compared to subglacial sediments of lacustrine origin. The total microbial abundance and diversity was relatively low and the community was dominated by Proteobacteria. The identified clones were related to bacteria with both aerobic and anaerobic metabolisms, indicating the presence of both oxic and anoxic conditions in the sediments. Significant numbers of methanogens (up to 7×10^4 cells g^{-1}) were detected and clones of Methanomicrobiales were identified in the clone library. Long lag periods (up to >200 days) were observed before significant methane concentrations (~0.2 pmol g^{-1} day^{-1} at 1°C) were measured in long-term incubation experiments. These rates were lower than those measured in subglacial sediments containing more bioavailable OC. We use the measured rates of methanogenesis to estimate the potential for methane production beneath European and North American ice sheets during a typical Quaternary glacial/interglacial cycle. We predict that contrasting rates of methane production are likely to occur beneath glaciers that overran different types of substrate. Methane production from overridden soils such as those in Greenland is likely to be lower than that from lacustrine-derived sediments, possibly due to a difference in organic substrate lability. This finding highlights the importance of considering the character of different OC pools when calculating present and predicting future subglacial CH_4 production rates. We also examine the modern potential of subglacial microbes, including methanogens, to be exported to downstream ecosystems in an active state, and suggest that due to the accelerated melting of glaciers and ice sheets worldwide large amounts of active microbes are transported to downstream ecosystems where they can resume their activity.

BIOGEOGRAPHY OF *PHORMIDIUM AUTUMNALE* (OSCILLATORIALES, CYANOBACTERIA) IN WESTERN AND CENTRAL PARTS OF SPITSBERGEN

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Filamentous types from the order Oscillatoriales, particularly the species *Phormidium autumnale* Kützing ex Gomont 1892 have widely diverse morphotypes which dominate in Arctic and Antarctic aquatic microbial mats and wet soils. We cultivated 25 strains of *Ph. autumnale* from Svalbard and compared them with available strains from surrounding regions. The comparison of strains, based on of 16S rDNA and 16S-23S rDNA intergenic spacer sequences, revealed identity of strains from Ellesmere Island, Canadian Arctic and Abisko, Sweden with strains from Svalbard. The rate of colonization of *Ph. atumnale* from aquatic habitats is relatively high and we suggest geese as a main transmission vector from surrounding lands. Strains of *Ph. autumnale* were positioned in the phylogenetic tree according to their occurrence in similar habitats. An apparent clustering factor is the duration of availability of water in lakes and long-lasting streams in contrast to rapid and repeated desiccation in soil and on wetted rock in the spray zone of waterfalls. Strains that grow in very cold waters just above the melting point of snow or ice form distinct genetic group. Strains investigated in this study show morphological similarity in shape of trichomes of studied specimens. Cell diameter except for terminal cells ranged from 3 to 10 μm for all studied strains. Comparison of 16S rDNA sequences of the genus *Ph. autumnale* with the previously published definition of the species *Microcoleus vaginatus* revealed the identity of these two species.

Little is known also about dispersion of cyanobacteria in Antarctica and their population history. We tested the hypothesis of their survival through the glaciations using relaxed and strict molecular clock methods in the analysis of a 16S rDNA within the strains collected in vicinity of maritime Antarctica, mainly at James Ross Island. We estimated that the biogeographic history of Antarctic cyanobacteria belonging to *Ph. autumnale* lineages has ancient origins. The oldest exceeded the break-up of Gondwana and originated somewhere at the supercontinent between 442 Ma and 297 Ma. Enhanced speciation rate was found around the time of the opening of the Drake Passage (~31–45 Ma) with start of glaciations (~43 Ma). The high morphological diversification of *Ph. autumnale* suggested the co-evolution of lineages and formation of complex associations with different morphologies. Our results support the hypothesis that long-term survival took place in glacial refuges, resulting in a specific endemic cyanobacterial Antarctic flora.

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THE IMPACT OF THE COAL COMBUSTION ON THE ATMOSPHERE AND THE SNOW COVER CHARACTERISTICS AT BARENTSBURG SETTLEMENT, SPITSBERGEN ARCHIPELAGO

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KEYWORDS: SVALBARD, SPITSBERGEN, CLIMATE, SNOW COWER, RADIATION FLUX

The climate system in the polar areas is the most sensitive to the external impact, including those provided by humans. In recent times the problem of the global warming and its sources is widely disputed. The basic ground of the recent warming, as most scientists suppose, is the atmosphere However, the coal combustion-related human impact on the climate system considerably affects the values of the short and long wave radiation flux, and thus causes substantial climate changes, which reveal both near the very source and far away from it. As an example of such impact we see the Russian miners settlement of Barentsburg on Spitsbergen archipelago. As a result of the fumes emission from the heat station, large amount of the aerosol particles in the form of the carbon-black pollute the atmosphere and so do the coal particles which are blown from the coal depository. Subsequently, these aerosol particles are accumulated on the surface causing a substantial income of carbon particles into the snow cover. A decrease in the atmosphere transparency, as well in the surface albedo and the change in the snowcover-penetrating solar radiation are observed. Thus, the radiation balance of the surface is considerably changing due to the human impact.

To estimate the human impact in the form of the carbon pollution, the scientists of the Arctic and Antarctic Research Istitute and the climatology and environmental monitoring department of St. Petersburg State University obtained an expeditionary research in and nearby the Barentsburg settlement.

Aerosol reduction of the incoming short wave radiation was investigated by the implementation of the simultaneous observations of the direct solar radiation held at Barentsburg settlement, and at the site free of aerosol emission impact. The observations were implemented with the use of AT-50 actynometers. The measurements obtained revealed 80 Wt/m^2 attenuation of the direct solar radiation value.

The measurements of the snow cover relative reflectivity, considering the pollutions, were implemented with the use of M-115 pyranometers (wave lengths 0.3 – 3.0 mcm) and LI-190SA / LI-192SA pyranometers (visible wave lengths 0.3 – 0.7 mcm). According to the measurements outcome, the snow cover integral albedo has a wide range of values depending on the surface pollution level. The data of the table 1, which contain average measurements series, indicate a more than double decrease of the fresh fallen snow albedo as well as of the polluted snow cover albedo. As a result, there is more than double-size change in the short wave radiation, absorbed by the snow cover, which correspondingly boosts the process of the snow cover melting.

