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Research · October 2016

DOI: 10.13140/RG.2.2.34724.27520

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POLAR ECOLOGY CONFERENCE 2016

19TH – 21ST SEPTEMBER 2016

ČESKÉ BUDĚJOVICE, CZECH REPUBLIC

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Supported by:

Conference is organised by the Faculty of Science, University of South Bohemia and University Centre in Svalbard and is supported by Norway Grants via the NF-CZ07-ICP-4-292-2015 project "Polar Hydrology Field Course"

ISBN 978-80-7394-594-7

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České Budějovice, Czech Republic

CONFERENCE PROCEEDINGS

edited by
Jan Kavan
Alex Bernardová

České Budějovice 2016

Dear friends, dear colleagues,

it is our great pleasure to welcome you at the 3rd Polar Ecology Conference 2016. After two years of intensive work in the Arctic or Antarctic we meet again in České Budějovice to discuss progress and efforts in our scientific work. We hope that the conference will deepen the existing research relationships and offer new opportunities especially for students and young researchers. Almost a hundred participants from 15 different countries will gather for these three days of conference and exchange their knowledge and experience. The conference is aimed to enhance the general knowledge of functioning of the polar ecosystems covering topics from atmospheric research, soil science, hydrology, through ecology to very distinct biological disciplines such as parasitology, microbiology or animal behaviour. Apart that, we also put emphasis on promoting the general skills necessary for successful research such as fundraising or initialising scientific cooperation – all that through the APECS panel with our experienced mentors.

We hope that you will really enjoy the conference itself but also the city of České Budějovice with its historical city centre and a world-famous Budweiser beer. We hope that you will bring home exceptional memories from these few days with us. At last but not at least, we sincerely hope to meet you again here in České Budějovice or perhaps somewhere far away North/South in the polar landscape!

Yours sincerely,

Jan & Alex

September 12th 2016, České Budějovice

ABSTRACTS

BACTERIAL ACTIVITY IN TWO ARCTIC FIORDS: HORNSUND AND KONGSFJORDEN

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Samples for the bacterial activity and abundance determination were collected from the board of r/v Oceania in July/August 2013, in two arctic fjords, Hornsund and Konsfjorden, located on the west coast of Svalbard. Kongsfjorden is under the influence of Atlantic waters, while the latter southern fjord is more affected by cold Arctic waters.

In addition to microbiological analysis (bacterial production (BP), total bacterial number (TBN), bacterial biomass and cells' morphology) a number of other physicochemical and biological parameters was measured. This allowed the analysis of factors influencing the bacterioplankton community.

Comparing the two fjords, the higher BP and TBN was observed in Hornsund, which was under the influence of colder arctic waters and terrestrial tundra outflow. Water temperature, dissolved organic carbon concentration (DOC) and pheophytin concentration were the main factors affecting the bacterial production in both fjords. This may indicate a greater influence of processed phytoplankton (instead of fresh one) on the microbial activity there.

REINDEER GRAZING PRESSURE ON LOCAL VEGETATION IN PETUNIABUKTA, CENTRAL SVALBARD

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Keywords: reindeer, grazing, vegetation, population

Grazing represents an important factor influencing characteristics of Arctic tundra vegetation. Most important herbivores affecting tundra in Svalbard are reindeers and geese. Main attention of the study is put on Svalbard reindeer (*Rangifer tarandus platyrhynchus*) behaviour and evaluation of its impact on the local vegetation. The study site is located in Petuniabukta, central Svalbard. A representative location with rather dense tundra vegetation was chosen. According to our observations from previous seasons, the place is visited by reindeers relatively often. It is rather remote location with the presumption that reindeers are not disturbed in their behaviour by humans (nearest site regularly visited by humans is Czech and Polish research station some 5km away). We would like to estimate impact of reindeers on the local vegetation, especially on the total biomass consumed by reindeers. Also first information on local reindeer population characteristics will be of great value. This information should be compared with long-term study on reindeer population that is carried out in other parts of Svalbard (e.g. Reimers, 2012) or especially in Adventdalen, where the population has grown from approximately 600 individuals in 80ies up to present 1200 reindeers (Tyler et al., 2008) and pressure on vegetation is expected to increase. The area of our interest is however much smaller in extent and also environmental conditions are different.

Five grazing cages were installed at the beginning of the vegetation season in the area with often presence of reindeers. These cages protect vegetation from being consumed by reindeers or geese. 1x1m cages were used and control vegetation plots were chosen in the vicinity. Apart that, two time-lapse cameras were deployed at the locality to assess number of reindeers, frequency and length of their visits. Time-lapse recordings are analysed at the end of the summer season, vegetation from the cages is collected, weighted for biomass and main taxa are determined.

Acknowledgement:
The study was supported by project Polar Hydrology Field Course (NF-CZ07-ICP-4-292-2015).

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Tyler, N. J. C., Forchhammer, M. C., Oritsland, N. A. (2008) Nonlinear effects of climate and density in the dynamics of a fluctuating population of reindeer. Ecology 89(6): 1675-1686.

MOVEMENT VARIABILITY AND FINE SCALE MORPHOLOGICAL DIFFERENCES WITHIN A CAVE DWELLING SMALL BENTHIC ARCTIC CHARR POPULATION IN ICELAND

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SUMMARY: We assessed the relationship between divergent habitat use and morphological variability within a cave population of small benthic Arctic charr (*Salvelinus alpinus*), found near Lake Mývatn in NE-Iceland. We repeatedly measured morphological features as well as quantified diet and habitat use (movement) of PIT tagged individuals using radio telemetry. We show that: a) considerable variation in habitat use can be seen among individuals within the population; b) this variability in habitat use is correlated with fine scale differences in morphology; c) these morphological features are related to foraging; and d) differences in morphology correspond well to different feeding strategies which are thought to be associated with different habitats. This is the first record of a relationship between morphological and habitat use divergence within a wild population of small benthic Arctic charr in Iceland.

BACKGROUND: Behavioral (e.g. habitat use) plasticity is thought to drive evolutionary change as changes in behavior may expose organisms to novel selection pressures. This can result in individual specialization in habitat use within populations, eventually leading to diversification of morphological characteristics and ultimately to population divergence. Consistent variability in selective pressures among individuals within a single population may lead to similar divergence among individuals of that population. This can result in differential behavioral specializations among individuals, lead to diversification of morphological, physiological, and/or life history traits, and ultimately to population adaptive divergence. Such specialization is likely a key step in the early evolution of biodiversity however this has little been studied in fishes.

We hypothesized that if morphological diversification within populations is preceded by specialized behavior, in the form of habitat use, then we should be able to find evidence of divergent habitat use among individuals displaying only fine scale morphological variability. Recent laboratory evidence suggests that variability in behavior may precede morphological differences in the early stages of diversification in some Icelandic Arctic charr populations. Here we used a wild population to assess behavioral variability, prior to the appearance of morphological differences, in order to provide novel insight into the early steps of the evolution of resource polymorphism, and ecological speciation.

HYDRATION-INDUCED SIZE AND VOLUNTOMETRIC CHANGES IN ANTARCTIC LICHEN THALLI ASSESSED BY ADVANCED DIGITAL OPTICAL MICROSCOPY

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Keywords: Antarctica, James Ross Island, foliose lichens, 3D microscopy,

Introduction

Several studies have been conducted to study various aspects of water-holding capacity in lichens such as e.g. thallus size, surface characteristics, growth forms, interspecific differences), and limitation of photosynthetic processes in highly-hydrated lichen thalli. Changes in thallus volume and hydration-dependent changes of thallus morphology have been, however, studied less frequently. In this study, we used advanced 3D integrated systém of digital microscpoy, that enabled observing, capturing and measuring of morphometrical parameters of Antarctic lichen thalli during hydration.

Material and Methods *Xanthoria elegans* and *Umbilicaria decussata* were collected at northern part of the James Ross Island in February 2016. Collecting site of *X. elegans* was located close to Big and Small Lachman lakes on North-East slopes of the Berry Hill mesa (S, W). *U. decussata* was collected from the upper parts of volcanic boulders located N of the Berry Hill mesa (N, W). The thalli of collected lichens were dried under natural outside conditions and then stored at 5°C. They were transported in dry state into the Czech Republic where stored in a refrigerator until used for wetting experiment. In this preliminary study, we applied a new method of measurements hydration-dependent changes in dimensions of lichen thallus. In dry state and during wetting, thalli were analysed using a digital VHX-500F microscope (Keyence, Japan) powered by the USB port of a notebook computer and controlled by Keyence software.

Upper surface of dry thallus was lit by a high intensity halogen lamp and then documented by a high-resolution CCD camera and software resulting in a digital photograph file. Then, water was added to the experimental thalli by regular spraying by demineralized water and the thalli were measured repeatedly each 30 min. Each measurement was documented by recording a digital image. The images were of high-resolution quality thanks to a short-wavelength light used for illumination of a thallus, and the HDR (high dynamic range) function that captures high-color gradation images at different exposures and then compiles them into a single image. Then, we used the images of dry and fully wet thalli and measured hydration-induced changes in size of particular thallus parts, e.g. apothecia using tools for metrical measurements in the Keyence software.

Results and Discussion

X. elegans forms foliose thallus organized in a rosette up to 6 cm in diameter. Marginal parts shows dorsiventral lobes with rotund to truncate upper surface. The species does possess apothecia. Hydration of *X. elegans* thallus led to an increase in thallus size (diameter), as well as diameter of apothecia. Hydration of *U. decussata* thallus led to an increase in thallus size (diameter) as well. Data are presented recently (Ošťádal et Hazdrová 2016). It might be concluded that hydration-dependent changes in lichen morphology can be studied by a new technique of digital optical microscopy presented in this study. In this approach, reflected light capacity enables whole lichen specimens or particular surface structures such as e.g. apothecia to be observed, saved as a 3-D image and processes using different image processing tools. Such as e.g. height profile along a selected line placed across a thallus from a margin through centre to an opposite margin or through an apothecium. Another option is to use DFP method (Depth From Defocus) which compiles an image from images taken at different focal planes (typically from bottom to the top of investigated object). This approach might be applied in upper thallus structures like pustulas or apothecia and supplemented by advanced techniques like e.g. calculation of cross-sectional area of pustulas and their volume.

References:

Ošťádal, R., Hazdrová, J. (2016): "Thallus morphology of two Antarctic foliose lichens evaluated by a digital optical microscopy approach" Czech Polar Reports 6(1): accepted, in press. Pre-publication on-line first available at http://www.sci.muni.cz

PHOTOSYNTHESIS MEASUREMENTS IN FIELD AND LABORATORY RESEARCH OF STRESS PHYSIOLOGY OF ANTARCTIC AUTOTROPHS.

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Keywords: Antarctica, James Ross Island, chlorophyll fluorecence, oxymetry, spectral reflectance

Introduction

Photosynthetic parameters are generally-accepted markers of the effects of a wide variety of stressors. In Antarctic autotrophs capable to survive and maintain positive carbon balance withinn a season and/or several consecutive years, short- and long-term responses of photosynthesis to paarticular stressors have been focused recently. In this study, we bring an overview of photosynthetic measurements and most important results gained in the field (James Ross Island, Antarctica) and in laboratory experiments. Main emphasis is given to particular stresses and their indications by a variety of chlorophyll fluorescence techniques.

Material and Methods

Field experiments are carried out at a long-term research plot at James Ross Island (Antarctica) using an approach of repetitive measurements of effective quantum yield of photosynthetic processes in PSII (Yield PSII). The parameter has been measured since 2007 on *Bryum* sp by permanently installed FluorPen FL100 fluorometers (PSI, Czech Republic). The measurements results in daily and seasonal courses of Yield PSII that reflect the effects of freezing temperature, partial and full hydration, and lack of light during austral winter season. In shalow freshwater ponds (Interlagos ponds, Dulanek), photosynthetic processes are monitored by daily courses of dissolved oxygen concentration (DOC) that are measured by an oxygen electrode (Cellox WTW system) during austral summer seasons. Shapes of daily DOC courses are affected by daily courses of incident photosynthetic radiation (PAR) and water temperature.

Laboratory experiments comprise measurements of a wide variety of chlorophyll fluorescence parameters (typically Fv/Fm, Yield PSII, non-photochemical quenching (qN, NPQ) and its components qI, qT, qE) in algae, cyanobacteria, lichens and mosses. Parameters are measured by several fluorometers using the approaches of fast chlorophyll fluorescence transient (OJIP) and slow chlorophyll fluorescence kinetics supplemented with quenching analysis. The parameters are measured in response to the following stressors: (1) photoinhibitory doses of photosynthetically active radiation (PAR), (2) photoinhibitory doses of UV-B, (3) short-term low and freezing temperature treatments, (4) osmotic and salt stress, (5) dehydration, (6) chemicals affecting linear (photosynthetic) electron transport or causing oxidative stress. Simultaneously with photosynthetic measurements, supplementary measurements of photosynthetic pigments and PAR- or UV-B- induced secondary metabolites are done

spectrophotometrically. Moreover, spectral reflectance indices PRI (Photochemical Reflectance Index) and NDVI (Normalized Difference Vegetation Index) were measured.

Results and Discussion

Here we present only a limited number of results gained in our lab within last year. Short-term direct effect of temperature (20, 15, 10, and 5 ^{o}C) on chlorophyll fluorescence curve was measured for *Physconia muscigena*, and *Umbilicaria antarctica*. It was found that that the time at which O,P,S,M points that could be distinguished on the curve were temperature-dependent, especially the time of S, and M occurence was prolonged with temperature fall. Spectral reflectance indices were measured in *Xanthoria elegans*, *Leptogium puberulum, Rhizoplaca melanopthalma*, *Physconia muscigend,* and non-lichenized *Nostoc commune* colony in response to dehydration. It was found that PRI declined in all studied species with dehydration from fully wet (RWC=100%) to dry state (RWC=0%). PRI dehydration-response curves however, differed in their shapes and a range of PRI values reached during dehydration as well. Linear relation was found in *X. elegans* and *R. melanopthalma.* PRI showed only a little change throughout whole RWC range in *X. elegans* (-0.3 to -0.4), while the relation was much steeper in *R. melanopthalma.* In *X. elegans*, almost constant NDVI was found in desiccating thallus. Other species showed curvilinear responses of NDVI. It increased from fully wet (RWC=100%) to partially dehydrated state reaching species-specific maximum at 20 (*R. melanopthalma*), 30 (*L. puberulum*), and 50% RWC (*C. muscigena* and *N. commune*). In all species, NDVI decline started at 50% RWC. Yield PSII to PRI, NDVI relationship was studied as well.

Acknowledgements: The authors thank CzechPolar-I, and CzechPolar-II infrastructure.

RESPONSES OF A HIGH ARCTIC ANIMAL COMMUNITY TO CLIMATE CHANGE - A LONG TERM STUDY IN NE GREENLAND

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Keywords: Population dynamics, predator-prey interaction, global change

The reasons for cyclic fluctuations of small rodent populations have been - and still are - intensely discussed among ecologists. The questions relating to the driving factors behind these remarkable fluctuations have been addressed in the scope of the Karupelv Valley Project since 1988 in a long term study of lemming cycles. The approaches adopted here include the assessment of lemming population dynamics as well as those of its predators. The high Arctic tundra in the Karupelv Valley in North East Greenland serves as study area for our investigations and features one of the most simplified terrestrial animal communities offering ideal conditions to explore basic ecological interactions.

Lemming populations have been monitored through systematic recordings of winter nests in an area of 1500 ha. As winter nests are easy to detect, the study of uncovered lemming nests in summer also allows tracking back predation by stoats in winter. Nests eliminated by stoats are characterized by the remainders of a typical, 'sleeping bag like' fur lining. Besides stoats, other predators such as snowy owls, long tailed skuas and arctic foxes are recorded. Especially avian predators and foxes are easy to monitor by annual assessments of their breeding success or occupation of dens respectively. The sampling of pellets and scats provides detailed information on predators' diets. There are also more aspects that are repeatedly addressed within the scope of the Karupelv Valley Project like radio-telemetry of foxes, satellite telemetry of snowy owls as well as color ringing and the use of geolocators on waders and skuas.
Lemming populations first displayed the typical pronounced cycling patterns with recurrent and quite severe irruptions every 4 to 5 years. Based on modeling approaches, these fluctuations could be attributed to the delayed density response of stoats, supporting the hypothesis of specialized predation being the driving factor behind the distinctive population cycles in lemmings. The changes that became apparent within the past decade suggest a fading or even levelling of these cycles and may be related to effects of global change (Gilg et al. 2009). Simulations of lemming population development which take into account changes in snow cover seem to support this theory. The missing cyclical outbreaks of lemming populations also affect the reproduction rates of its predators, e.g. the breeding success of snowy owls and long-tailed skuas during the past decade. Our observations suggest a dramatic decrease of the reproductive output in the area.

The results of research activities within the Karupelv Valley Project show that long term observations are absolutely indispensable for the detection and correct interpretation of fundamental changes within this fragile ecosystem. In the face of its direct effects becoming

ever more visible in the study area, climate change has become a main research objective within the project during the past couple of years. In this regard, special attention has been drawn to the assessment of changes in snow cover of the tundra as well as the patterns displayed by sea-ice cover in coastal areas. The latter constitute severe habitat changes for polar bears who become increasingly dependent on foraging ashore during summer.

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ARE THERE POSITIVE INTERACTIONS BETWEEN BRYOPHYTES AND VASCULAR PLANTS ALONG A BIOCLIMATIC GRADIENT IN HIGH ARCTIC SVALBARD?

Oliver Bechberger[1, 2], Ágústa Helgadóttir[1, 3], Uliana Bagina[4], Pernille Bronken Eidesen[5], Ingibjörg Svala Jónsdóttir[1, 5]

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Keywords: facilitation, permafrost, microclimatic fluctuations, gradient analysis

Facilitation and positive interactions are widely recognized processes that shape plant communities. It is generally believed that those positive interactions increase with environmental stress and harshness. In High Arctic Svalbard, vascular plant growth and distribution are limited by large temperature fluctuations, a short growing season, lack of nutrients and unstable substrate due to freeze–thaw cycles. Depending on the depth of the bryophyte layer, bryophytes may improve growing conditions and facilitate vascular plant species richness and abundance by reducing soil movement and ameliorating microclimatic fluctuations.

To examine the facilitating role on community structure we studied plant communities on six different locations within three different bioclimatic zones along the west and north coast of Svalbard. We measured abundance and richness of vascular plants, bryophyte cover and depth on each location. Furthermore we recorded soil temperature and humidity in bare ground and below the bryophyte cover. We tested the possible relationship between bryophytes and vascular plants by using linear regression models and checked for floristic similarities among all sites using ordination techniques to see if the species composition and abundance reflects the bioclimatic gradient.

We found no significant relation between bryophyte cover and depth and vascular plant species richness and abundance, except for one site below a bird cliff and therefore nutrient-enriched. This was also reflected in the gradient analysis. Both vascular plant species richness and cover increased southwards and the bioclimatic zones were well differentiated in the ordination plots. Species composition varied along a bryophyte cover gradient between the different sites as revealed by the ordination. However, soil temperature was lower under the bryophyte cover compared to bare ground, supporting that bryophyte cover acts as insulation when it exceeds a certain thickness and affects the active layer thickness below. Our results indicate that facilitation of vascular plants by bryophytes is rather low under low-nutrient conditions in the High Arctic.

A SONG OF ICE AND FIRE – SHORT TERM VEGETATION RESPONSE TO TEPHRA DEPOSITION AFTER A SUBGLACIAL VOLCANIC ERUPTION

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Keywords: aeolian deposition, disturbance, recovery, primary succession, ecosystem development

The early development of ecosystems and how species conquer new space over time is one of the key questions in ecology. Another factor that highly influences species distribution is the frequency and intensity of disturbance. Our study area is the world's largest outwash plain Skeiðarársandur south of the Vatnajökull ice cap in SE Iceland with only little topographic variation like kettleholes. Strong winds and storms occur frequently in the area and aeolian deposition rates are very high. Vegetation cover on Skeiðarársandur is low except for some well vegetated parts. In May 2011 a phreatomagmatic eruption occurred in Grímsvötn volcano beneath Vatnajökull and lead to the greatest tephra fall from Vatnajökull's volcanoes in the past 100 years.

We started monitoring the effect of tephra on vascular plant species richness and abundance in 15 kettleholes and the corresponding flats aside in the vegetated area of Skeiðarársandur and compared it with data from Martin (2006). Raunkiær's life-form system was used to examine whether plant strategies are important for survival after such a major disturbance. We hypothesize that a) kettleholes are more affected by ash cover compared to flat as they trap the ash for a longer time but b) plants on flat will be more easily damaged through abrasion effects of the tephra, c) low growing plants and mosses in kettleholes are more easily disturbed by the ash through burial whereas d) on flat a low growth form could reduce negative abrasive effects.

Vegetation on Skeiðarársandur was more or less completely covered by ash right after the eruption in May 2011 which changed quickly. Mosses were affected more heavily by tephra fall than vascular plants and tephra had greater impact on moss in the kettleholes than on the flats. Relative rates of moss recovery appeared to be similar in the two habitats. Vascular plant cover increased in kettleholes and flats after the eruption 2011 compared to 2006. 2012 recovery was much higher in kettleholes. A slight increase in species richness could be detected in the flat but remained on the 2006 level in kettleholes (Fig.1). Chamaephyte cover on the flat was stable over the years but increased significantly in kettleholes. Geophytes showed a consistent increase in both habitats with a steep increase between 2011 and 2012. Phanerophytes played the most important role in terms of total vascular plant cover with higher cover in kettleholes over years. They showed a significant increase between 2011 and 2012 in kettleholes but stayed at the same level on the flat.

Differences in moss cover after the eruption between kettleholes and flats may largely be explained by the greater tephra cover of the kettleholes. The use of Raunkiær's life-form

system proved helpful to explain recovery after the eruption. Kettleholes appear to be a much more benign and favorable place for vascular plant growth. The results confirm our hypotheses and we clearly see how deposition and aeolian dispersal of tephra changes ecosystem properties, composition and cover of vascular plants and mosses. Further successional changes should be monitored.

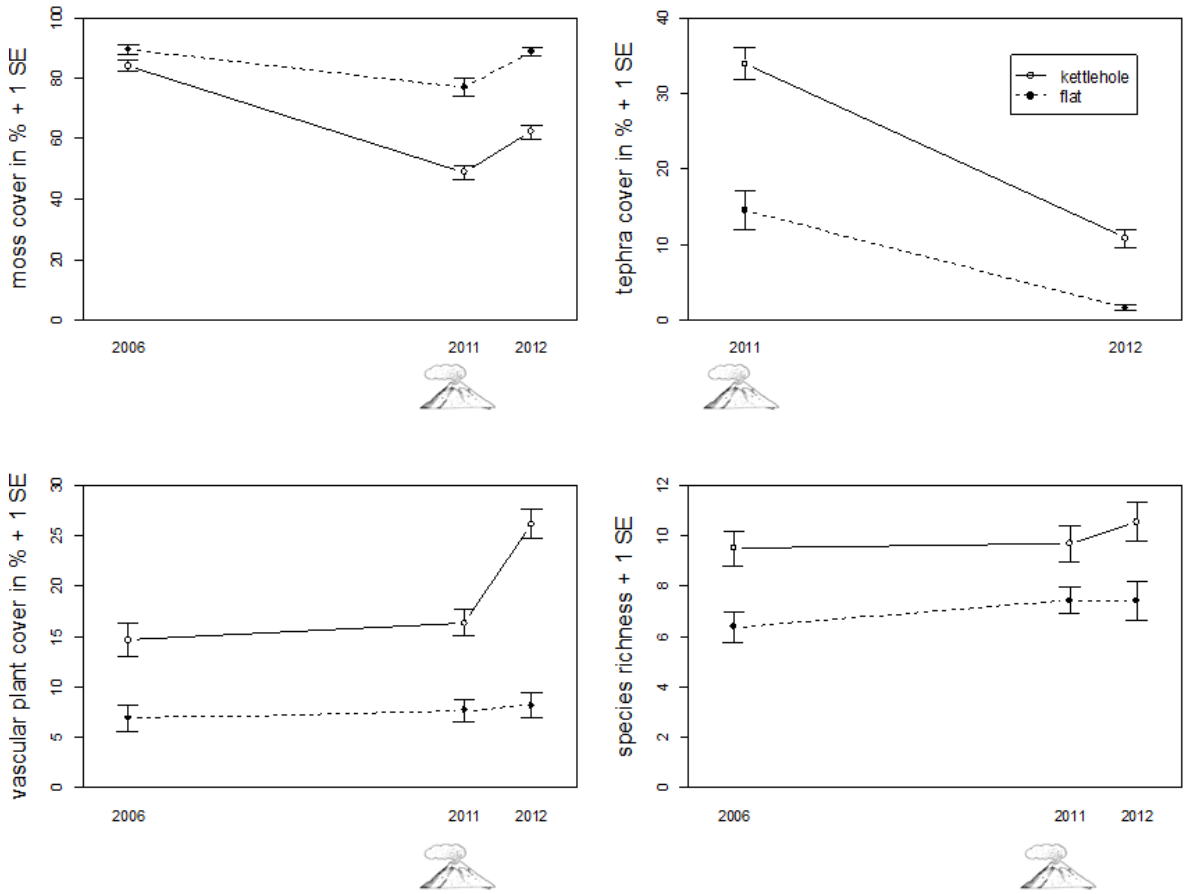

Figure 1: Percentage surface cover of moss (top left), tephra (top right) and vascular plants (bottom left) and species richness (bottom right) in kettleholes and flats on Skeiðarársandur. Legend on top right graph.

Martin, J. A. (2006): "The ecology of kettleholes in successional environments: Skeiðarársandur, Iceland". MSc Thesis University of Iceland.

UNINVITED GUESTS: HUMAN DISTURBANCE OF SOUTHERN GIANT PETRELS ON KING GEORGE ISLAND, ANTARCTIC

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Keywords: Antarctic, seabirds, human impact, Antarctic stations, nest site shifts

Manifold human activities influence increasingly the Antarctic terrestrial environment. The Fildes Region in the southwest of King George Island represents an area of high biodiversity with extensive vegetation as well as with bird and seals concentrations and reproduction sites. At the same time, the area is a major logistic hub for the northern Antarctic Peninsula and a wide spectrum of human activities, including logistic, science, tourism, environmental programs, delegations, ect., occur here. As a result, the pressure from human activities on the local fauna and flora is exceptionally high. Based on seabird monitoring data collected between 1979/80 and 2015/16 we assessed the effect of human impact on a highly susceptible seabird species, the southern giant petrel (SGP, *Macronectes giganteus*), that breed in the area in numbers of several hundreds of breeding pairs.

Our long-term data show that despite large interannual fluctuations the population of SGP giant petrel in the Fildes Region has been stable for many years (Braun et al. in press). While the total breeding pair number even tends to increase, the already low breeding success in the area is declining significantly. Regarding the development of breeding pair numbers and breeding success in particular, individual colonies had been considerably affected by the establishment of new Antarctic stations on SGP in the 1980s are (Peter et al. 2008) in terms of a considerable nest site shift towards undisturbed areas (Braun et al. 2012; Peter et al. 2013; Braun et al. in press). New and continuing translocations of SGP nests observed during the past 10 years are attributed again to anthropogenic disturbance as only colonies that were subject to extensive visits by station members in their leisure time were affected by decreasing breeding pair numbers and reduced breeding success. Neighbouring but rather unvisited colonies instead showed a steady growth of breeding pair numbers and stable breeding success. Hence, environmental conditions (e.g., predation by skuas, climatic conditions, food availability) are unlikely to cause the observed changes within the SGP population, as they would affect all colonies in the area equally.

On the other hand, we found some evidence of habituation effects resulting in an increasing number of nesting attempts in numerous formerly abandoned breeding sites, which are partially affected by a high level of human activities. This suggests a possible habituation to regular and predictable disturbance, e.g., by approaching aircrafts or tourists remaining in an adjacent visitor zone. In the recolonised sites, however, hardly any chick has been successfully raised to fledging.

The findings of dead SGP as bird strikes indicate that this species is also affected negatively by the station antennae and signal masts and their guy wires.

In summary, SGP breeding in the Fildes area has negatively been affected by the anthropogenic influence. Therefore, measures should be taken immediately to reduce the risk of anthropogenic disturbance.
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MOSS DIATOMS INHABITING GLACIAL SURFACES (GLACIAL MICE, JOKLAMYS) AND FOREFIELDS FROM SVALBARD, HIGH ARCTIC

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Keywords: diatoms, diversity, glacial mice, high Arctic,

Glacial mice (joklamys) are conspicuous features on supraglacial habitats, such as those from the Svalbard Archipelago, and consist of round balls of sediment covered in mosses (fig. 1). Because of their presumed mobility, and therefore potential as a dispersal vector, their diversity is of interest to polar and alpine microbiologists. Despite this, the structure and diversity of glacial mice has been neglected.

Diatoms are single-celled, eukaryotic algae, and represent one of the most common algal groups in the region. Diatoms have a long study history thanks to cost-efficient community analysis, and are common microbial study organisms for answering ecological questions. Arctic glacier forefields are often dominated by mosses, and although moss-inhabiting diatoms are common, they are only rarely studied, and information on glacial mice diatoms are completly absent. Thus, while glacial mice might present a favorable habitat for non-marine diatoms, little is known about their composition, ecological preferences, and source of diversity. One possibility is that the glacial mice diatom communities are seeded by proglacial mosses, and thus represent a subset of the forefield communities. However, they could also consist of an entirely unique flora to the supraglacial habitat, and both options remain to be tested.

