ECOSYS 2014

Functioning of Antarctic Terrestrial Ecosystems in Changing Environment
Satellite meeting Polar Ecology Conference
České Budějovice, 24.9.2014
http://www.sci.muni.cz/ECOSYS-2014/

Editorial Note - ECOSYS 2014

Dear Czech Polar Reports readers,

it is a great pleasure for me to introduce the below abstracts to you. They are related to the ECOSYS 2014 workshop held in České Budějovice as a satellite meeting of the Polar Ecology Conference. We asked several authors, young specialists and early career polar scientists, who presented oral presentations at ECOSYS 2014 to submit their abstracts to one of the forthcoming issues of the Czech Polar Repors (CPR). The abstracts are presented in this CPR issue together with the abstracts from another meeting: Antarctic Biosciences (Brno, December 2015) – *see* also the Editorial Note (Antarctic Biosciences).

Prof. M. Barták
CPR Editor-in-Chief

Adaptations of a native Subantarctic flightless fly to dehydration stress: more plastic than we thought?

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Introduction

Physiological plasticity allows adaptation to different environmental conditions, and is critical for the persistance of species endemic to rapidly changing ecosystems, such as Subantarctic terrestrial ecosystems. Water availability is one of the main challenges for invertebrates inhabiting polar regions, because water is biologically unavailable for most of the year, and many polar arthropods have developed adaptations to cope with dehydration. However, these mechanisms are energetically costly and organisms need to balance their allocation of resources. We used a flightless fly, native to the Kerguelen Islands, *Calycopteryx moseleyi* as a model organism, to investigate local adaptations to dehydration stress. *C. moseleyi* is able to exploit two environments with contrasting relative humidity (RH) and salinity: the axils of the leaves of the native Kerguelen cabbage (*Pringlea antiscorbutica*; ~80% RH, non-saline conditions) and decomposing seaweeds in rocky seashores (~60% RH and salinity of up to 70 ppt). Populations of *C. moseleyi* inhabiting each of these habitats have shown distinct molecular and morphological adaptations, in particular with relation to saline stress, resulting in two distinct ecophenotypes. Here we investigate local adaptations of the two ecophenotypes of *C. moseleyi* to dehydration stress. Flies from each ecophenotype were collected from two localities in the field and raised under controlled, low (10%-40%) and ambient (65%) RH conditions in the lab. Initial differences in morphology (*i.e.* body size) and body water content were assessed, as well as physiological responses to reduced RH conditions (*i.e.* dehydration tolerance and survival rates).

Results and discussion

The two ecophenotypes differed in body size, with flies living under seaweeds being larger, but had similar percentages of body water content ranging between 62-84%. Flies from the two populations also differed in their dehydration tolerance; flies from seaweeds were more sensitive to water loss, tolerating losses of up to 45% (vs 57% in cabbage flies). Rates of water loss at low humidity (40%) only differred initially (1 hr after the start of the experiment) and were higher for the cabbage ecophenotype, but declined and remained similar thereafter. Our results suggest a high plasticity in dehydration-related traits in *C. moseleyi*, with local adaptations potentially playing a role in the persistence of wild populations.

Quantification of iron-rich volcanogenic dust emissions and deposition over ocean from Icelandic dust sources

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Iceland has extremely active dust sources that result in large scale emissions and deposition on land and sea. The dust has volcanogenic origin of basaltic composition with about 10% Fe content.

We used two independent methods to quantify dust emission from Iceland and dust deposition on sea. Firstly, aerial extent (map) of deposition on land was extended to ocean areas around Iceland. Secondly, survey of number of dust events over the past decades and calculations of emissions and sea deposition for the dust storms were made. The results show total emissions range from 30.5 (dust event based calculation) to 40.1 million tons (map calculation), which places Iceland among the most active dust sources on Earth. Ocean deposition ranges between 5.5 (dust events calculations) and 13.8 million tons (map calculation). Calculated iron deposition from Icelandic dust ranges between 0.56 to 1.4 million tons, which are distributed over wide areas (> 370 000 km^2) and consist of fine reactive volcanic materials.

We provided the first quantitative estimate of total dust emissions and oceanic deposition from Iceland. Iron is a limiting nutrient for primary production in the oceans around Iceland and the dust is likely to affect Fe levels in Icelandic ocean waters.