The results of the visible spectral range albedo measurements above the surface areas, different in the pollution level, showed 41-83 % change in the albedo value depending on the snow surface pollution level.

The 2007 intercomparison of the snow cover albedo values for Barentsburg with its active aerosol emissions with the ones for Ny-Ålesund international research center with minimum emissions showed the 15-20% negative difference between the average values of the snow cover albedo for Barentsburg and for Ny-Ålesund.

The investigation of the pollution impact on the solar radiation, deeply penetrating the snow cover, included the synchronous measurements of the incoming, reflected and the penetrating

radiation in the visible wave lengths rage. The penetration radiation measurements were obtained at the 5 cm depth. In each site of measurement a snow sample was taken from the 0-5 cm layer for subsequent filtering and pollution level estimation by means of weighing the filter. The measurement sites were placed in different areas of Barentsburg, with variable pollution level. The maximum value of pollutants of 1.93 g/l was measured near the coal depository and the minimum value was 0.1 g/l.

The synchronous measurements of the incoming, reflected and the penetrating short wave radiation helped estimating the attenuation of the radiation in the upper 5 cm layer, considering the amount of polluting particles. Attenuation in the upper level reaches the value of 50-100%. In the 0.12-0.73 g/l low pollution level range we could not find an effect of an increase in attenuation of the penetrating radiation as a result of absorption by the carbon particles. A continuation of such in-situ measurements can help estimation this interdependence.

The implemented investigations of the atmosphere radiation factors and the snow cover reveal a considerable impact of aerosol components emission into the atmosphere with the coal mining and combustion and the subsequent absorption by the snow cover, on the radiation balance of the surface, one of the basic climate forcing factor. Such impact leads to a decline in the value of the photosynthetically active radiation, lack of which can affect the health conditions of the settlement inhabitants and cause snow cover melting process boost. Introduction of the fuel postcombustion system and additional filters at Barentsburg heat station in 2011 changed the ecological conditions at the settlement for the better.

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EVOLUTION OF COLD HARDINESS IN PLANTS AND THEIR COLONIZATION OF THE POST-GLACIAL ARCTIC REALM

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Over their evolutionary history, organisms have been adapting to most diverse environments. Plants, from the green algae to the most advanced angiosperms have diversified in their forms and survival strategies to fill all reachable niches over a great range of conditions. Those, living in the most contrasting habitats are called *extremophiles* („lovers" of extremes: hot-cold, wet-dry, alkaline-acid, etc.), although some of them may not necessarily "love" but rather only tolerate their habitat conditions. The cold-hardened arctic and alpine species, the *cryophytes*, belong to this category. They evolved in regions subjected to orogeny by being slowly carried up with the rising mountains to high altitudes. In some cases, they have been rafted to the polar regions by the Northward migration of the continents.

During the Interglacial and after the last Ice age, the clean slate of the deglaciated North American continental landmass acted as a large sheet of chromatographic paper along which the plant species travelled as far north as they were able to tolerate the increasingly hostile conditions. Some tundra species are more cold-hardened than others, although additional limiting factors are also involved. According to the degree of cold- and stress tolerance, various species reached and established at different geographical positions and now form separate or overlapping ranges of their *spatial distribution*.

All tundra species would prefer more favourable environment than the one they occupy most. Even these cold hardened plants are under stress. However, they recover fast, if the conditions change for the better. At present, vegetation complexes of similar vigour, competitive strength and stress tolerance form distinct vegetation zones in the N. American tundra biome. The vegetation of these zones has been in a dynamic equilibrium with the extant climate. However, the zones have shifted in the past and are bound to shift again, as the climate ameliorates.

The cold-hardened algae and bryophytes play a crucial role in the colonization of freshly deglaciated terrain by fixing nitrogen and building the first biomass for the higher plants establishment.

The horticultural experiment with southern cultivars at Alexandra Fiord 79^0N confirmed that even warm-climate vegetables grow well in an naturally ameliorated space bubbles, "igloos" (sun-heated greenhouses) in a generally hostile climate. Similarly, the native tundra plants, transplanted into the same "igloos", grew much taller and produced several times more seeds and bulblets than plants in the nearby tundra.

NUTRIENT IN SEDIMENTS AS DRIVING FORCE BEHIND ANTARCTIC LAKE ECOSYSTEMS

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KEYWORDS: ANTARCTIC LAKES, MATTER CYCLE, MICROBIAL MAT, ECOSYSTEM, BIOLOGICAL SUCCESSION

One of the most productive ecosystems in continental Antarctica is found in freshwater lakes, where benthic microbes form thick mats, and aquatic mosses can flourish on the lakebeds of the Sôya Coast region. This is despite low nutrient levels, low temperatures, and seasonally limited solar radiation. In previous studies, we examined the detailed light environment in the water columns (Tanabe et al. 2008), and light usage and protection of the phytobenthic communities in Antarctic lakes (Tanabe et al. 2010), and have revealed that the phytobenthos allowed the growth and survival by using the possible light energy while preventing from death during a short but strong light summer, and discussed the ecological implications of microbial communities in Antarctic lake and terrestrial ecosystem (Tanabe & Kudoh 2012). Because the Sôya Coast lakes are oligotrophic and have sparse phytoplankton, the flux through the water column to the sediments of detrital, algal-derived organic material may be much lower. A question arise where can the benthic phototrophs obtain nutrients from in such oligotrophic lake ecosystems? In the oligotrophic Antarctic lake water, although the benthic organisms are thought to obtatin nutrients through nitrogen fixation ability of cyanobacteria and also guessed to utilize from inside the lake sediment, the quantity and utilization of nutrients are not clear yet. To dissolve this question, we measured the nutrients in gap water and bioelements such as carbon, nitrogen, phosphorus of Antarctic lake sediments with the vertical profiles which remain to be defined. Then, as compared to the sediment gap water and C/N ratio, and the lake water that collected from over a wide range of Syowa Oasis, the present study aimed to reveal the nutrients utilization of the phytobenthos. From this, in terms of matter cycle, we approach to the mystery for success and formation of the benthic vegetations in Antarctic lakes that have their own and diverse ecosystem by each lake.