This poster discusses the above project, carried out in the 2016 summer, from several localities on high Arctic. The diatom community composition of the glacial mice is here presented and compared with glacial forefield moss communities from several catchments (Jotunfonna, Hørbyebreen,Ragnarbreen), (Ebbabreen), (Nordenskiöldbreen), Svalbard. Diatoms will be studied using light and scanning electron microscopy, and resulting communities visualized and compared with multivariate methods.

Our scientific questions:

- *Does the diversity correlate with joklamys size?*
- *Will Svalbard and Iceland eventually show different slopes?*
- *Is the composition of the joklamys diatom community unique or just a nested sample of proglacial mosses?*

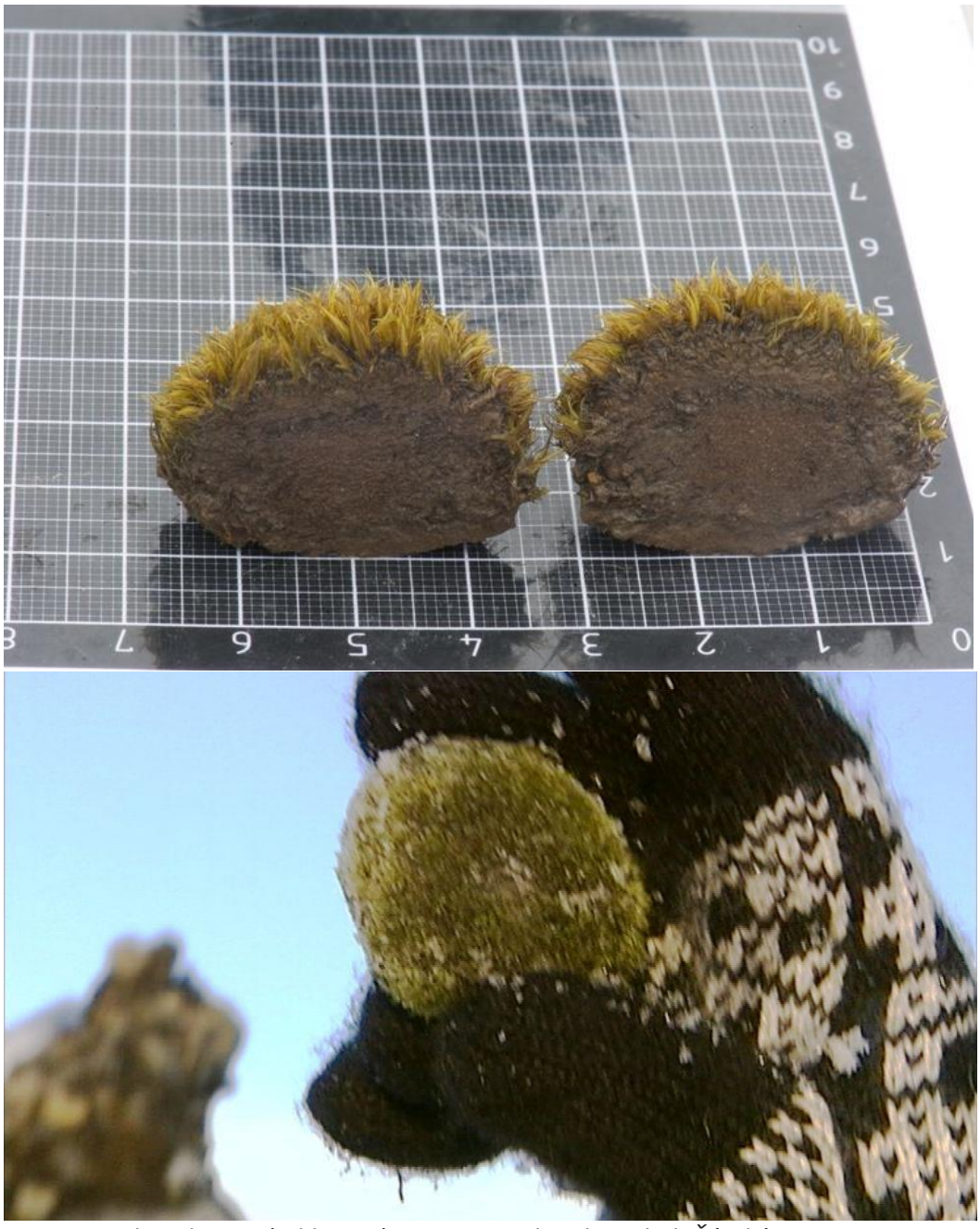

Figure 1: Glacial mice (joklamys). *Pictures taken by Jakub Žárský*

THE INFLUENCE OF FRESHWATER RUNOFF ON THE DISPERSAL OF COD EARLY LIFE-STAGES IN ICELANDIC WATERS

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Keywords: Cod; Dispersal; Fish larvae; Iceland; Particle tracking

The main spawning grounds for cod in Icelandic waters are located in the southwest. From here, the early life-stages drift in a clockwise manner to the favorable nursery areas in the North. One of the main mechanisms facilitating this circulatory pattern is the Icelandic coastal current which is driven by entrained freshwater runoff and advects eggs/larvae in a north-westerly direction. However, the southwest spawning area is far from homogenized in terms of the abundance of spawning females. Previous studies have identified sub-regions in the area, each of which varies in its importance as a contributor to the pelagic larval population. And furthermore, these sub-regions vary in their importance to the different ecotypes of cod found in Iceland. This spatial variation in spawning activity raises the question: what is the relative importance of freshwater runoff as a mechanism maintaining dispersal for the spawning sub-regions in the southwest area? To address this question, we carried out an extensive particle tracking simulation utilizing a suite of known spawning grounds, each of which differs in its physical and biological characteristics. Particles were released from six locations throughout the spawning season from 1992 to 2006. In addition, a sensitivity analysis was performed where identical simulations were performed in an environment with no freshwater runoff in 2006. The results showed little variation between spawning grounds in terms of drift trajectories, with larvae consistently drifting in a north-westerly manner in all years. However, unique and distinctive seasonal patterns in dispersal were evident each year. These seasonal signals were evident across all spawning grounds although the magnitude of dispersal was reduced in the two outermost spawning regions. Whilst variation in freshwater runoff does not appear to be responsible for these signals, its influence is evident in the nearshore spawning sub-regions through a consistent reduction in the amplitude of dispersal when freshwater runoff is not present in the model. The results highlight that the temporal, rather than the spatial, context of spawning activity has the biggest influence on the dispersion of larvae from within the main spawning grounds.

PRELIMINARY RESULTS OF GEOCHEMICAL AND PETROPHYSICAL ANALYSES OF THE SEDIMENTARY CORE FROM ANONIMA LAKE (VEGA ISLAND, ANTARCTIC PENINSULA)

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Keywords: deglaciation, Anonima Lake, magnetic susceptibility, carbon analysis, X-ray fluorescence, Antarctic Peninsula

In the present context of fast warming in the Antarctic Peninsula (AP) the understanding of past and present environmental dynamics is crucial for a better understanding of the future environmental responses in this region. From this point of view, palaeolimnological research broadly contributes to this interdisciplinary topic, because lake sedimentary records generally provide an eligible type of (palaeo)information to study. The Anonima Lake (24 m a.s.l.; 63°49'20.34" S, 57°19'29.61" W), located in a northern part of Vega Island, was selected as a study site for palaeolimnological research. The studied lake is located in Cretaceous calcareous sediments (Marambio Group; Mlčoch et al. 2016), however its surrounding is dominated by Neogene volcanic mesas composed of basalts and hyaloclastite brecchia of the James Ross Island Volcanic Group (JRIVG; Smellie et al. 2013).

For the analysis of sedimentary core a basic geochemical and petrophysical methods were applied. Content of main litophile elements (by means of X-ray fluorescence – XRF method) together with organic/inorganic carbon and sulphur were measured and magnetic parameters (magnetic susceptibility – MS) were determined. MS values were compared with data from Esmeralda Lake (Chaparro et al. 2014), in order to determine: 1) relative age of bottom section of the core, 2) intensity of clastic material input. Thanks to Chaparro et al. (2014) we were able to suggest the approximate age of lake to 7–8 ka.

Bottom section (69–52 cm) of the core is characterised by relatively low MS values indicating generally warmer climate conditions in this area. This is supported by higher total organic carbon (TOC) values and also by higher values of frequency-dependent susceptibility (FDS). This parameter has been calculated in order to define the amount of superparamagnetic grains (SP), which indicate chemical weathering intensity (Dearing et al. 1996). It is not excluded, that the deposition of the bottom section of the core can be linked with initial deglaciation of the area, already described by Björck et al. (1996) and Hjort et al. (1997).

Higher Rb/Sr ratio in lower section of the core also suggests a significant match with the mean ratio of Cretaceous calcareous sediments (0.225), which indicates short transport of clastic material from nearby area. On the other hand, lower values of Rb/Sr ratio in a middle section of the core (52–24 cm) strongly correspond with mean values of Neogene volcanic rocks of JRIVG (0.034). From our perspective, changes in Rb/Sr ratio, together with the regional

knowledge of geological setting, can be used for the interpretation of the changes of the material transported into the lake basin, bringing thus further piece of evidence of environmental changes of this area in the Holocene.

From a future perspective, our most important task is to establish the chronology of the deposition in the lake by means of radiocarbon dating. The following analyses (such as diatom biostratigraphy, grain-size analysis, ^{210}Pb dating) are also planned to bring further data about the paleoenvironmental evolution of the Anonima Lake catchment.

Acknowledgements

The authors gratefully thank Marcos A. E. Chapparo, Jan Kavan and other members of the PICTO project nr. 2010–0096 Antarctic Expedition 2012/13 to Vega Island, for providing the core for the analyses.

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ICELAND - THE LARGEST EUROPEAN AND ARCTIC DESERT

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keywords: dust storms, wind erosion, volcanic ash, snow thawing

Iceland is located in high-latitude cold region where both volcanic and glacial activity affect most of the areas. New calculations and classification of the land surfaces have shown that total Icelandic desert areas cover over 44,000 km^2 suggesting Iceland being the largest Arctic as well as European desert (Arnalds *et al*., 2016). The most active areas prone to the volcanic dust mobilization and resuspension are defined as “dust hot spots”. Such dust hot spots cover about 15 % of the country and are mainly located in vicinity of the glaciers. We used meteorological observations (synoptic codes for dust and visibility) to identify the frequency and severity of dust-storm events in Iceland. The annual mean of dust days in 1949-2011 was 135 dust days per year. The annual dust deposition was calculated as 31 - 40.1 million tons yr^{-1} affecting the area of > 500,000 km^2, which places Iceland among the most active dust sources on Earth. Volcanic dust is distributed over local glaciers (about 4.5 million t annually) and surrounding oceans (6 – 14 million t annually).

Despite the location of Iceland in the high-latitude cold region, half of the annual dust events in the southern part of Iceland took place at sub-zero temperatures or in winter, when dust may be mixed with snow. We observed a “Snow-Dust Storm” in March 2013 when dust was transported over 250 km and consequently was deposited on snow in Reykjavik. The snow was nearly black with several mm volcanic dust layer close to the dust source, while a clumping mechanism was found in thin layer of impurities in Reykjavik. This has been the first observation of such mechanism in natural conditions.

Icelandic dust consists of fine reactive volcanic materials. It is dark in color and it contains sharp-tipped shards, often with bubbles. About 75-80 % of the material is a volcanic glass rich in heavy metals. However, extreme dust storms in Iceland transport also large proportion of organic material or diatoms. We conducted several experiments during winter campaigns investigating changes in albedo, bidirectional reflectance factor and other snow properties monitored on the clean snow and areas affected by the dust deposition through the following melting period. These experiments also included black carbon (BC) observations revealing that volcanic dust has similar effects on snow albedo and snow density as BC. This suggests that

the Icelandic dust may both directly and indirectly act as a positive climate forcing agent while dust may be a contributor to the Arctic warming.

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TEMPORAL VARIABILITY OF TOTAL MASS FLUXES IN KONGFJORDEN (SVALBARD)

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Keywords: melting glaciers, melting permafrost, particle flux, Arctic, *Kongsfjorden*.

Introduction:
Over the last 3 decades, the Arctic area has experienced more warming than any other region on Earth. This Arctic amplification may be due to feedback mechanisms from loss of sea ice or changes in atmospheric and oceanic circulation.
Kongsfjorden is a small fiord at 79°N, 26 km long, 6-14 km wide, extended in SE-NW direction in the western part of Svalbard. All glaciers reaching *Kongsfjorden* are rapidly retreating. There is ample evidence that land-to-ocean fluxes of particulate material along the Arctic coasts are changing, too.
The aim of my research is to detect the main contribute of particle flux into *Kongsfjorden* and its provenance. It could be due to a terrestrial input, such as the surface runoff from the surface layer permfrost erosion, or a marine input generated by the biological pump.

Methods and materials:
To verify the temporal variability of particle fluxes and composition on long time-scale, an instrumented mooring, equipped with an automatic sediment trap, a temperature and salinity recorder and two current meters, was deployed in September 2010 in the inner fjord at ~100m water depth. Sediment trap samples have been processed in order to measure the mass flux and splited into quantities suitable for laboratory analyses following the *Chiarini et al*. 2014 procedure: to separate the coarse and fine fractions (> and < 580µm), to pick out and count the *swimmers* to determine at the lowest taxonomic level possibile. For total and organic carbon (OC), total nitrogen (TN) contents and the stable isotope compositions was used a Finnigan DeltaPlus XP mass spectrometer directly coupled to a FISONS NA2000 Element Analyzer via a Conflo III interface for continuous flow measurements (Kristensen and Andersen, 1987; Verardo et al., 1990; Tesi et al., 2007). OC filters were first decarbonated after acid treatment (HCl, 1.5M).

Results:
The first 4 years of the total mass flux are here presented together with the organic and inorganic elements. The highest peaks of TMF have been recorded in summer and fall months, followed by reduced fluxes during winters; in particular, during the summer 2013 the TMF reached ~330 g m^{-2} day^{-1} (fig.1) and on this date it has been observed also the maximum value of %C inorg (3.78) and the minimum values of %OC (0.21) (fig.2).
The Zooplankton abundance has been calculated by the number of items/mq*d (fig.3). The results show that the most abundant organism is the *Calanus* sp., though has been decreasing over time.

The temporal variability of mooring data will be discussed concurrently with meteorological parameters recorded by the Amundsen-Nobile CCTower of CNR in Ny-Ålesund; the rain precipitation, for example, is used as a runoff proxy. We can make a comparison of these data, to elucidate the main processes involved in the particle sedimentation in the inner *Kongsfjorden*.

Discussion:

During spring and summer: there's the maximum content of organic matter, maybe due to the primary production, also the $\delta^{13}C$ values show a higher quantity of marine matter, while the values of total mass flux are the lowest ones. During the end of summer and fall we have low values of organic matter content with $\delta^{13}C$ more negative (it means that the terrestrial organic fraction is higher than the marine one) are also recorded high peaks of total mass flux due to the increasing of precipitations and melting of glaciers.

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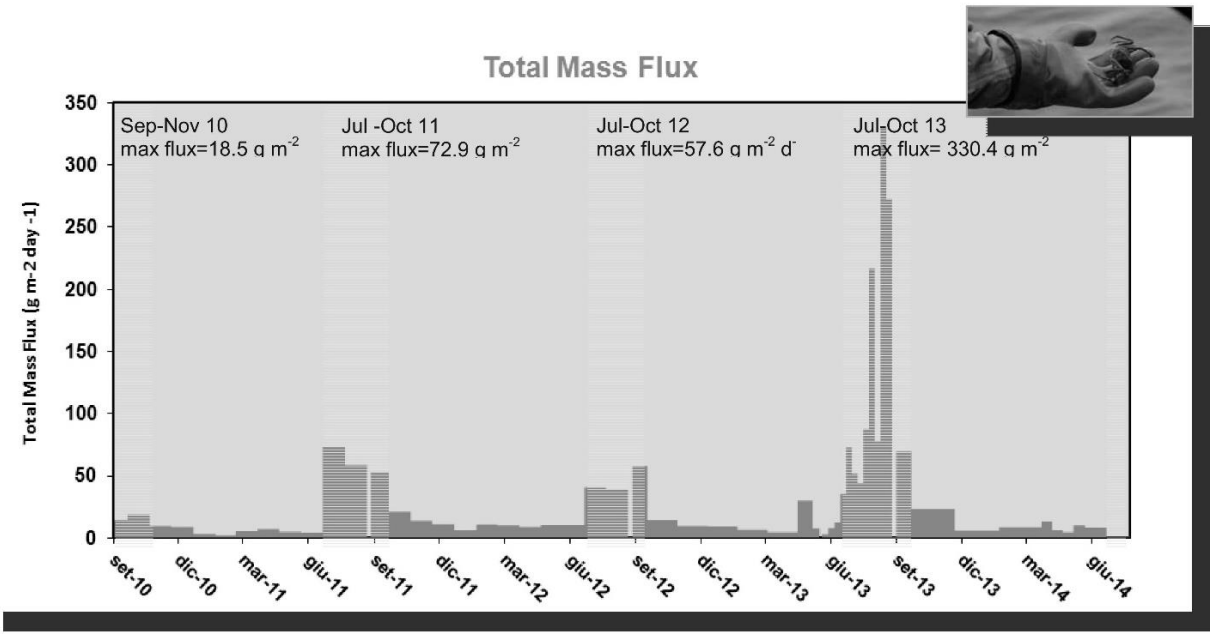

Figure1: Total mass flux from 2010 to 2014. No data from July 2014 because of crubs in the sediment trap.

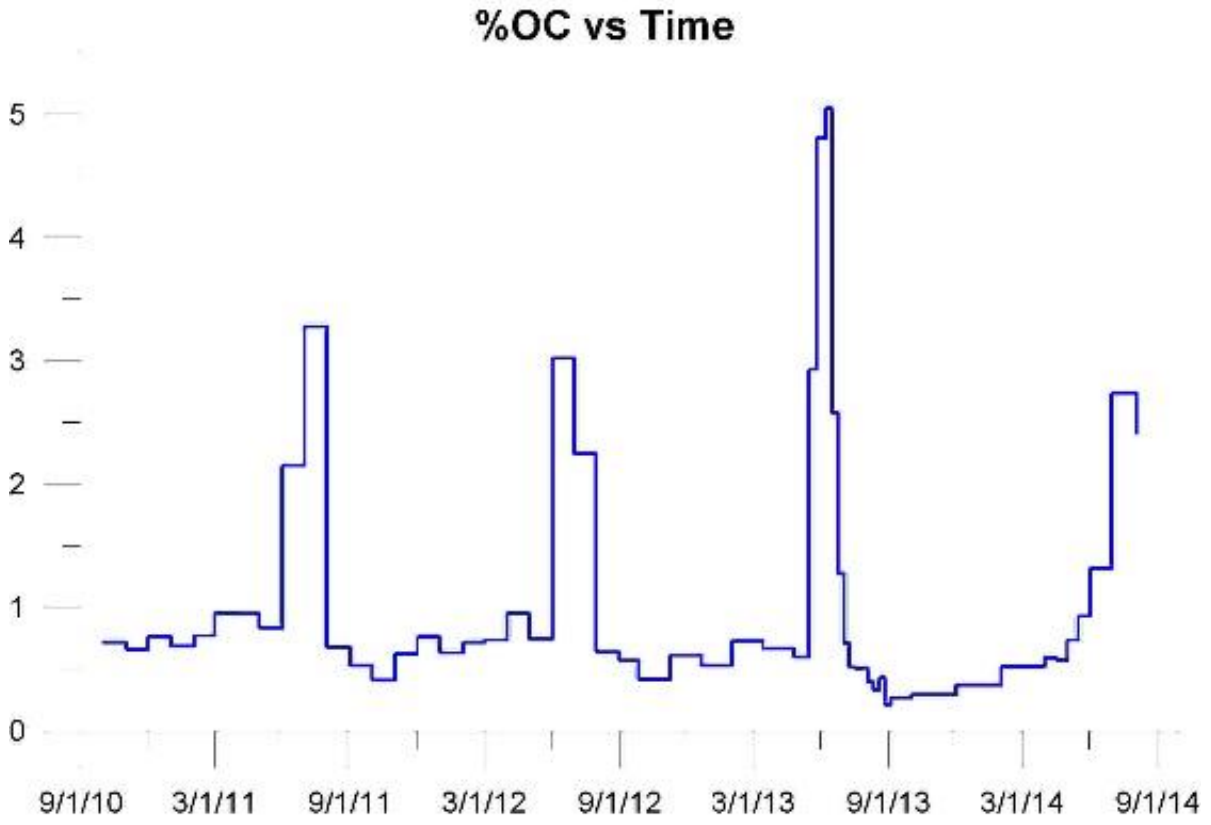

Figure2: Organic Carbon content from 2010 to 2014

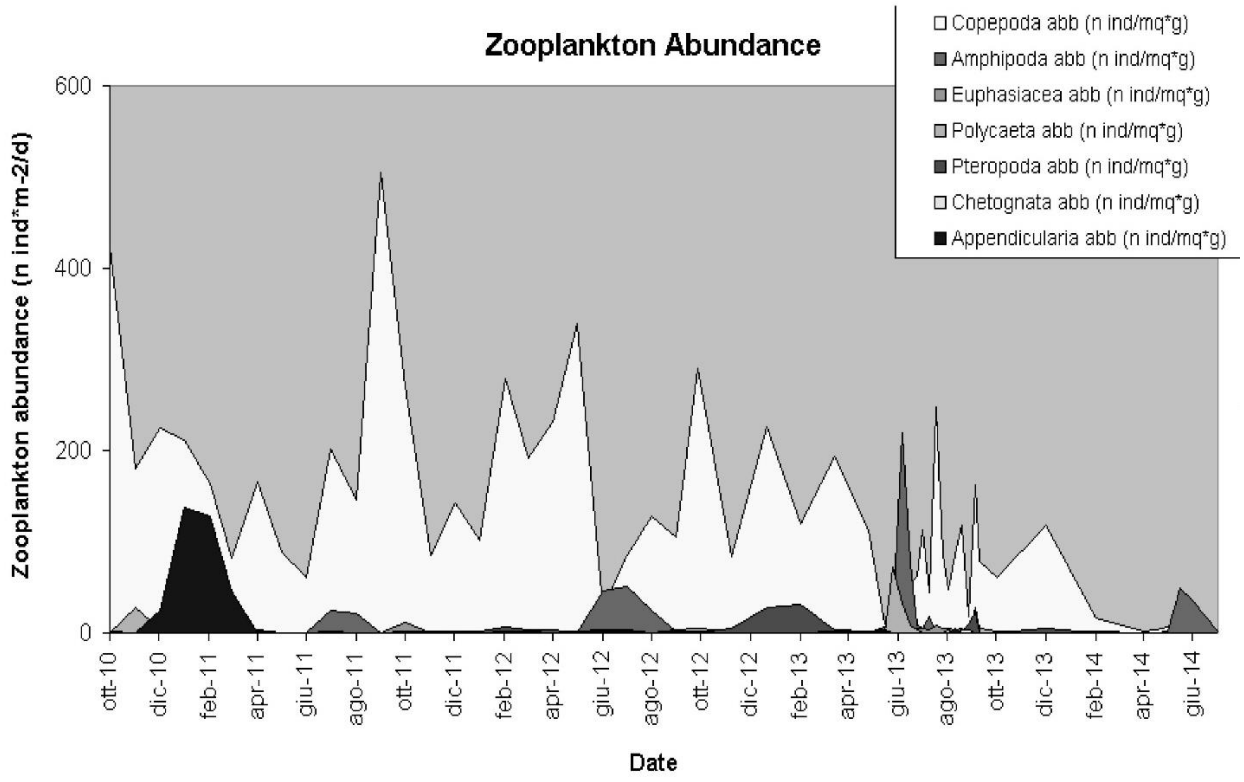

Figure3: Zooplankton abundance from 2010 to 2014

TEMPORAL AND SPATIAL CHANGES IN MACROINVERTEBRATE ABUNDANCE AND DIVERSITY IN STREAMS OF VARYING STABILITY IN NORTHEAST GREENLAND

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keywords: Greenland, Freshwater, Streams, Macroinvertebrates, Chironomidae

In high Arctic regions, snowmelt, permafrost, glacier and groundwater contributions to river flow are expected to change in response to a warming climate, with a predicted shift from predominantly meltwater dominated systems to systems more dominated by groundwater. This shift will influence the physicochemical habitat template from one characterised by low water temperature and high turbidity in low stability systems, to more stable systems with higher temperature and lower turbidity. This change will affect stream biodiversity.

Here we present a study on the ecological characteristics of Arctic streams of different stabilities. This project was the first hydroecology project to be conducted in east Greenland. Fieldwork took place in the Zackenberg valley during the summer of 2013, 2014 and 2015 in five streams of varying stability, with unstable systems representing typical current streams of the region, and stable streams representing systems predicted to become more common in the future. Water physicochemical variables were monitored using data loggers and by collecting water samples during the summer months. Water temperature was recorded continuously during the 24-month period of the study. Macroinvertebrates were collected from all sites using Surber sampler.

The results show that Chironomidae (non-biting midge) were the dominant taxa in all streams. Streams with higher channel stability supported a higher macroinvertebrate abundance and diversity compared to low stability streams. 32 Chironomidae morphological types were recorded, with one possibly being recorded for the first time in modern day Greenland. Inter-annual variation over the three years was heavily marked, with macroinvertebrate community assemblages being strongly influenced by fluctuations in the precipitation regime. For example, *Diamesa*, a genus adapted to cold environments of the family Chironomidae, abundance at one site was 13/m^2 in 2013, a year that received below average snowfall, but increased to 591/m^2 in 2014, a year of above average snowfall.

Climate change is predicted to cause an increase in alpha diversity and a decrease in beta diversity in Greenlandic streams. If increasing temperatures are to become the new norm, in the future, we can expect cold-adapted species to be at risk of extinction in the area.

THE CONTENTS OF PLASTID PIGMENTS DURING THE MOSSES DEHYDRATION

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KEYWORDS: MOSSES, DEHYDRATION, PLASTID PIGMENTS

Most of mosses can survive with low water content in tissues (up to 5-10% of dry weight) in nature during the some months and even years. This is one of the marvellous differences between bryophytes and vascular plants. In nature, the photosynthetic activity of mosses is recovered after rehydration.

The aim of our investigation - to study an influence of slow drying of mosses on content of plastid pigments under laboratory condition.

Objects of research are widely distributed moss species of forest belt of the Khibiny mountains: endohydric *Polytrichum commune* Hedw. (the absorption of water and minerals occurs on internal gametophyte tissue system), ectohydric *Hylocomium splendens* (Hedw.) Schimp.in B.S.G. and *Pleurozium schreberi* (Willd. ex Brid.) Mitt. (the absorption of substances occurs all over the surface of the gametophyte). The mosses were collected in nature. Some of them were analyzed immediately. Other moss samples were dried in laboratory and their pigments content was studied after 2, 3, 6, 18 months drying. Chlorophylls (*a* and *b*) and carotenoids contents were estimated in ethanol extracts spectrophotometrically with an UV–1800 spectrophotometer (Shimadzu, Japan) at corresponding absorption maxima. In *P. commune* and *H. splendens* we analyzed the increments of current and previous years. In *P. schreberi* all assimilating part was analyzed because borders of annual increments are not expressed.

It is shown that after 2 months drying the content of chlorophylls in all species decreased by an average of 20%. With increasing time of dehydration (up to 18 months) the content of chlorophylls decreased in *P. commune* to 50%, and in *H. splendens* and *P. schreberi* to 90-80% respectively. In a greater degree changing of the chlorophylls amount was caused by decrease of chlorophyll *a*. The reduction of carotenoids was faster than chlorophylls. In the endohydric mosses, the whole destruction of the carotenoids did not observed even in 18 months of dehydration, while the amount of yellow pigments in ectohydric mosses reduced to minimum. The water content in the moss tissues in this period amounted to 4-6% of dry weight. The photosynthetic apparatus in leaves of different ages responds to dehydration differently. In *P. commune*, the increments of previous year were most resistant to dehydration, in *H. splendens* - the increments of current year were more stable.

It was also estimated the ability of pigment complex in dehydrated mosses to restore after rehydration. After 6 months drying and subsequent rehydration during 30 minutes the amount green pigments in endohydric moss has recovered to the starting level and after 18 months - was below at 20%. The content of chlorophylls in *Pl. schreberi* was similar to starting amount only after 3 months of drying and rehydration during 30 minutes, in *H. splendens* -

recovery up to starting level was not observed. In all species the carotenoids content after rehydration did not increase up to starting level. So carotenoids are more sensitive to dehydration than chlorophylls.

