Report on Polar ecology training course on Czech research base in Petuniabukta, Billefjorden, Svalbard

POLAR ECOLOGY COURSE SVALBARD 2012

Centre for Polar Ecology
University of South Bohemia in České Budějovice
Czech Republic

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INVESTMENTS IN EDUCATION DEVELOPMENT

The Polar Ecology course is organized within the project Creating of Working Team and Pedagogical Conditions for Teaching and Education in the Field of Polar Ecology and Life in Extreme Environment, reg. No. CZ.1.07/2.2.00/28.0190 co-financed by the European Social Fund and by state budget of the Czech Republic.

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Cover photo: Jana Kvíderová

1. Introduction

The Polar Ecology course is provided by Centre for Polar Ecology (CPE) of the University of South Bohemia in České Budějovice, Czech Republic. The course is focused equally on both physical and life sciences in the Polar Region. The course itself consists of 1 week intensive theoretical preparation in respective fields of interest, and of approximately 10 days of field work at the Czech research station in Svalbard.

Of more than 160 applications, only 26 students were selected (Tab. 1). The theoretical part of the course took place in CPE facilities in České Budějovice during spring semester (28/05 – 01/06 2012). For the field work during the summer season in Svalbard, students were divided into six groups according to their specialization. The groups performed their field work in Svalbard on 02/07-16/07 2012 (botany/plant physiology + zoology/parasitology), on 16/07-31/07 2012 (geology/geomorphology + climatology/glaciology), and on 30/07-17/08 2012 (hydrology/limnology + microbiology/phycology).

For more information visit polar.prf.jcu.cz, please.

Tab. 1. 1. The instructors and students (in alphabetical order)according to their specialization.

Group	Instuctors		Students	
GEO	Martin Hanáček	MU+JU	Jiří Lehejček	UK
	Daniel Nývlt	CGS+JU	Peter Mida	UK
			Václav Stacke	OSU
			Gabriela Tóthová	MU
CLIMA	Zuzana Chládová	UFA+JU	Marie Doležalová	MU
	Kamil Láska	MU+JU	Filip Hrbáček	MU
			Eva Kadlčková	JU
			Petra Polická	UK
HYDRO	Jan Kavan	JU	Denisa Čepová	UPOL
	Kateřina Kopalová	UK+IBOT	Eva Hojerová	JU
	Linda Nedbalová	UK+IBOT+JU	Iveta Kodáková	UK
			Roman Juras	CZU
MICRO	Josef Elster	JU+IBOT	Petr Kotas	JU
	Jana Kvíderová	IBOT+JU	Marie Pažoutová	JU
	Marie Šabacká	JU+BAS	Ekaterina Pushkareva	JU
	Daria Tashyreva	JU	Lukáš Veselý	JU
BOTA	Alexandra Bernardová	JU	Radek Jupa	MU
	Tomáš Hájek	JU+IBOT	Petra Světlíková	JU
	Jitka Klimešová	IBOT+JU	Vojtěch Študent	JU
	Otakar Strunecký	IBOT+JU	Stanislav Vosolsobě	UK
ZOO	Miloslav Devetter	ISB+JU	Jiří Černý	JU
	Oleg Ditrich	JU	Jan Havlíček	JU
	Karel Janko	IAPG+JU	Kamil Hromádka	UPOL
	Václav Pavel	UPOL+JU	Eva Myšková	JU
	Tomáš Tyml	JU+PARU	Jiří Richta	JU
			Jindra Šíchová	JU

Abbreviations:
Groups: BOTA - botany/plant physiology; CLIMA - climatology/glaciology; GEO - geology/geomorphology; HYDRO - hydrology/limnology; MICRO - microbiology/phycology; ZOO - zoology/parasitology.
Affiliations: BAS – British Antarctic Survey, Cambridge (UK); CGS – Czech Geological Survey, Brno; CZU – Czech University of Life Sciences, Prague; IAPG – Institute of Animal Physiology and Genetics AS CR, Liběchov; IBOT – Institute of Botany AS CR, Třeboň; ISB – Institute of Soil Biology AS CR, České Budějovice; JU – University of South Bohemia, České Budějovice; MU – Masaryk University, Brno; OSU – University of Ostrava, Ostrava; PARU – Institute of Parasitology, České Budějovice; UFA – Institute of Atmospheric Physics AS CR, Prague; UK – Charles University, Prague; UPOL – Palacký University, Olomouc.

During the field part of the course, used sampling methods, sample processing and measurement procedures were recorded by Mr. M. Dvořáček.

2. Physical Sciences (Geosciences)

2.1. Geology and Geomorphology

Instructors: ***Martin Hanáček* & *Daniel Nývlt***

Students: ***Jiří Lehejček*, *Peter Mida*, *Václav Stacke* & *Gabriela Tóthová***

We continued with our study of the past and present glacial conditions of the Bertilbreen in the northern part of Billefjorden, Spitsbergen. Description of individual sediment types using clast shape and roundness and the reconstruction of debris transport history in the glacial system were undertaken beside glaciological field measurements on the Bertilbreen glacier. Glacier bedrock is composed of Devonian Old Red facies sedimentary rocks, Carboniferous clastic sedimentary rocks and Carboniferous to Permian limestones. Cobble clasts from the right-hand lateral moraine, frontal moraine and proglacial glaciofluvial sediments were studied. The upper part of the lateral moraine is composed mostly of passively transported supraglacial debris (originally unmodified scree, snow and scree/rock avalanche deposits) with a small proportion of actively transported clasts or reworked glaciofluvial sediments. Clasts in the middle part of the lateral moraine originate predominantly from the frontal moraine of a small glacier in the lateral valley. The lower part of the lateral moraine and frontal moraine of Bertilbreen are rich in subglacially transported material, which is supported by isometric clast shapes, roundness degree and common clast surface striations. Coarse gravel forms longitudinal bars in the glaciofluvial stream flowing from the glacier front. In the southern mouth of the valley, the proglacial stream grades into a braided outwash fan. Clast nature is affected by the source from the surrounding glacial deposits and bedrock outcrops, the impact of glaciofluvial transport on the clast nature increases in the braided outwash fan. Clast shapes are primarily influenced by bedding and fractures of source rocks, but are also significantly influenced by the type and proximity of material sources. Striation is cleared away the clast surface during the glaciofluvial transport. A morphostratigraphically older glaciofluvial terrace formed by glaciofluvial sediments deposited during the glacier advance culminating during the Little Ice Age is located at the southern end of the valley. The comparison of active proglacial stream sediments and those from older glaciofluvial terrace was done using the coarse pebble fraction. Detailed description of results from Bertilbreen glacier was presented at the Polar Ecology Conference held in České Budějovice as a poster. This year we started to work also on the glacial sediments of the Hørbyebreen located north of the Petuniabukta to compare different modification of sedimentary rock and crystalline rock clasts by glacier transport.

Short study of recent fluvial changes in the terminoglacial environment has been undertaken in the right-hand latero-frontal zone of Nordenskiöldbreen. This showed prominent changes of individual stream directions in the lateral position of the glacier connected with river piracy, ice-dammed lake creation and its sudden discharge connected with the retreating Nordenskiöldbreen during the last few years.

Monitoring of ground temperature variations in solifluction lobes and patterned grounds continued also during this year, together with the study of recent activity of the most common periglacial landforms in the northwestern coast of Billefjorden. The data allow us to reconstruct diurnal frost regime and shallow penetration of the freezing front in the shallow ground, which controls most of the frost action processes. Two methods were applied to the selected landforms to obtain quantitative data on the solifluction process. Plastic pegs were injected along vertical profiles (50 cm) into solifluction lobes and painted rocks were placed along the cross sections on the surface of sorted stripes. Position of the painted rocks will be recorded each year, whereas vertical profiles should be excavated in three to five years.

2.2. Climatology and Glaciology

Instructors: ***Zuzana Chládová* & *Kamil Láska***

Students: ***Marie Doležalová*, *Filip Hrbáček*, *Eva Kadlčková* & *Petra Polická***

In a frame of the Polar Ecology Course, climatological and glaciological fieldworks of the students were performed in the coastal ice-free zone of Petuniabukta and Bertilbreen (Bertil Glacier) in the period 18–30 July 2012. The main goal of the fieldwork activities was:

1) to carry out the standard meteorological measurements and observations at Petuniabukta according to the Guide to Instruments and Methods of Observations prepared by the World Meteorological Organization (e.g. WMO No. 8),
2) to study the relationship between present weather observations, cloudiness, cloud genera, and atmospheric circulation pattern in the central part of Svalbard archipelago,
3) to estimate an effect of local orography on the surface wind speed and direction in the coastal area of Petuniabukta and surrounding valleys,
4) to estimate the components of the surface energy balance of tundra vegetation at Petuniabukta,
5) to launch measurements of the glacier mass balance and ice-flow velocity of the Bertilbreen glacier by a dense array of the ablation stakes (PVC tubes) and stony points.

Meteorological observations

During the fieldwork students regularly carried out the observations every hour during the day and every two hours at night. They observed total cloud cover, cloud genera, cloud type and varieties, height of the cloud base, visibility, present and past weather conditions (during last hour) like occurrence of rain, drizzle, fog, photometeors, etc. (Fig. 2.2.1).

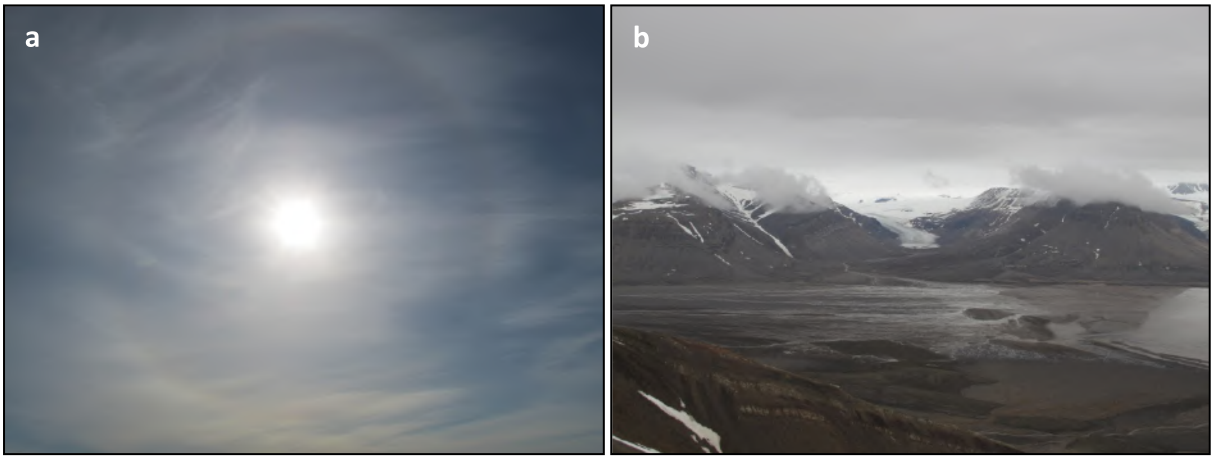

Fig. 2.2.1. (a) Little halo and occurrence of high-level (*cirrostratus*) and **(b)** low-level (*stratus fractus* and *stratocumulus opacus*, right) clouds at Petuniabukta (Billefjorden, Spitsbergen) in the period 18–30 July 2012.