As a result of nutrients analysis, 3-220 times of DIN (dissolved inorganic nitrogen) and 2-102 times of DIP (dissolved inorganic phosphate) were contained in gap water of the lake sediments surface, but the nutrient concentrations in gap water were disaggregated in each lake even though the concentrations were similar levels in the lake waters. The profile of nutrient concentrations in sediment cores drastically changed the gradient in the sediments surface. Comparing with DIN concentration in 20 cm depth and DIN difference in the surface of sediments, indicates that the more DIN accumulation in sediments, the larger DIN decrease in the surface. Also comparing with DIN difference and C/N ratio of the sediments surface, indicates that the larger DIN decrease in the surface, the lower C/N ratio in living phytophentos.

These results suggest that nutrients are utilized by phytobenthos from the lakebeds, and low nutrients in the lakebeds lead the phytobenthos to nitrogen deficiency, in addition, there are any mechanisms that nutrients are hardly discharged from lakebeds to lake water column. The scenario previously thought in Antarctic lake ecosystem is that the benthic organisms obtain nutrients through nitrogen fixation ability of cyanobacteria, however, the present study raised the new hypothesis that the nitrogen fixation of cyanobacteria is not so important and the benthic organisms can obtain nutrients from lakebed in the present stage of lake ecosystem.

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IN SITU MONITORING OF SEASONAL CHANGES IN DEVELOPMENT OF *PHORMIDIUM* POPULATIONS (SVALBARD, WEST SPITSBERGEN)

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Cyanobacteria belonging to the genus *Phormidium*, especially those which inhabit polar regions, are known for their capability of tolerating stresses of different kind, e.g. freezing and freezing-melting cycles, desiccation, starvation, and long-term light unavailability. They are well adapted to stressful conditions and often form macroscopic populations. In the Arctic, *Phormidium* occupies various types of wetlands, including seepages, shallow pools, streams, and wet soils and rocks. They are one of the most abundant photosynthetic organisms, and often accumulate high biomass in form of thick biofilms and crusts. For our study we selected two *Phormidium* populations in close proximity to the Czech Polar Research Station (Petunia bay-Billefjorden-Isflorden). The selected populations inhabit shallow pools (namely, seepages) that represent quite unstable environments that can be exposed to numerous drying-rewetting cycles during summers and short freezing episodes during spring and autumn. In this study we describe the observations on seasonal development of these populations based on the macroscopic community structure, morphology of cells and filaments including the production of sheaths and description of the accumulated inclusions that were followed by studies of ultrastructure with the help of electron microscopy. The assessment viability and metabolic activity of cells was performed *in situ* by staining with fluorescent dyes according to the cells' plasma membrane integrity (cell-impermeant nucleic acid dye SYTOX Green), nucleoid localization/ presence (cell-permeant nucleic acid stain DAPI), and respiration activity (redox dye CTC). This approach helped to reveal the state of cells in heterogeneous communities of cyanobacteria. The study gave some clues for understanding of cyanobacterial dormancy and stress resistance since the properties of cells which are responsible for their survival have not yet been described.

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BRAVE PIONEERS: GROWTH AND FLOWERING OF PLANTS COLONIZING GLACIER FORELANDS IN PETUNIABUKTA, SVALBARD

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KEYWORDS: COLONIZER, DEGLACIATION, ENDOPHYTE, SUCCESSION

Introduction

Glacier forelands represent unique habitats in Arctic and Alpine ecosystems. Recently deglaciated, these sites are heavily disturbed by paraglacial processes and lack soil structure favorable for plant growth. Nonetheless, potential plant colonizers of this habitat can benefit e.g. from relatively high nutrient availability which is an important factor considering general nutrient deficiency in the Arctic tundra. The glacial forelands are hence colonized by vascular plants and this process is a classical example of primary succession. Here, we complement the current vegetation ecology-based knowledge by focusing on population ecology of two model species *Saxifraga oppositifolia* and *Braya purpurascens*, common members of the glacier foreland plant communities shedding light on mechanisms that could underlie patterns of vegetation succession in glacier forelands in the Arctic.

Materials and Methods

Data on both study species were collected on four glacier forelands in Petuniabukta, Central Spitsbergen, Svalbard. We measured size of plant and counted number of flowers in *Saxifraga oppositifolia* and root diameter, length of the longest leaf, number of flowering shoots, number of sterile shoots and recorded flowering in *Braya purpurascens*. The sampling was done at five sites per glacier on the gradient of distance from the glacier forehead to the most distant moraine. This gradient approximates the time since deglaciation although the relationship between the two variables does not need to be linear and can have different nature in different glacier forelands. Therefore, available dating of glacier retreat (Rachlewicz et al. 2007) was used to estimate the time since deglaciation at each of the sampling sites. This variable was then used as a predictor in models testing its effect on the plant traits. In addition, roots of both species collected at two glacier forelands were inspected for presence of endophytic fungi.

Results

Saxifraga opositifolia was confirmed as the omnipresent pioneer on the glacier forelands in Petuniabukta and was sampled at all 20 sites as planned. We detected a clear relationship between the size of *Saxifraga* plants and the time since site deglaciation. The youngest sites with *Saxifraga* were deglaciated *ca* 10 years before the sampling and local plants were just simple shoots few centimeters long. Plant size first steeply increased with the age reaching however a plateau on sites that were deglaciated for *ca* 50 and more years. The plants growing on the youngest sites were sterile but sparse flowering was recorded on sites only slightly older (*ca* 20 years since deglaciation) and around 50% of the plants were in flower on sites older than 50 years.

In contrast to *Saxifraga, Braya purpurascens* occurred in scattered populations and was missing from a large proportion of the foreland area. Therefore, the sampling could not be conducted at all sites since at some of them the species was missing. The resulting dataset is hence less robust compared to the data on *Saxifraga*, nonetheless still allowing some inferences. *Braya*

was able to colonize as young sites as *Saxifraga*, except for the very youngest sites and large proportions of its populations were often in flower. Apart from this, we did not detect any statistically significant effect of the age since deglaciation gradient on the analyzed traits of the species.

No arbuscular mycorrhizal structures were detected in the roots, however, both species associated with dark septate endophytes; these were omnipresent on only one foreland but were missing from the other foreland.