LINEAR COOLING OF THREE LICHEN SPECIES WITH *TREBOUXIA* PHOTOBIONT: INTERSPECIFIC DIFFERENCES IN PHOTOSYNTHETIC RESPONSE TO LOW AND SUBZERO TEMPERATURES

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Keywords: cryoresistance, Antarctica, James Ross Island, temperature stress

Introduction

There are only few studies that have focused responses of photosynthetic processes, photochemical ones in particular, to changing temperature and the evaluation of critical point, *i.e.* temperature in which the photosynthetic processes are fully inhibited. Recently, attempts have been done to estimate S-shape temperature response curves of F_V/F_M from repeated measurements at distinct temperatures within a range -20 to 20 °C but not from simultaneous measurements of chlorophyll fluorescence parameters during a constant-rate controlled temperature fall. In our study, we hypothesized that combination of linear cooling and simultaneous measurements of chlorophyll fluorescence parameters may be used in the assessment of interspecific differences in cryoresistance of photosynthetic parameters in Antarctic autotrophs, lichens in particular.

Materials and Methods

Usnea antarctica was collected from surfaces of stones and boulders of volcanic origin in northern part James Ross Island (63°48'50'' S, 57°50'00'' W), Antarctica, at elevations ranging from 200-250 m a.s.l. Thalli of *Usnea aurantiaco-atra* were collected from a lichen-rich locality at the King George Island (62°12'20'' S, 58°57'10'' W, 50 m a.s.l.), Antarctica. *U.cylindrica* was from Petunia bukta, Svalbard.

To evaluate interspecific differences in critical temperature for photosynthesis, we exposed thalli of *Usnea antarctica*, *Usnea aurantiaco-atra*, and *Umbilicaria cylindrica* to linear cooling from +20 to -50 °C at a constant rate of 2 °C min^{-1}. Simultaneously, two chlorophyll fluorescence parameters (F_V/F_M – potential yield of photosynthetic processes in photosystem II, Φ_{PSII} - effective quantum yield of PS II) evaluating gradual decline in photosynthetic processes were measured by a modulated fluorometer (PAM-2000, Walz, Germany).

Results and Discussion

For the studied species, the response of F_V/F_M and Φ_{PSII} to declining temperature showed a S-curve shape. The decline in F_V/F_M and Φ_{PSII} at low temperature started at -5 and 5 °C, respectively in majority of cases. The decline was, however, species-specific. *U. aurantiaco-atra*, showed constant-rate decline of Φ_{PSII} from physiological temperature 20 °C. *U. antarctica* exhibited the first sign of F_V/F_M decline at -12 °C. Critical temperature related to full inhibition of photosynthetic processes in PSII (F_V/F_M) was -20 °C. *U. cylindrica,* however showed -30 °C.

F_V/F_M decreased with decreasing sample temperature forming a typical S-curves. From the curve, three phases could be distinguished: (1) *phase I* initial linear slow decrease found at the sample temperature decreasing from 20 to -10 °C, (2) *phase II* typical of a rapid decrease (typically in the temperature range of -20 to -10 °C), and (3) end part of the curve (slow decrease or constant close-to-zero values of F_V/F_M found typically below -20 °C). Within the third phase, an increase in F_V/F_M to 0.05 and 0.1 was apparent in *Usnea antarctica* and *Umbilicaria cylindrica*, respectively, at -35 °C. Apart of this, some species-specific differences were found. *U. aurantiaco-atra* did show the same rate of F_V/F_M decline within phase I and II with temperature fall, contrastingly to other two species.

Φ_{PSII} decreased with temperature decrease from 20 to -20 °C following an S-curve in *U. antarctica* and *U. cylindrica.* Therefore, a biphasic decrease form Φ_{PSII} maximum to Φ_{PSII} =0 was apparent. For *U. antarctica* and *U. cylindrica*, *phase I* and *II* were distinguished within the temperature ranges of 8 to 20 °C, and -13 to 8 °C. In *phase I*, only small change in Φ_{PSII} was apparent, while a decrease was found with cooling within the latter temperature interval. Somewhat different temperature response curve of Φ_{PSII} was obtained for *U. aurantiaco-atra.* It lacked a plateau, i.e. constant maximum values at high above-zero temperature. It exhibited rather constant-rate decline with cooling from 20 to -10 °C. This phase corresponded to *phase II* distinguished in other two species while the *phase I* was lacking.

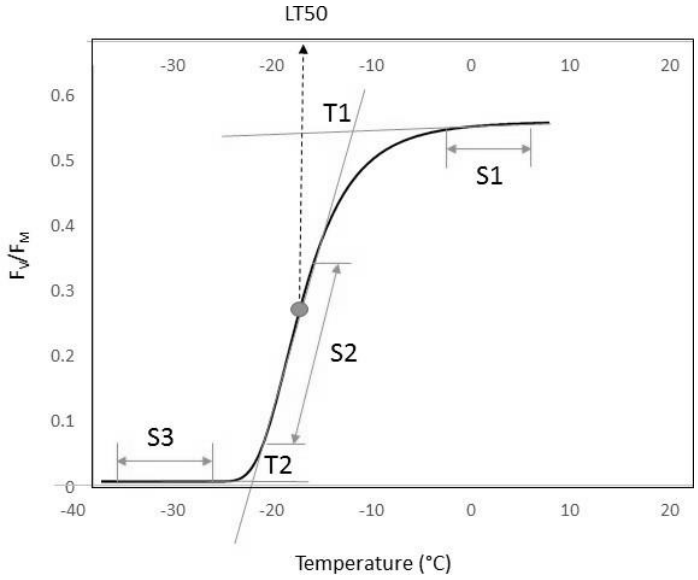

Fig. 1 S-curve showing temperature dependence of a chlorophyll fluorescence parameters with graphical indications of the following parameters: LT50 – lethal temperature at which chlorophyll fluorescence parameters reach 50% of their maxima, S1 – temperature interval from which chlorophyll fluorescence data were used to fit linear regression, S2 – temperature interval from which fluorescence data were used to fit linear regression , T1 – temperature at which temperature-dependent inhibition of F_V/F_M and Φ_{PSII} starts, T2 –critical subzero temperature at which F_V/F_M and Φ_{PSII} reach zero.

Acknowledgements
Possibility to use the infrastructure of J.G. Mendel station during the expedition to James Ross Island, Antarctica, is acknowledged as well as laboratory facilities of CzechPolar infrastructure. The research reported in this study was supported by CzechPolar Project I (LM2010009) and II (LM2015078) provided by the Czech Ministry of Education, Youth and Sports.

DEVELOPMENT OF SMALL ICE-DAMMED LAKE AND ITS SEDIMENTARY INFILL (NORDENSKIÖLDBREEN, SPITSBERGEN)

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Keywords: ice-dammed lake, Gilbert-type delta, Nordenskiöldbreen, Spitsbergen

Studied temporary lake existed in the proglacial zone of Nordenskiöldbreen in the north coast of Adolfbukta between the early 90th of the 20th century up to the year 2012. The lake itself filled depression in mica schist bedrock and was bounded by the margin of the glacier. The lake can be divided into two parts separated by basement elevation (”intrabasinal high”) - east elongated depression and circular west depression.

Proglacial stream entered into the east depression and continuously delivered sediment. Due to that fact, lake was almost completely filled by gravels, sands and occasionally also silts. Coarse grained Gilbert-type delta formed at the stream entry. Water from the east depression freely continued into the west depression, which was filled with thin blanket of fine grained deposits.
Delta in the east depression has tripartite structure of topset, foreset, bottomset. Topset is represented by braided alluvium. Foreset beds are formed by deposits of turbidity currents and debris flows. Deposits of bottomset reflect suspension deposition, deposition from low-density turbidity currents and occasional debris flows. Deltaic deposits create four morphologically terraces. Whereas the highest and also the oldest terrace is located close to margin of the east depression, the youngest and lowest terrace is situated near the centre of the east depression. Each sedimentary terrace follows morphology of the bedrock surface, which reveals several morphological steps. Evolution of the delta was directed by bedrock morphology.

Reconstruction of the lake history is possible based on sedimentary properties and results of satellite images, which delta and bedrock morphology and their areal distribution. Water level in the lake was generally stable, because the incoming water lake was drained through the gorges in the bedrock. The lake partially entered also under the glacier, which caused calving of the glacier. Especially steep - bounded concave shape of the glacier margin proclaims the lake on satellite images. Continued calving of the glacier enlarged rock depression, which was available for inundation by the lake. The lake did not grow in volume, but shifted laterally following the retreating glacier. Stepped deepening of the lake bottom towards the glacier was responsible for every decrease of the lake level (terrace) as each rock step was exposed by the retreating glacier.

The lake disappeared by the complex decrease of glacier barrier. Water drained by subglacial gorge in the bedrock to Adolfbukta. Development of the lake was driven by three main factors: morphology of bedrock, stability of glacier barrier and clastic sediment delivery.

This research was supported by the project „Polar ecology course - geosciences, EEA grants & Norway grants (NF-CZ07-ICP-1-032-2014)“, which was solved by the Department of Geography, Faculty of Science, Masaryk University.

ADAPTATION STRATEGIES OF ARCTIC AND ALPINE *ZYGNEMA* SP. (ZYGNEMATOPHYCEAE) TO DESICCATION AND UV RADIATION

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Conjugating green algae (Zygnematophyceae) are considered to be closest algal relatives to land plants (Embryophyta) and therefore their common ancestor is considered to have adaptations that enabled colonization of land. Today, several members of this group still typically grow in an aeroterrestrial environment. In Polar or high Alpine regions, some filamentous Zygnematophyceae often dominate and typically produce relatively large amounts of biomass.

These organisms have been shown to develop good resistance mechanisms against desiccation stress, particularly in modified vegetative cells (pre-akinetes). These are storage compound and lipid rich permanent stages, that develop during the arctic summer, and have the capacity to survive the arctic winter. We have investigated the fatty acid composition, which shows a significant change in FA composition upon pre-akinete formation. Oleic (C18:1) and linoleic (C18:2) acid increased most (up to 17- and 8-fold, respectively). Metabolomic investigations of field collected vegetative cells and pre-akinetes are ongoing, and show differences in osmotically active substances. The formation of zygospores by conjugation is a rare event in arctic samples, and was only observed in the closely related genus *Zygnemopsis* sp.

Tolerance to UV radiation has been shown in field collected samples from Svalbard, as well as laboratory grown samples, that show a significant increase in phenolic compounds absorbing in the UV-range. Sun simulation experiments with enhanced UV B and subsequent metabolomics analysis were performed.

This work was supported by The Czech Science Foundation (GAČR) [15-34645 L to M. P.] and by Austrian Science Fund (FWF) [I 1951-B16 to A. H.].

RESPONSE OF ACTIVE LAYER THICKNESS ON AIR TEMPERATURE COOLING ON JAMES ROSS ISLAND IN 2006–2015.

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Keywords: active layer thickness, permafrost, Antarctic Peninsula, climate cooling

Antarctic Peninsula region had been considered the most rapidly warming area of the Earth during last decades. However, the recent study showed that significant cooling of near-surface air temperature started between years 1998 and 2000 along the whole Antarctic Peninsula region and continues until present (Turner et al., 2016). Therefore, it is very probable that the air temperature decrease will be reflected in the cryosphere of the Antarctic Peninsula region. One of the components of cryosphere, which response very quickly on climate variability, are permafrost and active layer. As some recent studies showed, gradual swallowing of the active layer thickness under changed climate conditions in last years have been reported from some localities in the South Shetlands, Western Antarctic Peninsula (e.g.; de Pablo et al., 2016; Ramos et al., 2016). In this study, we analyse changes of annual active layer thickness and its relationship with air temperature on James Ross Island, Eastern Antarctic Peninsula, in the period 2006–2015.

The measurement of air and ground temperature at 75 cm deep profile started in 2006 on site near to Johann Gregor Mendel Station on James Ross Island. Based on the ground temperature data, we defined the active layer thickness as the deepest position of 0 °C isotherm for every austral-summer. Furthermore, the effect of air temperature averages for different time scales on active layer thickness was studied using regression analysis. Our results showed gradual thinning of active layer from 85 cm in 2006 to 45 cm in 2011, while relatively stable thicknesses between 50 and 60 cm was observed in 2012 to 2015 (Figure 1). Analysis of air temperature effect on active layer thickness showed that the mean annual air temperature had only low effect (R^2=0.23), while the effect of summer air temperature (R^2=0.55) and mean January air temperature (R^2=0.73) was found much significant. From this perspective, active layer thickness variability was strongly dependent on climate regime during particular summer seasons.

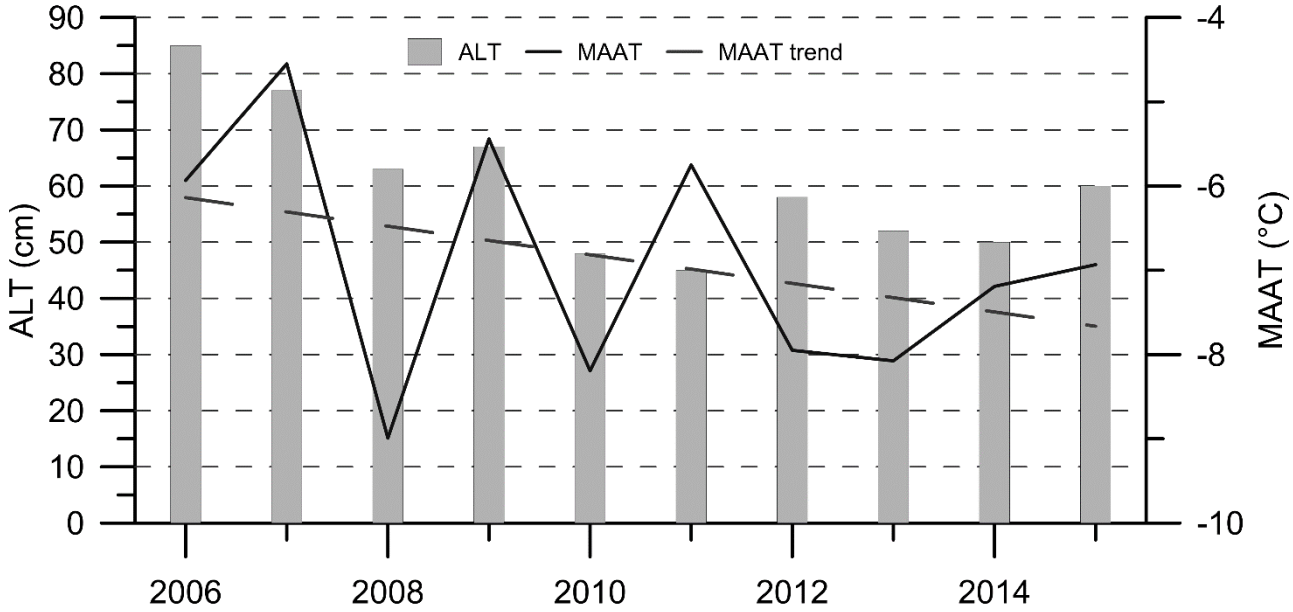

Figure 1: Variability of the active layer thickness and mean annual air temperature on Johann Gregor Mendel station in 2006–2015.

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GENETIC CHARACTERIZATION OF PARVOVIRUSES ISOLATED FROM BIOLOGICAL SAMPLES

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Parvoviruses are important carnivore pathogens. Despite effective vaccines are available to fight with Canine parvovirus 2 (CPV2) and Feline panleukopenia virus (FPV) in domestic animals, these viruses may still endanger wild living carnivores which cannot be vaccinated. As mortality caused by these viruses can reach up to 90% of infected individuals, they pose a significant thread for infested populations. Situation is even worse in small fragmented populations (for example wolves and lynxes in Czech Republic) in which appearance of such pathogens will most probably lead to their extinction. Therefore systematic surveillance is needed to detect coming epidemics as soon as possible which would allow us to make suitable measures. The goal of this work is to screen samples of Carpathian wolves (*Canis lupus*) and Eurasian lynxes (*Lynx lynx*) living in Czech Republic for CPV 2 and FPV, and even scan for CPV2/FPV in Polar foxes (*Vulpes lagopus*) living on Svalbard, which live in equally fragmented populations. Positive samples will be further genetically analyzed to elucidate their relationship to parvoviruses infecting local domestic animals. The results of this work will not only give us new information about eco-epidemiology of CPV2 and FPV in Czech Republic but they will be used for protection of our newly reintroduced population of wolves and lynxes in field. On the other hand, prevalence of CPV2/FPV in polar foxes on Svalbard can provide us with crucial information about prevalence of this virus, and therefore could be used as a protective measure. This is very important as well because of behavior of pathogens on islands in closed environment, where almost all animals can meet each other at some point and spreading can be quick and lethal for the whole population.
Keywords: Parvovirus, CPV2, FPV, *Vulpes lagopus, Canis lupus*

SEABIRDS IN THE HIGH ARCTIC: A PREDICTIVE GIS OPEN ACCESS DATA STUDY OF LARGE ARCTIC SHIPPING IMPACTS

Falk Huettmann

EWHALE lab - Inst of Arctic Biology, Biology & Wildlife Dept. University of Alaska Fairbanks

The Arctic is affected by many stressors; industrial Arctic shipping is a relatively new one where impacts are not well addressed yet. Seabirds make for an inherent component of the High Arctic but accessible and valid colony and pelagic survey data with a good research design are widely missing. Based on four internationally reviewed publications (Huettmann et al. 2011, Huettmann 2012, Humphries and Huettmann 2014, Huettmann et al. 2016) here the best-available publicly accessible Arctic data and model predictions (GIS-bassed randomForest ensembles, SPM7 Salford Systems Ltd) are presented to assess realistic impacts of Arctic shipping while the Arctic is also expected to change in dramatic terms with global change. Findings show that seabirds are in full conflict with Arctic shipping for ocean access, shelf regions, colony sites, subsidized predators, ports and hinterland infrastructure. So far, environmental impacts of Arctic shipping to the Arctic ecosystem got widely marginalized and sacrificed for a one-sided economic growth model underlying globalization, neoliberalism and latest geo-political trends. This presentation shows how Strategic Conservation Planning using Marxan optimization for protected areas can help, but not fully resolve, international ecosystem mismanagement while ocean acidification, sea level rise, algae blooms and urbanization are all ongoing in the circumpolar Arctic without relevant abatement.

OBSERVATION AND MODELLING OF LOCAL WIND CIRCULATION IN THE COMPLEX TOPOGRAPHY OF SVALBARD ARCHIPELAGO

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Keywords: Svalbard, model evaluation, low level jets, föhn

Introduction

The atmospheric boundary layer processes over Svalbard fjords are strongly influenced by complex topography and sea ice occurrence (Vihma et al., 2014). The topographic effects over Svalbard include commonly known processes such as barrier winds, foehn winds, drainage flows and mountain waves (Mäkiranta et al., 2011, Láska et al., 2016). In this study we point at foehn winds and low level jets in surrounding of Petuniabukta in central part of Spitsbergen.

Methods

Modelling of local wind circulation in case of such complex topography requires specific attention paid to model setup and simulation strategy. In this study we used the Weather Research and Forecasting (WRF) mesoscale model. Model has been run in three different configurations and compared with the 12-day summer measurements of surface wind characteristics (from 9 to 22 July 2013). Wind characteristics have been measured at three sites along the western coast of Petuniabukta. For studying wind pattern over complex topography we chose the sites differing in terrain elevation and local surface characteristics as follows: raised marine terrace (15 m a. s. l.), foreland of Hørbyebreen glacier (67 m a. s. l.) and top of Mumien Peak (773 m a. s. l.), see Fig. 1. The WRF simulations were conducted using three boundary layer parameterization schemes, the Yonsei University (YSU), the Mellor-Yamada-Janjic (MYJ) and the Quasi-Normal Scale Elimination (QNSE) schemes with 1-km horizontal resolution of the inner domain.

Results and summary

The WRF simulations agreed fairly well with the surface wind observations at all the sites. For the wind speed, the mean correlation coefficients between the modelled and observed data ranged from 0.56 to 0.67. The best results across all stations were found for the QNSE parameterization scheme. The wind speed simulations were sensitive to geographical location and elevation of the stations. Three low level jets and two foehn situations with their typical changes of vertical profiles of air temperature and wind (Fig. 2) have been successfully simulated by the model.

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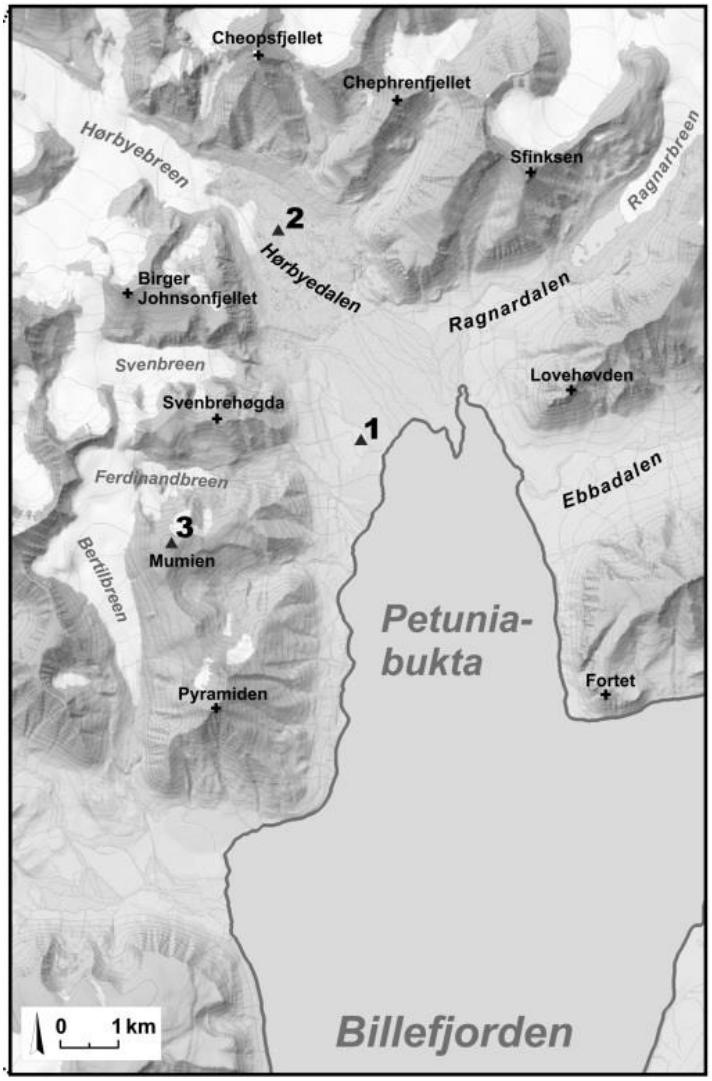

Figure 1. The inset map of the northern part of Billefjorden and Petuniabukta area with the location of automatic weather stations (black triangles): 1 – Terrace, 2 – foreland of Hørbyebreen glacier, 3 – top of Mumien Peak. Map: Svalbardkartet data, Norwegian Polar Institute

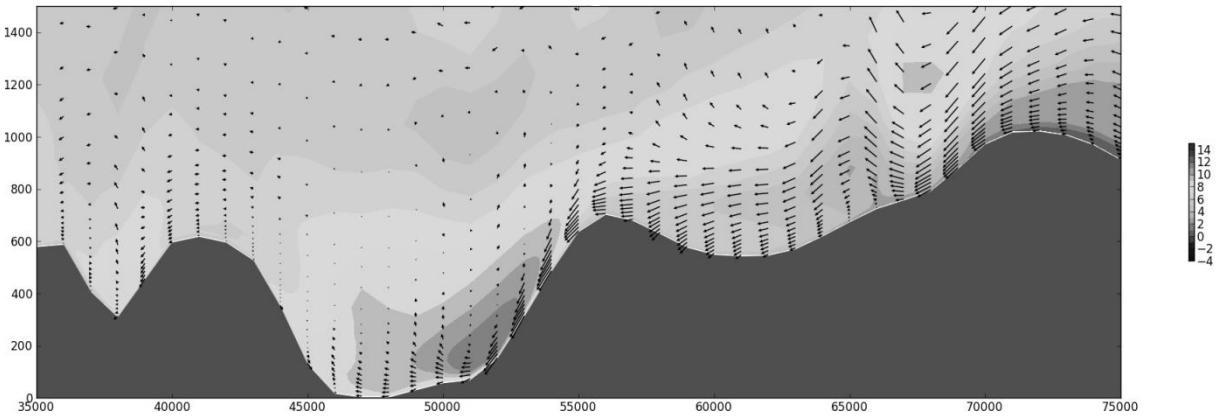

Figure 2. Example of model vertical wind profile (parametrization QNSE) with foehn wind. East-west section on July 20, 2013 at 13 UTC. Y axis represents altitude in meters, scale-temperature in Celsius and arrows represent wind speed and direction.

GENETIC POPULATION STRUCTURE OF BLACK ROCKCOD (*NOTOTHENIA CORIICEPS*) ALONG THE WESTERN ANTARCTIC PENINSULA AND OFF ADÉLIE LAND

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Keywords: connectivity, population genomics, Southern Ocean, icefish

Natural populations are structured in time and space. Genetic differentiation is determined by the interplay between genetic drift, local adaptation, and potential barriers to gene flow. In marine populations high amounts of connectivity, for example through long pelagic larval phases and dispersal promoted by oceanic currents, are often masking or eroding genetic structuring. Yet, with advances in molecular techniques more and more examples show that marine fish populations are not as homogenous as previously thought. Within the endemic notothenioid fishes of the Southern Ocean, the black rockcod (*Notothenia coriiceps*) is a widely studied organism and the first species of which a draft of a full genome has been sequenced (Shin et al 2014). To facilitate further genomic studies, such as on the evolution of the anti-freeze glycoprotein, solid knowledge on background levels of genomic variation is needed. Here, we present for the first time insights into the genetic population structure of black rockcod.

Specimens were sampled during various expeditions and land-based sampling campaigns at five localities in the Western Antarctic Peninsula (WAP) region, including Elephant and South Orkney Islands, and off Adélie Land (East Antarctica). DNA was extracted and combined in a double-digestion restriction-site associated DNA (ddRAD) sequencing library. Results were analysed using the dDocent pipeline (Puritz et al 2014) with and without reference genome to call genetic variants. Subsequently, population genetic analyses were conducted to assess spatial genetic structure.

After extensive quality filtering 3422 and 2783 single nucleotide polymorphisms (SNPs) could be called from *de novo* assembly and reference genome alignment, respectively. Based on these genetic differentiation, particularly between samples from East Antarctic and WAP, could be detected using fixation index matrices, ordination methods such as DAPC, and Bayesian clustering analyses.

The detected genetic differentiation despite of long pelagic larval phase indicates potential local adaptation. The observed pattern furthermore appears to follow large circulation patterns within the Southern Ocean, such as the Antarctic Circumpolar Current. It remains unclear, how exactly these shape the genomic diversity of Antarctic fish on a finer scale. Further studies including better sampling coverage are needed to resolve this. Nevertheless, the findings have important implications for management and conservation.

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SPECIAL FEATURES OF THE REGIONAL CLIMATE OF THE SVALBARD AND ITS RELATIONSHIP WITH THE ICE CONDITIONS IN THE SURROUNDING WATERS

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Keywords: *Svalbard, climate change, ice conditions, air temperature*

The analysis of the relationship between the ice conditions in the waters surrounding the archipelago of Svalbard (Fram Strait and "Whale Bay", areas of the Barents, Greenland and Norwegian Seas) and the special features of its regional climate was carried out. For this purpose the following open data sources of sea ice and meteorological information were used:

- 7-days regional ice charts in SIGRID format from the AARI World Data Center archive (Greenland, Barents Seas for the period 1933-2015, http://wdc.aari.ru, on 0.25°x0.25° grid);
- Daily ASI algorithm total concentration patterns (based on the SSM/I-SSMIS data,12.5x12.5 km grid, 1991-2015, IFREMER, ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/psi-concentration /);
- Daily NASATEAM algorithm total concentration patterns (based on SSMR-SSM/I-SSMIS data, 25x25 km grid, 1978–2015, NSIDC, ftp://sidads.colorado.edu/DATASETS/nsidc0051_gsfc_nasateam_seaice/final-gsfc/);
- Monthly mean surface air temperature at 6stations for the period 1978-2015 (Ny-Alesund, Isfjord Radio, Barentsburg, Longyearbyen, Pyramiden, Polish Polar Station), derived from www.Eklima.no, www.met.no, www.aari.ru, www.rp5.ru, www.meteo.ru archives.

As a first step assessment of sea ice conditions is variability in the form of spatially-distributed basic and robust statistics (quantiles, frequency and distribution functions) was carried out. Next, division of the waters surrounding the Svalbard archipelago into 6 quasi-homogeneous regions for subsequent calculations of ice extent was performed based on expert analysis of the gained statistics. As a final step statistical analysis of the produced data series and cross-correlation analysis of the ice extent and surface air temperature were accomplished. That included linear trends of the ice extent and surface air temperature for different seasons and areas (weather stations). Gained estimates characterize the long-term variability of some basic parameters of the Svalbard climate system.

NARYAN-MAR FRESH GROUNDWATER DEPOSITS (BOLSCHEZEMELSKY ARTESIAN BASIN, EUROPEAN ARCTIC, RUSSIA)

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Arkhangelsk scientific centre Ural branch of the russian academy of sciences[1],
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Géosciences Environnement Toulouse, Université de Toulouse, CNRS-IRD-OMP[3], Tomsk State University[4].