Additional two anemometers were installed near the Czech polar research station. The first one near the Fortet Peak on the opposite coast of Petuniabukta at the height of 265 m a. s. l. (Fig 2.2.2.a) and the second one near the Mumien Peak at the height of 475 m a. s. l., where the measurement of air temperature and relative humidity were supplemented by the wind monitoring instruments (Fig 2.2.3.b).

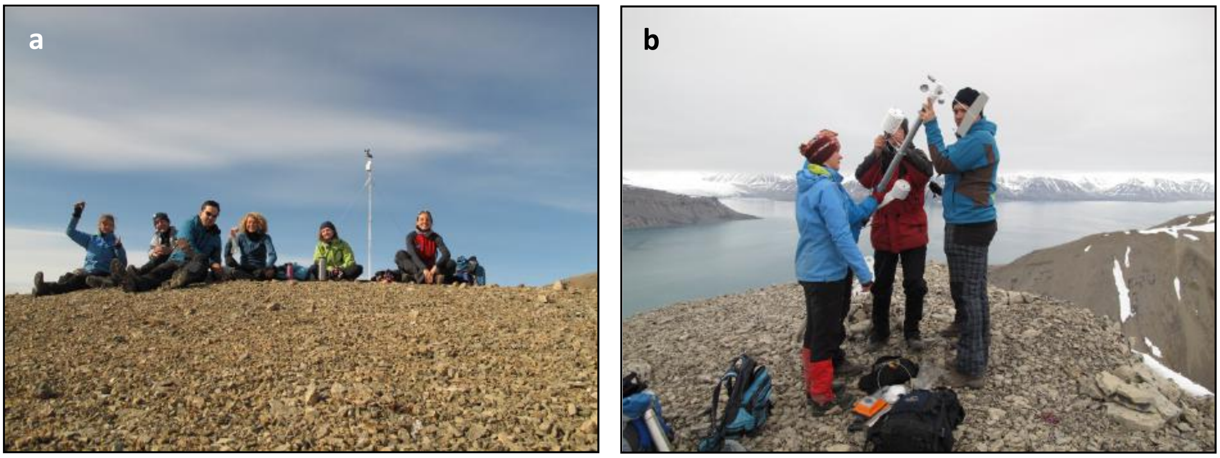

Fig. 2.2.2 Service and replacement of the wind monitoring instruments at **.** **(a)** Fortet and **(b)** Mumien Peak.

Glacier mass balance

Glacier mass balance measurement was carried out on the Bertilbreen glacier (northwest part of Billefjorden) in July 2012. First of all, glacier mass balance network (established in 2011) was renewed and supplemented by additional measuring points. New ablation stakes were drilled into the glacier surface using a portable hot water drill (Fig. 2.2.3.ab). The position and height of the stakes (Fig. 2.2.3 c) was measured using static GPS techniques. The observational network consists of 49 points placed in both the ablation and accumulation zones of the glacier (Fig. 2.2.4). Finally, meteorological station in the middle part of Bertilbreen was repaired and moved about 20 m to the center of the glacier.

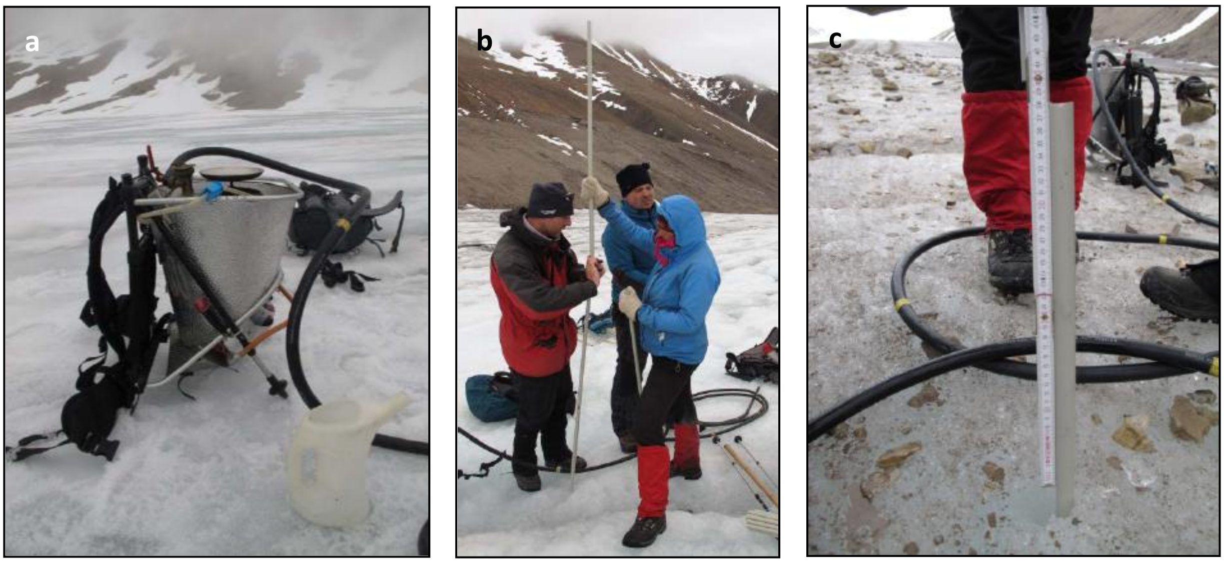

Fig. 2.2.3. **(a)** Portable hot water drill used for **(b)** installation of ablation stakes on the Bertilbreen in July 2012. **(c)**Measurement of the height and position of the ablation stakes.

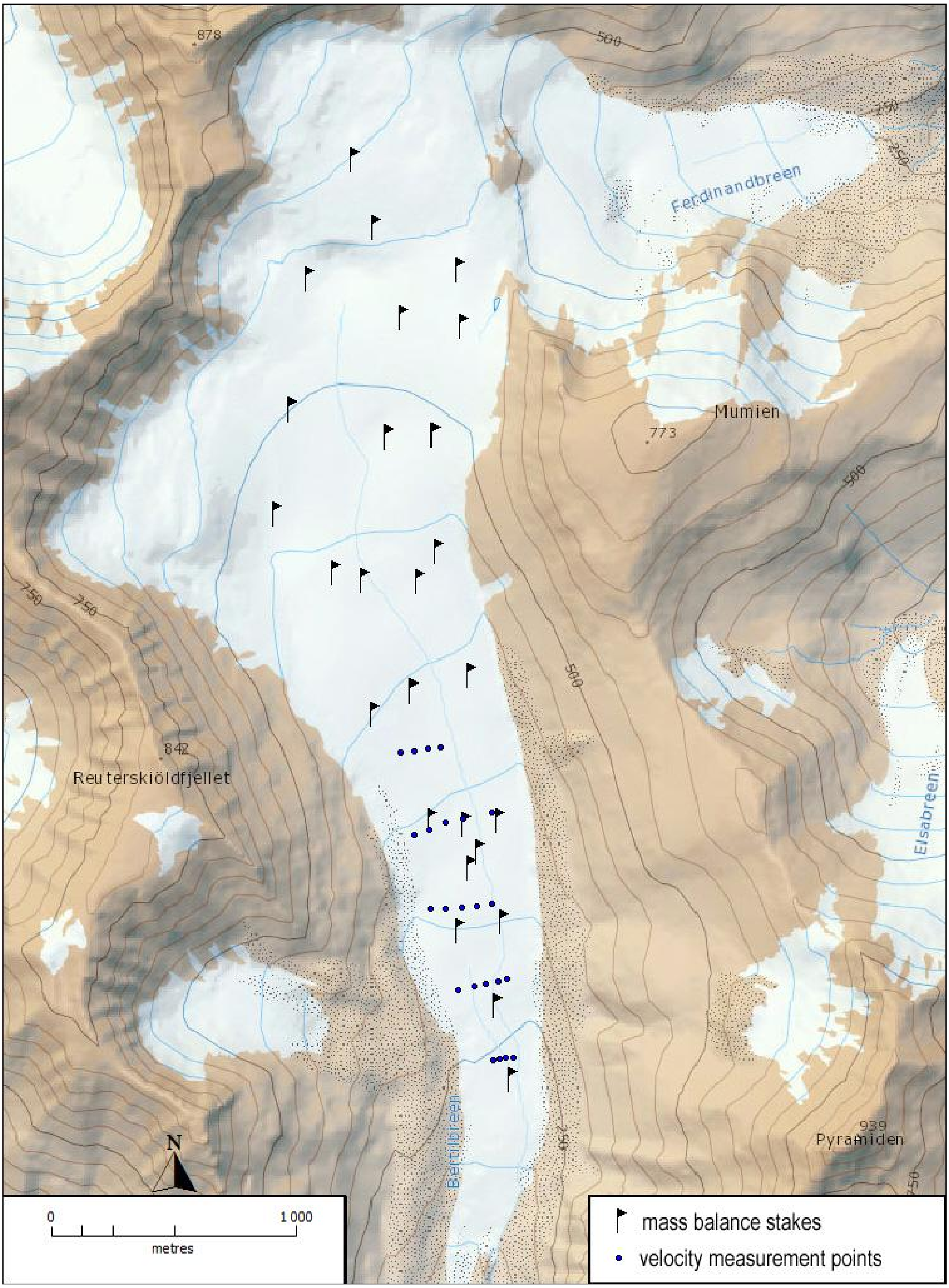

Fig. 2.2.4. Observational network on the Bertilbreen in July 2012.

2.3. Hydrology and Limnology

Instructors: ***Jan Kavan*, *Kateřina Kopalová* & *Linda Nedbalová***

Students: ***Denisa Čepová*, *Eva Hojerová*, *Roman Juras* & *Iveta Kodáková***

The main goal of hydrology/limnology group (fig.X) was to demonstrate specific features of polar aquatic ecosystems and how these can be studied directly in the field. The hydrology/limnology group has been organised in the manner, that all students have participated on two common projects. The first and main one was the study of lake ecosystems in the Billefjorden area. The second one was focused on study of hydrological and thermal regime of selected water streams. Apart that, all students had their own specialised projects focusing on one particular hydrological and limnological feature of the polar environment.

Fig. 2.3.1. Hydrology/limnology group at work.

The common project of lake ecosystems monitoring has built up on the similar project realised last season. The whole group has participated on measurements of the basic physico-chemical parameters (temperature, pH, conductivity, dissolved oxygen), as well as on the sampling of biological material for further analyses (fig.X). Biological samples were then examined using microscopy techniques directly at the research station. The data for construction of bathymetric maps have been produced using GPS sonar device. Besides this, a paleolimnological study on selected lakes has been done. Students were made familiar with several techniques used for lake sediment sampling, processing of the sampled material and preparation for further analyses.