Discussion

The contrasting patterns in the response of *Saxifraga oppositifolia* and *Braya purpurascens* to the gradient of the age since deglaciation on the glacier forelands could be attributed to their differential life strategies. *Saxifraga* is a slow-growing long-living species with a broad ecological amplitude occurring on both disturbed forelands and "climax" tundra. It is an omnipresent species in the area; hence its intense seed rain can be assumed on the glacier forelands also due to a rather high seed production (in terms of number) and light seeds easily dispersed by wind. The revealed effects of the site age therefore directly reflect favorability of site and the age of *Saxifraga* individuals.

Braya, on the other hand, is a specialist pioneer species and as such it is a relatively short-lived (albeit perennial) fast-growing species with rather big seeds (0.5 mm in diameter). In the study area, it occurs virtually only on the glacial forelands or other disturbed sites (land slides, tracks etc.) and is rather rare or scattered. The effect of site age on its populations and individuals is largely idiosyncratic most probably due to its fast growth and short life cycle. It can produce several generations during the almost 100 years long gradient our study covered. Apparently, dispersal limitation can also play an important role resulting in lack of *Braya* at some sites and blurring possible patterns in analyzed traits.

Fungal spores and hyphae are available and viable already in recently deglaciated soils. The colonization by endophytic fungi, however, does not seem obligatory for pioneer plants in disturbed forelands.

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FREE LIVING AMOEBAE OF SVALBARD

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Free living amoebae (FLA) occur in almost any environment containing at least temporarily liquid water. They are able to live in localities with harsh conditions like hypersaline or highly acidic habitats, hot springs and hydrothermal vents or extremely cold places. To survey the FLA diversity near the Czech polar station in Petuniabukta, Billefjorden, Svalbard, we have isolated FLA from various environmental samples and from tissues of fish and aquatic invertebrates.

So far we have obtained over 50 strains of freshwater and marine FLA. We have most of them documented by light and electron microscopy, and from part of them we have prepared SSU rDNA sequences. All strains are stored in liquid nitrogen. The most common among the freshwater strains are amoebae of the genus *Naegleria* Aléxéieff, 1912. From both freshwater and marine environments we isolated a lot of strains belonging to vannellid amoebae (covering more genera - *Vannella* Bovee, 1965, *Clydonella* Sawyer, 1975, *Lingulamoeba* Sawyer, 1975 and *Ripella* Smirnov, Nassonova, Chao et Cavalier-Smith, 2007). A novel amoeba strain, morphologically similar and phylogenetically related to *Vermistella antarctica* Moran, Anderson, Dennett, Caron et Gast, 2007 was isolated from gills of hermit crab *Pagurus pubescens* Kroyer, 1838. It is the only record of *Vermistella* since its original description, moreover on the opposite side of the Earth.

Obtained strains will contribute to phylogeographic analyses of some groups of amoebae.

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SUCCESSION AND CARBON CYCLE IN A HIGH ARCTIC TUNDRA ECOSYSTEM

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KEYWORDS: HIGH ARCTIC, CARBON CYCLE, PRIMARY SUCCESSION, TERRESTRIAL ECOSYSTEM

Current climate change predictions indicate that warming will be more pronounced at high alatitudes in the Northern Hemisphere. The Arctic terrestrial ecosystem is believed to be extremely susceptible to climate change, and major ecological impacts are expected to appear rapidly. Responses of the ecosystem carbon cycle to climate change are of crucial importance, because of the large carbon stock in Arctic soils and possible feedback effect on global atmospheric CO_2. However, because of the diverse responses of ecosystem components to climate change, overall response of the ecosystem carbon cycle to climate change is difficult to predict. Understanding the contribution of each ecosystem component to carbon flow, and the response of the components to environmental parameters, is prerequisite for predicting response of the Arctic terrestrial ecosystem to climate change.

Since 1994, we have conducted field and laboratory studies of the ecosystem carbon cycle in a deglaciated area of Ny-Ålesund, Svalbard in the high Arctic. This project aims to clarify the carbon cycle pattern in this area and to construct a compartment model for future prediction of climate change impacts on the cycle. For these purposes, changes in plant species composition, plant and microbial biomasses, and soil carbon flows were examined along a successional series.

In 1994, four permanent plots were set up along a primary successional series of the deglaciated area. At the beginning of this study, five major carbon pools were considered: aboveground and belowground biomasses of vascular plants, biomass of cryptogams, soil organic carbon and soil microbial biomass. Determined carbon flows were total soil respiration, belowground (root) respiration, primary production of vascular plants and cryptogams, and net ecosystem production.

Vegetation cover and plant species composition changed with the progress of succession. Purple saxifrage (*Saxifraga oppositifolia*) colonized in all successional stages, ranging from relatively young to old stages. In contrast, two dwarf shrubs, *Salix polaris* and *Dryas octopetala*, and the moss *Sanionia uncinata* predominated in later stages of succession. Biological soil crusts are also important vegetation in the area. The crusts were observed throughout the successional stages.

Carbon pool sizes tended to increase with the progress of succession. The amount of soil carbon increased from 110 g C m^{-2} at the newly deglaciated site to about 3,200 g C m^{-2} in the latest stage of sauccession. These values are much smaller than those reported for Alaskan Arctic tundra. This is largely owing to the thin organic layer at our study site. Microbial biomass carbon showed a similar pattern of increase.

Cryptogams contributed the major proportion of phytomass in the later stages. However, because of water limitations, their net primary production was much smaller than that of vascular plants. On the other hand, biological soil crust production is important in the carbon cycle during the early stages of succession. The compartment model incorporating major carbon pools and flows suggested that the ecosystem of the later stages is likely to be a net sink of carbon, at least in the summer season. In addition, our results illustrate the main factors controlling net ecosystem production shifts with season, which are mainly the coverage of vascular plants, photosynthetic photon flux density (PPFD) and precipitation.