Keywords: Arctic, groundwater, chemical composition

Introduction

Intensive petroleum sector development in the northern European area of Russia involves an excessive anthropogenic impact on the environment, including the water zones. Groundwater within Nenets Autonomous Area is used not only for domestic water supply but also in the technological hydrocarbon production, which, in its turn, changes the natural element cycle itself. As a consequence, this has become a major issue in geoecology and environmental protection. Naryan-Mar fresh groundwater deposits are located within Bolschezemelsky taiga as a peninsula surrounded by Kazennoe Lake streams westward, Gorodetskiy Shar streams northward, Karmanovskaya Kurja Bay north-eastward and Tomarkin Bay southward.

Methods and materials

Geologically, the described area within studied cross-section (to the depth of 100 m) embraces Cretaceous, Neogene and Quaternary systems (Glavatskikh et al, 1990). Exposed Lower Cretaceous sediments at the depths of 25 to 54 m revealed thicknesses of inhomogeneous clay, aleurolite, aleurite (very fine sand), sand and sandstone interbeddings. Lower Cretaceous sediment thickness ranges from 115 to 263 m areally surrounding Naryan-Mar. Neogene-Middle Quaternary sediments include alluvial gravel-cobble sediments, exposed at the depth of 25-33 m in northwestern part of studied area, revealing thickness of 5 to 25 m. Quaternary sediments are well represented throughout the described area. These sediments embrace loam and clays, rarely, sand loam with interbedded sand and fine-grained sand. Alluvial sediments are well represented in the valleys of Pechora, Kuindzhi and Tomark Rivers, including sands, loam, silt and sand loam. Swamp sediments are locally well represented as brown, dark-brown poorly-decomposed and/or hemic peat.

Naryan-Mar fresh groundwater deposits are located in the northwestern part of the Pechora artesian basin. The permafrost has a significant impact on its hydrogeological conditions. Permafrost rocks hinder groundwater recharge and is a confining stratum (aquifuge).

Aquifer systems of Quaternary sediments, nonsegmented Neogene- Middle Quaternary sediments and Lower Cretaceous sediments were identified within the studied area.

Available fresh groundwater for Naryan-Mar is supplied from recent mature alluvial aquifer confined to through flood plain-channel talik of Pechora River. This aquifer includes homogeneous thickness of bedded fine-grained sands and rare and insignificant thicknesses

of sand lens and gravel sediments. Confining stratum includes Vychegodsky horizon clay and loam. The groundwater chemical composition is hydrocarbonate calcium-sodium, including high iron concentration (0.4 – 2.2 ppm). Water salinity level - 90 – 170 ppm. Aquifer recharge source involves precipitation and surface water. Groundwater discharge of described aquifer originates in braided Pechora River and Lake.

Aquifer of no segmented Neogene- Middle Quaternary alluvial sediments are correlated with Lower Cretaceous aquifer, overlying this aquifer. Fresh hydrocarbonate - sodium water has salinity of up to 370 ppm. Catchment area forms as a result of water overflow from Lower Cretaceous aquifer.

Lower Cretaceous aquifer sediments are well represented. Fresh water level is found at the depth of 40 m – 50 m, lower-saline water showing salinity of 2800 to 15800 ppm. Water chemical composition is chloride-sodium. Aquifer recharge is obstructed (Hydrogeology USSR, 1970).

This paper examines field survey data, as well as references and publications. The chemical analyses were conducted in the Institute of Ecological Problems of the North and Laboratory of Georesources and Environment of Toulouse (French National Center for Scientific Research / *Centre national de la recherche scientifique*, CNRS).

Results

Based on obtained and published chemical analysis results, Naryan-Mar fresh groundwater deposits reveal high iron concentration, turbidity, coloration and oxidability conditioned by the non-conformance of natural groundwater quality to standards (Sanitary requirements and sanitary rules and regulations 2.1.4.1074-01). Increased iron concentration in groundwater aggravate water - supply well performance, due to the fact that as a result of Fe^{2+}- oxygen reaction, hydroxide is formed, negatively affecting the filter operation.

Bacteriological analysis of drinking water in Naryan-Mar water intake was conducted in sanitary-epidemiological station since 1999. According to microbiological seasonal sample analysis departure from Sanitary requirements and sanitary rules and regulations was not identified.

Acknowledgement

The work is financially supported by grant № 15-17-10009 of Russian Science Foundation and by grant of President of Russian Federation MK-4984.2016.5.

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MONITORING OF THE STATE OF THE EARTH'S OZONE LAYER AND SOLAR UV-RADIATION IN ANTARCTICA – THE CONTRIBUTION OF THE CZECH REPUBLIC TO THE VIENNA CONVENTION AND THE MONTREAL PROTOCOL

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Keywords: Ozone Hole - Ozone Layer - Total Ozone - Antarctica - Vienna Convection - Montreal Protocol.

The Antarctic ozone hole had continued to observe each spring, despite a moderate decreasing of the Ozone Depleting Substances (ODS) in the atmosphere since the mid-80's (Assessment 2014). The continued observation of the Antarctic Ozone Hole is expected because ODS declined only moderately over the last decade (WMO 2011).
In February of 2010 the Brewer ozone spectrophotometer – MKIII, No. 199 (B199) was installed at the the Marambio Base (Argentina) in Antarctica.
This activity is the project of the Ministry of the Environment of the Czech Republic and the State Environmental Fund of the Czech Republic "Monitoring of the State of the Earth's Ozone Layer and Solar UV-radiation in Antarctica - the Contribution of the Czech Republic to the Vienna Convection and the Montreal Protocol". Cooperation with Argentina is the result of close cooperation in matters relating to the Antarctic between the Government of the Czech Republic and the Government of the Argentina in 2010.
The B199 has been independently calibrated by travelling standard the Brewer No. 17 - International Ozone Service, Toronto Canada (IOS) in 2012 and 2016. The B199 is regularly checked and maintained each year during austral summer.
The measurements of total ozone is analyzed and compared with the satellite data (AURA-OMI). The possible detection of the ozone recovery is also presented .

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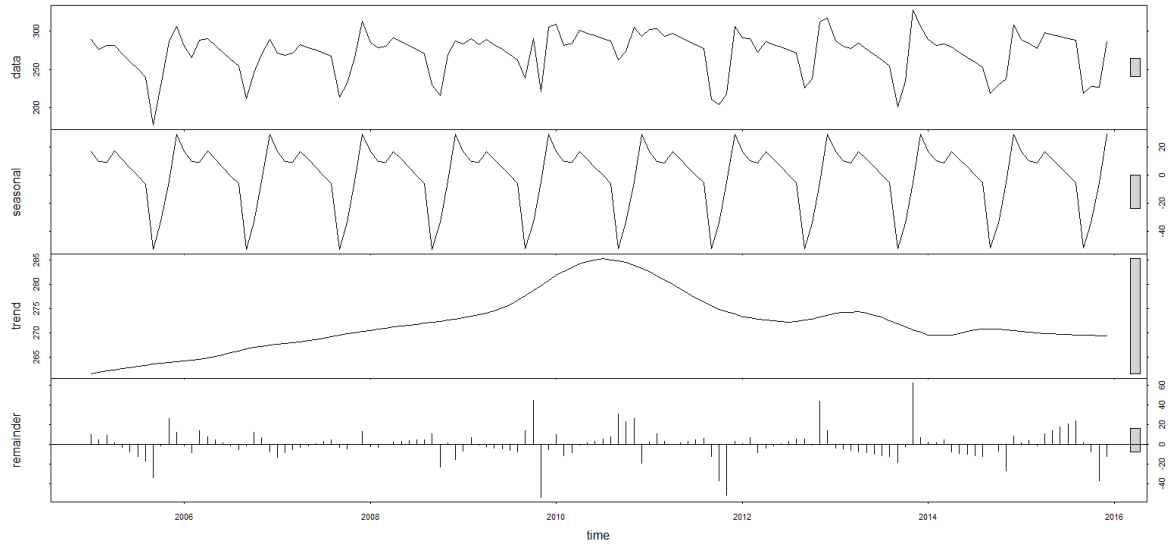

Fig.1: Total Ozone over Antarctic Penninsula (satellite AURA-OMI), 2005-2015.

THE EFFECT OF TOPOGRAPHY AND VEGETATION COVER ON SURFACE TEMPERATURES IN SVALBARD

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keywords: surface temperature, thermal refugia, topography, vegetation cover

Complex landscape topography represents resilient system in condition of climate change. In this respect, we sought to answer role of topography on climate in polar ecosystem. Climate extremes are critical for ecosystem processes in polar areas influencing in particular the biota survival. The aim of our study was to assess the influence of topography on surface temperatures (ST) and the relation between ST and percentage of vegetation cover. We hypothesize the topography will influence the ST distribution due to variability of incoming solar radiation. We suppose the increasing of percentage vegetation with higher ST. ST is a function of weather condition, topography, water supply, soil properties and vegetation cover. Finding consequences among surface temperature, vegetation- cover can be useful for delineating areas as a potential refugia for plant vegetation. 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. These two localities are approximately 20 km distant from each other. ST were obtained from the Landsat satellite imagery taken in 22th June 2002. ST are reflecting on landscapes level wider context of climate condition in comparison to microclimate including fundamental topoclimatic phenomenon that is created by landscape relief. We found that Landsat ST are related to the topography, when the highest values occurred on the southern and SE slopes, which reflects the highest incoming sun radiation those slopes at the time of Landsat data acquisition of this area (9:10 am). Our next research question was to assess the influence of ST on percentage of vegetation cover. We suppose the highest vegetation densities will relate to highest ST. For that issue we calculated the Normalized Differential Vegetation Index (NDVI) From Landsat data. The NDVI reflects biomass density and percentage of vegetation cover. To parametrize the NDVI values we estimated percentage of vegetation cover on 58 field plots using visual interpretation in 2012. Because of good relation between the field estimation of vegetation cover and NDVI (Fig. 1A) we assessed the influence of ST on the vegetation cover. The Fig. 1B shoved unimodal NDVI distribution that the highest NDVI values for 20 – 25 °C Landsat ST. We consider the decrease of NDVI after 25°C is due to dry slopes, which not suitable for plant vegetation. These results are preliminary and more research is needed.

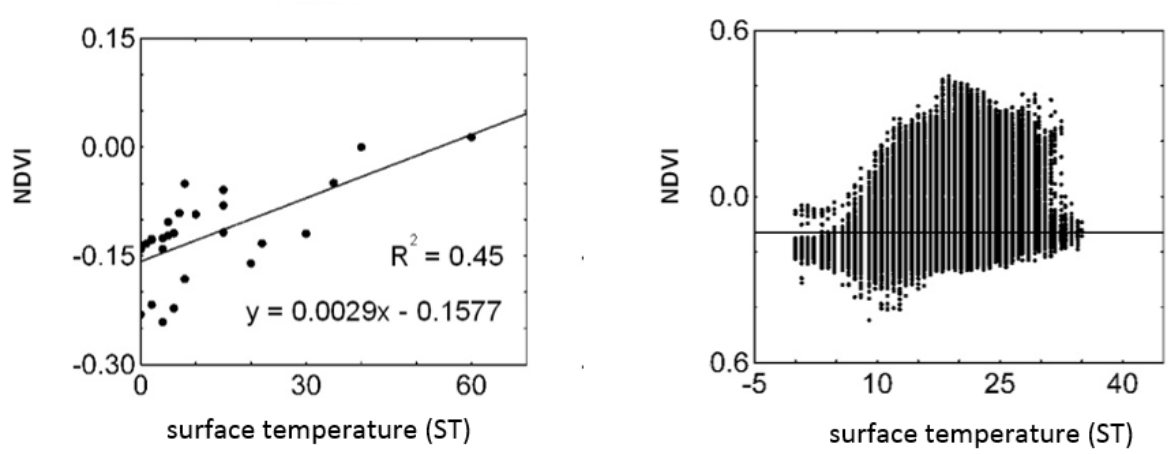

Fig. 1. A) Regression between percentage of vegetation cover and NDVI and B) the change of NDVI with surface temperature (ST).

VEGETATION MAPPING USING UNMANNED AERIAL SYSTEMS (UAS) ON KING GEORGE ISLAND, MARITIME ANTARCTIC

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Keywords: Antarctic, King George Island, vegetation mapping, Unmaned Aerial Systems

The vegetation cover in maritime Antarctic is scattered and often dominated by mosses and lichens. In the few places where continuous vegetation occurs, the plant communities change from meter to meter. For a sensible mapping of such scattered or patchy vegetation ultra-high resolution is needed. The aim of this study is to map the vegetation in Arctowski area on western part of the Admiaralty Bay area on King George Island in maritime Antarctic, a total area of about 1.5 square kilometer.

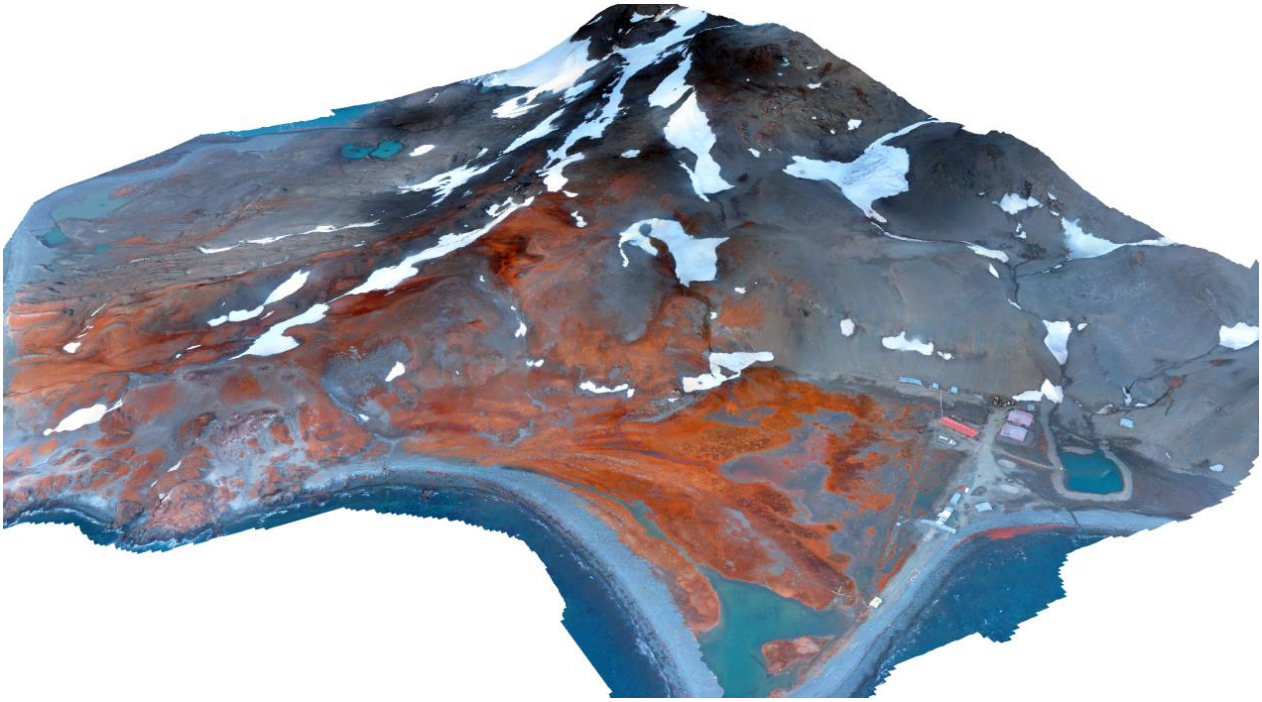

Figure 1. NDVI Image of the Arctowski area on western part of the Admiaralty Bay, King George Island, Antarctic. The image is from 3 February 2016 and has 7 cm pixel resolution.

We use the Cryowing Scout drone, a twin engine fully electric Unmanned Aerial Systems (UAS) with a wingspan of 2.5 m and maximum flying time of 90 minutes. The UAS is hand launched

and well suited to be operated in the field with no need of a runway. The UAS was equipped with two sensors, a NDVI camera and a hyperspectral camera (Rikola), where the NDVI camera providing pixel resolution of 7 cm, and the Rikola camera pixel resolution of 30cm. First we used the hyperspectral Rikola camera on a stand in field and measured the spectral properties for the dominated bryophytes, lichens and vascular plants in 196 bands in the range 500 to 900nm. Based on these measurements we selected the 15 most suitable bands for discriminating the main vegetation formations in the area, and used them in the hyperspectral -based mapping. However, the geo-coding of the hyperspectral data was not good enough in parts of the study area and for these parts only the NDVI data could be used. The preliminary results of the hyperspectral/NDVI based mapping indicate that three variants of Antarctic hair grass (*Deschampsia antarctica*) dominated vegetation types can be mapped, four forms of moss-dominated vegetation, where two of them are dominated by *Sanonia uncinata*, and one lichen (*Usnea antarctica*) plant community.

The vegetation mapping is a part of the MONICA project, funded by EEA grants –the Polish-Norwegian Research program.

REMOTE SENSING BASED MAPPING OF THE SEASONAL DYNAMICS (PHENOLOGY) ON SVALBARD

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Keywords: Svalbard, remote sesning, phenology

Svalbard is characterized by a short and intense growing season, where even small changes in the timing of the growing season highly influences the plant production and the population dynamics of most animals, birds, and insects. Changes in the growing season are also important for the feedback loop to the climate.

The main aim of this study is to map the growing season at three different scales, where each scale is closely connected and complementary in a way that observations on a finer scale provides the base for interpreting the scale above. On a field scale we use near surface hourly time lapse RGB phenology cameras ('phenocams') for the years 2013-2016. These cameras are placed in a range of different vegetation types, and from these RGB images we calculate different indices. From the indices we then automatically calculate phenophases as onset, peak and end of the growing season, on both species and plant community levels. On a local to a regional scale, we use time series of Landsat 8 satellite images with 30m pixel resolution for the years 2014 and 2015. Due to the location close to the North Pole and the polar orbit of Landsat 8, data are obtained several times a week. Our datasets for the 2014 and 2015 seasons (15 May to 15 September) are composed of 85 and 74 images, respectively. For the entire archipelago Svalbard, for the 2000 – 2015 period, we use MODIS satellite data, the 8 days composites products MOD09A1 and MOD09Q1, with 250m and 500m pixel resolution, respectively.

Due to scattered vegetation cover, ice and snow, short season, and very frequent cloud cover, cloud detection on Svalbard is a challenging task. For both the Landsat 8 and the MODIS satellite data the first step is to remove the cloud cover, where we use a combination of three cloud removing methods (quality information provided with the data, own algorithms, and manual removal). This combination of methods worked well, but is time consuming as it requires manual interpretation of cloud cover. Then we interpolate the cloudy parts and smooth the time series data. The onset of the growing season is mapped with a NDVI threshold method, which shows high correlation with photos from the phenocams. For mapping the end of the growing season a combination of different methods have to be used, depending on the land cover type. However, this work is still not completed.

The results demonstrate a multiscale mapping of the seasonal dynamics from species level, to vegetation types, and to ecosystems. The MODIS-based results show large variations in the onset of growing season from year-to-year during the 2000 to 2015 period, however, without any significant trends in the mapping period. Due to the high availability of Landsat 8 data from Svalbard, the study area creates a unique opportunity for a high spatial and temporal resolution mapping of the seasonal dynamics, and is a good preparation for planned Sentinel-

2 based mapping with 10m pixel resolution and daily data. The work is in part funded by the ESA Prodex project ‘Sentinel-2 for high north vegetation phenology’, and MOSJ (Environmental Monitoring of Svalbard and Jan Mayen), which is an environmental monitoring system and part of the Government’s environmental monitoring in Norway

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ON THE ORIGIN AND EVOLUTION OF RAGNAR LAKE – EXAMPLE OF RECENT DEGLACIATION

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Keywords: deglaciation, Svalbard, proglacial lake, glacier retreat

During last several decades an important increase of temperature has occurred in Svalbard and especially in the central part of the archipelago (Malecki, 2016). This atmospheric trend is followed by increased retreat dynamics of most Svalbard glaciers. Ragnar glacier is not an exception. This valley glacier originates from large ice caps – Lomonosovfonna – as is therefore fed by large amount of ice mass. This however doesn't stop the glacier from retreat. It has receded some 1,5 km within last few decades (Rachlewicz et al. 2007) leaving vast area to be flooded by meltwater and so the Ragnar lake has been formed.

The evolution of lake has been studied on the basis of aerial photos taken since 1960ies. This reveal that the origin of lake has to be looked for in the early 80ies. Apart its areal extent measured from aerial photos, the dynamics of lake bottom has been in the centre of our focus as well. Three bathymetric campaigns has been carried out – first detailed in 2011, a basic one in 2014 and finally a detailed one in 2016. After a basic bathymetry mapping in 2014, significant differences in lake bottom has been recognised. More than 4 meters differences in water depth has been recorded in some distinct areas of the lake. The most dynamic part is located in southeast part of the lake where upwelling water from a subglacial channel was the main factor shaping lake bottom relief. This upwelling current from the subglacial environments has however stopped between 2013 and 2014.

Apart studying areal extent and bottom relief of a lake, basic physicochemical parameters were measured as well. Automatic water temperature readings were carried out at the outlet of the lake. As a meltwater fed lake with continuous throughflow (average summer discharge around 0.5 m^3/s), the temperatures are rather low reaching 6°C at maximum and being frozen some 8-9 months a year.

Acknowledgement:
The study was supported by Czech Polar (LM2010009) and NF-CZ07-ICP-4-292-2015.

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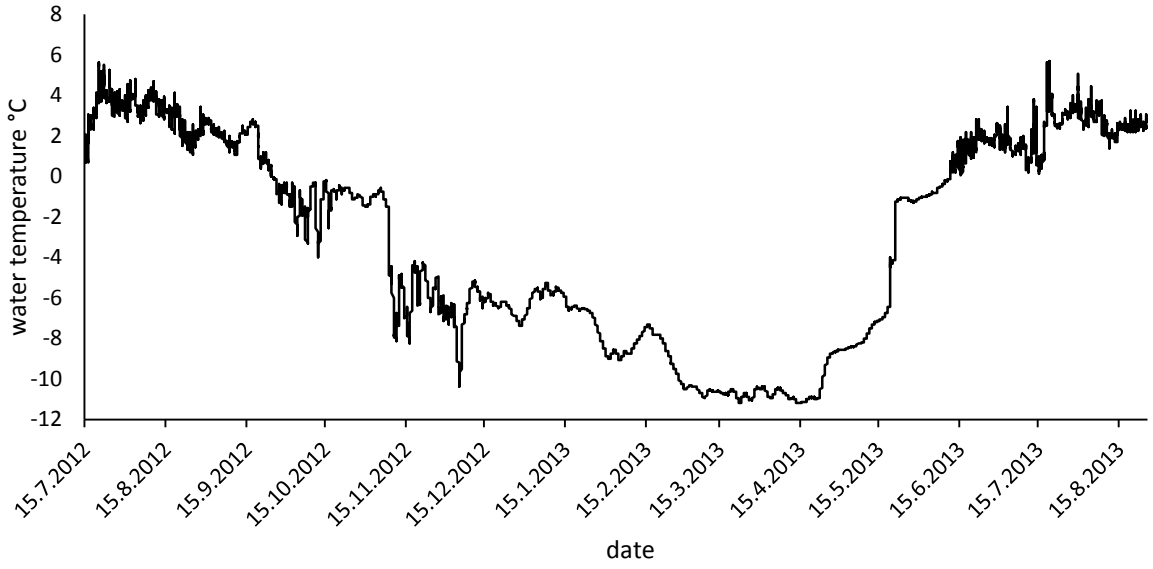

Figure 1 – water temperature record on the lake outlet from 15.7.2012 to 15.8.2013

LOCAL FLORA APPROACH IN STUDY AND MONITORING OF VASCULAR PLANTS DIVERSITY: EXAMPLES FROM THE ARCTIC YAKUTIA

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Keywords: local flora, vascular plant diversity, Russian Arctic, monitoring, habitats

Local flora approach allows estimate plant species diversity at the landscape level. 250 local floras studied by the scientists from Komarov Botanical Institute during the last 50 years, have been included into the database which allows spatial comparisons of various floristic characteristics along longitudinal and latitudinal gradient within the Russian Arctic (Khitun et al. 2013). The area of local flora is ca. 100 km^2.

Field research was performed in 2013-2014 at four sites along the Indigirka River low reaches: 1) around Chokurdakh settlement, 70° 39'N, 147° 52' E; 2) at Kytalyk research station, 70°49´N, 147°48´E, 28 km NW from Chokurdakh settlement; 3) around the Burulgin cape, 70° 47' N**,** 148° 45' E, on the right bank of the Indigirka River, 45-50 km to the north of Chokurdakh; 4) around Polyarnui settlement, 71° 07' N, 149° 05'E, in the Indigirka River delta.

Areas around Chokurdakh and Cape Burulgin have the most diverse topography as the spurs of, respectively, the Allaikh Uppland and the Kondakovskoe Highland, reach these sites. Landscape around Polyarnui is lowland, with numerous watercourses but gently sloping flat-top hills also occupy big areas. Area around Kytalyk is extremely monotonous lowland, where floodplain, drained thaw lake basin with numerous thermokarst lakes and solitary pingos, and two remnants of the Pleistocene age terrace are practically the only landforms.

The highest species richness was recorded at the Burulgin cape (242 species) and in surroundings of Chokurdakh (228 species), the lowest species richness was at Kytalyk (133). Although Polyarnui was located in more northern subzone – subzone D, transition to subzone C (CAVM, team 2003) its richness was higher (157 species). Even at the level of habitats, species richness at Kytalyk was lower.

Several rare species, including those which are listed in the Red Data Book of Yakutia(they are marked with asterix) were found at one or two sites: *Triglochin maritimum, Pleuropogon sabinii, Trisetokoeleria cf. yurtzevii, Carex supina* ssp. *spaniocarpa*, Lyziella oligantha*, Minuartia obtusiloba*, Sagina nodosa, Batrachium eradicatum, Arabidopsis bursifolia, Arabis umbrosa, Parnassia kotzebuei*, Vicia macrantha*, Androsace ochotensis*, Pedicularis pennellii*.*

Areas around Chokurdakh and Polyarnui were investigated for the first time approximately 40 years prior to our study (Boch and Tzaryova, 1974). After our inventory the checklists of each of those localities increased with 50 species. Probably local floras were not described completely then. We compared proportion of various latitudinal phytogeographic groups (Arctic, Hypoarctic and Boreal) at each of the sites in old and new checklists. We think that this ratio should be approximately the same if no principal change in flora composition took place. In Chokurdakh, proportion of Hypoarctic and Boreal groups increased with 6%, proportion of Arctic group respectively decreased. In Polyarnui, the proportion of Arctic species increased with 3%, proportion of Hypoarctic species decreased and proportion of Boreal species did not change. Notable, many new species at Chokurdakh are anthropochores and spread along the roads or were found only within the settlement. Therefore our results confirm the regularity found in other regions that forest-tundra ecotone is most sensitive to changes.

Acknowledgements
The work was supported by grant of RFBR 13-04-01682a and is a part of research conducted by Komarov Botanical Institute within the topic “Spatial and Temporal Changes in the Russian Far North Plant Cover”.

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TO STUDY OF LICHENS OF THE DUVEFJORDEN (NORDAUSTLANDET, SVALBARD)

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Keywords: lichens, Svalbard, Duvefjorden, rare species

Duvefjorden is situated in northern part of Nordaustlandet, the northernmost and hard to reach island in the Svalbard archipelago. We were collected lichens in Duvefjorden area, (Lusegrasvika Bay) in 2012. About 900 lichen specimens were collected in all type of communities. Morphological and anatomical characters were analyzed by applying standard light microscopical methods and chemical tests. Voucher specimens are deposited in the herbarium KPABG.

41 lichen species with widespread distributions in the Arctic was found in the Duvefjorden area to the literature data (Øvstedal et al., 2009) without exact locality. To data we are treated 129 lichen species from the Lusegrasvika bay. 88 lichen species recorded for the first time from the Duvefjorden. The most part of literature data was confirmed by us.

Rare species on the Svalbard archipelago were found: *Buellia pulverulenta* (Anzi) Jatta, *Lecidoma demissum* (Rutstr.) G. Schneid. & Hertel, *Polyblastia gothica* Th. Fr., *Protothelenella sphinctrinoidella* (Nyl.) H. Mayrh. & Poelt, *Rhizocarpon cinereovirens* (Müll. Arg.) Vain. and others.

The author would like to thank the staff of the Polar-Alpine Botanical Garden and Institute and the head of the Laboratory of Flora and Vegetation Dr. Nadezda Konstantinova for great support in field researches.

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FIVE YEARS WITH THE SAMPLEDTB, THE SAMPLE DATABASE OF THE CENTRE FOR POLAR ECOLOGY

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Introduction

Databases are becoming to play important role in research as the large amounts of ecology data are collected and analyzed, especially when access to published data starts to be required by the funding agencies and leading journals (Khalsa et Yarmey 2014). Such ecology-related databases can be divided into (i) relation databases that are designed according to project specific requirements, and (ii) data warehouses where anyone may contribute (Kvíderová 2014).

In the Centre for Phycology (CPE), we are using relation database SAMPLEDTB for records of collected phycological samples (Kvíderová 2014, Kvíderová et al. 2015). The SAMPLEDTB represents important source of data for statistical and ecological analyses as well as data back-up. It provides data for the final student seminar and for annual reports on Polar ecology course (available at polar.prf.jcu.cz). Since the database is available in the field, the data are recorded immediately, and the stored GPS coordinates are used to determine the exact site position for re-sampling.