Active layer thickness variability at the Johann Gregor Mendel CALM-S site on James Ross Island. Preliminary results

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Introduction

Active layer is considered one of the most vulnerable part of cryosphere due to recent climate change. The Circumpolar Active Layer Monitoring (CALM) program is one of the methods of active layer monitoring in both hemispheres. The CALM-S protocol (Circumpolar Active Layer Monitoring South) was implemented due to specific conditions in Antarctica, especially rocky terrain which limits mechanic probing (Guglielmin, 2006). Only eight CALM-S sites were established in the Antarctic Peninsula region before 2010 (Vieira et al. 2010). This contribution provides basic information about the CALM-S site established at the northern part of James Ross Island during the Czech Antarctic Expedition 2014.

Methods

CALM-S site was established on a flat ice-free area on a marine Holocene terrace (8–10 m a. s. l.) located about 150 m south of the Johann Gregor Mendel (JGM) Station. The grid area was limited to 80 x 70 m due to presence of the JGM technical facilities in the neighbourhood of the area (north), and rocky surface too hard for probing (south) *see* Fig. 1. Thin metal probing rode was used for an active layer thickness measurement in each of 72 grid points. Ground temperatures were recorded by two automatic monitoring systems (EdgeBox V12, EMS Brno) at depths from 5 to 200 cm. Moreover, heat flux and soil moisture sensors were installed inside the CALM-S site area up to 20 cm depth and 50 cm depth respectively. General climate characteristics (air temperature, global radiation, albedo, snow thickness, surface wind speed and direction) were provided by meteorological station located in the corner of the grid (Fig. 1).

Results and conclusions

The first measurement of the active layer thickness (ALT) was carried out on the 6th February 2014, *i.e.* the last day with continuously unfrozen active layer in the thawing season 2013/2014. The results of ALT measurement showed that the average thickness reached 66 cm with the variability ranging between 50 and 100 cm. Laboratory analysis showed great differences in soil thermal conductivity (λ) between the parts of the grid with the active layer thicker than 80 cm ($\lambda = 0.90$ $Wm^{-1}K^{-1}$) and the parts of the grid with the ALT lower than 60 cm ($\lambda = 0.16$ $Wm^{-1}K^{-1}$).

Results of the field measurement and laboratory analysis indicate that soil physical properties should be the most important factor which controls the local differences in the active layer thickness. The use of Ground Penetrating Radar to detect and map the permafrost table and different soil properties inside the CALM-S site should be one of the main perspectives for further research.

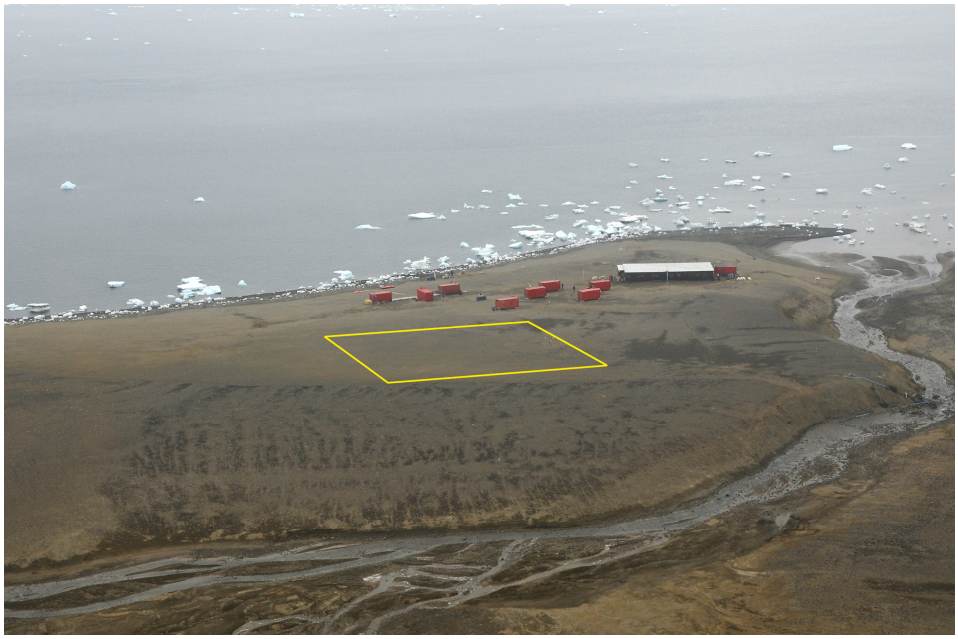

Fig. 1. Aerial photo of the CALM-S site (indicated by a yellow rectangle) located close to the Johann Gregor Mendel Station.