Discharge measurements have been done on chosen water streams to demonstrate different reactions of catchments to climatic forcings. A highly glaciated catchment was compared with catchment without any ice cover. Field techniques of hydrological measurements have been demonstrated, and all students participated on the long-term project of establishing a hydrological monitoring network. Students had the opportunity to study this data after they have been downloaded at the end of expedition.

Fig.2.3.2. Working on the lake near Nordenskioldbreen.

Not only the freshwater ecosystems, but also the marine environment was studied. A gradient from Nordenskiold tidewater glacier towards deep sea environment was studied. Basic physico-chemical parameters were measured and the influence of freshwater inflow to marine environment was demonstrated. Vertical stratification of selected measured features was shown. Again zoo and phytoplankton samples were collected and later examined in the laboratory.

Lakes and their ecosystems

Denisa Čepová has studied general characteristics of lake ecosystems and their relationship to lake origin. The goal of the study is to bring new information about the dynamics of lake ecosystems, describe its morphology, physico-chemical characteristics and last but not at least also phyto and zooplankton diversity. Billefjorden and its surroundings is a rather heterogeneous region with different types of landforms to which different types of lakes are related. According to the origin and development of lakes, it is possible to distinguish several types of lakes. Most of them are related to glacial dynamics of the area especially during the deglaciation after Little Ice Age in the last 150-200 years (Rachlewicz et.al., 2007).

According to their origin, the lakes in Billefjorden can be divided to:

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

Table 2.3.1. Physico-chemical parameters of selected studied lakes.

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

Hydrologic regime and isotopic changes of δ^2H and δ^{18}O

The basic goal of Roman Juras´s project was investigation of hydrologic regime and isotopic changes of δ^2H and δ^{18}O. These were carried out in the Elsa river catchment. River channel is approximately 3 km long with quite high elevation gradient. This represents an example of braided river typical for this region. This means that the river flows in unstable channel/channels and carry large amounts of sediment load. Two samplings and measuring campaigns were carried out to study the flow rate changes and diurnal regime of the river flow. The largest changes in discharge in the catchment are related to precipitation events. Significant changes – especially strong diurnal regime – are however related to air temperatures and radiation level. Ice and snow melt stands for the main contributor to runoff. Melt water originating from Elsabreen glacier and adjacent snow fields as well as the melting permafrost layer are main sources of water available for runoff during summer season. The sources feeding the river flow can be distinguished on the basis of isotopic changes of δ^2H and δ^{18}O – these were therefore studied on sampled material.

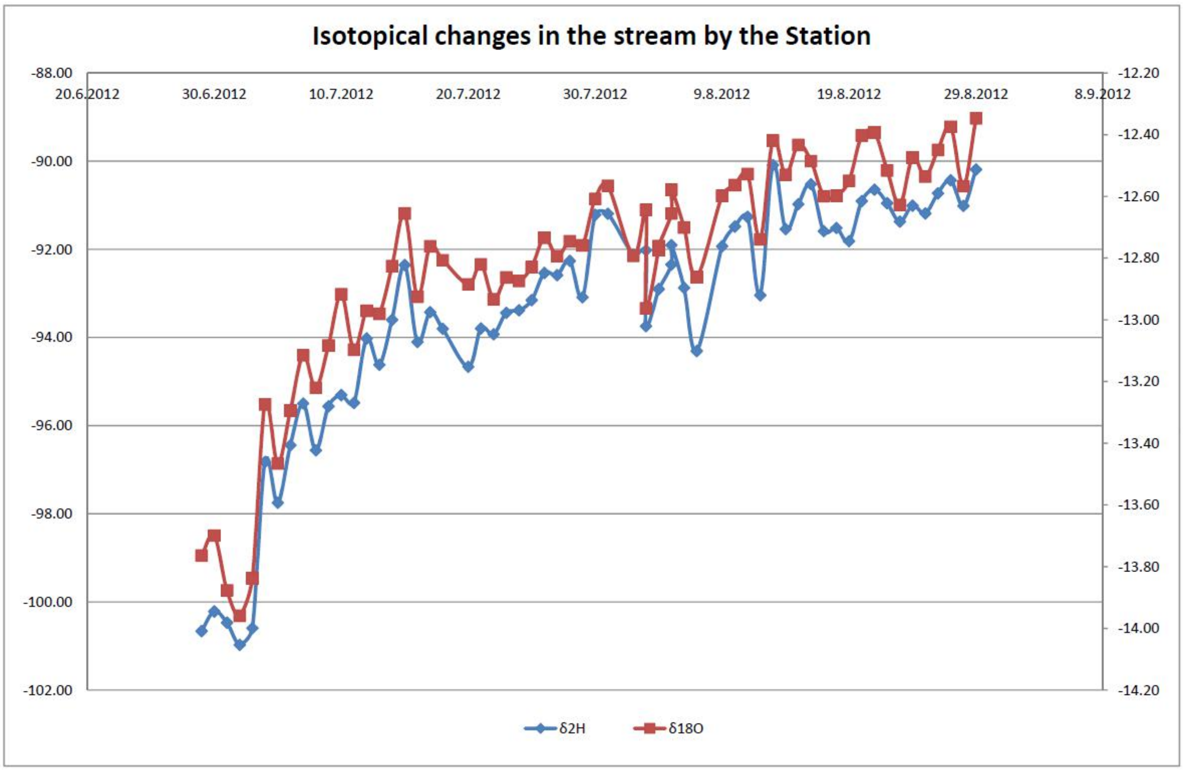

Fig. 2.3.4. Isotopical changes of the water samples from a study catchment.

Fluvial dynamics of Bertilbreen

Iveta Kodádková has focused on the study of fluvial dynamics of Bertilbreen river on the glacier foreland outwash plain. This area has been identified as highly dynamic during the 2011 season field campaign. Hydrological monitoring has been set up last year and continued throughout this season including manual discharge measurement. Two timelapse cameras have been installed to monitor the study area in regular intervals. Apart that, a detailed digital elevation model (DEM) was produced with help of laser scanning (LiDAR). This has been done in two timesteps (7days) with intention to compare the two DEMs and quantify precisely the amount of transported material as well as change in drainage system. Unfortunately, the study period was characterised by very stable weather conditions and subsequently also the hydrological regime was very stable leading to almost no change in drainage system. Significant changes has been observed only from the timelapse cameras in periods out of the LiDAR study.

Fig. 2.3.5. Comparison of two timelapse camera shots in 7 days interval in the beggining of July.

Aerobic anoxygenic phototrophic bacteria

Eva Hojerová was interested in occurrence of aerobic anoxygenic phototrophic bacteria (AAPs) in hydro-terrestrial and seawater systems in Petuniabukta region. Infrared kinetic fluorometry was used for determining of absence or presence of AAPs in water microbial community. Positive samples were fixed and analyzed in laboratory (after coming back from Svalbard) using infrared epifluorescence microscopy. Abundance of AAPs (red on the picture below), cyanobacteria and total prokaryotes (blue) was determined and calculated in 10 from 29 samples, only in freshwater. Amount of AAPs ranged between $9{,}5x10^3$ cell/ml^{-1} and almost $290x10^3$ cell/ml^{-1}, which represents 24% of total prokaryotes. The highest counts of phototrophic bacteria were found in oligotrophic lakes with high amount of nitrogen – BrucebyenI and BrucebyenII.

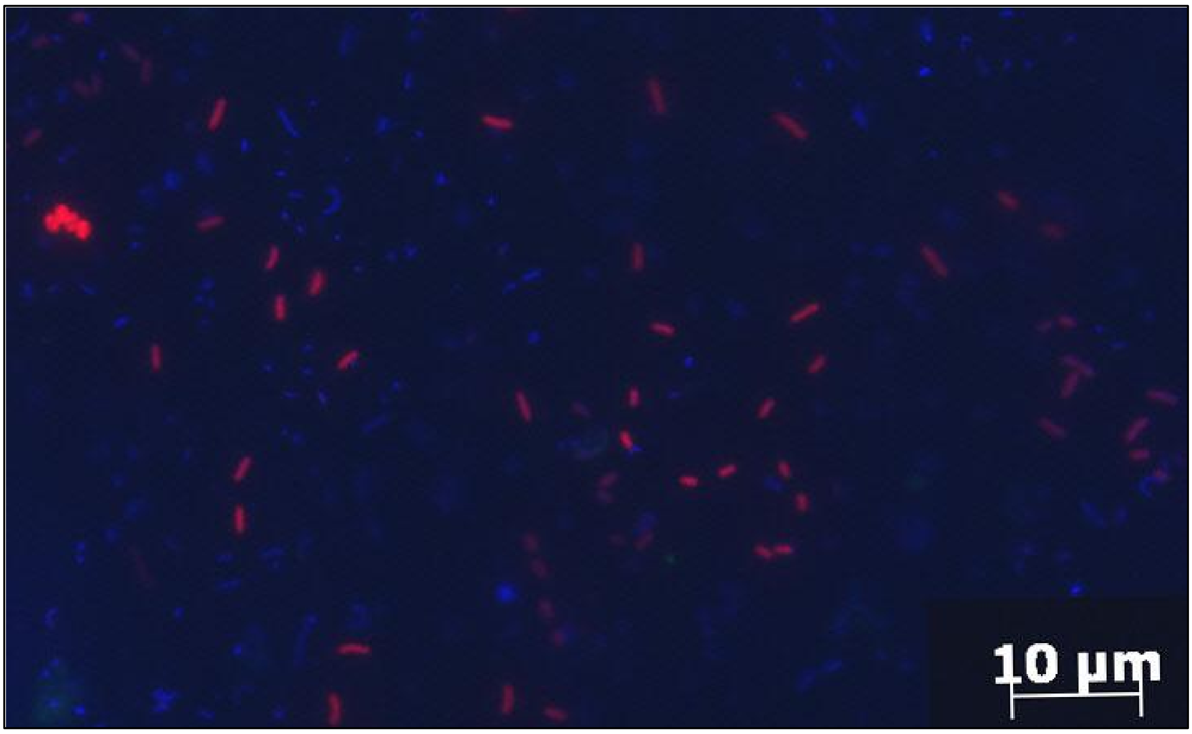

Fig. 2.3.6. AAPs on the microscopy photograph.

3. Life Sciences (Biosciences)

3.1. Microbiology and Phycology

Instructors: ***Josef Elster, Jana Kvíderová & Daria Tashyreva***

Students: ***Petr Kotas, Marie Pažoutová, Ekaterina Pushkareva & Lukáš Veselý***

The aim of the microbiology/phycology group was to characterize the microbial diversity of algae and cyanobacteria in various freshwater and aero-terrestrial biotopes (streams, pools and lakes, seepages, soil surface, wet rocks, snow, snow cryoconites) to get familiar with its respective communities and the most abundant algal representatives. We also sampled a longitudinal transect along a short freshwater stream ranging from its spring to its mouth into the sea to look at the changes of the benthic assemblages along the gradient.