Here, we present the data on samples collected in frame of the Polar ecology course organized by the CPE in the time period 2011 – 2015

Material and methods

The structure of the SAMPLEDTB and data management were described in detail in Kvíderová (2014). At present (June 2016), the SAMPLEDTB includes data on 362 samples of which 234 were collected in the frame of Polar ecology course in Petuniabukta area, Svalbard.

The unimodal multivatiate analyses were performed using Canoco 5 software (Ter Braak and Šmilauer 2012). For purpose of multivariate analyses, 187 samples were used and the habitats were grouped into environments according to Kvíderová et al. (2015) (Fig. 1). Only presence/absence of a given taxon was evaluatedThe Monte Carlo permutation test was used to test the statistical significance, and the results were considered significant for $P < 0.05$.

Results

Total of 222 taxa (at level of genus or species) were identified at 107 different sites. The proportions of habitats and communities sampled are shown in Figs. 1 and 2, indication unequal sampling in different types of habitats. The most abundant classes were cyanobacteria and diatoms (Fig. 3).

All environmental variables (environment type, community type and year of sample collection) explained 13% of total explained variability (pseudo-F = 1.3, P = 0.024). The environment type, the community type and the year of collection contributed to the total explained variability by % (pseudo-F = 1.9, P = 0.002), by 3.2 % (pseudo-F = 1.5, P = 0.002) and by 9.4 % (pseudo-F = 1.3, P = 0.058), respectively.

The CCA separated the samples from cryo-environments and lotic environments. The samples from lacustrine, hydro-terrestrial and terrestrial overlapped (Fig. 4).

Discussion

The SAMPLEDTB showed that that the habitats and communities are sampled unequally, reflecting thus (i) research focus on particular habitat and community types, (ii) the abundance of individual types of habitats and communities in Petuniabukta area, and (iii) difference in access to individual habitat types and communities caused by logistics issues and/or date of sampling. The observed dominance of cyanobacteria and diatoms reflects the dominancy of these groups in the non-marine ecosystems of the polar regions (Skulberg 1996) as well as research focus of the phycological groups.

The environmental variables (environment type, community type and year of sample collection) explained only minor part of the variability, so other environmental parameters should be measured in the field systematically (e.g. temperature or pH). The overlap among the lacustrine, hydro-terrestrial and terrestrial environment may be caused either environment overlap in the field, e.g. there is a continuous transient from lake littoral to wetland/wet thufur tundra in Brucebyen, by lack of microenvironmental data, or by simplification of data for the analysis. For example, diatom *Meridion circulare* was found in streams as well as in seepages. Probably the CCA analysis using at least the semi-quantitative abundance scale could separate even these environments.

Acknowledgement:

The research was supported by project LM2015078 - CzechPolar2 - Czech Polar Research Infrastructure (MŠMT), and a long-term research development project no. RVO 67985939 (IB). We would like to thank all people who helped during sampling, microscopical analyses and taxa identifications.

- Employees and students of the CPE (in alphabetical order): Josef Elster, Tomáš Jehlička, Jiří Komárek, Jana Kvíderová, Otakar Strunecký, Katya Pushkareva, Daria Tashyreva, Lukáš Veselý, Jakub Žárský;
- Groups ALGO2011, ALGO2012, ALGO2013, ALGO2014 and ALGO2015 (see reports on Polar Ecology course at polar.prf.jcu.cz for group members lists).

Keywords: database, ecology, taxonomical diversity, CCA

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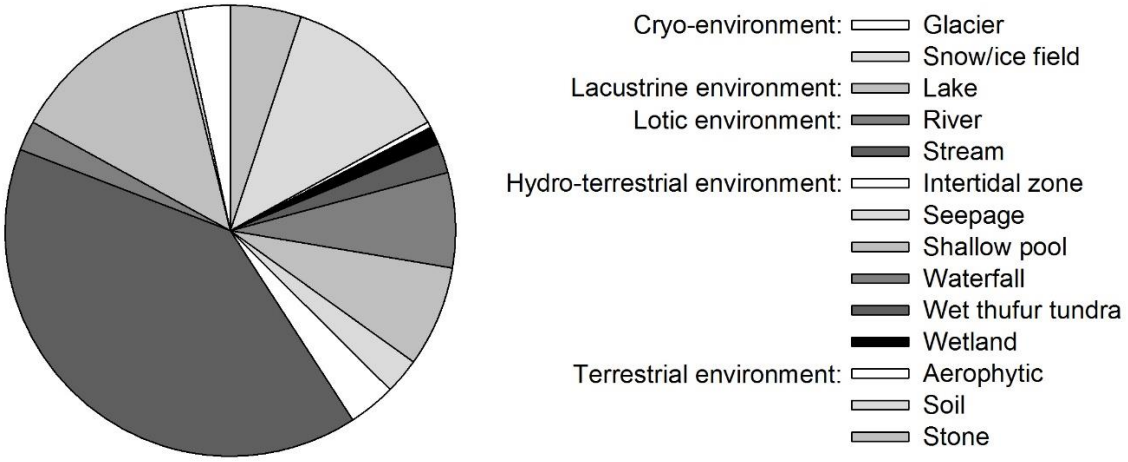

Fig. 1. The proportions of habitats sampled. Start from the top, counterclockwise direction.

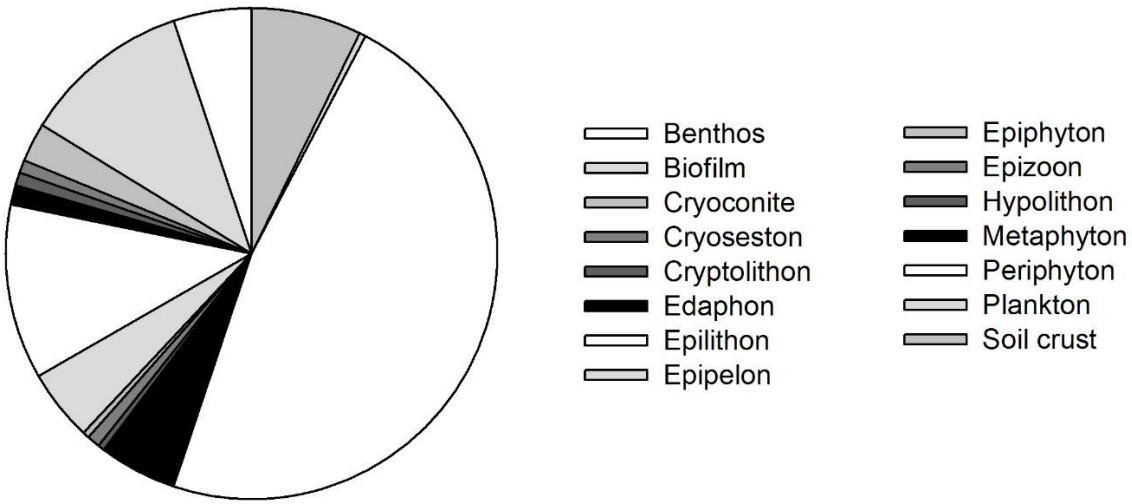

Fig. 2. The proportions of communities sampled. Start from the top, counterclockwise direction.

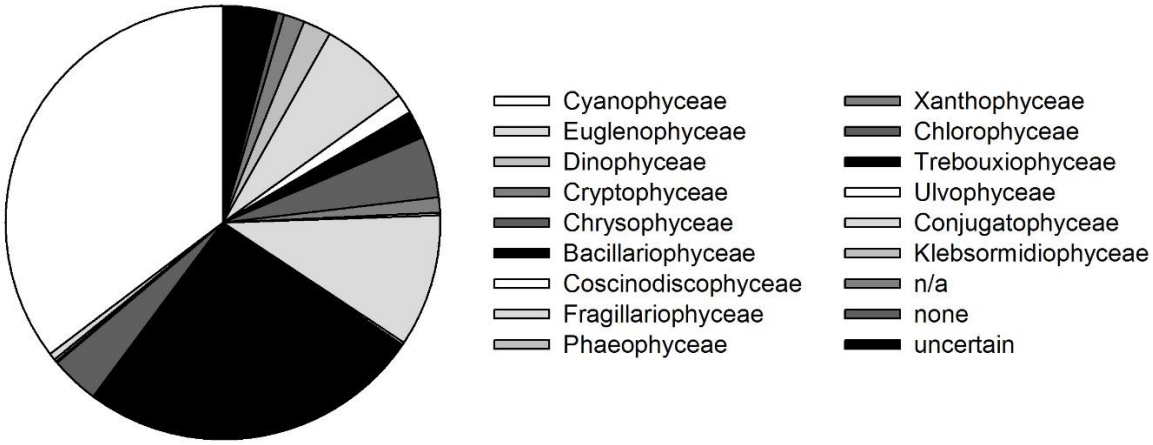

Fig. 3. The proportions of phototroph taxonomical classes observed. n/a – non-phototrophs, none – no microor-ganisms observed, uncertain – incertain determination. Start from the top, counterclockwise direction.

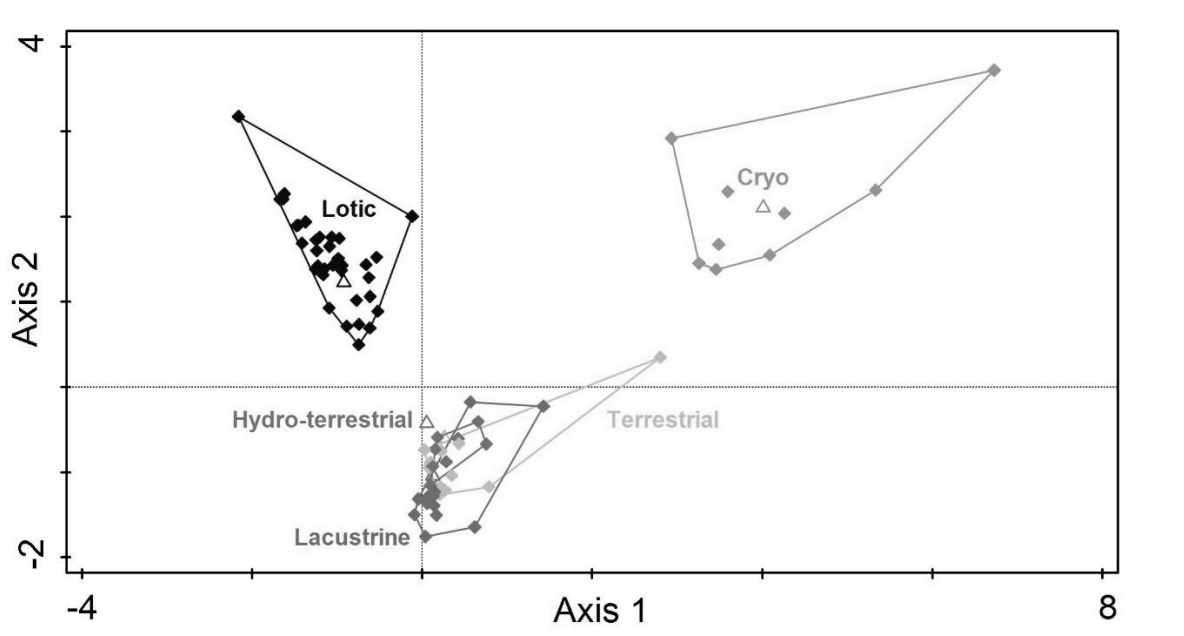

Fig. 4. The CCA diagram of samples and environment. The Axis 1 explains 1.05 % of the explanied variability and Axis 2 does 0.94 %.

PRELIMINARY RESULTS OF THE PHYCOLOGICAL RESEARCH OF THE ANDAKILL PROTECTED HABITAT AREA, WESTERN ICELAND

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Keywords: Ramsar, Andakill Protected Habitat Area, Iceland, phycological research

Introduction

Iceland currently has 6 sites designated as Wetlands of International Importance. One of the youngest Ramsars of Iceland, Andakill Protected Habitat Area (3,086 hectares, 64°33'41"N 021°46'09"W), a Nature Reserve and Habitat Protected Area, is a complex wetland located at the estuary of the fjord Borgarfjörður, with two rivers, Hvítá and Andakilsá, and the lake Vatnshamravatn, as well as alluvial floodplains, marshes, and managed hayfields. Till now, botanical and ornitological research has been done.

Methods and materials

Together with ecologists from Faculty of Environmental Sciences**,** Agricultural University of Iceland, Hvanneyri, has been earmarked 7 areas for a phycological research. Sampling of plankton and periphyton was done from various microhabitates in early spring (May 2016).

Studied areas:

Area No.I situated near the fjord, with extensive freshwater bogs between rows of rocky outcrops, with small rivulet and erosive slop (horse pasture).

Area No.II situated in alluvial floodplain near fjord, a net of meadows divided with former drainage ditches (ditches, wet gras, flat water bodies with abundant birds).

Area No.III near the campus is important as a restorated landscape with several lakes of various sizes and several small water eyes in sedges.

Area No IV in cultivated landscape between campus and Anadakill river: extensive wetlands and marshes primarily used for livestock grazing, with ditches and river branches.

Area V, the Vatnshamravatn lake with a research station: the main lake, a nearby small flat lake and sedge marshes.

Area VI (outside of Ramsar Site): two subareas: a meadow with sditches and holes of local peat mining origin and a wet meadow with small lakes of meander origin, with a part unsuccessfully managed hayfields in the past (several ditches remaining). Biodiversity of this area is enriched by several tiny springs near the rock base.

Area VII is situated at the estuary of Andakiill river into fjord, with marshes of different character (from saline to freshwater ones), tiny springs on the base of rocks, river banks and small inlets.

Preliminary results

The most interesting data come from marshes in Area VI: nostocolean cyanobacteria, oligotrophic diatoms, green algae (e.g. Oonephris sp.), desmids in pools, chrysophytes and coccal cyanobacteria in peat holes. Also restorated area just near the Hvanneyri campus (Area III) is interesting in a variety of habitats from natural pools near rock bases (e.g. with a strong dominance of Palmodictyon sp.) to renewed lakes with planktic chrysophytes, desmids and interesting green algae in littoral (e.g. Bulbochaete, Binuclearia). Surprisingly, ditches in

extensive agricultural land (e.g. AreaIV, VI) are settled with microflora resembling springs near the rock base. Saline habitats are situated near the fjord (Area II) and near the estuary in Area VII, but this part is highly diversified in habitats from freshwater (near rocks) to pools with high a conductivity. Vatnshamravatn lake and surrounding flat lakes were interesting as environment with oligotrophic species in littoral but planktic green algae and cyanobacteria predicting problems caused by eutrophication (incl. water blooms of cyanobacteria).

Conclusion: next activities and collaboration

Detailed study of samples is ongoing on several lines: chrysophytes (Synurophyceae) are studied in Charles University, Prague, coccal green algae in phycological laboratory in Dep. of Botany, Fac. of Science, South Bohemian Univ., diatoms will be used for comparative studies with polar regions in cooperation with diatomologists from Masaryk University, Brno., etc.

This pilot research was done during early spring period. Some interesting points were appointed from the results of phycological research. There is a task for the local ecologists to take samples for monitoring and send them for consultation. The cooperation has been started and keep on going!

Acknowledgement:

Author is gratefull to EEA and Norway Grants (EHP-CZ07-INP-3-198-2015) and to the staff of Hvanneyri campus, mainly Hlynur Oskarsson and Thorunn Reykdall.

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ARCTIC SHRUBS – THE ENVIRONMENTAL STORYTELLERS

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Keywords: *Juniperus communis*, cell parameters, environmental reconstructions, Greenland Ice Sheet melt rates, Atlantic meridional overturning circulation

Historically unprecedented environmental change in the Arctic ecosystems is often given into the context of its past and possible future development. In the region where instrumental observations are scarce archives need to be investigated in order to address this issues. We present the comprehensive synthesis one of the archives – long-live circumpolar evergreen *Juniperus communis* shrub. 20 individuals from southwest Greenland were investigated at the cell anatomy level to understand the ecology of the species and unhide its potential for environmental and climate reconstructions. Our findings are as follows:

i) Stop of exponential cross-sectional conduit-lumen widening with increasing age is in contrast with conduit-lumen nature of trees. This indicates that shrubs do not need to saturate their water and nutrient demands via traits of classical hydraulic conductivity law but rather developed different mechanisms. Extreme weather conditions result in prostrate growth form. However, different weather factors probably influence shrub growth differently: While snow and wind act mechanically (a), temperature influences the form of growth physiologically (b). a) So long as the young shrub stem has high resilience to bend back to an upright position after snow melt and so long as it can withstand the wind during the vegetation season it most likely grows upright and the conduit-lumens widen. b) Temperature, resp. freeze-thaw events are responsible for the shrub's preference of safety (finite size of conduit-lumens) over hydraulic efficiency, thus not allowing for more primary growth. All of these (and other) factors are apparently working together and the transition of vertical to more horizontal growth is gradual. As a consequence, the conduit-lumen sizes may not have to be further increased (due to ecophysiological restrictions possibly also must not) because water is no longer transported against gravity.

ii) Observed age/growth trend has to be taken into consideration for further employment of the wood anatomical parameter in reconstruction-based studies. That is, shrub cell parameters can only be used for this purposes if correctly detrended. This allows for more accurate as well as longer reconstructions because youth trend is often neglected in reconstructions based on shrub annual-rings.

iii) We present the reconstruction of Greenland Ice Sheet (GrIS) melt rates of the south-western part of GrIS for the whole 20th century. This part of GrIS is considered as the most active. According to our reconstruction current GrIS melt rates are not uncommon for the last century being comparable to first decades of 20th century. This finding is particularly important contribution to the debate on

Atlantic meridional overturning circulation (AMOC). Too high fresh water inputs into the Northern Atlantic from GrIS melting may slow down or even stop the AMOC which would result in more continental climate in Europe. Our results indicate that this threshold lies higher than observed current melt rates of GrIS.

Fascinating species of *J. comunnis* has shown to be able to address many ecological as well as environmental open questions and due to its longevity and abundant distribution has a great potential to become an important player in the Arctic.

THE IMPACTS OF SHEEP GRAZING ON BRYOPHYTE COMMUNITIES IN ICELAND

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Depending on grazing intensity and growing conditions, disturbances caused by large herbivores have strong effects on vascular plant communities. However, it is not well known how sheep grazing activity affects bryophyte communities in tundra ecosystems. The aim of this study was to assess the impacts of sheep grazing activity on the structure and composition of bryophyte communities in Iceland. Bryophyte communities were compared in three grazed and three ungrazed valleys, in two regions in Northwest and North Iceland. Sampling was stratified to allow for an investigation of different growing conditions with respect to exposure, elevation, and landform. Bryophyte layer depth, species diversity and abundance were measured, and species were grouped by growth form and life-history.

This study found that growing conditions shape bryophyte communities in Iceland, and within certain conditions sheep grazing activity has a detectable impact. There were more pronounced effects on the bryophyte communities in the west than the east-facing slopes, and in low than high elevation. The bryophyte layer was significantly deeper in ungrazed than grazed valleys, which indicates that sheep grazing may have impacts on ecosystem function. Species diversity did not differ greatly but was somewhat higher in grazed valleys within slopes that had a west-facing exposure. Pleurocarpous mosses, the most abundant growth form, were more abundant in grazed than ungrazed valleys, suggesting this growth form tolerates herbivore disturbances relatively well. Competitive and stress tolerate species were more abundant in grazed valleys, suggesting they cope with disturbances caused by sheep grazing activity. While the main drivers in shaping bryophyte communities are the growing conditions, sheep grazing activity also has some impacts to these communities in Iceland.

RECENT CLIMATE ANOMALIES AT THE WESTERN COAST OF THE ANTARCTIC PENINSULA: LARGE-SCALE BACKGROUND AND ENVIRONMENTAL ISSUES

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Keywords: climate warming, climate anomalies, sea surface temperature, krill

Introduction

Recent climate in the Antarctic Peninsula (AP) region has been characterized by significant variability, including growth in near-surface air temperatures (SAT) during the last decades of the 20th century and following period of relative cooling. Local ecosystems are found to be very vulnerable to the changes in the environment including climate change, sea-ice transport, snow cover, anthropogenic influence etc. Anomalous phenomena in both weather settings and local live environment have been frequented in the coastal ice zone west of the AP during recent austral summer seasons.

Methods and materials

We aimed to examine the state of local live environment as well as large-scale atmospheric circulation background during recent summer seasons with meteorological anomalies, most of all sea ice, sea surface temperature (SST) in the region of Ukrainian Antarctic base Academic Vernadsky formerly known as Faraday, UK, (64°15' S, 67°14' W). We used climatological and operative data from Vernadsky base as well as other stations in the area and results of field mesurements from ships. Seasons with climate anomalies were chosen and juxtaposed to the state in regional environment

Results

The most significant warming is observed at Vernadsky and Bellinsghausen (King-George Island), with annual rates exceeding 2°C over 1971-2000. the recent warming in AP region is closely corresponds in time to warming in different remote regions, including Alaska, AP's northern geographical counterpart, Central Siberia, most of Europe. On the other hand regional warming in the AP region contrasts to weak cooling in continental Antarctica (Martazinova et al., 2010). Data after the turn of millennia showed no further increase in annual SAT the data of Vernadsky and other regional stations, as well as no growth in annual precipitation at Vernadsky. Latest years confirmed tendency to cooling on most regional stations.

Colder and warmer sea surface temperature (SST) anomalies were followed each by other; the warmer one in 2001 has become unprecedented by the data of Ukrainian base Vernadsky. Related meteorological regime, atmospheric circulation, sea ice conditions, state of the sea surface layer including biomass, first of all krill was studied. Each SST anomaly was followed by anomalies in the number of krill, with its abundance during colder summer seasons and lacking krill during warmer summers. The role of sea-ice and its variability during transition period to austral summer is shown.

Large-scale atmospheric circulation patterns responsible for the above-mentioned anomalies as well as ENSO-related responses are studied.

Discussion

Recent climate change is thought to be responsible for significant changes in regional terrestrial and marine ecosystems taking into account their high degree of vulnerability to any sharp changes in climatic and **meteorological settings** in high latitudes (Turner et al., 2009). Important changes within food chain due to climate change were detected in Antarctic waters, e.g. changes in penguin population followed by shortage in krill and predominance of salps; these changes are attributed to important changes in atmospheric transports right after turn of millennia.

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A COMPARATIVE STUDY ON THE SEXUAL REPRODUCTION OF *RACOMITRIUM LANUGINOSUM* ON TWO DISTINCT HABITATS

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keywords: bryophyte, sexual reproduction, phenology, snow cover

Bryophytes show a number of phenological patterns that reflect their adaptation to a wide variety of environments (e.g., Stark 2002). A regulating effect of environmental factors on bryophyte reproduction has been established for several species (Benson-Evans 1964).

The length of the growth period is thought to be one of the regulating factor restricted by some environments such as temperature and water availability. In this study, we focused on the effect of the length of the growth period regulated by snow cover.

We compared the seasonality of development of gametangia and sporophytes of *Racomitrium lanuginosum* in two distinct habitats, seasonally snow-covered site (*ca.* 2200 m alt. on Mt. Fuji) and snow free site (*ca.* 645 m alt. on Mt. Mihara) to clarify the effect of the length of growth period. The number of inflorescences and the number, size and developmental stages of male and female gametangia and sporophytes were recorded.

The reproductive characteristics of *R. lanuginosum* in the two study sites are summarized as follows:

(i) Archegonia and sporophytes develop faster in snow-covered site than in snow free site.
(ii) Antheridia take longer time to develop in snow-covered site in snow free site.
(iii) The timing of fertilization is the same in each sites.
(iv) The dispersal of sperms initiate earlier than the maturation of ova and continue over the long term in snow free site.
(v) The dispersal of spore initiates in winter and continues until spring in snow free site.

On Mt. Fuji, although the development of antheridia and sporophytes stopped under the snow cover for 4.5-months, maturation of both gametangia and spore dispersal occurred in June, the most well-known fertilization and spore dispersal season for bryophytes. On the other hand, peculiar phenology patterns that the release of sperms started from long before the maturation of ova and the spores dispersal started from winter, were observed on Mt. Mihara. *R. lanuginosum* is thought to be a well adaptive species for seasonally snow covered site.

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SEA ICE EFFECT ON LOCAL CLIMATE ALONG A TOPOGRAPHIC GRADIENT. A 12- YEAR RECORD FROM KAPP LINNÉ, WESTERN SPITSBERGEN

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Keywords: sea ice, local climate, lapse rate, Svalbard

The occurence of sea ice determines the amount of heat exchange between sea and land. Understanding sea ice-air temperature feedbacks is thus crucial for the study of all temperature related processes in high arctic environments, especially in view of climate change and projected global sea ice decline. Changing sea ice occurence may impact both ecosystems and landscape dynamics significantly.

Previous studies related to sea ice and climate have mainly focussed both on global scale dynamics and on long-term effects of sea ice decline in quaternary studies and future models. Anectodal evidence of sea ice effect on local climate has been provided for central Spitsbergen (Christiansen et al. 2013). Benestad et al. (2001) found a significant connection between coastal microclimate and sea ice extend. However, no data-based study of sea ice effect on local climate along a topographic gradient has been conducted to the author's knowledge to date.

In view of recently published high resolution records of sea ice cover in Isfjorden (Muckenhuber et al. 2016), this study aims to assess the response of local climate patterns to the occurence of sea ice with a focus on lapse rate from near coastal to montane areas.

Air temperatures were recorded at 6 locations at Kapp Linné, Western Spitsbergen from 2004 to 2016, covering a range of different topographic settings, including immediate proximity to the coastal shoreline, several sites in the Linnédalen valley bottom as well as higher elevated ridges flanking the adjacent Linnébreen glacier. Other relevant meteorological parameters (wind direction, wind speed, humidity, radiation etc.) and parallel monitoring of lake ice extend, snow cover and ground temperatures may further prove valuable data input to understand and correlate environmental processes at the study area.

Diurnal and interannual temperature variability between sites was studied subsequently, particularly focussing on lapse rate in years with and without sea ice. This study aims to provide maps of interpolated mean DJF and JJA air temperatures from the study period, closely following the regional approach by Tveito et al. 2000, and further depict deviations from mean values during years of extensive sea ice occurence.

First results show a significant interannual variability of air temperatures, especially throughout winter months. Preliminary assessment of years with extensive sea ice cover shows buffered lapse rates between sites. The impact of sea ice needs yet to be studied carefully however, as microclimate in maritime arctic valleys proves to be highly complex.

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UNRAVELING THE COMPOSITION AND DISTRIBUTION OF SOIL ORGANIC MATTER IN PERMAFROST SOILS OF ALASKA AND SIBERIA

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A large number of studies predict changing organic matter (OM) dynamics in arctic soils due to global warming. In contrast to rather slowly altering bulk soil properties, single soil organic matter (SOM) fractions can provide a more detailed picture of the dynamics of differently preserved SOM pools in climate sensitive arctic regions. Although there is a large number of studies using physical soil fractionation for temperate soils to unravel the fate of soil organic matter and its stabilization within soil aggregates, there is only scarce information for permafrost affected soils. As especially the separation by means of density is used to differentiate between free particulate organic matter and such occluded in soil aggregates, it is questionable if aggregation is important at all in permafrost soils? Also only scarce information is available on the importance of the association of organic carbon (OC) with mineral surfaces for the sequestration of OC in arctic soils. Thus a mechanism known to play an important role for long term carbon sequestration in temperate soils is not well understood in arctic soils.

To study the importance of soil aggregation and organo-mineral associations in permafrost soils, we studied soils derived from the Alaskan and Siberian high arctic. Air dried soil samples from soil horizons of the active and permanent layer were subjected to density fractionation in order to differentiate particulate OM and mineral associated OM. By the study of the chemical composition of distinctive SOM fractions using nuclear magnetic resonance spectroscopy (NMR) together with radiocarbon analyses and/or biomarker analyses it was possible to evaluate the stability of the major OM pools. Additional to bulk analyses we used microscopic techniques to evaluate soil aggregation and organo-mineral associations in-situ. Namely we analysed selected samples using a cascade of reflectance light microscopy, scanning electron microscopy (SEM) and nano-scale secondary ion mass spectrometry (NanoSIMS).

The study of microscale soil structures (SEM) and the elemental distributions (NanoSIMS) showed the initial formation of aggregates and organo-mineral interfaces in the studied permafrost soils. For the studied soils we can show that large amounts are stored mostly as probably labile particulate SOM rich in carbohydrates. To a lower extent OC was sequestered as presumably more stable mineral associated OC dominated by aliphatic compounds.

Comparable to soils of temperate regions, we found small POM (< 20 µm) occluded in aggregated soil structures which differed in the chemical composition from larger organic particles. This was clearly shown by increased amounts of aliphatic C in these small POM fractions. As revealed by 13C-CPMAS NMR, with advancing soil age increasing aliphaticity was also detected in occluded small POM fractions. By 14C dating we could show the stabilization of younger more labile OM at greater depth in buried O horizons.
Although climatic stabilization due to reduced microbial decay at low temperatures is the most important factor in permafrost soils at the moment, in a warmer future this may change to other mechanisms, likely OC stabilization in aggregated soil structures and organo-mineral associations.