Acknowledgements

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Seasonal changes in microbial diversity, biological activity and nutrient cycling in snow and ice-bound ecosystems on Signy Island, maritime Antarctica

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Continued warming of the maritime Antarctic is leading to expansive areas of snow and ice becoming increasingly biologically active, resulting in an increased flux of microorganisms and nutrients from snow and ice-bound habitats to the marine environment. Microbial abundance on the surface of glacier ice alone is estimated to be 10^{14}-10^{17} cells per km^{-3} making it the largest freshwater reservoir of microorganisms on Earth. Due to the recent rapid regional warming in West Antarctica and around the Antarctic Peninsula in particular, large masses of ice and snow have been lost into the surrounding ocean (~180 Gt of ice $year^{-1}$). With this ice, around 16 Gg of organic carbon are also released every year and transferred into the ocean, but the ecological implications of such loading for the marine ecosystem remain unclear.

We aim to assess climate forcing on biogeochemical activity in snow and ice-bound ecosystems in the maritime Antarctic and to estimate nutrient and biomass export by glacier meltwater into terrestrial habitats and coastal waters. Microbiology, nutrient economy and productivity of snow and ice surface habitats were assessed at two major glaciers on Signy Island (South Orkney Islands) in maritime Antarctica. These sites represent the broad range of melting and nutrient gradients found along much of the Antarctic Peninsula's west coast and associated archipelagos. Microbial community structure and biomass changes were studied in snowpack, slush and superimposed ice during the austral summer 2012-13 using molecular techniques, phospholipid fatty acid analysis and flow cytometry. Fluxes of carbon, nitrogen, phosphorus and iron were also monitored throughout the season within snowpacks and the runoff they produced in order to estimate the timing and magnitude of nutrient transfer into the nearby coastal waters. Net ecosystem production, respiration and photosynthesis of the snow and ice-bound habitats were evaluated using radioisotope labelling (^{14}C and ^{3}H) and CO_2 flux measurements. This multidisciplinary approach enabled us 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 ecosystems.

Workshop 2015: ANTARCTIC BIOSCIENCES

December 7th 2015, Faculty of Science, Masaryk University Brno, UKB, Kamenice 5, building A13, room 332
http://www.sci.muni.cz/biosciences/

Editorial Note - Antarctic Biosciences, 2015

Dear Czech Polar Reports readers,

in December 2015, a national workshop entitled Antarctic Biosciences was organized at the Masaryk University, Brno, Czech Republic. Since the workshop met great success and the participants suggested establishment of an annual event, we decided to publish abstracts from the workshop to attract a broader international scientific community to attend the forthcoming workshop BIOSCIENCES IN POLAR AND ALPINE RESEARCH 2016, that will be organized on November 23rd, 2016 in Brno. For further details, please *see* http://www.sci.muni.cz/biosciences/.

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Physiology and 3D structure of the *Nostoc* sp. colonies

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Cyanobacterium *Nostoc* sp. is a significant primary producer in Svalbard where it provides important C and N inputs into the Arctic ecosystem. The microclimatic conditions at upper exposed surface of a colony and the lower shaded one are different, since the upper surface (*i.e.* air-colony interface) is exposed to more intense irradiation (VIS and UV) and drier conditions than the lower one (colony-soil interface). Although photosynthetic activity, evaluated by fluorescence imaging, of both surfaces is comparable and is driven by irradiance, the colony structure seems to play important role in the change of photochemical parameters. To assess the internal structure in Svalbard, a method for 3D imaging using light microscope was tested. Indeed, the 3D imaging revealed heterogeneity in the vertical profile of the *Nostoc* sp. colonies. The exposed surface is characterized by higher density of the filaments than the shaded one. The higher number of cells at the exposed surface may improve photon absorption the in low-light conditions and may participate in protection to excessive irradiance in the high-light ones.

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Diversity of microfungi from James Ross Island, Antarctica

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Antarctic microfungi diversity research was made during three austral summers of 2007 - 2009 at north part of James Ross Island (Ulu Peninsula). Totally, 286 isolates of filamentous fungi were obtained from 67 soil crust samples and other substrates. *Geomyces pannorum* var. *pannorum*, *Phoma herbarum*, *Mortierella* spp., *Cladosporium* spp. and *Penicillium* spp. were most frequent taxa. The majority of isolates were cosmopolitan, cold-tolerant mesophilic species belonging to the anamorphic Ascomycota. Only *Thelebolus microsporus* and black meristematic fungi were psychrophilic. *T. microsporus*, obtained from soil inside bird colonies, was only one strains reproduced sexually. Black meristematic fungi were isolated from cold habitats of the Ulu Peninsula.