Total of 146 samples were collected at 55 different localities during the course. We found 48 species without benthic diatom species which are being identified in laboratory now. The proportions of sampled habitats, communities and abundance of individual classes of algae and cyanobacteria are summarized in Fig. x.

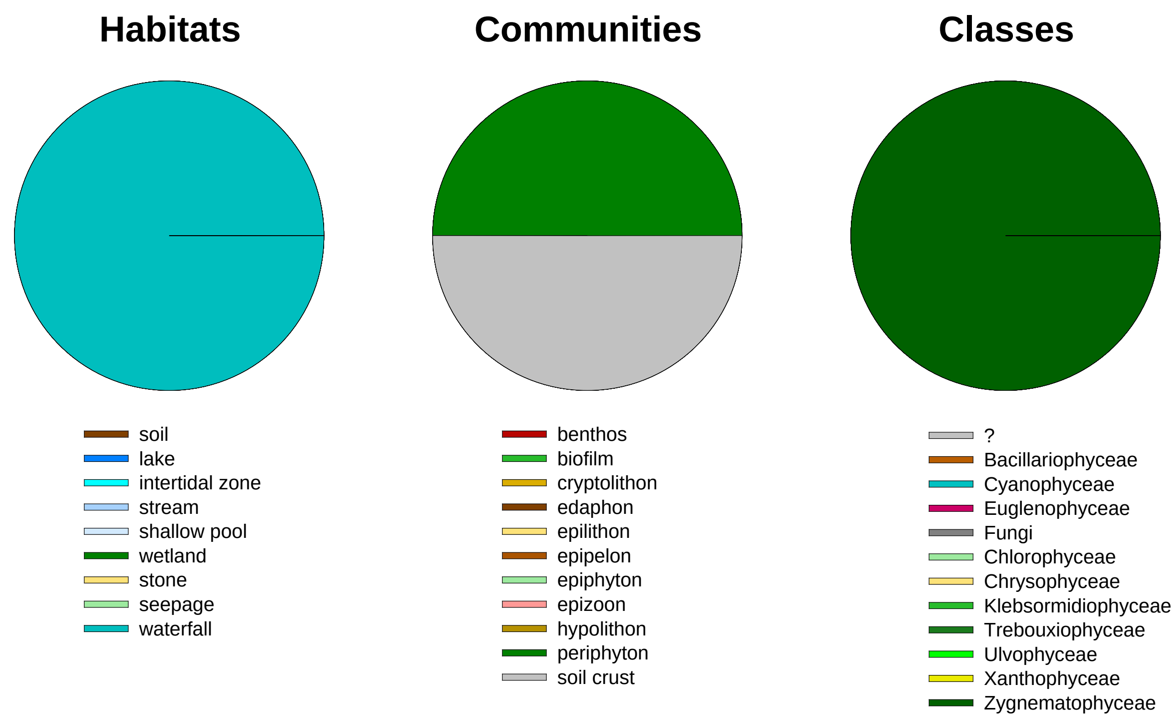

Fig 3.1.1. The proportions of sampled habitats and communities and abundances of individual algal and cyanobacterial classes(glacial and snow habitats are not included, since they are being proceeded).

Diversity of algae and cyanobacteria

The species that we found and determined belong mainly to three major groups of algae (sensu lato): prokaryotic cyanophytes and eukaryotic chromophytes (mainly desmids) and green algae. The macroscopic cyanobacterium *Nostoc* was the most conspicuous and dominant on soil surfaces, including the wet meadow with the open top chambers. Besides *Nostoc*, the most common cyanobacterium was *Phormidium*, growing in huge mats in streams and seepages, our favourite experimental species. The stream benthic communities were dominated either by *Phormidium* (Cyanobacteria), by various diatoms (Bacillariophyceae, Chromophyta) or by *Hydrurus* (Chrysophyceae, Chromophyta; Fix. Xx). Strikingly green *Zygnema* (Zygnematophyceae, Streptophyta) was most common in shallow pools, puddles and seepages. On the beaches near the Czech base, *Ulva* spp. (Chlorophyta, Fig. x) were found in the Petuniabukta littoral. Bright red spores of *Chloromonas* (Chlorophyta) represent common snow algae. The moistened walls hosted a colorful assemblages dominated by *Gloeocapsa* with concspicuous black, red and yellow mucilaginous sheaths. The surroundings of our field toilet supported the richest community of *Prasiola*, a macroscopic green alga well known from both polar regions (Arctic as well as Antarctic). The anthropogenic nitrogen-rich substratum hereby simulates the conditions of bird rookeries, which are known as favorite localities of some *Prasiola* species.

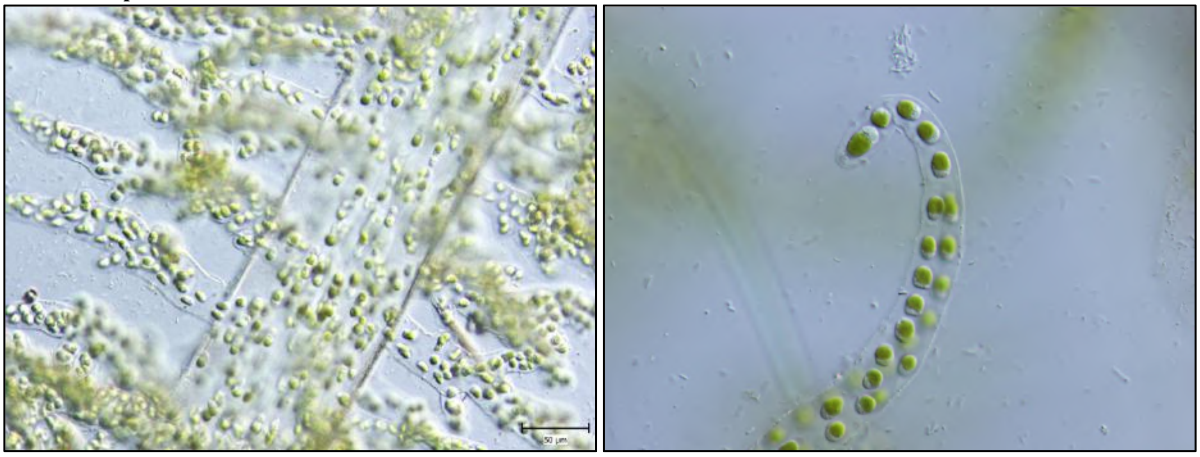

Fig. 3.1.2. *Hydrurus foetidus* (Chrysophyceae, Chromophyta) dominant species in clean cold fast-running streams.

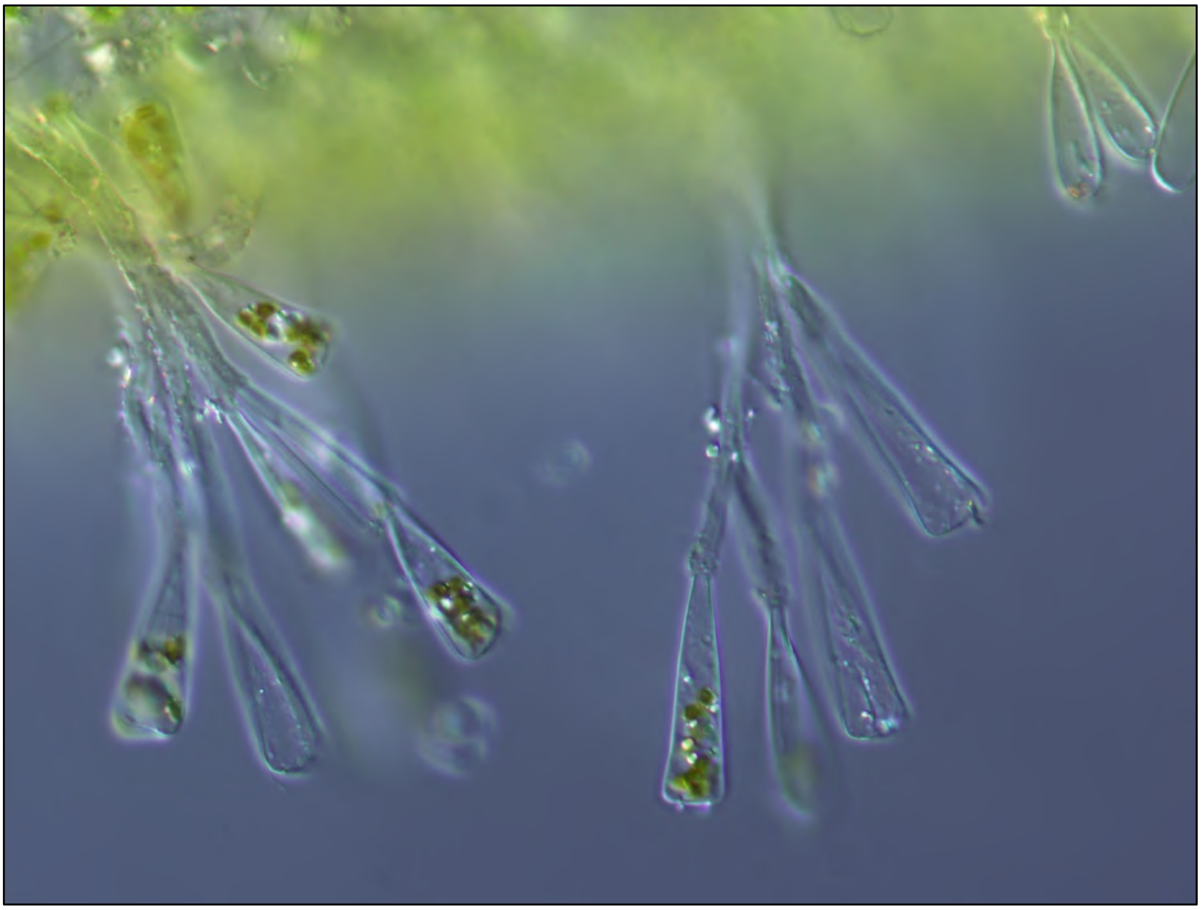

Fig. 3.1.3. *Ulva* sp. (Chlorophyceae) with epiphytic diatoms (Bacillariophyceae).

For a students' project, Marie Pažoutová, focused on green alga *Prasiola*, one of the most common genera of green algae in polar and cold-temperate regions. The samples were taken from aerial, freshwater and marine upper-tidal environment (1 freshwater, 1 upper intertidal and 5 terrestrial). We determined two different species out of 8 collected specimens, this material will be further analysed with molecular methods to account for several taxonomical as well as biogeographical hypotheses. *P. fluviatilis* was found in the freshwater sample; it formed a dense population attached to a stone in a fast-flowing stream. Some specimens with large blades were reproducing sexually; gametangial portions of the blades showed a mixture of dark and green patches similar to those of the marine species *P. stipitata*. *P. crispa* was found in the terrestrial samples; it occurred on bare soil, concrete and rocks at the upper tidal line.