DETECTION OF ABOVIRUSES FROM THOUSANDS OF MOSQUITOES FROM SVALBARD AND GREENLAND

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Keywords: arboviruses, polar areas, mosquitoes

Arboviruses are a large polyphyletic group of viruses being transmitted from arthropods vectors to vertebrates hosts. They are important human and animal pathogens. The most famous representatives from arboviruses are Tick-borne encephalitis virus (TBEV), Dengue virus (DV), Zika virus (Zika) or Rift Valley fever (RVF) etc. They are studied in tropical and temperate zones abundantly but their occurence is still omitted in polar regions despite climate changes and migration of vectors to the higher latitudes. Moreover, it is very important to know the worlwilde occurence of arboviruses because they might be pathogenic to humans. Arboviruses were detected in many countries such as *Alaska, Norway, Canada and in North America, but never in Svalbard nor in Greenland.*

Our research was focused on monitoring of arboviruses in north Atlantic areas. We examined thousands of mosquitoes species *Aedes nigripes*, *Aedes impiger* from Greenland which were collected in 2015, and *Aedes nigripes* from Svalbard, collected during the years 2014 -2015. We tested these samples for the presence of different arboviral families; *Bunyaviridae* (genus Orthobunyavirus), *Reoviridae* (genus Orbivirus), *Flaviviridae* (genus Flavivirus) and *Togaviridae* (genus Alphavirus). For testing of these samples RT-PCR reactions were perfomed and vizualised using gel electroforesis subsequently. Positive samples were isolated directly from the gels and sequenced. Interestingly, we figured out some positive samples which likely contained a viral sequence, but all of our results will be discussed on the international conferences.

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CARBON DYNAMICS OF MOSS TUNDRA IN THE HIGH ARCTIC, SVALBARD

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Keywords: Carbon acccumulation, CO_2, CH_4, DOC, peat

Moss tundra that accumulates a thick peat layer is one of the most important ecosystems in the High Arctic, Svalbard. In order to know the current carbon dynamics of moss tundra, we estimated carbon accumulation rates, CO_2 and CH_4 fluxes, and dissolved organic carbon (DOC) flow at moss tundra in northwestern Svalbard.

Study site and methods

The study site is in the northern part of the Brøgger Peninsula (Stuphallet; 78°57'N, 11°39-40'E). The area was covered with a thick peat layer dominated by various moss species.

Apparent rates of carbon accumulation was estimated based on the ^{14}C age and amount of of peat in the active layer. Detailed description of the method appeared in Nakatsubo et al. (2015).

We set up 4 plots along a 80-m line in early July of 2013, and measured the fluxes of CO_2 and CH_4 using static chamber method from 8 July to 8 September. To estimate the whole growing season GEP (gross ecosystem production) and ER (ecosystem respiration), the hourly GEP was calculated using the light-response curve with photosynthetic photon flux density (PPFD), and the hourly ER was roughly calculated by moving average between two observed ER for data gap filling.

Dissolved organic carbon (DOC) and hydrophobic DOC amount in the stream water through the peat was measured by a batch method using DAX-8 resin adsorption, in order to estimate the carbon amount which flows to a sea from the peat in a moss tundra area. The carbon mass flow was estimated based on the data of water samples that were taken from the stream and on the data monitored by a water flow meter in the stream.

Results and discussion

The calibrated age of peat from the bottom of the active layer (20-30 cm) ranged from 81 to 701 cal yr BP. Based on the total carbon (4.5-9.2 kg C m^{-2},), we estimated the apparent rate of carbon accumulation in the active layer as 9.0-19.2 g C m^{-1} yr^{-1} (Nakatsubo et al. 2015).

CH_4 emission from the studied moss tundra was small, ranging from 0.08 to 2.9 mg CH_4-C m^{-2} day^{-1}. Total CH_4 emission from the moss tundra was estimated as 89 ± 70 mg CH_4-C m^{-2} for the growing season. Maximum GEP and ER differed significantly among the plots and correlated positively with moss surface temperature. We estimated the total GEP as 138 g CO_2-C m^{-2}, the total ER as 84 g CO_2-C m^{-2}, which yielded an estimated total NEP of 53 g CO_2-C m^{-2} for the growing season (6 July to 16 September).

The amount of C flowed out as DOC from the area were estimated as 15 g C m^{-2} for the summer period, which is comparable to the apparent rate of carbon accumulation. It was also indicated that the hydrophobic DOC so called refractory organic carbon, occupied the more than half of the flow-out C. These results indicate that carbon flow through stream water plays an important role in the carbon dynamics of moss tundra in the High Arctic.

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ZOOPLANKTON OF THERMOKARST LAKES OF WESTERN SIBERIA.

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Keywords: zooplankton, thermokarst lakes, Western Siberia, DOC

Thermokarst lakes of Western Siberia play an important role in producing and emission of dioxide carbon and methane, but still poorly studied. There are few information about flora and fauna of that water bodies. To study biodiversity and quantitative characteristics of zooplankton, 12 thermokarst lakes located in the central part of Western Siberia (63.5°N, 75.4°E, Noyabrsk region) were investigated. All of the investigated lakes are small and shallow, with surface areas and maximum depths of less then 0,4 km^2 and 1,5 m, respectively. The main particularities of the thermokarst lakes of Western Siberia are as follows (Manasypov et al., 2014): (i) high concentration of dissolved organic carbon (DOC), (ii) acidic environments due to peat/moss leachate products and (iii) full freezing of these shallow water bodies during winter. Zooplankton samples were collected in July-August 2015 by filtration of 50 L of lake's water through planktonic Apstein's net (64 μm mesh) and fixed with formaldehyde 4%. Identification of the samples has been done in the laboratory using standard methods and keys (Borutsky et al., 1991, Manujlova, 1964, Rylov, 1930, 1948). 27 species of Cladocera, 5 species of calaniod copepods, 7 species of Cyclopoida and 19 species of Rotifera were found in all lakes (58 species in total). Despite the amount of founded species, the majority were scarce and very small abundant. In all lakes were 1 or 2 dominant species with total abundance of more then 70–80%. Species diversity ranged from 8 to 16 species per investigated site. Abundance of zooplankton ranged from 1060 to 100740 ind./m^3, biomass – from 0,7 to 7,8 g/m^3. In most of the lakes cladocerans dominated in abundance, but calanoid copepods dominated in biomass. Among cladocerans, the most common species were *Bosmina longirostris* and *Chydorus sphaericus* and were found in all lakes. *B. longirostris* dominanted in abundance in half of the lakes. In nine lakes was registered only one dominant (>20% of total abundance). There were five dominant species: *B. longirostris, C. sphaericus, Polyphemus pediculus, Cyclops vicinus* (was registered in one lake) and *Heterocope saliens*. Shannon's index calculated on abundance and biomass ranged from 0,4 to 2,4 and from 0,1 to 1,5, respectively. Comparison of species diversities of the lakes using Serensen's coefficient showed little similarity in the most lakes and ranged from 0,13 to 0,66. We also correlated total abundance of zooplankton with DOC concentrations (Spearman's rank correlation), the results are significant and relationship is strong ($r=0,7$, $p<0,05$). It means that zooplankton can become an important source of DOC in investigated water bodies.

Acknowledgments. The research has been supported by the grant issued in accordance with Resolution of the Government of the Russian Federation No. 220 dated 9 April 2010, under Agreement No. 14.B25.31.0001 with Ministry of Education and Science of the Russian Federation dated 24 June 2013 (BIO-GEO-CLIM), by grants of President of Russian Federation №№ МК-5336.2016.4, МК-3684.2015.5.

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LARGE-SCALE VARIATIONS IN ARCTIC FRESHWATER MICROCRUSTACEANS

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Keywords: Cladocera, Copepoda, Arctic, climate, distribution

Introduction

Understanding the mechanisms controlling spatial patterns in species richness and community structure is among the major goals of modern ecology, essential to conserve biodiversity and ecosystem functions in the face of climate change and increased human disturbance. The impacts of climate change are expected to be the most severe in high-latitude regions as the result of accelerated warming in the Arctic over the next century. Moreover, because of the strong climatic and environmental gradients, high latitude regions represent convenient areas to explore the environmental drivers of biodiversity. Microcrustaceans are the important component of freshwater ecosystems, which local diversity is known to be driven by many factors. In the present study, we used a comprehensive database on freshwater microcrustaceans (cladocerans and copepods) from various Arctic regions, both insular and continental, to detect factors that may be responsible for large-scale variations in species richness and composition.

Materials and Methods

Geographically, the 27 considered regions cover wide range of latitudes (46°-85° N) representing several climatic zones from boreal forests to polar deserts. They also engirdle the circumpolar areas longitudinally, with both the Eurasian and American continents equally represented. The data were compiled both from published literature and original data collected in Iceland, Wrangel Island, Bering Island and Svalbard. For each region, we calculated the number of cladoceran species, the number of copepod species, and the total number of both Cladocera and Copepoda. To select the best-fitting subset of predictors, multiple stepwise (forward-type) regression analysis was performed at a 5% probability level to enter and remove variables from the model.

Results and Discussion

The total species list included 380 species. The number of recorded species varied widely among regions, with Franz Josef Land the poorest and Norway the richest (7 and 184 species, respectively). In general, the total richness decreased northwards, following the common latitudinal trend. Stepwise regression analysis with eight predicting variables revealed that the resultant "best fit" models included from one to three predictors each. The temperature of the warmest month was the only factor indispensably entered in every model. Temperature alone could explain 80-86% of the species richness variations for cladocerans and 48-66% for copepods. The steep drop in richness occurred if the summer temperature fell below 10-15 °C, whereas the warmer temperatures had no noticeable effect. The effect of low temperatures was much stronger on cladocerans than on copepods. The regression models predicted that a one-degree drop in temperature led, all other things being equal, to a 53% decrease in cladoceran richness (to 48% - on islands). For copepods, the corresponding

decreases were 17% and 24%, respectively. This difference in the diversity-temperature relationships resulted in the compositional changes along the climatic gradient: copepods predominated at temperatures below 13-15 °C, whereas cladocerans came out on top in warmer regions. Apart from temperature, the total species richness of microcrustaceans positively correlated with the ice-free area of a region. Cladocerans also showed a similar species-area relationship. Copepod diversity showed no such relationship but significantly depended on the "glaciation history", being lower by a quarter in glaciated areas on average. Also, copepods were less diverse on the islands than on the mainland areas. When only the insular data were considered, the copepod richness was negatively correlated with the distance from mainland. Together, these variables explained as much as 78-94% of the total variations in regional richness of microcrustaceans.

Acknowledgements
This research was supported by the Russian Scientific Foundation (grant № 14-14-00778). The fieldwork in Svalbard was supported by the Norwegian Institute for Nature Research (NINA) and the Research Council of Norway in the framework of the project FREMONEC.

GLACIAL HISTORY OF JAMES ROSS ISLAND SINCE THE LAST LOCAL GLACIAL MAXIMUM

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Keywords: glacial sediments and landforms, cosmic ray exposure dating, glacier changes, glacier mass balance, Antarctic Peninsula

During Pleistocene glacial times, the local James Ross Island Ice Cap (JRIIC), covering the James Ross Island (JRI) was connected with Antarctic Peninsula Ice Sheet (APIS) via individual ice streams, such as Northern Prince Gustav Ice Stream flowing from the Antarctic Peninsula to the continental shelf edge (O'Cofaigh et al., 2014). The ice recession started after 18 ka BP from outer continental shelf in Erebus and Terror Gulf and by 12.9 ± 1.2 ^{10}Be ka (from erratic boulders at the Cape Lachman neck, JRI; Nývlt et al., 2014) the ice sheet front receded to the inner continental shelf. This age corresponds also with the transition from grounded ice stream to floating ice shelf in the inner continental shelf of northern Prince Gustav Channel and the JRIIC thus became connected with the APIS by Prince Gustav Ice Shelf (PGIS). The extent of PGIS fluctuated during Holocene times and the marine record shows various break-ups of PGIS in the mid-Holocene times (Pudsey et al., 2006; Minzoni et al., 2015). These changes correspond with changes of local land-terminating and tidewater glaciers. Some mid-Holocene advances of local glaciers have been documented on JRI. Whisky Glacier advanced ~7 km towards the Brandy Bay, which was probably not covered by PGIS at the time of its culmination at ~4.7 ka (Hjort et al., 1997). The glacier receded shortly after that time leaving long boulder train with hyaloclastite breccia boulders up to 20 m large, in which many lakes evolved, some of them persisting till present (Davies et al., 2013). The last glacier advance took place during the Little Ice Age (LIA), when prominent ridges of frontal and lateral moraines surrounding present glaciers developed. In spite of the unknown timing of LIA glacier advances, we can calculate their areal and volumetric changes since that time. Five small glaciers in the northern part of the Ulu Peninsula, JRI retreated by 75–120 m and experienced surface lowering of 9–23 m since the LIA (Carrivick et al., 2012). A substantial portion of this change occurred during the last three decades as a result of prominent air temperature warming around the northern AP. This is not only evidenced by PGIS break-up in 1995, but also by the comparison of Digital Elevation Models from 1979 and 2006, which reveal average surface lowering of 8.5 m and 10.1 m for Davies Dome and Whisky Glacier, respectively (Engel et al., 2012). Since 2006, the rate of surface elevation change of these glaciers remained in the same order. According to mass-balance measurements on the two glaciers, the elevation differences ranged from –0.4 to +1.1 m, with a mean annual lowering up to 0.3 m yr^{-1}. The position changes of mass-balance measurement sites suggest higher surface velocities on Whisky Glacier compared to the Davis Dome glacier.

Acknowledgements:
This is a contribution to the Czech Science Foundation bilateral project GC16-14122J and MEYS Large Infrastructures for Research, Development and Innovation project LM2015078**.**

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COMPARING THE EFFECTS OF MATERIAL SOURCES AND FLUVIAL PROCESSES ON THE GRAVEL FRACTION OF THE MUNINELVA BRAIDED STREAM, CENTRAL SVALBARD

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Keywords: gravel-bed braided river, sediment sources, clast shape characteristics, Muninelva, Svalbard

Muninelva River flows down a narrow mountain valley (Munindalen) in Dickson Land, Western Spitsbergen, ~7 km west of Petuniabukta. Muninelva River flows from two connected glacier tongues (Muninbreen Glacier) in the NNW part of the valley and flows along the valley axis down to its mouth in Mimerdalen Valley at the SSE end of the valley. The river is ~6 km long and its channel belt is 50–250 m wide. It has a nature of a valley-train *sensu* Hambrey (1995). It changes into a braided outwash fan (*sensu* Hambrey 1995) at its mouth to the wide Mimerdalen valley. First-order channel in the valley train delimits bar assemblages with compound and unit bars and second-order channels cutting across the bar surfaces (Lunt and Bridge 2004). The first-order channel is branching on the outwash fan. The river is dominantly pebble-cobble gravely along the entire stream.

Muninelva River has the two main material sources according to their position in respect of the stream: I. head source – Muninbreen Glacier and its terminal moraine-mound complexes; II lateral sources – colluvial and alluvial fans, terminoglacial fan from a lateral glacier and bedrock in the channel belt banks (Devonian sandstone and conglomerate). All sources differ in the shape of their clastic material. Important effect of the fluvial transport on the size and shape of the clasts (downstream fining and increased roundness) could be assumed basing on the length of Muninelva River and well-developed channels and bars. This assumption has been studied using the analysis of the clast in the fraction 64–256 mm, which were sampled along the entire length of the river, as well as from source sediments. Bedrock provides implicitly angular debris and well-rounded clasts originates from conglomerates, so they could not be confused with the material originating from other sediments. Our results show that the clast grain size and roundness are dominantly controlled by material sources and not by the fluvial activity. Significant fluvial effects could only be found in the distal and axial part of the stream. Long morphologically developed braided stream is therefore not sufficiently competent to significantly modify the material from their sources, which resembles braided outwash fans of Hørbyebreen and Bertilbreen in the same area (Hanáček et al. 2013). This fact is of great interest for possible interpretations of fossil gravely braided streams without a preserved morphology, which could resemble alluvial fans basing on clast shape characteristics.

Acknowledgements:
The research has been financially supported by the projects: NF-CZ07-INS-6-263-2015 and NF-CZ07-ICP-4-292-2015. The field assistants are also gratefully acknowledged.

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MONITORING OF TWO SNOW/GLACIER-FED STREAMS IN THE VICINITY OF JOHANN GREGOR MENDEL STATION, JAMES ROSS ISLAND, ANTARCTIC PENINSULA

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Keywords: Antarctic Peninsula, hydrology, hydrochemistry, suspended sediment transport, water temperature, XRF

Proglacial and periglacial fluvial systems represent an important environment of recently deglaciated surfaces in Antarctica as they substantially control the sedimentological, morphological, as well as ecological processes. As the ongoing environmental change occurring in Antarctica causes – among others – melting and retreat of land-terminating glaciers, fluvial processes have been increasing in the overall importance and thus it also have raised the awareness of scientists aiming to understand a current evolution of the continent. However, the monitoring of streams in Antarctica is very sparse. Long-term monitoring of streams has been conducted only in McMurdo Dry Valleys so far. Recently, South Shetland Islands have become of the high interest to fluvial scientists as well.

In 2015, streams monitoring was commenced by Czech researchers in the vicinity of the Johann Gregor Mendel Station situated in the northernmost part of the James Ross Island, northeast off the Antarctic Peninsula. The gauging stations were installed at the outlet of Bohemian Stream (BOH) and the only stable sector of Algal Stream (ALG) located several hundred meters from the outlet into the sea (Figure 1), recording continuously water stage and temperature. First suspended sediment sampling was undertaken during the same season. In austral summer 2016, monitoring has continued and was expanded by regular suspended sediment sampling (twice a day during the hours of low and high diurnal flows) and hydrochemistry (once a day during high flows). Furthermore, new gauging station recording water stage and temperature was established at the Dirty Stream (DIR), the right tributary of the Bohemian Stream.

In upcoming season, we intend to install further gauging stations within Algal, Bohemian and Dirty Streams' catchments in order to monitor spatio-temporal behaviour of water sources for aforementioned streams. An additional grow of the monitoring base is becoming impeded by the necessity of automatization due to the logistical restrictions, which allow us to visit localities only during the part of the ablation season.
Overall, the hydrological data will contribute to the understanding of the evolution of James Ross Island, which has been set to be the most important aim of Czech Antarctic Research, and thus complement the studies of recent environmental change direction of this part of Antarctica.

Acknowledgment
The research was supported by the project LM2010009 CzechPolar (MSMT CR) and was carried out on the J. G. Mendel Station with the support of the station logistics and staff.

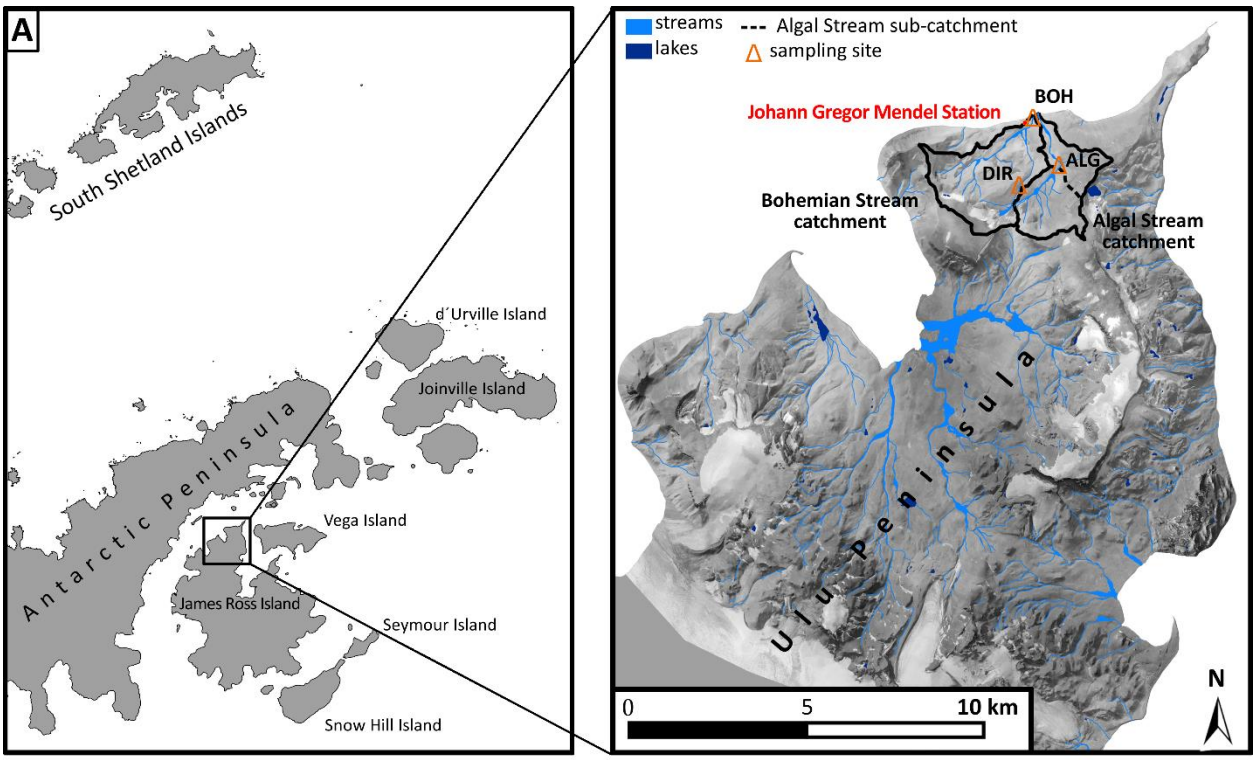

Figure 1: Scheme of the streams' monitoring activities in James Ross Island

SPATIO-TEMPORAL VARIABILITY OF WATER TEMPERATURE IN A SMALL NEARLY DEGLACIATED CATCHMENT, JAMES ROSS ISLAND, ANTARCTIC PENINSULA

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Keywords: Antarctic Peninsula, James Ross Island, water temperature, thermal regime, stream, hydrology

Water temperature affects physical, chemical, as well as biological processes within the aquatic environments (Caissie, 2006; Webb et al., 2008) and thus needs to be regarded among the key variables in ecological studies of fluvial systems. Extreme environment present in Antarctica – widespread glaciers, low temperatures and limited rainfall – impedes the presence of most of the living organisms. Places with liquid water represent more favourable environment for a growth of plants and microorganisms (Amils et al., 2007) and thus present fluvial systems are expected to have substantial positive effect on ecological value of deglaciated surfaces. Despite the recognised importance, studies on thermal properties of fluvial systems are very sparse in Antarctica. This study contributes to fill the gap in the understanding of Antarctic streams and provides the insight into the spatio-temporal variability of thermal regime of small snow/glacier-fed stream in the semi-arid northern part of the James Ross Island - ice-free area in the precipitation shadow of the Antarctic Peninsula. In total, eight monitoring sites measuring water temperature were distributed across the Bohemian Stream catchment, six on the Bohemian Stream and two on the Dirty Stream, the most important tributary. Studied period between 15th January and 7th February, 2016 fall into the high austral summer and covers the whole time of the Czech scientific expedition to James Ross Island. Water temperature was recorded every 30 minutes by sensor Minikin Tie (EMS Brno) with ±0.1 °C accuracy.

First results clearly highlight the presence of spatial, as well as temporal variability among the study sites. Mean water temperature varied between 1 and 4 °C. The highest values were observed in lower reaches of the Bohemian Stream braidplain. These sites also experienced the largest diurnal amplitudes. The Dirty Stream was generally colder than the Bohemian Stream. Further analyses of the relationship between water temperatures and meteorological variables, discharge, water sources and surface variability will be desirable in order to fully comprehend the studied properties of the stream water.
Overall, this study provides further insight into the functioning of fluvial systems in Antarctica and thus contributes to the understanding of geo- and ecological process evolution of deglaciated surfaces in Antarctica occurring as a consequence of rapidly changing environmental conditions.

Acknowledgments
The research was supported by the project LM2010009 CzechPolar (MSMT CR) and was carried out on the J. G. Mendel Station with the support of the station logistics and staff.

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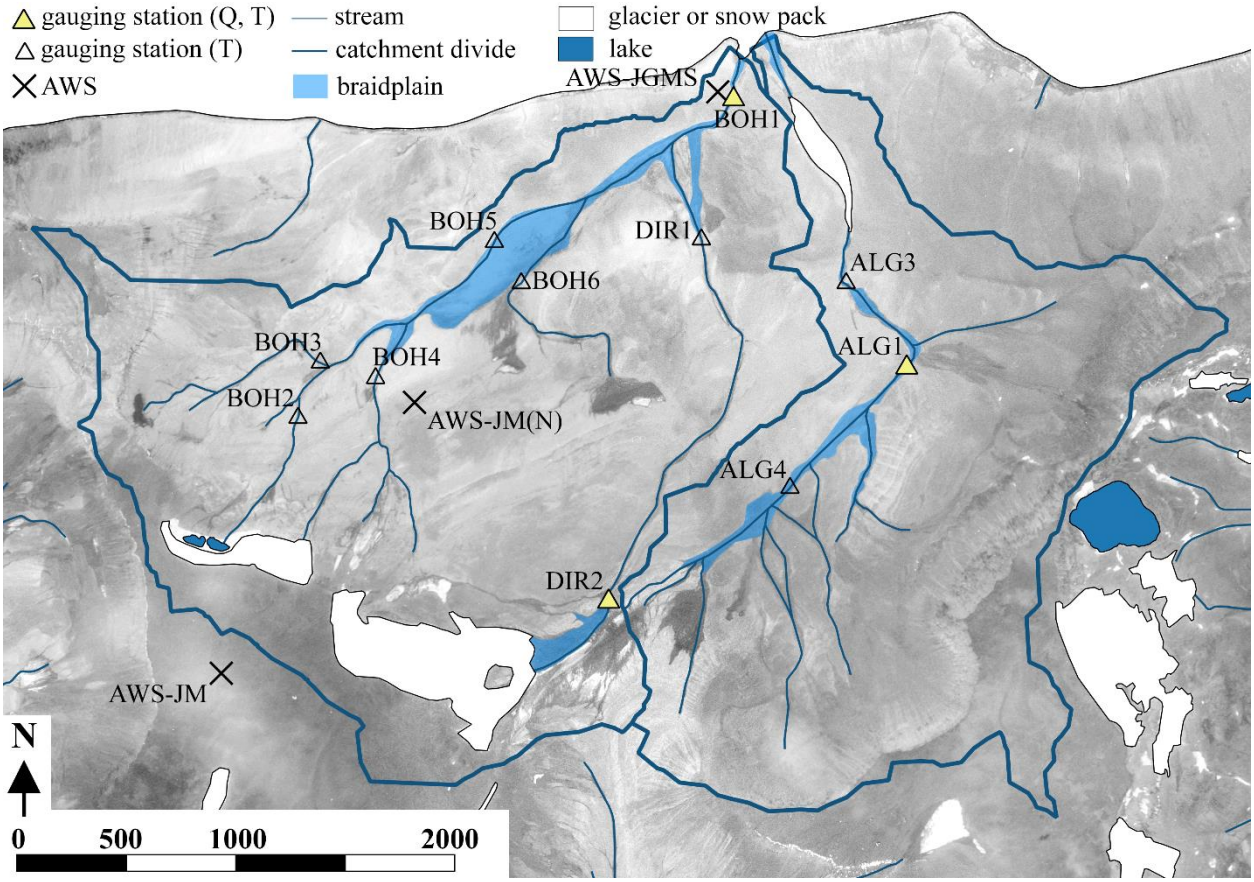

Figure 1: Distribution of gauging stations in studied catchment.

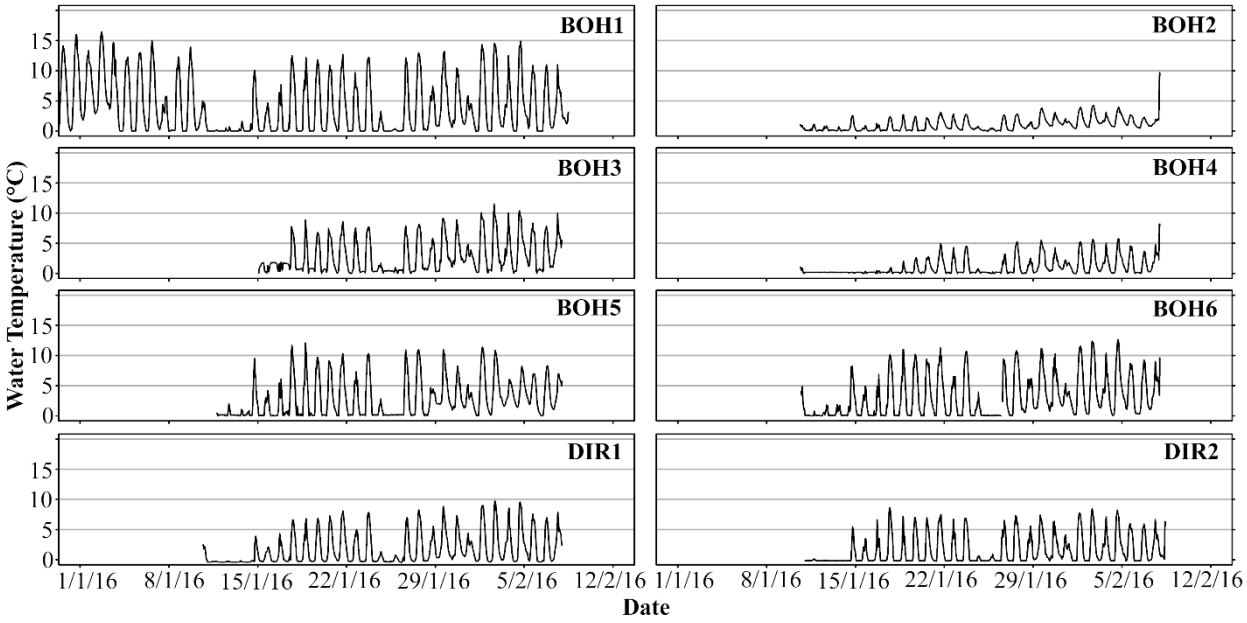

Figure 2: Time series of water temperature at studied sites in the Bohemian Stream catchment.