DIATOM DISTRIBUTIONS IN SPACE AND TIME – A CASE STUDY FROM THE POLAR REGIONS

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KEYWORDS: LAKES, DIATOMS, BIOGEOGRAPHY, ENDEMISM

The composition, diversity and distribution of present-day biota are shaped by the geological, tectonic and climatic past, which resulted in the distinct biogeographical realms we observe in the terrestrial biosphere. Here I summarize our recent studies on the biogeography of polar freshwater diatoms. Antarctic lake-dwelling diatom communities are impoverished and imbalanced in comparison with Arctic communities, and characterized by high levels of endemism. Moreover, molecular data on ubiquitous morphospieces that are widespread in the Antarctic region are starting to reveal substantial hidden diversity, with distinct Antarctic and sub-Antarctic lineages. This suggests that estimates based on the morphospecies concept are conservative and may strongly underestimate the observed levels of endemism. The Antarctic communities are further characterized by the absence of key functional groups such as planktonic taxa, a general paucity of globally successful genera, and an overrepresentation of terrestrial lineages. Comparison of contemporary Antarctic floras with fossil Miocene assemblages points to high rates of local extinction during glacial maxima, in combination with radiations and the selective survival of aerophilic taxa in glacial refugia. We also observed strong bioregionalisation patterns within the Antarctic Realm, which are highly concordant with the three main biogeographical regions traditionally recognized in plants and animals, namely Sub-Antarctica, Maritime Antarctica and Continental Antarctica. Within Continental Antarctica, the observed biogeographic provincialism is likely related to differences in the glacial history of the ice-free regions. Sediment records spanning the Late Quaternary period indicate that lake districts which escaped complete glacial overriding during the Last Glacial Maximum (LGM) hold a relict diatom flora, composed of Antarctic endemics and ubiquitous taxa that inhabit cold environments elsewhere. By contrast, in regions that were completely overridden by the East Antarctic Ice Sheet, the diatom communities are composed of aerophilic Antarctic endemics and ubiquitous taxa. These taxa were probably derived from a local diatom pool that was able to survive in local terrestrial nunataks. This is confirmed by a time-constrained molecular phylogeny of the aerophilic diatom *Pinnularia borealis* which suggests that the Antarctic lineage diverged 7.8 (2-15) Ma ago, and hence before the onset of Pleistocene glacial-interglacial cycles. In addition, there is evidence for large-scale extinctions during the LGM of species currently thriving in Sub-Antarctic habitats but which were present in Continental Antarctica during the warmer Eemian interglacial.

CYANOBACTERIA/ MICROALGAE AND INVERTEBRATE DIVERSITY AND ABUNDANCE ON ARTIFICIAL SUBSTRATUM (FIBERGLASS NETS) INSTALLED IN FRESHWATER LOTIC HABITATS IN CENTRAL SVABARD

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In Arctic summer 2012, several shallow lotic freshwater habitats were selected for study of invertebrates feed pressure on benthic cyanobacteria and microalgae communities. 10x10cm fiberglass nets were installed on the bottom of streams. After some period of time the nets were quickly over-growth by community of cyanobacteria, microalgae and herbivores which fed on them. After fourteen days of incubation the nets were collected and evaluated for diversity of cyanobacteria, microalgae and invertebrates together with detail description of size categories distribution for estimation which phytobenthos components are easily eatable for particular invertebrate species. In these selected shallow wetlands also basic ecological parameters as temperature, oxygen content, conductivity and pH were also measured. The goal of this preliminary study was ecological reconnaissance of freshwater habitats suitable for the study of invertebrate feed pressure on communities of cyanobacteria and microalgae in shallow freshwater habitats in north part of Billefjorden, Central Svalbard.

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LIFE OF ANTHERS AND POLLINATION IN ARCTIC

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KEYWORDS: DRYAS, SAXIFRAGA OPPOSITIFOLIA, SVALBARD, ENTOMOGAMY

Pollination of arctic plants is not well described thema. Signifiance of insect pollination has not been still evaluated. We collected set of evidence for evaluating of insect-mediated pollen transfer importance in Arctic (Petunia Bay, Pyramiden, Svalbard) . In the first place, we detected that many flowers of Dryas octopetala and Saxifraga oppositifolia are permanently occupied by insects (predominantly flies, Diptera) living in the flowers. During optimal weather, flies are mobile and crawl or fly between flower and pollen transfer may occur. The highest count of pollen grains, we observed on hoverflies (Syrphidae), but their abundancy was low. The second important feature of arctic flowering is that life-time of anthers is very long (a few days) in contrast to mid latitude (a few hours) and pollen is available for a very long time. Based on this data, we hypothesize that insect pollination can play role in arctic plant reproduction and it may be a tool for maintaining genetic diversity in plant populations.

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CONTEMPORARY CHANGES IN VEGETATION OF TUNDRA IN SPITSBERGEN

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KEYWORDS: SØRKAPP LAND, KAFFIØYRA, PHYTOSOCIOLOGY, REINDEER, ARCTIC

Introduction

Arctic terrestrial ecosystems, although well adapted to extreme and fluctuating environmental conditions (Jónsdóttir 2005; Prach et al. 2010), are in many places undergoing significant changes due to the contemporary climate warming. In recent years most of the information on changes in tundra vegetation of Spitsbergen (e.g. Jónsdóttir 2005; Olech et al., 2011) relates directly to climate change. Biotic factors influencing vegetation, such as high activity of herbivores, have been also investigated recently (e.g. Elvebakk 1997).

The current research was based on comparative phytosociological studies in two areas of Spitsbergen, where historical data are available. Vegetation changes were described and possible causes, were assessed.

Materials and methods

Field studies were conducted in two locations: western Sørkapp Land (SW Spitsbergen) and Kaffiøyra (Oscar II Land, NW Spitsbergen), in the years 2008 and 2012, respectively. Western shore of Sørkapp Land is characterized by stable terrain, where the boundaries of the dry, damp and wet areas are clearly visible and permanent (Węgrzyn et al. 2011). There are no glaciers adjacent to the marine terraces, and thus there are no glacier rivers. On the other hand, the coastal plain of Kaffiøyra is strongly influenced by erosion-accumulation processes induced especially by the activity of five big glacier rivers.

Series of phytosociological relevés performed in both areas included all the tundra vegetation components (vascular plants, mosses and lichens). The results were compared with historical data. A new phytosociological map of Western Sørkapp Land was also prepared (Węgrzyn et al. 2011).

Results and discussion

In Sørkapp Land, the ranges of different plant communities have not changed since the early 1980s, while changes were observed in species composition of plant communities. In this area, as a result of high reindeers activity, whose population has recently significantly increased during the last 20 years, plant communities forming lichen tundra, have become completely degraded (Węgrzyn et al. 2011). Lichen species such as *Flavocetraria nivalis*, *Flavocetraria cucullata*, *Cladonia rangiferina*, *Cladonia arbuscula* ssp *mitis* in places easily accessible to herbivores, have been completely eliminated.