Fig. 3.1.4. Macroscopic and microscopic photograpfs of *Prasiola* (Chlorophyta).

Diversity of algae and cyanobacteria in streams

In Arctic summer 2012, several shallow lotic and lentic freshwater habitats were selected for study of invertebrates feed pressure on benthic cyanobacteria and microalgae communities. The goal of this preliminary study was ecological reconnaissance of freshwater habitats suitable for the study of invertebrate feed pressure on communities of cyanobacteria and microalgae in north part of Billefjorden, Central Svalbard. For study was used artificial substratum (fiberglass nets) which were installed on the bottom of streams, pools and/or lakes. After fourteen days of incubation the nets were collected and evaluated for diversity of cyanobacteria, microalgae and invertebrates. We found that only in lotic environment cyanobacteria and microalgae started to overgrow nets. Most species were found in lotic habitats with stable stream beds. We found difference species diversity among the streams . Species composition among the stream was different (Fig. 3.1.5.). Relatively the most abundant species was diatom *Hanea arcus,* which was followed by chrysophyte *Hydrurus foetidus* (Fig. 3.1.2.) and filamentous cyanobacterium *Phormidium* sp. (Figs. 3.1.6. and 3.1.7.). Only two species of herbivores with different abundance in each stream were found.

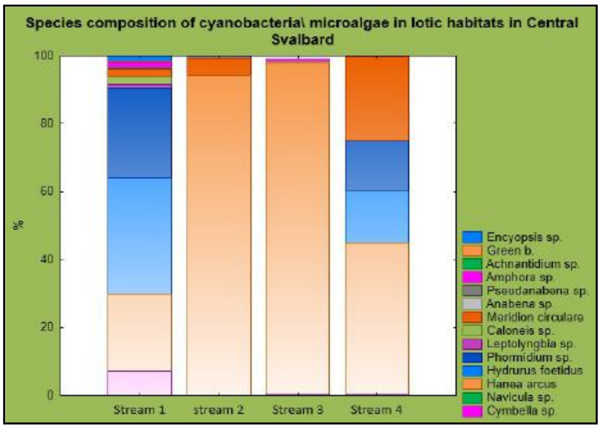

Fig. 3.1.5. Species composition of cyanobacteria and microalgae in four streams in Petuniabukta.

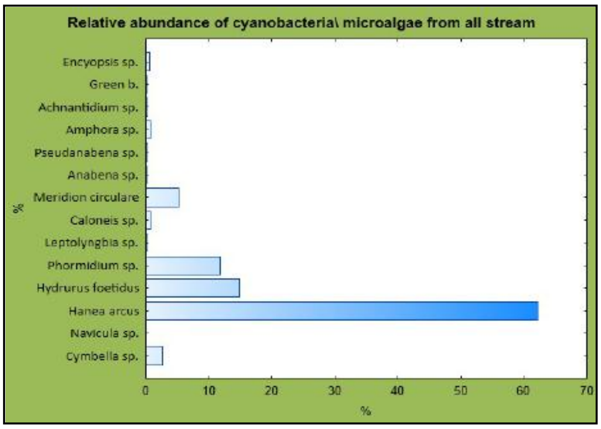

Fig. 3.1.6. Relative abundance of cyanobacteria and microalgae in all studied streams in Petuniabukta.

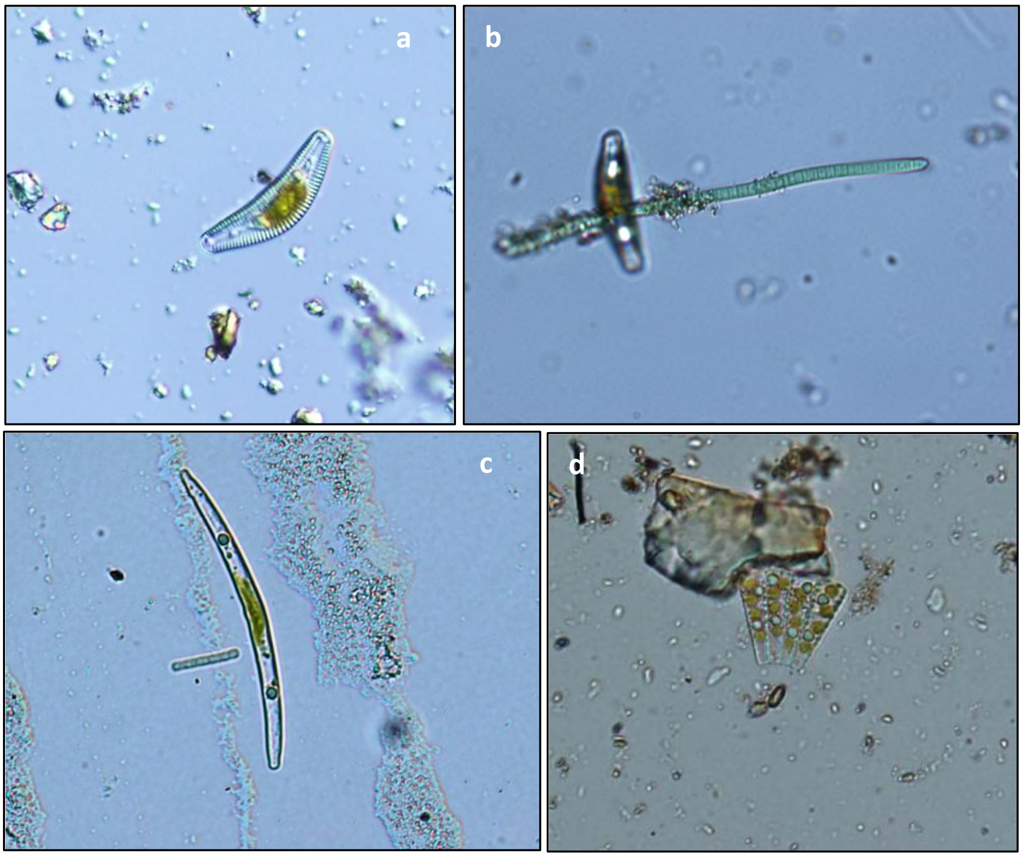

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Fig. 3.1.7. Dominant species of Arctic streams. **(a)** Diatom *Cymbela* sp., **(b)** cyanobacterium *Phormidium* sp., **(c)** diatom *Hannea arcus* and **(d)**diatom *Meridion* sp.

Soil crusts

Soil crust from studied area can be divided on three types: black-brown soil crust with low diversity of algae, brown soil crust with high diversity of algae, and gray-brown soil crust with low diversity of algae (Fig. 3.1.8.). In most cases cryptogamic crusts were dominated by cyanobacteria as *Gloeocapsa*, *Nostoc*, *Microcoleus*, *Scytonema*, *Komvophoron* and green algae as *Coccomyxa*, *Hormotila*. There was a high amount of *Trebouxia* in soil covered by lichens which have this alga as photobiont. Soil crust that is located in conditions with high humidity, usually was covered by *Nostoc*.

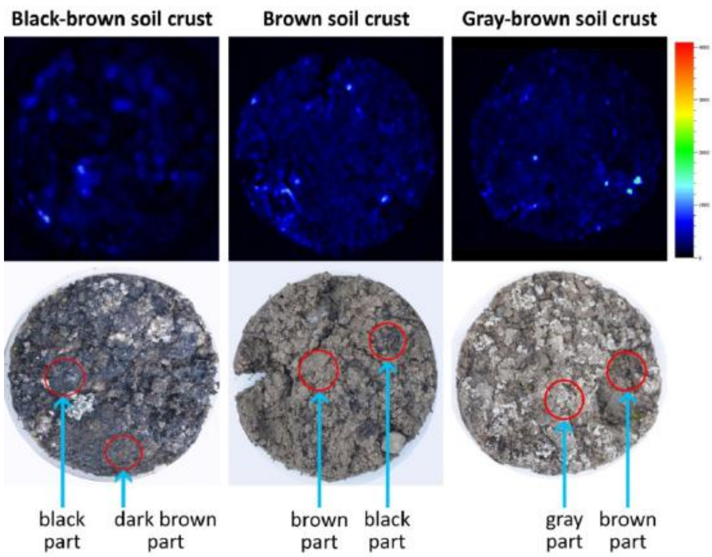

Fig. 3.1.8. The types of soil crusts. The upper row shows the 2D epifluorescence images of the crust visible using FluorCam 700MF fluorescence imaging camera (Photon Systems Instruments, Czech Republic). The false color scale is at right. The bottom row shows the crust image taken by normal digital camera.

Asssesment of viability of *Phormidium* seepage community

The viability and metabolic activity of *Phormidium* cells was assessed *in situ* in a seepage community (Fig. 3.1.9.) by staining with fluorescent dyes according to the cells' plasma membrane integrity (cell-impermeant nucleic acid dye SYTOX Green), nucleoid localization/ presence (cell-permeant nucleic acid stain DAPI), and respiration activity (redox dye CTC).

Fig. 3.1.9. *Phormidium* mat in a shallow seepage.

Diurnal cycles in photosynthetic activity of *Zygnema* sp. in Petuniabukta

The diurnal changes of phoptosynthetic acitivity of a *Zygnema* sp. population was studied *in situ* during a two day experiment in August, 2012. Two seepage communities dominated by a green algae *Zygnema* sp. were investigated for they photochemical features using method of rapid light curves measurement (the dependence on photosynthesis on light determined from variable chlorophyll fluorescence measurements). Following parameters were observed: temperature, pH, PAR and UVR intensity, QY (actual quantum yield), MQY (maximum quantum yield; QY after 15 min. adaptation in the dark) and rETR (proxy for the photosynthesis rate; rETR= QY*PAR*0.5).