SEASONAL DEVELOPMENT OF ICE ALGAL BIOMASS AND SYMPAGIC MEIOFAUNA IN VAN MIJENFJORDEN, SOUTHWEST SVALBARD

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Keywords: Sympagic meiofauna-Ice algae-Sea Ice-Van Mijenfjorden-Svalbard

This is the first study to investigate the seasonal development of ice algal biomass and sympagic meiofauna abundance in Van Mijenfjorden in southwestern Svalbard (77°N, 15/16°W). The study examined the correlation between sympagic and ice algal biomass and whether the findings were comparable to more well-studied Arctic areas, such as the Canadian Arctic. The study focused on the lower 10 cm of the collected cores, but several cores were analyzed fully. First-year ice core samples for sympagic meiofauna (> 20 µm), chlorophyll *a*, ice temperature and brine salinity were collected from April to May 2014, and from March to May 2015 at seven different sampling locations in Van Mijenfjorden. Snow depth, ice thickness and freeboard were measured at each sampling site. GF/F 0.7 µm glass fibre filters (Whatman, England) were used to obtain total chlorophyll *a* concentrations and 10 µm nucleopore glass fibre filters (Whatman, England) were used for larger algal cells. Sympagic meiofauna samples were analyzed in the laboratory using a Leica stereomicroscope (Leica Wild M3B 6.4-40 x magnification).

A total of 13 identified taxa, a few unidentified organisms, copepod and chaetognatha eggs, and unidentified eggs were found in the sea ice cores. Among the fauna identified was a rare sympagic hydrozoan species that has not previously been described in the European Arctic. Total mean metazoan abundance in the lower 10 cm of the ice ranged from 471 to 11 513 ind m^{-2} with higher densities of sympagic meiofauna observed at the ice-water interface than towards the ice-air interface. There was a seasonal increase in sympagic meiofauna abundance from March until late April 2015 and a mid-May decline was observed in the 0-3 cm section. Similarly to other Arctic regions, nematodes dominated sympagic assemblages in terms of numbers from late April onwards, especially in 2014. Total (> 0.7 µm) and larger (> 10 µm) algal cell biomass showed an increase from March to late April in 2015 and decreased from the end of April to mid-May in 2014 and 2015. There was a significant difference in total (> 0.7 µm) and larger (> 10 µm) ice algal biomass in 2014 and 2015 in the lower 3 cm of the ice, which was not detected in the 3-10 cm section. Species identification based on morphology was not conducted in this study and DNA analysis of the preserved samples is needed to establish whether the specimens found in Van Mijenfjorden are of the same species as the sympagic fauna in other Arctic areas. However, this study is the first to quantify sympagic communities in Svalbard, which will facilitate future studies and enable comparison

between Arctic sympagic communities and their distribution. Additionally, seasonal studies of sea ice communities can be used to assess sea ice decline in southwest Svalbard and its potential impact on the local Arctic ecosystem.

INITIAL SOIL DEVELOPMENT IN FRONT OF THE NORDENSKIÖLD GLACIER: PHYSICO-CHEMICAL AND MICROBIAL TRENDS IN SOIL CHARACTERISTICS ALONG DEGLACIATED FORELANDS WITH DIFFERENT BEDROCK

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Keywords: glacier forefield, high arctic, soil development, microbial succession

The Nordenskiöld glacier, Svalbard (78.67°N, 16.78°E) is retreating since the culmination of the Little Ice Age at the end of the 19th century (Rachlewicz et al., 2007). The newly exposed ground in front of the glacier has different geology on its southern and northen part. Northern "silicate forefield" is mostly made of metamorphites (significantly higher amount of silica), while the southern "silicate + carbonate" forefield is build of magmatites, metamorphites and carbonates and is a source of a significantly higher cationt exchange capacity (mainly Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} exchangeable ions). Although the soil succesion in the glacier forefields has been studied intensively, little is known about the microbial functioning which plays a significant role in the soil development. We assume that bedrock chemistry is particularly important for initial microbial colonization and establishment in this this nutrient poor environment.

We sampled initial soil from both forefields with a chronosequence approach collecting soil in four zones of increasing age from the glacier front (I. 0-25, II. 26-44, III. 45-79 years old) to the tundra behind the front moraine from the end of the Little Ice Age (IV. > 107 years old). Microbial analyses (microbial biomass, DNA, RNA, enzyme activity, respiration rate) were supplemented by a set of physical (soil texture, WHC, bulk density) and chemical parametres (elemental soil analysis with X-ray fluorescence, pH, TOC, TN, DOC, available nutrients).
Considering close vicinity, similar slope and exposure of both forefields we suppose the same sources of allochtonous derived nutrients (atmospheric deposition, glacial ablation) and similar conditions for photoautrophic C fixation. Across the studied chronosequence, soil from "silicate + carbonate" southern forefield contained significantly higher amount of ammonia and cation exchange capacity (mainly induced by Ca^{2+} and Mg^{2+} ions) and displayed higher water holding capacity. These differences could explain significantly higher microbial biomass detected on this forefield in the first years of soil development and slightly higher organic C content. Released soluble ions are gradually being washed out with the increasing age and the divergence between forefields in microbial biomass and available nutrients declined. Already after 50 years of deglaciation most of the soil characteristic except the WHC became similar

and the influence of bedrock on microbial biomass was mitigated. The possible effect of bedrock on enzyme activities and composition of microbial communities will be discussed.

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Acknowledgments: The study was supported by projects Czech Polar (LM2010009) and Czech Polar 2 (LM2015078) and by the internal project of the Czech University of Life Sciences in Prague – CIGA (No. 20154304).

ANTARCTIC SOIL CRUSTS AS A SHELTER FOR CYANOBACTERIAL COMMUNITIES

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Keywords: cyanobacteria, soil crust, Antarctica

Due to climate change, Antarctica is of particular interest for many researchers. It can be expected that increasing temperatures will cause changes in living communities, including soil microbiota. Hence, it is a matter of urgency to obtain a global image of the communities living in this continent and, therefore, Antarctic soil crusts have been the focus of many studies. Here we provide the description of cyanobacterial abundance and diversity in soil crusts from nunataks and mountain ranges of Dronning Maud Land, East Antarctica. Three nunataks (Utsteinen, Pingvinane and Teltet) and northern part of Tanngarden ridge were chosen for the sampling. Soil parameters together with cyanobacterial biovolumes revealed differences between the four studied sites. Filamentous cyanobacteria were dominant (52-65 % of total biovolume) in all sites except in Utsteinen where unicellular cyanobacteria were the most abundant (78% of total biovolume).

To obtain a detailed assessment of cyanobacterial community composition, we applied molecular tools including the high-throughput sequencing. For 454 pyrosequencing analysis, the cyanobacteria-specific primers were used to amplify the V3-V4 variable region of the 16S rRNA gene. Amplification of the samples from Teltet did not produce relevant bands, and thus these samples were excluded from further analyses. The pyrosequencing analysis produced a total of 25,419 reads for eight soil crust samples. After bioinformatic analysis, 22,621 cyanobacterial sequences remained, which corresponded to eighteen cyanobacterial OTUs. Taxonomic assignment of sequences revealed the presence of the orders Oscillatoriales, Nostocales and Chroococcales. At the genus level, the dominant cyanobacteria were *Leptolyngbya* sp. (49.05 % of sequences) and *Microcoleus* sp. (27.18 % of sequences).

ECOLOGY OF ANTARCTIC GLACIER SNOWPACKS

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Snow and ice remains the least understood of the Antarctic ecosystems, despite 99.7% of the continent being permanently ice-covered. Microbial abundance on the surface of glacier ice is estimated to be 10^{14}-10^{17} cells per km^{-3} making it the largest freshwater reservoir of microorganisms on Earth. Microorganisms living on the surface of glaciers and ice sheets are active throughout the melting season, and can readily transform inorganic nutrients and CO_2 from the atmosphere into organic biomass. Due to the recent rapid regional warming in West Antarctica and around the Antarctic Peninsula, large masses of ice and snow have been lost into the surrounding ocean (~180 Gt of ice $year^{-1}$). Snow contributes to roughly 83%, of all surface melting in Antarctica. With the snow and ice loss, around 16 Gg of organic carbon are also released every year and transferred into the ocean, but there are only few insights into how biogeochemical and biological processes are enhanced by this melting. The paucity of ecological studies of snowpack habitats must therefore be addressed so that we can quantify changes in in-situ microbial processes and address the enormous uncertainty that exists with respect to how the export of labile nutrients and viable microorganisms by runoff might influence downstream terrestrial and marine ecosystems. Snowpack ecosystem studies in coastal Antarctica, especially in the Antarctic Peninsula region, are therefore urgently required and the present knowledge and future challenges will be discussed. The presentation will provide a new insight into the ecology of the snowpacks in South Shetland and South Orkney Islands where we used a multidisciplinary approach to calculate the internal biological production and biogeochemistry of snow and ice-bound ecosystems on Signy Island and to estimate the significance of the nutrient and microbial loading from these melting icy habitats into the surrounding coastal waters.

MODELLING OF ARCTIC HYDROLOGY

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Most hydrological models are developed for temperate climates, and the representation and parametrization of processes are based on the main processes in the hydrological regimes in these climate zones. Models applied in northern areas will naturally include nival processes, as these have a major impact on the hydrological regimes, in particular on the seasonality. However, as we move into the Arctic, process not identified in most hydrological models dominate. In addition to the snow processes – accumulation, redistribution, maturing, melt and refreezing - permafrost and glaciers play an important role. Permafrost processes and the dynamics of the active layer bring another non-stationarity into the picture which cannot be handle by the normal structure of hydrological models. Glacial processes have a time scale and a dynamic response which is very different from the non-glaciated areas of the catchment, and call for different approaches than what are normally implemented. In continuous permafrost areas the groundwater systems are different and behave differently compared with non-permafrost systems. The presentation discusses these issues and different approaches to handle them in various models that have been applied to Arctic catchments. The implications of shortcomings in model parametrizations for Arctic hydrological regimes are addressed, in particular how they affect the performance of the models for simulations of effects of climate change.

STRUCTURE OF THE POPULATIONS OF DOMINANT SALTMARSHES PLANT SPECIES (PLANTAGO MARITIMA L. AND TRIGLOCHIN MARITIMA L.) ALONG TIDAL GRADIENT ON THE HOLARCTIC SEA'S COASTS

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Keywords: population, tidal zone, White Sea

The objects of this study are *Plantago maritima* L. (fam. Plantaginaceaae)– hemicryptophyte, and *Triglochin maritima* L. (fam. Juncaginaceae)– rhizomatous hemicryptophyte. The field study was conducted on the Western coast of White sea (64°22'81"N 35°93'14"E).

In the conditions of tidal zone two plots (one for *P. maritima* and second – for *T. maritima*) were laid with width of 10 m each from the supralittoral to level at maximum low tide. Within the sample areas into three zones were visually divided, differing in duration of flooding, type of substrate and vegetation. To characterize the spatial structure of populations of *P. maritima* and *T. maritima* all individuals within the sample area were counted and mapped with the assessment of their age status: virginile, mature generative, and aging. Using the method of full extraction total biomass of individuals, separate overground and underground parts, biomass of vegetative and generative shoots, above-ground biomass of shoots and weight of roots, have been determined. The work analyses results of 120 descriptions of vegetation. All biometric measurements were made on 10 plants in ten replications in each zone.

The projective cover of dominant species *P. maritima* within the plot decreases along gradient from supralittoral to level at maximum low tide from 26% to 6% , the projective cover of *T. maritima* on plot varied in the range of 10-20%, with the average value of 11%. The highest coefficient of variation in *P. maritima* is observed in characteristics such as total biomass of aboveground parts (CV = 91), the mass of individual vegetative shoots (CV = 81), mature generative individuals (CV = 127), height of generative shoot (CV = 74) and length of spike (CV = 72). The least variable indicators are number of leaves on single shoot (CV = 32) and number of shoots in one individuals (CV = 49).For *T. maritima*, largest coefficient of variation seen in the number of generative shoots (CV = 67), number of vegetative shoots (CV = 49) in the clone, total number of particulas (CV = 47) and length of spike (CV = 48). The smallest coefficient of variation are length of the sheet (CV = 21), height of the vegetative shoot (CV = 21) and the length of the roots (CV = 25).

The total mass of aboveground shoots and the mass separately of vegetative and generative shoots of *P. maritima* in I zone (near the coast) exceeds the same parameters of plants from II and III (near the water) zones, while dry weight of roots from plant of II zone is greater than from plants I and III zones. The plants of *T. maritima* in zone III had a greater dry weight of roots and their length, which indicates they realized effort for firmly established in the substrate of zone, exposed to more severe wave and ice impacts. The greatest differences between *P. maritima* within populations showed that plants growing in upper littoral. Evaluation of biometric parameters of plants *T. maritima*, growing in the unstable conditions

of ecotope, showed that morphological indicators of vegetative and generative shoots of *T. maritim*a in three selected zones have the distinction of vegetative shoots had no significant differences in height but the generative shoots in zone III was higher than in zones I and II about 10 cm due to the formation of longer stems.

This study supports the conclusion of M. G. Popov that "adaptive evolution is primarily somatic, affecting primarily vegetative organs". The high level of variation in biometric and population indices of individuals of *P. maritima* and *T. maritima* shows large adaptation capabilities of species to be implemented in coasts of Holarctic seas.

INDIVIDUAL SOIL ORGANIC COMPOUNDS ON THE BARENTS SEA COAST

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Keywords: Arctic soils, low-molecular-weight organic compounds

Introduction

Dissolved low-molecular-weight organic compounds influence almost every process in soil and aquatic environment. Sea coastal soils are regularly flooded with waters with a high ionic power. So, identification of organic compounds which pass into salt solutions is important for understanding coastal soil geneses. The purpose of the study was to identify composition of water and KCl-extracts from soil organic horizons on the Barents Sea coast.

Methods and materials

The study region is located in the coastal part of the Khaipudyrskaya Bay (the Barents Sea). The area belongs to the north hypo-arctic tundra subzone. Organic horizons of two soil types served study materials. The first of them is Cryic Folic Histosol Fluvic (World Reference.., 2014) and the second – Histic Reductaquic Cryosol Thixotropic (N 68°20'05.7", E 59°33'21.9" and N 68°16'58.9", E 59°54'49.5", correspondingly, h = 8 m a.s.l.). Water and KCl-extracts (*c* = 1 mol dm^{-3}) from organic soil horizons were prepared at a ratio of 1:25. Low-molecular-weight organic compounds in extracts were identified by the GC-MS method (Shamrikova et al., 2012-2015). Chemical analyses were done at the Chromatographia Collective Usage Centre, also at the Soil Science Department and the Botanical Garden Department of the Institute of Biology Komi SC UrD RAS.

Results and discussion

Weight concentrations of total organic carbon in water extracts make 0.2-0.5 g dm^{-3} which is similar to the previously obtained data on taiga and south tundra soils of the Komi Republic (Shamrikova et al., 2013-2015). Total carbon values in extracts are interdependent. Total carbon value in water extracts ($\rho(C_{H2O})$) in two cases largely exceeds that in salt extracts ($\rho(C_{KCl})$) and does not have true differences from the other organic soil horizons. On the average, $\frac{\rho(C_{KCl})}{\rho(C_{H2O})}$ = 0.9. Consequently, salt solution, in contrast with water solution, tends to decrease total carbon content of KCl-extracts. We identified nine acids (mainly oxyacids) and seven carbohydrates.

Table 1. Qualitative composition of extracts from organic soil horizons

Classes of compounds	Extragent	
	H_2O	KCl
Acids	2-oxypropionic, 2- oxybutandicarbonic, 2,3,4-trioxibutanoic, 2,3,4,5-tetraoxipentanoic	
	2-oxyethanoic, 3-oxybutanoic, pentanoic, butanedionic, 1,2-dioxypropionic	–
Carbohydrates	galactose, arabinose, ribose, glucose, sucrose	
	xylopyranose, turanose	–

Variety of low-molecular-weight acids and carbohydrates in salt extracts is less than that in water extracts (Table 1). Major water-soluble carbohydrates or acids pass into salt solution. *E.g*., salt solution-extracted acids in water extracts make 42-94 and carbohydrates – more than 90 % of total content. Analogically with total carbon content, there exists a close correlation of low-molecular-weight compounds (acids and carbohydrates) carbon in water and salt extracts. The ratio of $\frac{\rho(C_{IC-KCl})}{\rho(C_{IC-H2O})}$ = 0.5 and is inferior to the analogous ratio for total organic carbon. So, salt solution decreases solubility of organic compounds, which is not the case with water extraction, but decrease itself is different. Found organic acids serve acidity source in extracts. Proton activities calculated using pH values of extracts also have high correlation values and the ratio of $\frac{a(H^+)_{KCl}}{a(H^+)_{H2O}}$ = 2-60.

Increase of ion power in solution can cause decrease of compounds solubility. This process is called the "salting-out effect". Previous to salting out high-molecular-weight organic compounds (HMWCs), they change conformation. Change in ion power of solution destroys some weak bonds and forms others and so causes slight displacement of particular chain parts and appearance of new ionization-able functional groups on surface (Sposito, Holtsclaw, 1977). Thus, increase in ion power of solution can significantly lower solubility of low-molecular-weight compounds. But their part in composition of total organic carbon in soil water extracts is insignificant and so we do not see any serious decrease in total carbon content of soil water extracts. Salt solution extraction power of high-molecular-weight compounds decreases less or does not decrease at all compared with water extraction.

Conclusion

On sample of soil types on the Barents Sea coast, increase in extragent ion lowers solubility of low-molecular-weight organic compounds identified by the gas chromatography method. Low pH values of soil KCl-extracts compared with those of water extracts seem to be related to comformation changes of high-molecular-weight compounds. Sea water in flood area possibly lowers mobility of low-molecular-weight soil organic matter fraction.

Acknowledgement

The work was done in frames of the RFBR (project № 16-04-00749) and Complex Program of Ural Branch, Russian Academy of Sciences (project № 15-2-4-28).

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OCCURRENCE OF SELECTED POLY- AND PERFLUOROALKYL SUBSTANCES (PFAS) IN ARCTIC FRESHWATER: A CASE STUDY FROM SVALBARD

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Keywords: Perfluoroalkyl substances (PFAS), Arctic, Svalbard, Lake, Freshwater

Polyfluoroalkyl and perfluoroalkyl substances (PFASs) is a diverse group of fluorine-containing organic compounds containing the perfluoro moiety within its structure and different functional groups. PFASs have been found ubiquitously in the aquatic environment, even at remote locations such as the Arctic. A recent study found high concentrations of short-chain PFASs in muscle and liver of Arctic Char *(Salvelinus alpinus)* from Lake Linnévatnet (Garsjø 2013). All PFASs are very persistent, long-chain PFASs tend to bioaccumulate in the food web and several adverse effects have been observed for some compounds. Two major transport pathways of PFASs to the Arctic have been suggested; direct oceanic transport of ionic PFASs and long-range atmospheric transport and oxidation of neutral precursor compounds.

In this study, samples of lake water were collected in March 2014, April 2015 and June 2015 from Lake Linnévatnet in Svalbard. In addition, lake sediment, snow, meltwater and river water was collected in June 2015. As a reference for local pollution, samples were collected downstream a firefighting training site (FFTS) at Svalbard Airport in November 2014 and June 2015. Water samples were extracted by weak anion-exchange (WAX) solid phase extraction (SPE) and sediment samples were extracted by methanol liquid-extraction. Extracts were analysed for 18 target PFASs by liquid chromatography coupled with tandem mass spectroscopy (HPLC-(-)ESI-MS/MS).

Procedural recoveries were acceptable (>70 %), except for the neutral PFASs and sediment samples. Mean between-laboratory difference of parallel water samples collected in June 2015 used to assess reproducibility showed a difference below 30 % for most compounds, except PFBA, PFHxA and PFUnDA, which was comparable to reproducibility reported in a recent inter-laboratory comparison.

Sum PFASs in the water of Lake Linnévatnet was in the range of 4.7 – 5.1 ng L^{-1} in March 2014, 1.6 – 8.3 ng L^{-1} in April 2015 and 0.49 – 1.7 ng L^{-1} in June 2015. Sum PFAS for sediment samples was in the range of 0.3 – 3.29 ng g^{-1} (DW). Higher ΣPFAS in the winter indicated a seasonality in concentrations in water. Water samples were categorized in five distinct groups based on their composition profiles using principal component analysis (PCA). Linear regression in addition to congener ratios was used to identify patterns, and used to discuss possible source origins. The short-chain perfluoroalkyl carboxylic acid PFBA was the dominating compound in lake water, meltwater river water and sediment, contributing approx. 50 percent of the total PFAS concentration. Water samples from March 2014 where dominated by the long-chain perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) was the dominating compound in snow. Runoff downstream FFTS had high total PFAS concentrations during melt in June, where perfluorooctane sulfonate (PFOS) was dominating in both and sediment, and

with no runoff in November the total PFAS concentrations were lower and dominated by perfluoroheptanoic acid (PFPeA) and perfluorohexanoic acid (PFHxA). Observed ratios between PFOA/PFNA in surface water samples were similar as reported elsewhere in the Arctic, which indicated long-range atmospheric transport as the main source. Significant linear correlation between PFBA, PFOA and PFNA indicated a common transport route.

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REVIEW OF THIN (<5 µM) FILAMENTOUS CYANOBACTERIA FROM BOTH POLAR REGIONS BASED ON MORPHOLOGICAL AND MOLECULAR DATA

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Cyanobacteria are very important photosynthetic microorganisms, particularly in both Polar Regions. They are primary colonizers of deglaciated land and moraines after the retreat of glaciers and ice sheets. Cyanobacteria in the polar areas belong mainly to filamentous types without heterocytes that are mainly classified to the traditional genera *Leptolyngbya*, *Phormidium, Microcoleus* and *Oscillatoria* or to the heterocytous genus *Nostoc* Cyanobacteria are responsible for a significant fraction of primary productivity, carbon sequestration, and nitrogen fixation in polar areas. They remain major players in global oxygen supply also. Despite the evident importance of oscillatorialean cyanobacteria in polar areas, there are only a few taxonomic studies focusing on morphological, genetic and biogegraphic comparisons of polar strains belonging to very thin <5 µm species.

For many years they were traditionally studied according to morphological properties and compared mainly with species from temperate zones. Proper identification of thin filaments below 5 µm wide is particularly difficult. Observation with 1000x magnification is essential for recognition of details in small cyanobacterial cells and fillaments. Geitler grouped almost all thin, immotile cyanobacteria with simple filaments and facultative sheaths into the genus *Phormidium.* The very thin non-motile cyanobacterial filaments with simple morphology (without akinetes and heterocytes) and with facultative sheaths were later moved into the genus *Leptolyngbya* by Anagnostidis & Komárek. This genus became very popular, because many species with thin cyanobacterial filaments under 5 µm from any environment, but usually hardly taxonomically determinable only by optical methods, could be included in *Leptolyngbya*. With the introduction of additional taxonomical methods (cytomorphological analyses, molecular sequencing, exact ecological studies, better data about phytogeographical distribution), the genus *Leptolyngbya* was found to be polyphylethic. This lead into erection of genus *Phormidesmis* in 2009 that is sister taxon to *Leptolyngbya* due to characteristic cytomorphological markers, and distinct phylogenetic properties. To describe the variability within genus Phormidesmis we analyzed 26 strains from both polar areas and compared them with similar species from non-polar localities. We had found that this morphologically uniform genus contains several types from various habitats over the world and some of them occur in diverse ecosystems of both Polar Regions. The two new species (*P. arctica and P. communis*) found in Polar Regions were described. We have also found that even genus Phormidesmis is polyphyletic and we had to describe a new genus *Leptodesmis*.

The diacritical features of all these species are: width up to 1–4 µm, barrel-shaped cells, which can be shorter or slightly longer than wide, and with apparent constrictions at the cross-walls. Genus *Leptodesmis* have significant morphological similatrities, but genetic position of these genus is between cleid *Leptolygbya boryana* and genus *Phormidesmis*. The study shows that the genus *Phormidesmis* is a morphologically and genetically well-defined genus with a global distribution and genus *Leptodesmis* is criptic to genus *Phormidesmis*. In this study, we described the morphological and phylogenetical variability of thin ubiquitous filamentous cyanobacteria.

“FIGHT OR FLIGHT?” - ANTIPREDATION STRATEGIES OF NESTING ARCTIC TERNS (*STERNA PARADISAEA)*

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Key words: Arctic tern, antipredation behaviour, nesting behaviour, human impact, Svalbard

Arctic terns are colonially nesting birds with strong active reaction to predators including physical attacks. This type of behaviour is energetically very expensive and every mistake can lead to death. Adult animals can decide between ´fight or flight´, but eggs and birds on the nest can rely only on crypsis and parents defence. Individual differences in reactions might be caused not only by different type of predator but also by actual condition of defending animals, length of nesting, phase of nesting season, and in case of colonially nesting birds also by position of the nest within the colony, and surely by location of the whole colony. Moreover, it is well known that human impact can change animals´ behaviour. In current study we examined impact of human presence on behaviour of nesting terns.

We compared reaction of Arctic terns in two colonies on Svalbard. One colony was affected by presence of humans – the colony in Svalbard´s main settlements, Longyearbyen (N=23 tested pairs). And the second one without human´s influence – the colony on glacier foreland Rettretøya Island in Adolfbukta (N=33 tested pairs).

We found strong difference in reaction of terns between our two studied colonies. Terns in the colony influenced by humans were more aggressive to the human and after disturbing returned to the nest more quickly than the birds in Adolfbukta (Linear model, $F_{1,50}$=124.44, $p<0.001$, R^2=11.65). The latency of parents return to the nests was shorter in Longyearbyen (mean = 43s) than in Adolfbukta (mean = 422s). Other factors (age of eggs, number of eggs or phase of nesting season) had no effect. We can conclude that the reaction of terns in settlements is affected by human and that terns do behave riskier.

EXUDATION OF LOW MOLECULAR MASS ORGANIC ACIDS BY ARCTIC WILLOW (*SALIX POLARIS*) IN DIFFERENT TUNDRA HABITAT: RESPONSE TO SOIL ENVIRONMENT

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Keywords: exudation; *Salix Polaris*; arctic soils; Svalbard

The exudation of low molecular mass organic acids (LMMOA) represents a strategy of plants for releasing nutrition and risk elements detoxification. Exudates are also sources of carbon and energy for microorganisms. The aim of this contribution is to evaluate LMMOA speciation in exudates of arctic willow (*Salix polaris*) growing in different habitats of high-arctic tundra in Petuniabukta (Billefjorden, Svalbard) and investigate relationship between exudation and different soil properties.

Willow plants were sampled on 4 localities with different vegetation covers (almost bare glacier forefield 25–69 years after deglaciation, partly vegetated (30%) tundra, fully vegetated dry tundra, and wet hummock-tundra). Five willow plants with roots and surrounding soil were collected on each locality. Plants were carefully removed from the soil and washed by deionised water. The exudation was carried out in deionised water for 2 h. Analysis of LMMOA and inorganic anions were done by ion chromatography. Five pairs of soils samples (rhizosphere and bulk soil samples) were colected in each stands. Total content of main elements, water extractable and exchangeable contents of these elements were determined in soil samples.

The most abundant species of LMMOA in willow exudates were lactate, acetate, formate, malate and citrate. Lower amount of pyruvate, quinate and oxalate were also determined. Nevertheless, there was a trend showing lower amount of totally exuded LMMOA under partly vegetated tundra in comparison to other stands. Moreover, there were significant differences between certain LMMOA species (e.g. lactate, formate and malate) between habitats. These differences could reflect the influence of habitat on exudation rate and exudate composition (e.g. increased lactate content under wet hummock-tundra reflects anoxic condition of stand). The chemistry of soils was highly variable between stands. Glacier forefiled represent habitat with the highest differences between rhizosphere and bulk soil with comparison to other habitats. High amount of available nutrition (glacier forefield) or high concurrence between

plant species (fully vegetated tundra) seemed to stimulate the willow exudation the most.

THE RESPONSES OF PHOTOSYNTHETIC APPARATUS OF CYANOBACTERIA FROM ANTARCTIC SOIL CRUSTS TO UV-B EXPOSITION ASSESSED BY CHLOROPHYLL FLUORESCENCE TRANSIENT.