Changes concern also expansion of some species. Within pioneer communities, expansion of *Cetrariella delisei* and *Gymnomitrion coralloides* has led to significant unification of a former mosaic. In exposed ridge communities expansion of *Salix polaris* and *Luzula arquata* was marked.

Entirely different changes were observed in Kaffiøyra. The whole area is a mosaic of pioneer vegetation, where only successional changes were visible in the area. Only on the slopes of the surrounding mountains, as well as in the areas of higher marine terraces, where the river activity

is negligible, changes similar to the results from Sørkapp Land were noted. Materials collected from Kaffiøyra require further detailed analysis.

Describing vegetation changes related directly to changing climatic conditions in both studied areas was extremly hard, as other factors influence vegetation in a more visible way. Reindeer expansion in Sørkapp Land proved to be the major cause of shifts in tundra composition (Węgrzyn et al. 2011). Also in central Spitsbergen influence of herbivores masked the possible vegetation development due to warmer conditions (Prach et al. 2010).

In Kaffiøyra, instability of the ground has made it impossible to determine the actual changes in tundra vegetation under the influence of the changing climate. Thus it can be assumed, that recording and interpreting climate-induced vegetation changes is possible only on a stable ground, where erosion-accumulation processes, especially induced by glacier rivers activity, do not occur.

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INFLUENCE OF THE SYNOPTIC SITUATIONS ON SPATIAL DISTRIBUTION OF AIR TEMPERATURE IN CENTRAL PART OF SVALBARD IN THE PERIOD OF 2008 – 2010

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The main goal of study was to evaluate spatiotemporal variability of air temperature in the central part of Svalbard and to analyse the influence of synoptic situations on air temperature differences between selected stations. The attention was focused on two stations – Petunia Bay and Longyearbyen airport (Svalbard Lufthavn). The first study site is located at an altitude of 25 meters a.s.l. on the coastal ice-free zone of Petunia Bay, north-western branch of Billefjorden, Spitsbergen. The second site is situated at the beginning of Adventfjorden, 4.8 km northwest of Longyearbyen at an elevation of 28 m a.s.l. The distance between Svalbard Lufthavn station and Petunia Bay is 56 km in a southerly direction. The meteorological data for Svalbard Lufthavn were provided by the Norwegian Meteorological Institute in Oslo. Information about the atmospheric circulation type was provided by Niedźwiedź and it was used for the assessment of circulation pattern and air temperature differences between both sites.

The 1-hour, daily and monthly means from automatic weather stations were used in the analysis. Mean air temperature at Petunia Bay was -5.1°C and at Svalbard Lufthavn -3.3°C in the period from August 1, 2008 to June 30, 2010. Summer temperatures varied from -2°C to +12°C (June–August) at Petunia Bay and from 0°C to +11°C (June-August) at Svalbard Lufthavn. The winter temperatures ranged from +3°C to -30°C (December–February) at Petunia Bay, while at Svalbard Lufthavn ranged from +4°C to -28°C (December-February). Large interdiurnal variability of air temperature (more than 10°C day-1) was caused by fast changes in advection of different air masses, which were pronounced particularly in winter and spring. The absolute minimum air temperature -33.3°C was recorded on 12 January 2009 at Petunia Bay, while at Svalbard Lufthavn -28°C was recorded on 7 January 2009. In July 2009, the maximum air temperature rose to 16.2°C at Petunia Bay and to 12.1°C at Svalbard Lufthavn, due to sunny weather and only a light breeze with wind speed up to 2 m s-1.

In order to evaluate the effect of atmospheric circulation on air temperature in the central part of Svalbard, the classification of circulation pattern provided by Niedźwiedź (2006, 2011) for the Svalbard archipelago was used. In the study period, the prevailing cyclonic activity was found in 58.9 % of the days, while the anticyclonic situations occurred in only 38.1 %. The most common circulation types belonged to the north-eastern sector, with a frequency of occurrence between 9.6 % (Ec type), 9.0 % (Nc type), 8.3 % (SEc type) and 7.2 % (Nec type). Considerably high frequencies were found also for the anticyclonic wedge (Ka type – 9.0 %), trough of low pressure (Bc type – 8.6 %), and anticyclonic situations from the north- eastern sector, Na (5.7 %), NEa (5.3 %), and Ea (6.3 %) in particular. The highest activity of the cyclonic circulation was found in autumn (88.2 %) and winter (86.6 %). Conversely, the anticyclonic types were most common in summer (35.3 %) and spring (19.0 %).

Mean air temperature difference of -0.9°C between Petunia Bay and Svalbard Lufthavn corresponded to the specific thermal regime of Petunia Bay, which is situated on the northern most branch of Billefjorden and the interior leeward part of Spitsbergen Island. The highest values of the positive temperature anomalies (+6.3°C) occurred on 24th of March 2009 and (+6°C) 2nd of January 2009, while the highest values of the negative temperature anomalies were recorder on 12th of January 2010 (-6.8°C) and (-6.7°C) from 12th to 15th of January 2009.

Negative temperature anomalies were related to the prolongation of the period with permanent snow cover, sea ice occurrence, and suppressed air flow transfer deep inside the Isfjorden and Billefjorden respectively.

We found that climate conditions of the coastal zone of Petunia Bay slightly differed from

the rest of the Svalbard archipelago, Isfjorden in particular.

KEYWORDS: CLIMATE, AIR TEMPERATURE, SYNOPTIC SITUATIONS, SVALBARD, PETUNIA BAY

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ASSOCIATION OF POLAR EARLY CAREER SCIENTISTS (APECS): SHAPING THE FUTURE OF POLAR RESEARCH

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KEYWORDS: IPY, APECS, NETWORKING, YOUNG SCIENTISTS

The Fourth International Polar Year (IPY 2007-2008) brought together scientists from a different variety of research fields to collaborate on 228 endorsed projects in both the Arctic and Antarctic during a two-year period. All these projects help to advance our fundamental understanding of the Polar Regions and the cryosphere as a whole. But now, at the end of International Polar Year we face the most important issue - how to ensure the continuum of polar research. Looking back, we need to learn our lessons from the past IPY's and secure the legacy of the scientific advances at present.