These strains have optimum grow at 10-15˚C. They are unable to grow at temperatures above 20-25˚C. Meristematic strains showed ability to grow in up to 3-5% NaCl content in the test of salt tolerance.

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Some parasites like it cold: parasitological research progress in Prince Gustav Channel, Antarctica

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Parasitological survey on various Antarctic notothenioid fishes and one south polar skua (*Catharacta maccormicki*) was carried out during the Austral summer seasons 2012-2014. Fish were caught at the Prince Gustav Channel off the Johann Gregor Mendel Station on the James Ross Island. Metazoan parasites belonging to all major groups (Acanthocephala, Cestoda, Crustacea, Digenea, Hirudinea, Monogenea and Nematoda) were recovered. Up to now, the species identification based on morphological and morphometric analyses of taxonomicaly important features has shown the presence of 21 species: two crustaceans (one copepod and one isopod), two hirudineans, seven monogeneans of the genera *Gyrodactylus* and *Pavloskioides* and eight digeneans, including seven endemic to Antarctica. The digeneans belonging to the families Hemiuridae, Lepidapedidae and Opecoelidae were morphologically and molecularly characterised and identified. Additionally, nematode specimens which were collected from the skua's regurgitated pellet were genetically identificated as *Contracaecum osculatum*. Ongoing identification of the remaining parasitological material may reveal higher parasite diversity.

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Distribution of Genus *Phormidesmis* in Polar Regions

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Genus *Phormidesmis* was considered tropical according type species *P. molle*. Previously only one Antarctic endemic species *P. priestleyi* was described. We collected 26 strains of *Phormidesmis* in different habitats of both polar regions. Ecology of these strains can be categorized to 4 groups: Group 1 was collected from wet rocks and aeroterrestrial habitats with hight UV radiation, group 2 was isolated from the soil crusts in deglaciated coastal area in Maritime Antarctica and deglaciated hills in Arctic, group 3 formed microbial mats in cold streams in Antarctica, group 4 was collected from the hot springs in Arctic, and coastal pools and waterfall seep in Antarctic. Using polyphasic approach we compared genetic, morphological and ecological parameters of sampled strains. This allowed us to taxonomically transfer 3 previously described species and define 2 new polar species in this genus.

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Modern methods for detection of biological active compounds in cyanobacteria from polar regions

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Cyanobacteria are dominant component of biota in polar regions. In such extreme environment, they have to deal with combination of stress factor, such as lack of liquid water, lack of sunlight, low temperature, few nutrients and high dose of UV-radiance. Their success in such harsh condition suggests high level of adaptation and with this associated production of interesting biologically active compounds. Generally, the blue-green algae are well known for their ability produce a lot of various substances with diverse mechanisms of action. However, detection of such compounds is relatively expensive affair. But, I would like to present a several methods useful to effective detection of these interesting substances. In particularly, among those techniques belong to *in vitro* and *in vivo* biotests. These methods suggest relatively cheap and fast access to detection different group of compounds and they can provide suitable way for screening of biologically active compounds which are produced by cyanobacteria from polar regions.

Antarctic bacteria as a source of new antimicrobials

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Problem of antibiotic resistance leads to increasing activity in new antimicrobials searching. Bacteriocins are proteinaceous toxins produced by bacteria against another microorganisms. Cold-adapted bacteria have been neglected source of new antimicrobial agents. In this study, inhibition agents secretion was tested in 36 pseudomonads isolated in James Ross Island. Production of bacteriocins was confirmed by susceptibility to proteases, PCR detection and electron microscopy, respectively. Their activity was subsequently tested against 111 clinical strains of *Pseudomonas aeruginosa*. Twenty-one strains (58%) were capable to produce antibacterial agents, in all cases bacteriocins. The temperature significantly influenced bacteriocin production, boosted at low temperature. Negative PCR detection of known bacteriocin type suggesting detection of fully new types, but this will be confirmed by hybridization assays. Two strains, *Pseudomonas prosekii* 2406 and *Pseudomonas* sp. 2663, produced bacteriocin was active against 46.8% and 9% of clinical strains, respectively. In conclusion, cold-adapted bacteria showed to be reservoir of novel cold active antimicrobials with possible impact on clinical important pathogens.

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