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Keywords: biological soil crusts, cyanobacteria, chlorophyll fluorescence, UV-B, photosynthesis

The biological soil crusts are communities of cyanobacteria, algae, lichens, fungi and bryophytes occurring on the soil surface unshaded by vegetation. In polar regions, the soil crust could represent a major non-aquatic photosynthetic community. In this experiment, we examined the responses of such community to UV-B light, which represe common stress factor co-acting during summer season in polar regions.

We used samples of soil crusts from James Ross Island, Antarctica, formed predominantly by *Microcoleus* sp. with *Nostoc* sp., *Leptolyngbya* sp. and *Calothrix* sp. The samples were collected in February 2015 and transported to Brno where stored in dry state. For the experiment, they were rewetted for 3 days and then exposed to additional UV-B radiation doses of 1.4 Wm^{-2}. During the exposition, slow chlorophyll fluorescence transient was measured at 1st, 3rd, 6th, 24th, 48th, 72nd, 96th, and 120th hour of the exposition. From the measurements, the shapes of the transient as well as derived chlorophyll fluorescence parameters (F_0, F_V, F_V/F_M, ?$_{PSII}$) were evaluated. The change of the transient shape during first hour of exposition was dramatic. The minimum fluorescence (F_0) increased by 35%, the variable fluorescence (F_V) had rising tendency during whole period (5 min) of actinic light contrastingly to ± stable signal of F_V in unexposed crusts, and the decline of fluorescence after switching off the actinic light was slower than in unexposed crusts. With longer exposition (2-6 d), the fluorescence signal decreased during all time of measurement and the transient shape flattened. Mild increase of potential (F_V/F_M) and effective quantum yield (Φ_{PSII}) was measured from 2nd to 6th day, showing slow acclimation of cyanobacteria to UV-B doses. In this study, possible mechanisms of such behaviour, as well as the differences between *Nostoc* sp. and *Microcoleus* sp. dominated pieces of crusts are discussed.

PHOTOSYNTHETIC CHARACTERISTICS OF FIVE MOSS SPECIES IN A HIGH ARCTIC MOSS TUNDRA

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Keywords: Moss tundra, Moss, Photosynthetic characteristics, Stuphallet

Arctic terrestrial ecosystems are crucially vulnerable to climate change, and a major concern is how the carbon balance of these ecosystems will respond to climate change (Schuur et al., 2015). Wet tundra ecosystems have been strong sinks for atmospheric CO_2 after the last ice age and contain large amounts of accumulated soil organic carbon (SOC) (Lund et al., 2010). Climate change is likely to have a profound influence on this SOC pool by changing carbon balance. However there is little information about carbon cycle in the High Arctic wet tundra ecosystem. As a part of a carbon cycle study in a moss tundra, we investigated moss photosynthetic characteristics.

Study site was Stuphallet where on the Brøgger peninsula near Ny-Ålesund, Svalbard, Norway (79°N). The area is almost totally covered with mosses including relatively dominant species *Calliergon richadsonii*, *Campylium* sp., *Campyliadelphus stellatus*, *Sanionia uncinata*, and *Tomenthypnum nitens*. A few vascular plants such as *Ranunclus hyperboreus* and *Cardamine nymanii* grow in mosses (Nakatsubo et al., 2015). We collected a green part of five moss species (*Calliergon richardsonii*, *Meesia triquetra*, *Sanionia uncinata*, *Tomenhypnum nitens*, and *Paludella squarrosa*) and brought back to a station in Ny-Ålesund. The rates of net photosynthesis and dark respiration for mosses were determined using an open-flow gas exchange system with an infrared gas analyzer changing with temperature (2-23^{o}C) and Photosynthetically Active Radiation (0-1500 □mol photons m^{-2} s^{-1}). After the measurements, dry weight of the moss samples were determined. In order to know environmental condition, temperature of green part of moss layer and PAR were also measured.

During the growing season in 2014 (9 July – 31 Aug), temperature for green part of moss layer ranged from 0 to 16oC. The highest frequency in the temperature was observed at 7oC. 76% of the temperature frequency ranged from 2 to 8oC. On the other hand, Frequency of PAR showed the highest from 100 to 200 □mol photons m-2 s-1 (26% of the total). The frequency decreased exponentially with increasing PAR more than 200 □mol photons m-2 s-1 to 1300 □mol photons m-2 s-1. Net photosynthetic rate for all moss species within the range of 2 to 12oC did not change significantly when PAR was more than 200 □mol photons m-2 s-1. In contrast, the photosysnthesis tended to decrease with increasing temperature under 100 □mol photons m-2 s-1. On the other hand, Light(PAR) dependence of net photosynthesis tended to be different among the five species. Light saturation point of C. richardsonii, M. triquetra, and P. squarrosa showed approximately 400 □mol photons m-2 s-1. In contrast, the point for S. uncinata and T. nitens showed approximately 200 □mol photons m-2 s-1. In comparison to the net photosynthesis per unit moss dry weight between the five moss species at the most likely

temperature and PAR condition (7oC, 200 mol photons m-2 s-1), the highest value showed *P. squarrosa* and the lowest showed *T. nitens.* There was more than twice between them. On the other hand, *S. uncinata* and *M. triquetra* showed the highest net photosynthesis at the same temperature and PAR condition per unit area basis. Although net photosynthesis of *P. squarrosa* per unit dry weight basis showed the highest value, the moss per unit area basis showed the lowest value.

The net photosynthesis per unit area at 7^{o}C and 200 mol photons m^{-2} s^{-1} did not completely coincide with degree dominancy of vegetation at the study area. However, higher degree dominancy of mosses tended to be higher net photosynthesis per unit area. As a next step, we will construct a model to estimate net production and respiration including brown part of moss for the moss tundra.

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REPETITIVE PHOTOINHIBITION EFFECTS ON POLAR ALGAE: A PHOTOBIOREACTOR EXPOSITION SYSTEM AS A VERSATILE TOOL TO STUDY PHYSIOLOGY OF PHOTOAUTOTROPHS.

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Keywords: photobioreactor cultivation; high light stress; quantum yield; photoprotection

Introduction. Polar regions are known for its extreme conditions of the environment. Numerous cosmopolitan algal (and cyanobacterial) species are eligible to survive in such extreme environment conditions. There, the extremity is defined by low values of average and minima (and/or maxima) of basic physical environmental variables *e.g.* temperature, irradiance, precipitation, UV doses, *etc*. The irradiance limits the growth of biota by high light doses occurred here repeatedly within sunny days. High light doses events are typically appeared in direct sunlight increased by interference with light reflected from snow fields. A cultivation in photobioreactor is commonly used method for algal biomass production and further extraction of valuable metabolites. However, this method can be easily adapted for evaluation of growth and physiological reactions of cultivated strains of autotrophs exposed to various simulated environmental conditions. Even if, the photobioreactor system is supplemented with measuring unit (*e.g.* fluorometer, pH, O_2 electrode) enabling instant analysis of physiological reaction to changing experimental variables. In this study, we focused on evaluation of the effect of repetitive radiation stress on photosynthetic processes of selected algal strains originated from polar regions.

Material and methods. In the exposition experiments, we used several strains of green algae *e.g. Klebsormidium* sp. (CCALA, strain 859) originated form wetland surrounding the lake Monolith (James Ross Island, Antarctica) compared with *Desmodesmus* sp. For the exposition, we used small-scale photobioreactor cultivation (FMT 150, Photon Systems Instruments, CZ) equipped with fluorometer, pH and oxygen elctrode. During cultivation (temperature 10°C; irradiance 100 micromol.m^{-2}.s^{-1}; 16/8h day/night) and exposition (repetitive 4h, 3000 mikromol.m^{-2}.s^{-1}), the changes in photosynthetic activity were recorded by measuring of chlorophyll fluorescence induction (Ft, F_M, Quantum yield) and changes of oxygen evolution rate (OER). The samples for pigment analysis (chl a, chl b and carotenoids) were collected during exposition period.

Results and discussion. The changes in monitored parameters showed gradual reduction of photosynthetic recovery rate after repetitive episodes of photoinhibition. In analyzed strains, a constitutive level of photoprotective mechanisms can be determined. High level of tolerance of photosynthetic apparatus of *Klebsormidium* to short-time radiation stress could be considered as well.

Acknowledgement: The authors thank CzechPolar for support of field works and experimental infrastructure.

DIATOMS IN CRYOCONITE HOLES AND ADJACENT PROGLACIAL FRESHWATER SEDIMENTS, NORDENSKIÖLD GLACIER (SPITSBERGEN, HIGH ARCTIC)

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keywords: Diatoms, Cryoconite, Dispersion, Communities, Spitsbergen

In our research we focused on diatoms found in cryoconite holes, supraglacial micro-habitats of proved biological activity. Although diatoms are usually very abundant in polar lakes and streams, they are mostly only seldom reported from cryoconites. Yallop & Anesio (2010) cultured debris from Svalbard and Greenland cryoconites to promote the growth of diatoms, as the direct observations were unfeasible. They recorded between 12 and 15 live genera in Svalbard's cryoconites and 27 in total, which revealed significantly higher diversity than was previously reported elsewhere and is comparable with common polar habitats. The diversity, ecology and community structure of freshwater diatoms found in Putuniabukta, was later studied by Pinseel et al. (2016) who observed 59 genera and 310 diatom taxa from which one-third could not be identified below the species level. In the presented study, we characterized diatom communities from cryoconite hole sediments of the Nordenskiöld glacier, and compare these results with adjacent aquatic habitats that could potentially serve as a source, similarly as Stanish et al. (2013) compared diatom cryoconite communities of the Antarctica with microbial mats from adjacent streams.

A total of 58 diatom taxa belonging to 46 genera were identified in the cryoconite material, and additional 26 diatoms could not be identified below the genus level. Genus richness ranged from 9 to 24 with a median of 18. The most abundant and well distributed among sites were *Nitzschia, Pinnularia,* and *Psammothidium,* followed by *Staurosirella, Gomphonema* and *Luticola.* Commonly observed were species such are *Pinnularia. borealis* complex, *P. intermedia, N. perminuta* complex, *Gomphonema* aff. *nathorstii,* and *Psammothidium* sp1. Generally smaller number of valves could be enumerated from the samples, but the overall richness was comparable, and sometimes even greater than some of the lake sites. Using Nonmetric multidimensional scaling (NMDS) we uncovered a strong separation of the

cryoconite holes and the lake habitats, and according to PERMANOVA cryoconite hole diatom communities were significantly different from the pooled lake samples ($p < 0.001$). Despite the differences, some of the genera were linking the three habitat types identified as (1) cryoconite holes, (2) moraine kettle lakes of Nordenskiöld and Hørbye, and (3) Rettrettøya ponds. Whereas *Pinnularia, Luticola* and *Staurosirella* clearly separated the first group from the others, *Psammothidium* linked the first two, and *Nitzschia* linked the first with the third group, out of which *Adlafia* and *Encyonema* were clearly more abundant than in the previous two groups.

We hypothesized that if diatoms are being transported from surrounding aquatic habitats to cryoconite systems, then cryoconite communities should be highly similar to those from the habitat of origin. On the contrary, although 25 genera occurred in both habitats, we found that diatom communities from the cryoconite habitat were significantly different from the other habitats. According to our findings, the diatom communities of cryoconite holes are more likely to be formed as a result of aeolian dispersion and deposition. A number of genera found in cryoconite holes are typically aerophilic, inhabiting mainly moist terrestrial soil or moss habitats (*e.g. Hantzschia, Humidophila, Luticola*). Terrestrial diatoms make good candidates for cryoconite colonization as these are abler to resist freezing and desiccation stress than freshwater species. Many genera observed in the cryoconite material were rare in the lakes and ponds of Petuniabukta, or were characteristic for some unique habitat type.
Although genus-level might not be the best way how to study the similarities of distinct habitats, we found it to be of a great use in our study, in order to compare cryoconite holes with adjacent habitats in general. From our results, it became clear that localities in the immediate vicinity was not broad enough to fully assess 'the source' of the cryoconite diatom flora. In any event, the diatom cryoconite communities have the potential to inform researchers about microbial dispersal patterns through comparing the regional distribution of diatoms in between distinct polar habitat.

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BASIC SOIL PROPERTIES ON SOME SOUTH SHETLANDS ISLANDS (ANTARCTICA)

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Keywords: Antarctica, King George Island, Livingston Island, Deception Island, basic soil properties

Introduction

This paper summarizes the basic soil properties of the selected places on South Shetlands Islands (King George–KG , Livingston–L and Deception Island–D). Deglaciated/volcanic areas are mainly covered by relatively young soils with greatly varying character.

Methods and materials,

Soil samples were prepared for chemical and physical analysis according to ISO 11464. The particle size analysis were performed by the pipette method (Gee and Bauder, 1986). The content of C_{ox} was determined by the Walkley-Black method (Schumacher, 2002), with Novak-Pelisek modification (C oxidized by 0.167 M $K_2Cr_2O_7$ with addition of H_2SO_4, re-titration with 0.5 M Ammonium iron(II) sulfate); Soil reaction was determined by Labquest II (Vernier Ltd.) in the saturated paste and fixed soil:water or soil:KCl solution (1:2.5) extract methods. Content of calcium, magnesium, sodium, potassium and phosphorus in Aqua regia solution were determined by ICP-MS analysis at Bureau Veritas Commodities Canada Ltd. Clay minerals were determined by XRD diffraction.

Results

Deception Island - Whaler´s bay 62°58'S; 60°35'W; 4–30m a.s.l. Samples D(1–4). We determined in a separated fraction of fine earth following proportions of textural fractions: the average content (±Standard deviation) of clay was very low 2.96 ± 0.40% with variation range 2.2–3.9%; silt 13.43 ± 3.89% with variation range 3.6–22.4% and average content of sand was 83.61 ± 3.99% with variation range 75.2–94.2%. In separated clay fraction was detected small content of clay minerals albit and smectite (sample D4). The content of oxidized carbon (C_{ox}) was low, the average C_{ox} content was 0.11 ± 0.08% with variation range from 0.02% (D3) to 0.35% (D4). The average active soil reaction was 6.8 ± 0.3 with variation range from 5.8 (D4) to 7.4 (D3). The average exchangeable soil reaction was 5.0 ± 0.5 with variation range from 3.9 (D4) to 6.2 (D3). The average calcium content of samples was 0.94±0.15% with variation range from 0.74 to 1.40%. The average magnesium content was 0.89±0.02% and variation range was from 0.85 to 0.93%. The average phosphorus content was 0.07±0.02% and variation range was 0.03–0.13%. The average potassium content of samples was 0.09±0.01% and variation range was 0.07–0.11%. The average sodium content of our samples was 0.48 ± 0.04% and variation range was 0.40–0.58%.

King George Island 62°13'S; 58°55'W; 50m a.s.l. Sample K was sampling point near Kamil Suchanek´s memorial. Content of clay was relatively high 14.9%; silt 25.1% and sand content was 60.0%; texture class was sandy loam. In separated clay fraction was detected contents of clay minerals chlorite, smectite and illite. The content of oxidized carbon (C_{ox}) was the highest

from our samples: 0.54%. The active soil reaction was 7.2 and exchangeable soil reaction was 5.3. The calcium content was 0.78%; the magnesium content was 1.87%; the phosphorus content was 0.08%; the potassium content was 0.08% and sodium content was 0.14%.

Livingston Island 62°38'S; 60°36'W; 50m a.s.l. There was sampling point (sample L). Content of clay was the lowest: 1.9%; silt 1.6% and sand 96.4%; texture class was sand. The content of oxidized carbon (C_{ox}) was the lowest value: 0.01%. The active soil reaction was 7.0 and exchangeable soil reaction was 4.8. The calcium content was 1.90%; the magnesium content was 0.69%; the phosphorus content was 0.07%; the potassium content was 0.27% and sodium content was 0.25%.

Discussion

The low level of chemical weathering in cold climate needn't necessarily to be so clear. Vlček (2016) showed from the James Ross Island (Antarctica) virtually pure smectite, chlorite, illite or zeolite clay minerals. Smectite is in Antarctic soil quite rare (Margesin, 2009). The content of oxidized carbon (C_{ox}) is very low in general in Antarctic soils: Bargagli et al. (1998) reported at Edmonson Point (Victoria Land) range 0.1–1.1%; Navas et al. (2008) from 0.09 to 2.65%; Vlcek (2016) from James Ross Island showed range 0.09–0.92% C_{ox}. Our range of 0.01–0.54% C_{ox} in the fine earth lies on the lower limit of these intervals. Higher values could be found at sites with living organisms (lichens, algae), and/or with anthracite in epipedon (Campbell, Claridge, 1987). Campbell and Claridge (1987) reported Antarctic soils are typical by their slightly alkaline soil reaction; but soil reaction can differ depending on the specific local conditions and age. The variation range of active soil reaction was from 5.8: acid (sample D4) to 7.4 weakly alkaline (sample D3). The variation range of exchangeable soil reaction was from 3.9: strongly acid (D4) to 6.2: weakly acid (D3). These results don´t correspond with the salination or with results from James Ross Island (Vlček, 2016) where was generally alkaline reaction in surface horizons. Bowen (1979) reported average value of *total calcium content* 1.50% and variation range 0.07–50%. Calcium content is generally variable with depth (Vlček, 2016). The most commonly *total magnesium content* in the soil varies between 0.4 and 0.6%. The content depends mainly on parent material; Bowen (1979) presented average value 0.89% with variation range 0.04–0.90%. Magnesium content was in sample at King George Island relatively high. *The phosphorus content* in the samples varied between 0.03 and 0.13%; the same variation range was reported by Vlček (2016) from James Ross Island. *The potassium content* of samples varies between 0.07–0.27% and *sodium content* 0.14–0.58%. The sodium content could be commonly lower than content of potassium (minerals with sodium are more unstable) but in polar soils is only limited content of liquid water. It could be reason why total sodium (or potassium) content in our soil samples had so high value.

Acknowledgement

The Author is grateful to the Research infrastructure of the Johann Gregor Mendel Czech Antarctic Station at James Ross Island.

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DIFFERENCES IN HEAVY METAL CONCENTRATIONS IN ARCTIC LICHEN *CETRARIELLA DELISEI*

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Keywords: bioindicator, contamination, lichenized fungi, Spitsbergen

All abiotic and biotic elements of the arctic ecosystems receive contaminants from sources localized far outside the polar region. The majority of contaminants accumulate in the substrate from which the heavy metals are then taken up by vegetation. Lichens are an exception due to their anatomy and morphology, and can accumulate pollution both, from the ground, and directly from the air. Because of the ability of contaminant absorption from the air, lichens are among widely used bioindicators of heavy metal pollution in the Arctic. A macrolichen *Cetrariella delisei* seems to be an interesting alternative in heavy metals biomonitoring in the Arctic: it is widely distributed, easy to identify and reluctantly grazed by reindeer. Levels of heavy metals in its thalli are similar to these in other lichens used as bioindicators, which are currently rare due to overgrazing by reindeer. The two main aims of the study were: 1) a comparison of levels of selected heavy metals in thalli of Cetrariella delisei and in the surface of soil layer, and 2) designation of the main factors influencing deposition of heavy metals in the lichens, which are the primary component of the tundra. Research were carried out in the Kaffiøyra Plain (NW Spitsbergen). *C. delisei* and soil samples were collected from 5 localities. In lichen and soil samples the contents of Cr, Mn, Ni, Cu, Zn, Pb, and Cd were measured. Furthermore, a bioaccumulation factor (BAF) was calculated. The accumulation of Cu, Mn, and Ni in lichen thalli was low. The Cr, Pb, and Zn contnets in *C. delisei* was higher than in soil. The Cd levels in lichen and soil samples were almost equal. Canonical Correspondence Analysis (CCA) and permutation tests show that the ground stability mostly influenced the majority of the heavy metals levels in the lichen thalli and in the soil.

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HEPATOTOXIC MICROCYSTINS AND NEUROTOXIC ANATOXIN-A IN BIOLOGICAL SOIL CRUSTS OF ARCTIC

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Keywords: cyanobacteria, cyanotoxins, BSC, Spitsbergen

Cyanobacteria, commonly called blue-green algae, are the dominant group of primary producers in terrestrial and freshwater ecosystems of Arctic. They first colonize the nutrient-poor habitats, thus they play a huge role in the primary succession on glacial foreland. Furthermore, blue-green algae form extensive mats, also known as Biological Soil Crusts (BSC). These structures constituting microhabitats for other cryptogams and vascular plants. Cyanobacteria are well known for the production of bioactive secondary metabolites that may be toxic to organisms coexisting with them in these microcommunities. The synthesis of toxins and their physiological and ecological role in high latitudes is still poorly understood.

The analysed fragments of BSC were collected in the Kaffiøyra Plain (NW Spitsbergen, Oscar II Land) in 2012 summer season. The analysis of cyanotoxins was conducted using high-performance liquid chromatography (HPLC) and electrospray ionization mass spectrometry (ESIeMS). Results showed the ability of cyanobacteria of Arctic to synthesize hepatotoxic microcystins (MCs) and neurotoxic anatoxin-a (ANTX-a) at the level of from 0.123 to 11.058 µg per g dry weight (DW) and from 0.322 to 0.633 µg per g DW, respectively. Anatoxin-a was determined for the first time both, in Arctic and in the entire polar region. In the studied fragments of BSC, the dominant taxa of blue-green algae were classified to the orders *Nostocales*, *Oscillatoriales* and *Chroococcales*. These orders were considered as potential producers of MCs and ANTX-a. In many ecosystems of Arctic, cyanobacteria seems to be the dominant component of plant communities. Because of that, their occurrence may be crucial for the relations between organisms forming not only microhabitats in the early stage of primary succession, but also in the mature tundra.

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DIFFERENCES IN THE LICHEN COLONISATION IN THE SELECTED FORELANDS OF ARCTIC GLACIERS

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Keywords: primary succession, glacier moraine, Svalbard,

Among other cryptogams, lichens are one of the main components of Arctic vegetation. Their participation in the formation of plant communities as a result of the primary succession process in deglaciated forelands of Arctic glaciers is also significant. The aim of the study was to investigate and compare lichen diversity in the forelands of three Arctic glaciers: Irenebreen (NW Spitsbergen), Longyearbreen and Rieperbreen (both localised in the central Spitsbergen). The localisations of study areas were chosen in term of different climate and microhabitat conditions. Research were carried out in summer seasons of 2008 (Longyearbreen), 2012 (Irenebreen) and 2015 (Rieperbreen) using chronosequence method. One linear transect consisted of 1 m^2 plots was designated across each of studied glacier moraine form the front of glacier to the end of foreland. In every plot the percentage cover of each species was recorded. Furthermore, additional 250 plots were made in each of studied moraines to compare lichen composition of forelands: 50 plots in Longyearbreen foreland, 100 plots in Irenebreen moraine and 100 plots in Rieperbreen foreland. Based on collected data, Detrended Correspondence Analysis (DCA) was performed to define the lichen composition similarity of the plots. In total, 135 lichen taxa were recorded: 88 species in the Rieperbreen foreland, 60 species in the Irenebreen moraine and 43 species in the Longyearbreen foreland. According to the DCA ordination, the lichen composition of Longyearbreen foreland differs the most in comparison to two other glacier moraines. Although forelands of Rieperbreen and Longyearbreen are located in the warmest area of Svalbard, which directly contributes to the high species diversity, the lichen composition of Longyearbreen moraine showed the smallest species diversity in comparison to Rieperbreen foreland where the lichen richness was the highest.

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NEW TOOLS FOR ARCTIC RESEARCH: DNA BARCODING THE ENTIRE COMMUNITIES OF PLANTS AND ANIMALS IN ZACKENBERG, NE-GREENLAND

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Keywords: DNA barcode library, species diversity, Greenland, high arctic, arthropods

DNA sequences offer powerful tools for addressing questions of community ecology: not only do they allow us to identify and describe the community members, but also to reveal the biotic interactions between them. Here, we present a recent study (Wirta et al. 2016) offering a comprehensive library of DNA barcodes for a terrestrial site, the Zackenberg region in Northeast Greenland. This library includes almost all macroscopic animals and vascular plants known from the region. A total of 403 terrestrial animal and 160 vascular plant species were

recorded by morphology-based techniques. DNA barcodes were created with high sequencing success using standard gene regions (CO1 for animals; *rbc*L*a* and ITS2 for plants). 92% of the animal taxa were assigned to unique Barcode Index Numbers (BINs) and 93% to monophyletic clusters. For the flora, the discriminatory power was lower, with 54% of the plant species forming monophyletic clusters based on information combined from barcode regions *rbc*L*a* and ITS2 (Figure 1). In evidence of the utility of the library created, we applied it to community samples of arthropods from Malaise traps, thus resolving compositional turnover in space and time. Nearly 20 000 arthropod individuals were identified from Malaise trap catches, revealing 122 BINs not detected by previous sampling and DNA barcoding. The insect community proved to be dominated by a few highly abundant taxa, with Diptera being the most abundant order, and Chironomidae the most abundant family. Thus, the DNA barcode library established for the Zackenberg region now offers scope for ecological explorations, for the detailed dissection of interspecific interactions throughout the community, and for long-term monitoring. Importantly, the development, application and curation of the library rely heavily on constant collaboration and feedback between ecologists and taxonomists.

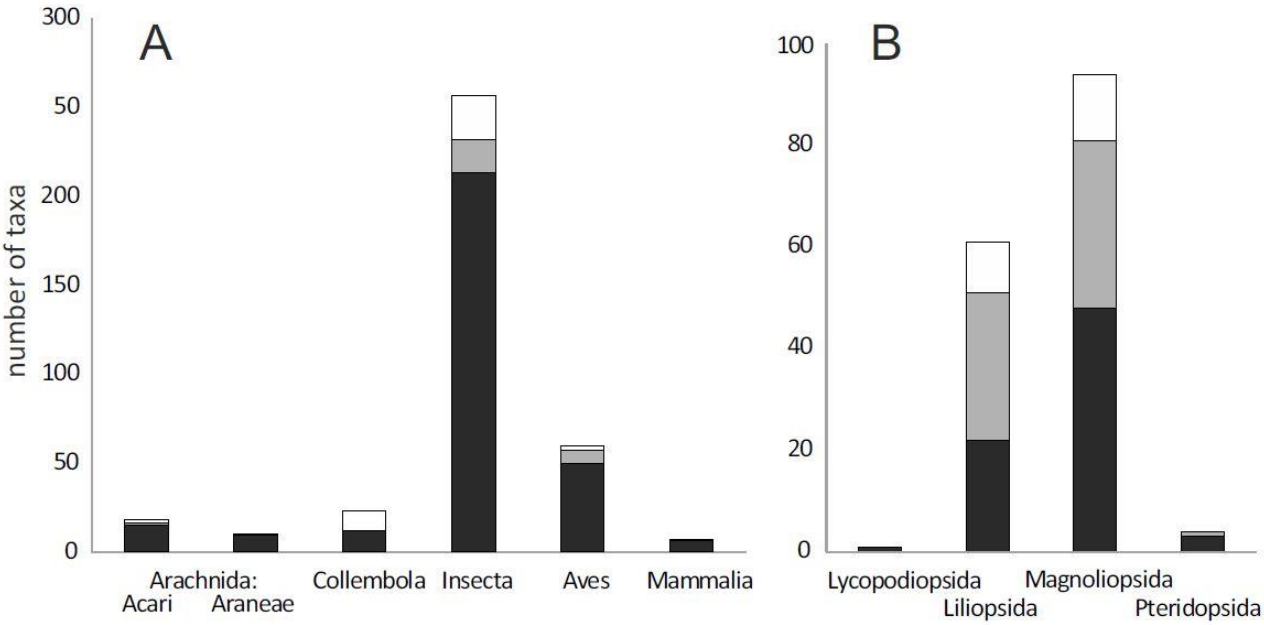

Figure 1. Coverage and discriminatory power of DNA barcodes for the terrestrial (A) fauna and (B) vascular plant flora of Zackenberg, with bars representing classes. For animals, we show the number of taxa for which each molecularly-defined BIN can be attributed to a single morphologically-defined taxon (black fraction); for which the same BIN is shared among multiple taxa (grey fraction), and for which a DNA barcode is missing (white fraction). For vascular plants, we combine information from barcoding regions *rbc*L*a* and ITS2, showing the number of taxa for which combined information will yield monophyletic clades attributable to a single morphologically-defined taxon (black fraction); for which each such molecularly-defined clade splits into several morphologically-defined taxa (grey fraction), and for which the DNA barcodes are missing (white fraction). Figure from Wirta et al. (2016).

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GLACIAL ZYGNEMATOPHYCEANS HIDDEN DIVERSITY?

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The surface of inland glaciers and ice sheets of the Arctic harbors a community of zygnematophyecan microalgae. The community composition and its ecological requirements differ from microbial assemblages in cryoconite. The dynamics of this community is a significant player in the surface albedo changes of the Greenland ice sheet. We focus on the phylogenetic position of these algae among streptophycean algae and plants and their proximity (phylogenetic or functional) to evolutionary process at the base of the terrestrial plants. The present lack of cultures makes the acquisition of robust molecular data difficult, so the first insight is based on environmental DNA amplicon sequencing. This data should give us the answer to a very basic question about the diversity of glacial algae: Do we see the same diversity based on morphology as we do using molecular taxonomy? And if not, how different is the hidden diversity of glacial algae?

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