To ensure this legacy, the next generation of polar scientists must be recruited, nurtured, educated, and mentored. Thus, professional development and networking activities must be expanded to address difficulties in international and interdisciplinary collaborations, rapidly developing technologies, logistical requirements of fieldwork, and the increasing need to disseminate science results to the public and policy makers.

One of the major legacies of the IPY was the creation of the Association of Polar Early Career Scientists (APECS), which now is recognized as "an outstanding success of the International Polar Year 2007-2008". Founded in 2006 by and for young scientists to facilitate opportunities, to share ideas and experiences and to develop new research initiatives and collaborations, APECS now is more than 3500 early career polar researchers (undergraduate and graduate students, PhD students and postdoctoral researchers, early faculty members, educators and everyone with interests in Polar regions and the wider cryosphere) from more than 75 countries.

APECS aims to stimulate interdisciplinary and international research collaborations, and to develop effective future leaders in polar research, education and outreach. The key aim of the association is to raise the profile of polar research by providing a continuum of leadership. We all recognise that the "soft skills" such as communicating with the media, influencing policy, fund raising and project management usually do not form a part of the graduate's training. APECS helps to equip young researchers with these kind of skills through diverse activities including: panel discussions; career development workshops at conferences already being attended by established polar researchers; webinars; comprehensive online resources; formal mentoring; online activities and many more. Due to APECS' inherently international nature, the APECS website hosts many initiatives to provide information and resources to early-career scientists, as well as to facilitate discussion and interactions between polar researchers from all disciplines. Furthermore, education and outreach activities are promoted to stimulate the next generation of polar researchers. All these initiatives not only serve as ways to develop the research, they also serve to provide leadership training to the many individuals who plan these activities and creates a strong sense of community across disciplinary and national boarders.

What is critically important is to create a strong community of early career and senior researchers helping and motivating each other to improve and stay connected to research. Since its inception, APECS has strived to develop the partnerships with international organizations and scientific bodies. APECS has been recognized by the IPY sponsors, the International Council of Science (ICSU) and the World Meteorological Organization (WMO), as the organization that, together with other partners (e.g., International Arctic Science Committee (IASC) and Scientific Committee on Antarctic Research (SCAR)), will carry forward the momentum of polar research, education and outreach in the years to come. In a period when the Polar Regions are experiencing rapid environ-

mental, social and geopolitical changes, we need to fully understand global connections and impacts. All these will require innovative, international and interdisciplinary approaches. To work effectively within and crossdisciplines, as well as outside the scientific community will be essential to address the changes through science-based policy and a well informed public. That is why stimulating, nurturing and training the future effective leaders of polar science is crucial. We are sure that the lessons learned by APECS will be valuable to other early career initiatives in many disciplines and countries.

SNAPSHOT OF SPATIO-TEMPORAL CONSTRAINTS IN MICROBIAL ACTIVITY IN MELTING HIGH ARCTIC SNOW

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KEYWORDS: ARCTIC, SNOW, ELUTION, CELL

Introduction

The melting snow pack represents a highly dynamic system not only for chemical compounds but also for bacterial cells. Microbial activity was found at subzero temperatures in ice veins when liquid water persists due to high concentration of ions on the surface of snow crystals and brine channels between large ice crystals in ice (e.g. Price and Sowers 2004, Bakermans and Skidmore 2011). Several observations also suggest microbial activity under subzero temperatures in seasonal snow (e.g. Larose et al. 2011) or even deeply frozen snow in the central part of the Antarctic ice sheet (Carpenter et al. 2000). The results indicating the microbial activity under subzero temperatures were also questioned from a theoretical point of view (Warren and Hudson 2003), which raises the question of how far can the limits of metabolism be pushed by means available to microorganisms (e.g. Deming 2003).

Even with regard to the spatial and temporal relevance of snow ecosystems, microbial activity in such an extreme habitat as liquid water film on the surface of ice crystals represents a relatively small proportion in the carbon flux of the global ecosystem. On the other hand, it still represents an remarkable piece of mosaic of the microbial activity in glacial ecosystems (Hodson et al. 2008, Anesio and Laybourn-Parry 2012). This topic also embodies vital crossovers to biogeochemistry and ecotoxicology (e.g. Larose et al. 2011), offering a quantitative view of utilization of various substrates relevant for downstream ecosystems.

Here we present our study of the dynamics of both solvents and cells suspended in meltwater of the melting snowpack on a High Arctic glacier to demonstrate the spatio-temporal constraint of interaction between solvent and bacterial cells in this environment.

Methods

We used 6 lysimeters inserted into the bottom of the snowpack to collect replicated samples of melt water before it comes into contact with basal ice or slush layer at the base of the snow pack. The sampling site was chosen at Midre Lovénbreen (Svalbard, Kongsfjorden, MLB stake 6) where the snow pack showed melting on the surface but the basal ice was still dry. Sampling was conducted in June 2010 for a period of 10 days once per day, whereby the snow profile was sampled according to distinguished layers in the profile at the beginning of the field mission and as bulk at its end. The height of snow above the lysimeters dropped from the initial 74 cm to the final 38 cm. The major ion composition (IC), pH, conductivity and cell abundances were measured.

Results

Bacterial cells were eluted from the snowpack with the lowest intensity at the beginning of the measurement and with the highest at its end. There was a significant positive trend even though we observed strong shifts probably caused by complex layering structure of the snow pack, containing ice layers up to 12 mm. On the other hand, the dynamics of dissolved chemical compounds showed exponential decrease (Fig. 1.), whereby a considerable proportion of some ions was eluted before the measurement started (when compared with the bulk analysis of the snow in April). In accordance with other studies, the highest concentration of solvents was found in the

basal ice (in the snow profile) and in the early phase of snow melting (at the outflow).