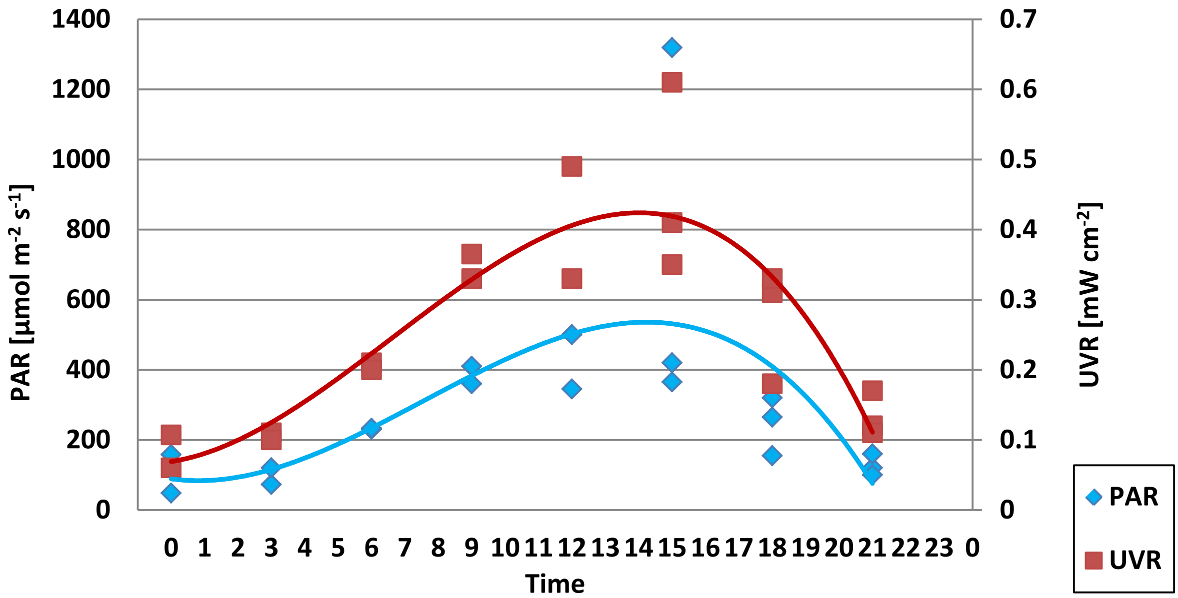

Fig.3.1.10. General daily progress of PAR and UVR intensity during a 57 h experiment.

Despite the polar day season, the PAR and UVR exhibit relatively strong diurnal oscillation with the highest irradiance in the afternoon and lowest at midnight time (Fig. 3.1.10.). In contrast, the MQY and QY values reveal decrease when the irradiance increased showing acclimatization to low light intensities and saturation of a photosynthetical apparatus of *Zygnema* with higher light intensity. However the approximate rate of phorosynthesis (rETR) is still highest in the afternoon, the daytime with the highest irradiance (Fig. 3.1.11.).

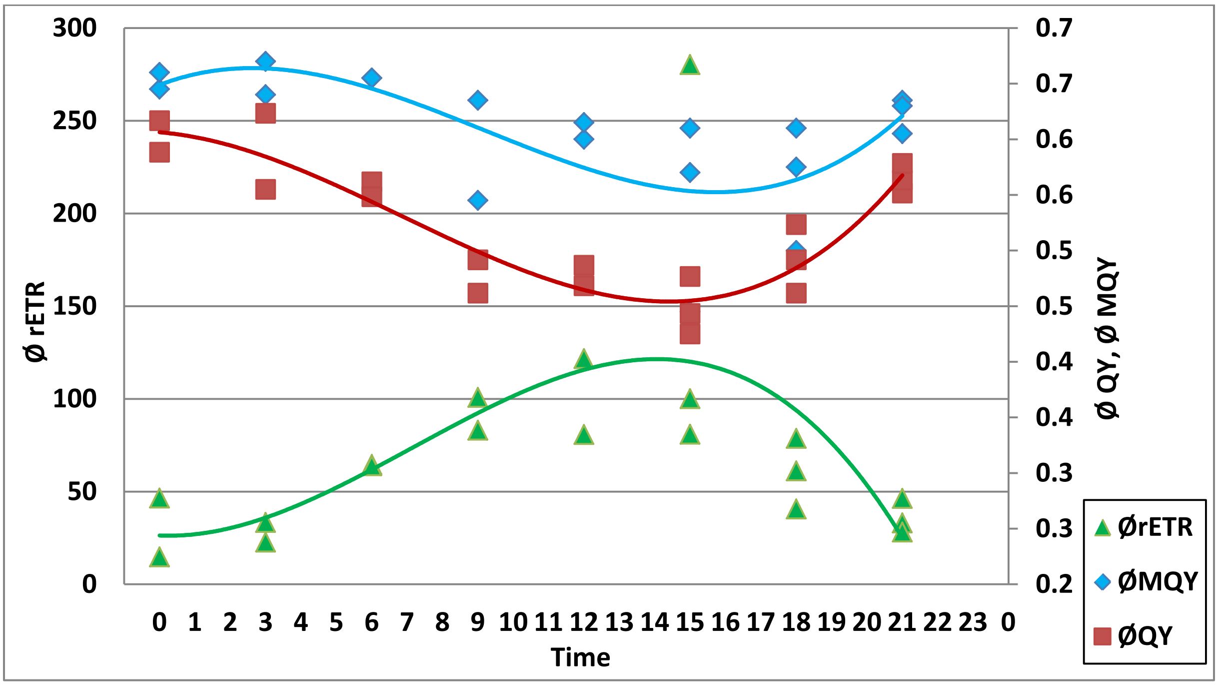

Fig. 3.1.11. General daily progress of rETR, MQY and QY (average values for both sampling sites).

3.2. Botany and Plant Physiology

Instructors: ***Alexandra Bernardová, Tomáš Hájek & Jitka Klimešová***

Students: ***Radek Jupa, Petra Světlíková, Vojtěch Študent & Stanislav Vosolsobě***

The aim of the course was to introduce students to plant ecology in high Arctic. We visited all the habitats in the area of Petuniabukta, Adolfbukta and Mimerbukta like glacier forelands, riverbanks, wet tundra, mature tundra, hilltops, bird manured sites and other interesting localities in surroundings to learn flora of the area. Plant species and their ecology were demonstrated, as well as the ecology, life strategies and adaptations to cold, freezing or desiccation. During the stay, students worked at their own projects, in which they deal with physiology of lichens, pollination strategies and species succession.

Photosynthetic activity of two lichen species *Umbilicaria*: *U. cylindrica* and *U. decussata* under partial dehydration.

We sampled two species of foliose lichen genus *Umbilicaria*: *U. cylindrica* and *U. decussate* (Figs. 3.2.1. and 3.2.2.). These species typically inhabit larger stones and boulders, without tight contact of their thalli with the substrate. Therefore the thalli are susceptible to rapid drying that greatly limits its period of metabolic activity. Therefore we asked whether the lichen is able to maintain its photosynthetic activity also under partial dehydration. This would significantly prolong the period of photosynthetic activity, growth and production. In the laboratory, the specimens were subjected to slow desiccation, during which the thallus water potential and photosynthetic activity (measured as effective quantum yield of photosynthetic processes in photosystem II using chlorophyll fluorescence) was recorded. In both species, full inhibition of photosyntehtic processes by desiccation was reached at water potential around −30 MPa that corresponds with relative air humidity of about 80 %(Fig. 3.2.3.). We conclude that both *Umbilicaria* species may thrive well in polar ecosystems with limited water availability and short period of thallus hydration.

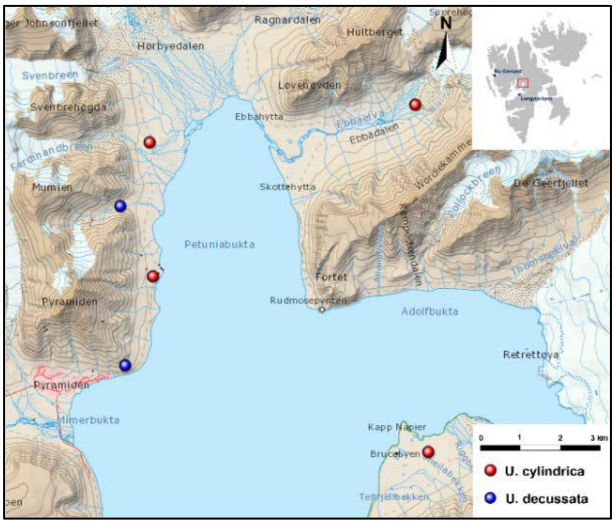

Fig 3.2.1. Map of Petuniabukta and its vicinity where the lichen species were collected.

Fig. 3.2.2. *Umbilicaria cylindrica* (left) and *U. decussata* (right).

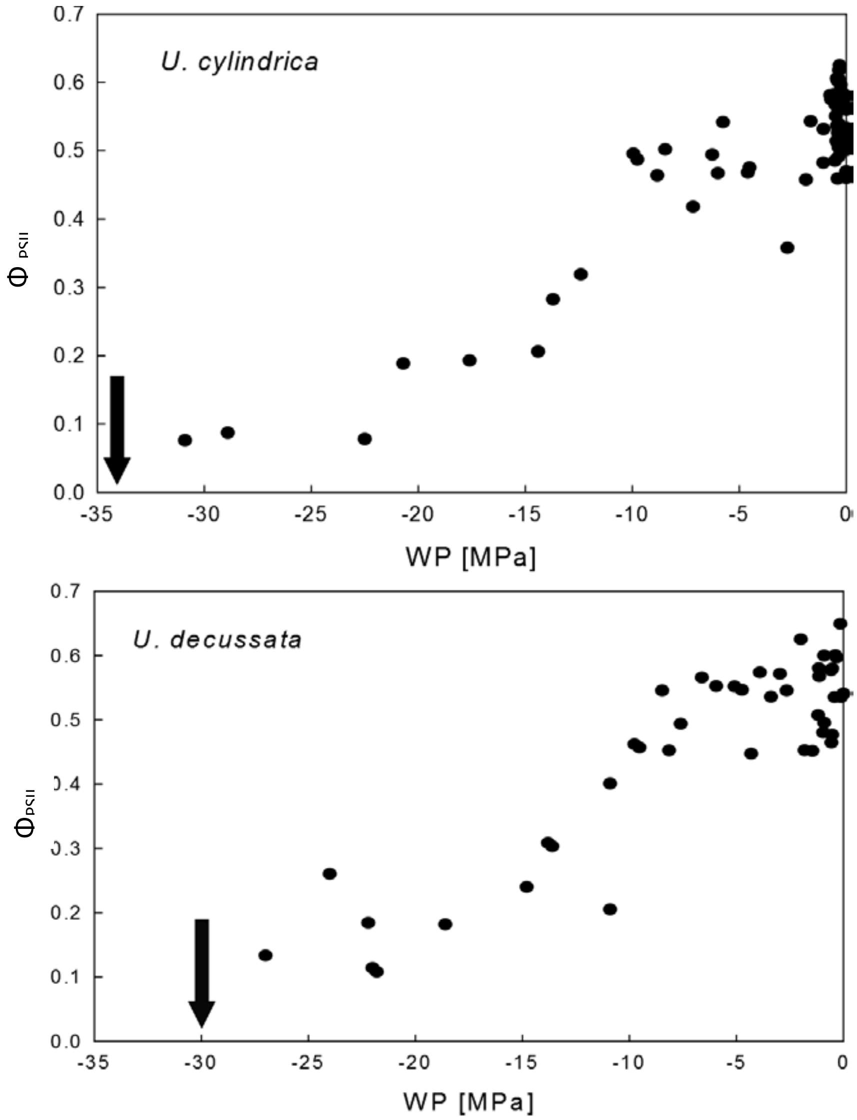

Fig. 3.2.3. Dependence of Φ PSII on water potential (WP) through dessication of thalli of *Umbilicaria cylindrica* and *U. decussata* (arrows indictae the value of critical WP).

The potential of species to establish at stands with various succession age

During this experiment, we established three plots 3*4m with 12patches in which 6 was manually disturbed (Fig. 3.2.4.). The plots were placed in i) in tundra, ii) recently deglaciated area (ca. 10years) and iii) long-time ago deglacieted area (more than 100 years) (Figs. 3.2.5. and 3.2.6.). At these plot, into a half of the patches, we sow distinct number of seeds of five species (*Cerastium alpinum, Dryas octopetala, Salix polaris, Braya purpurascens, Saxifraga aizoides*). Next year, the number of seedling will be counted.

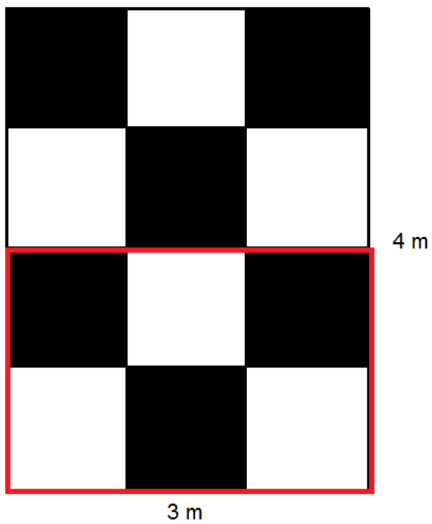

Fig. 3.2.4. Design of a plot with disturbed (black) and undisturbed (white) patches. Seed were sown only into the part marked with red square.

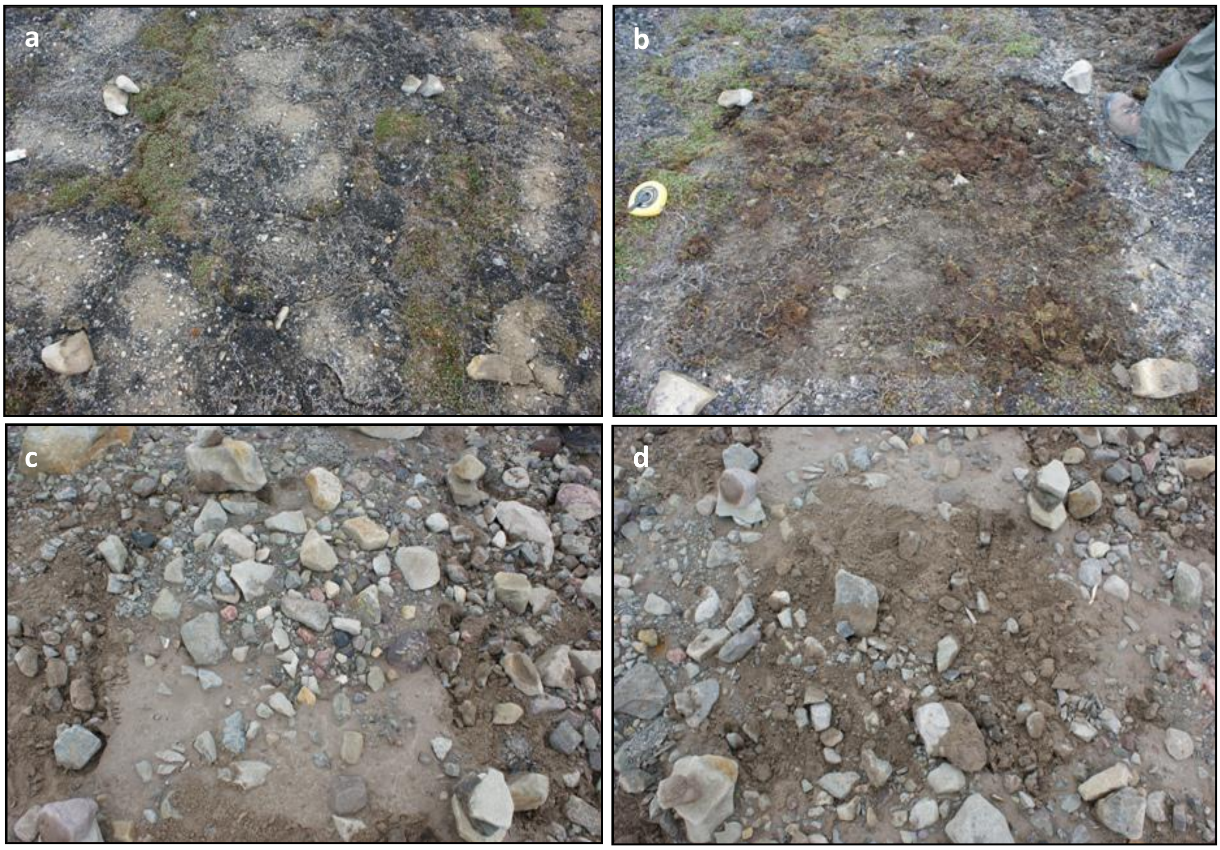

Fig. 3.2.5. The surface of **(a)** undisturbed and **(b)** disturbed mature tundra vs. **(c)** undisturbed and **(d)** disturbed deglaciated area.

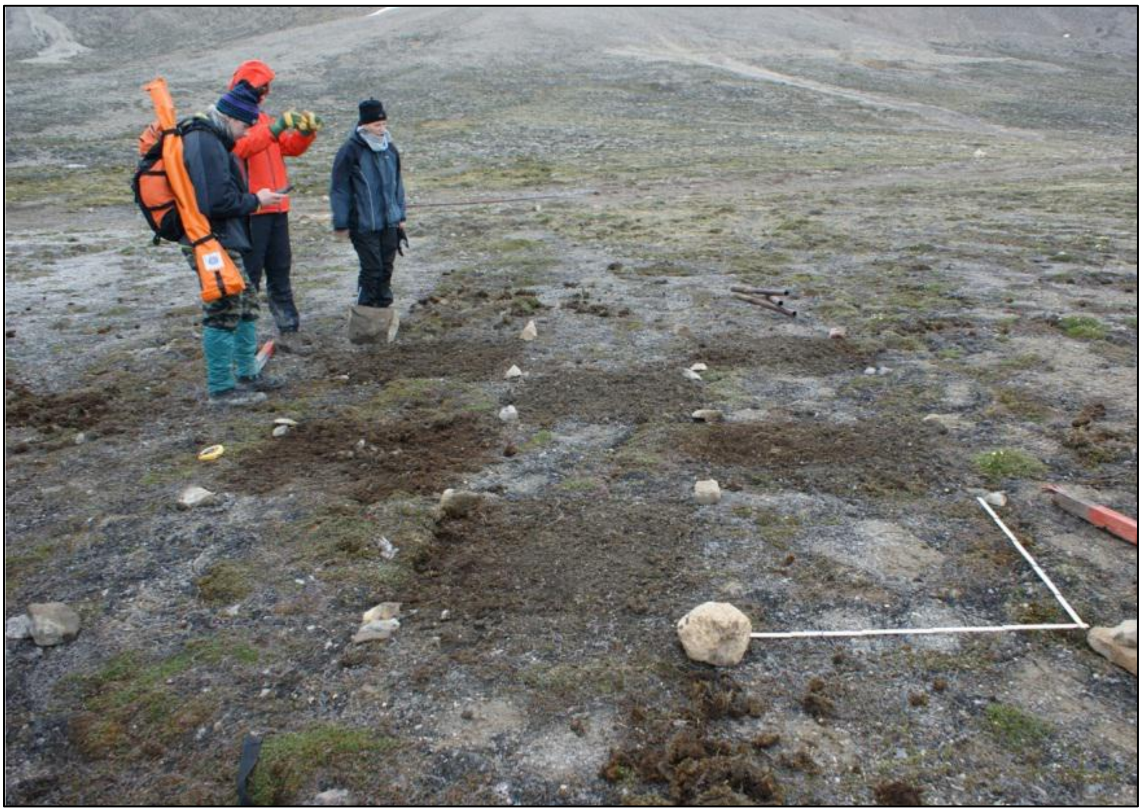

Fig. 3.2.6. Plot design in the field.

Of Svalbard's insect and pollen

Project was focused on insect herbivores and pollinators. We tried to prove their presence in the area of Petuniabukta. The number of insect herbivores on Svalbard is generally very low, and we were not able to find insect herbivore, so we focused our intention to pollinators. According to some studies, most of the plants on Svalbard are self-pollinating; however, allogamy takes place as well. The main vector of pollen is without doubt wind, but we want to find out, if i) insects is carrying pollen, ii) if insects is species-specific and iii) which species is insect carrying as pollen grains? In two stands – first with well-developed and second with scarce vegetation, we installed sticky traps into ten clusters of *Dryas octopetala* (Fig. 3.2.7.) and *Saxifraga oppositifolia*. Five traps were placed out of a cluster of florets as a control (Fig. 3.2.8.). Each day, the number of insects was counted and collected for the determination and analysis of pollen on their body (Figs. 3.2.9. and 3.2.10.). From the preliminary results we could say, that insect is able to carry pollen, but it is not species specific. However, the number of trapped insect is definitely influenced by weather.

Fig. 3.2.7. *Dryas octopetala* with a diptera.

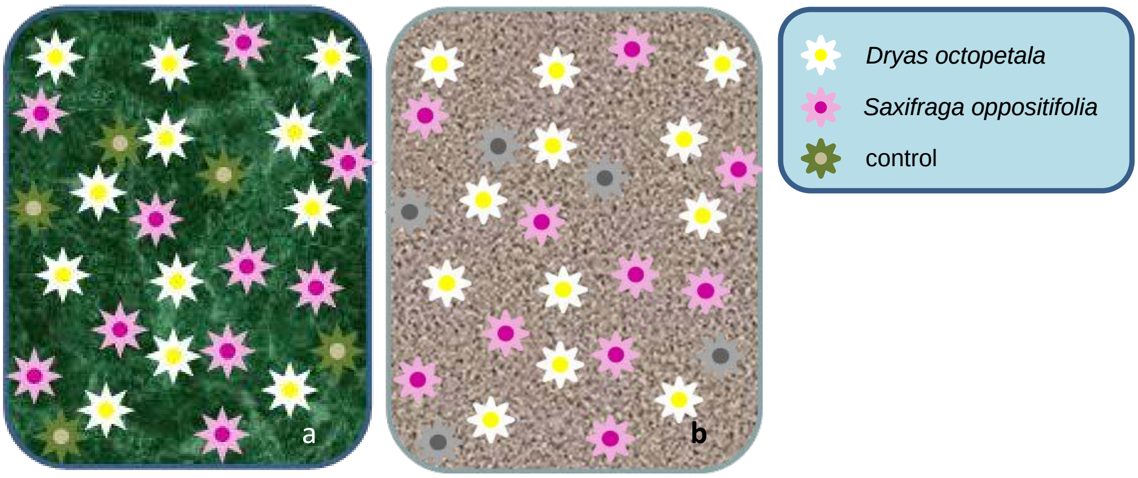

Fig. 3.2.8. Design of the pollination experiment: **(a)** mature tundra, **(b)** scarce tundra.