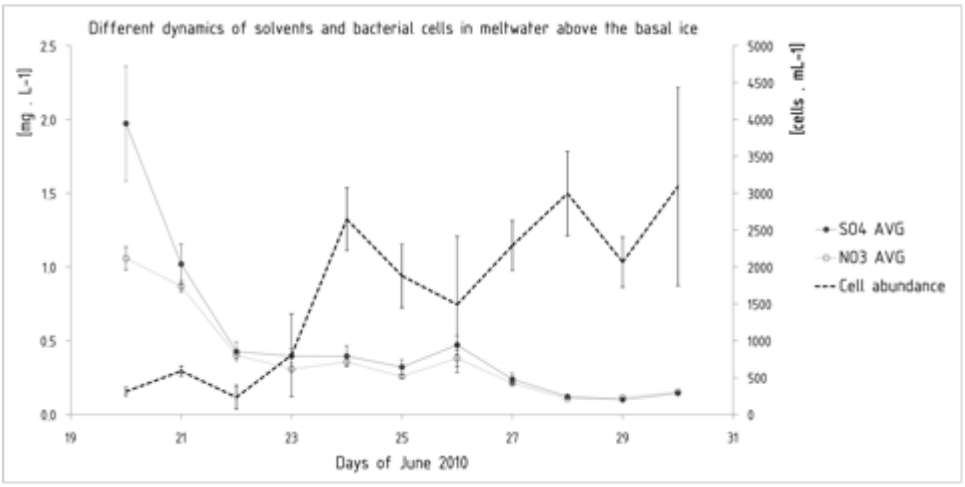

Fig. 1.: Different dynamics of solvents (only two of analyzed ions are shown in the graph) in compare to slow mobilization of bacterial cells. The temporal progression is represented by averages (from 6 lysimeters) with error bars (SD).

Summary and discussion

We suggest that there is a spatio-temporal constraint for bacterial utilization of chemical substrates within the snow pack. We present a snapshot into the dynamics of cells end chemical solvents in melting snowpack. As soon as the melting process reaches a particular depth of the snow pack, the majority of dissolved compounds move beyond the reach of microbial cells since their mobility is much lower. The possible hotspots of biogeochemical processes would then be either the contact with melt water, which is enriched by the melt of basal layer and cryoconite, or a (macroscopically) dry snow pack at temperatures close to zero. Also the temporal development of pH and osmotic stress on a micro-scale during the onset of the melt period has to be taken into consideration.

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LANDSCAPE ECOLOGY OF SØRKAPP LAND, SVALBARD

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KEYWORDS: ENVIRONMENTAL CHANGE, CLIMATE WARMING, SPITSBERGEN

Sørkapp Land, the southern Spitsbergen peninsula (ca. 1400 km^2), constitutes the narrowest part of the mountainous land barrier (or the land wedge's end) between warm Atlantic water in the west (Greenland Sea, West-Spitsbergen Current) and cold water from the central Arctic in the east (Barents Sea, East-Spitsbergen Current). The region is almost cut off from the rest of Spitsbergen by fjords. Its western coast, cut in resistant, old bedrock, consists of terraced lowlands at the foot of the mountains and is free of glaciers, and presumably overgrown with tundra. Its eastern coast, cut in non-resistant, young (Cretaceous–Tertiary) rocks (Dallmann et al. 1993), consists mainly of steep mountains without wider or continuous plains at their foot, glaciated to a high degree. Vegetal cover practically does not exist there, rare plants grow in small clumps or patches. Such an environmental variety results in the unique landscape ecology of the peninsula which splits into four very different parts.

Sørkapp Land was investigated by the Jagiellonian University Spitsbergen summer expeditions since 1980. Complex landscape field mapping at a scale of 1:25 000 was the basic method of surveying different parts of the peninsula. In sum, ca. 94 km^2 were mapped. Landscape analysis played the most important role in the research of abiotic environmental features, whereas botanical analysis and identification of animal species were crucial in research of biotic features. The interpretation of aerial photographs (from the Norsk Polarinstitutt) and the analysis of satellite data were combined with the results of field investigations (e.g. Ziaja 1999, 2004, Ziaja et al. 2007, 2009, 2011).

Western Sørkapp Land, isolated from the rest of the peninsula by the tidewater glaciers, is the most ecologically developed and best recognized. Its relatively warm climate and general lack of glaciers in coastal plains and mountains during all the Holocene have resulted in common presence of continuous tundra with several dozen species of vascular plants and a few hundred species of lichens and mosses (Ziaja et al. 2011). This tundra is a basement of a thriving terrestrial ecosystem. In addition, big colonies of birds feeding in the Greenland Sea fertilize the tundra and deliver food for bird predators and foxes.

Southern Sørkapp Land, equally isolated, is somewhat similar to the west in the existence of the continuous tundra on the coastal plain and mountain slopes, and in a full terrestrial ecosystem there (Ziaja 2004). However, its area is much smaller, and the number of birds and plant species is much lower, and there is a lack of mountains devoid of glaciers.

In the eastern Sørkapp Land, the Arctic desert predominates until today. The central part of its coast still consists of the tidewater glaciers' cliff. Some other sequences of the coast were partly abandoned by glaciers in the 20th and 21st centuries, and undergo first stages of plant succession and animal colonization (apart from a few very small, ca. 600 m^2 or less, oases which survived the Little Ice Age). Only 15 species of vascular plants and 6 species of nesting birds, in very small colonies, occur there. Animals feeding on terrestrial plants (like reindeer, gees, ptarmigan, etc.) are completely absent there (Ziaja 2004, Ziaja et al. 2007, 2009).

The Sørkapp Land's interior together with its northern part above the fjords is mountainous and heavily glaciated (net glaciation) and occupies about half the territory of the peninsula reaching the open Greenland and Barents seas by the tidewater glaciers. It is the real Arctic desert with life symptoms (bird colonies or single nests, plant patches) on nunataks (Ziaja 1999, 2004).

The mentioned ecosystems are very dynamic under the current climate warming and

environment protection (since the establishment of the national park in 1973), undergoing quick transformation. E.g. an entirely new landscape and ecosystem is just appearing in the northeastern coast warmed and ice-freed recently (Ziaja et al. 2007, 2009), and there is a great change in plant communities (Ziaja et al. 2011), bird life (nesting places) and food chain in the west and south due to the reindeer return and regeneration since the 1990s. Significant spatial changes are occurring both between four mentioned ecosystem and within them. Boundaries between them are being modified: the glaciated interior becomes smaller and smaller. Their internal structure is also in change. E.g. new fjords have appeared after 1936 and are being formed at present in the north, and extensive new bays have appeared and are being widened in the southwest and east, due to the glacial recession. Moreover, Sørkapp Land can be transformed from the peninsula into an island due to the progressive recession of glaciers on the isthmus between the peninsula and the rest of Spitsbergen (Ziaja 1999, 2004, Ziaja et al. 2007, 2009). That would influence very much not only terrestrial but also marine ecosystems there.

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