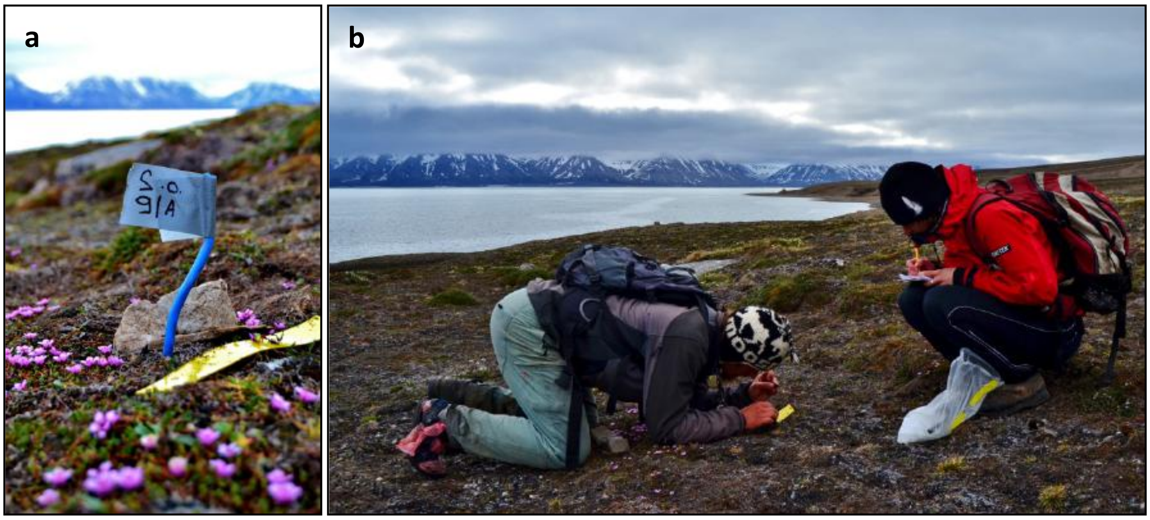

Fig. 3.2.9. (a) Sticky trap installed in the field and **(b)** the counting of trapped insects.

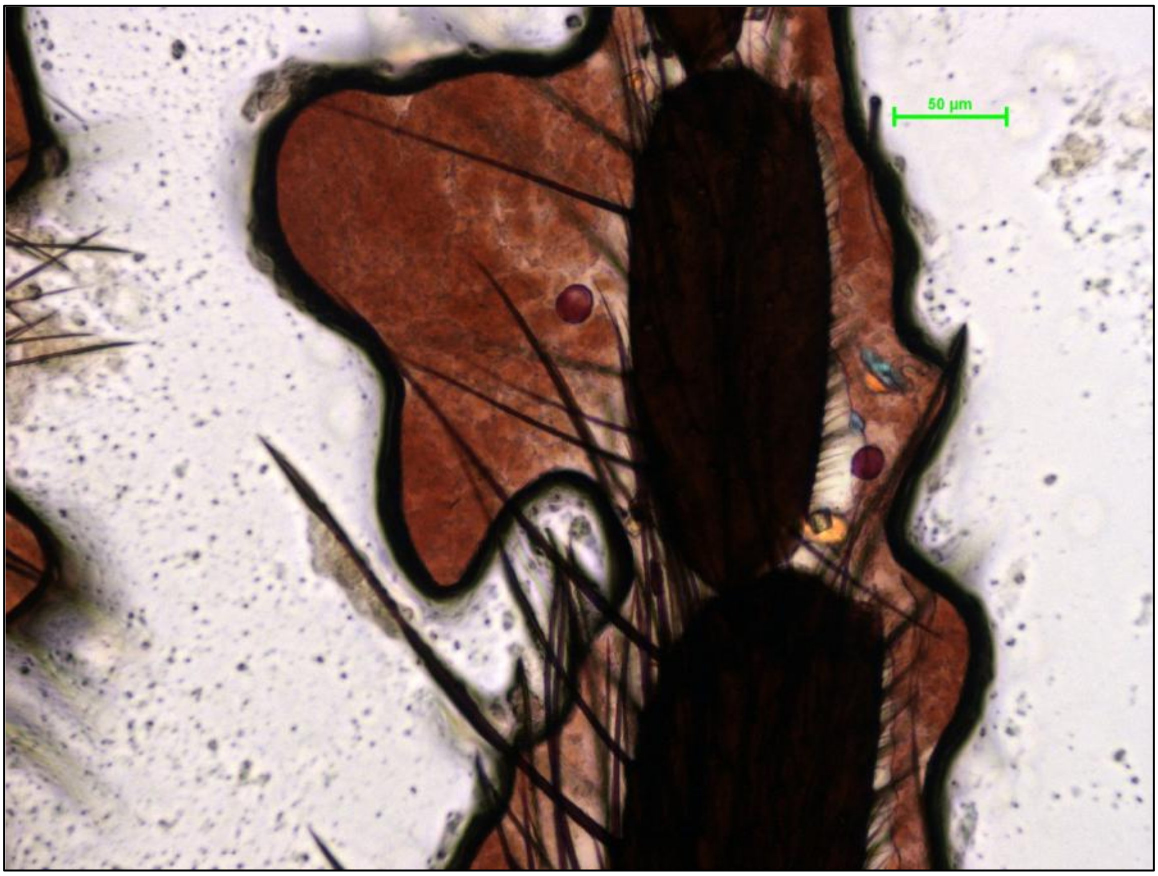

Fig.3.2.10. Part of a diptera's leg with *Salix polaris* pollen grain.

Flowering of *Saxifraga oppositifolia*

The aim of this project was to find out the lifetime of anthers on *Saxifraga oppostifolia*. As in central Europe, anthers usually live for 1 day only, so the pollen is available only for several hours. Moreover, Saxifraga has only 10 anthers per flower, so the probability of pollen transfer on Svalbard - if the viability is similar as in Central Europe - is very low. 46 flowers on 1 plant was observed for 5 days each 12hours and the status of anther (closed (budding), opened (active), senescent (empty)) was recorded. Pollen viability was than investigated with germination on medium.

The results suggest that the development of flowers and anthers is slow (vs. situation in central Europe). There is no relationship between pollen viability vs. time of anthers opening and pollen viability is retained for very long time and the time for pollen export by wind or insect is very long (Figs. 3.2.10. and 3.2.11.)

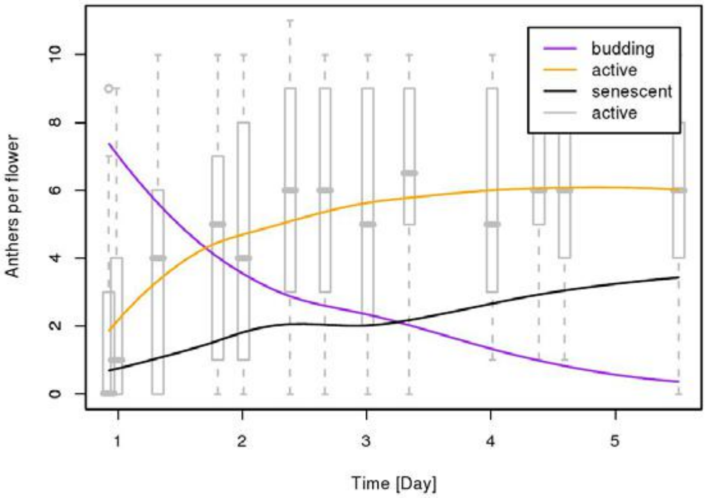

Fig. 3.2.10. Statuses of anthers during 5 days of observation. N=46 flowers.

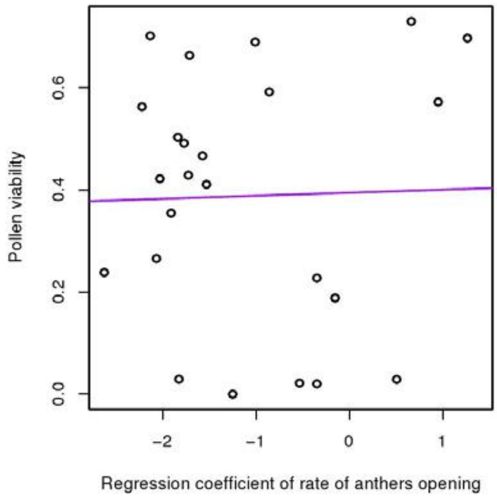

Fig. 3.2.11. Pollen viability plotted against the rate of anthers opening. P-value = 0.903, R-squared = 0.001.

3.3. Zoology and Parasitology

Instructors: ***Miloslav Devetter*, *Oleg Ditrich*, *Karel Janko*, *Václav Pavel* & *Tomáš Tyml***
Students: ***Jiří Černý*, *Jan Havlíček*, *Kamil Hromádka*, *Eva Myšková*, *Jiří Richta* & *Jindra Šíchová***

Fig. 3.3.1. The botany and zoology groups.

The course has been divided to common practical training and individual student projects (participants photo Fig. 3.3.1.).

In the common part of the course, participants became acquainted with the biodiversity of marine organisms. The most prominent animals were demonstrated in solid bottom litoral (*Spirorbis*, *Tonicella, Littorina, Strongylocentrotus*, *Myoxocephalus*), soft litoral with sediments (*Dendronotus, Euspira, Buccinum, Hyas, Sclerocrangon*, *Serripes, Marthasterias, Ophiocten, Lumpenus*), in psamnon (*Mya, Hiatella, Astarte*, polychaeta. sipuncula), as well as prominent plancton animals (*Mertensia, Periphylla, Clione, Mysis*, Foraminifera. Chaetognata).

Host-parasite relations were studied in invertebrate animals (prevalence of larvae of family Opecoelidae in *Buccinum* spp., prevalence and intensity of infection of *Proporus* sp. and *Gymnophalus* sp. in *Mya truncata* and *Hiatella arctica*) and in vertebrate hosts (Myxozoa, Trematoda, Cestoda and Nematoda in *Myoxocephallus scorpius* and *Gymnacanthus tricuspis*).

Amphipods form the littoral zone

Topic of the project of Jindra Šíchová were amphipods from littoral zone. Precise species determination is crucial for parasitological program, since they serve as second intermediate hosts for cestodes and trematodes, especially species of the family Opecoelidae. She developed method for molecular determination of amphipods using very small part of the specimen (e.g. one leg), that can be used for the determination previously dissected specimens (Fig. 3.3.2.).

Fig. 3.3.2. Examples of amphipods found in litoral of Petunia bay.

Parasites of birds and mammals

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

Scavenger activities of bentic animals

Jiří Richta used underwater camera and bait as trail trap for observation of scavenger activities of bentic animals. He found out, that dead fish did not attract fish of pray, but was attractive for crustaceans (*Hyas*, *Gammarus*).

Arboviruses

The project of Jiří Černý has been aimed to searching for arboviruses that had not been reported from Svalbard till now. He examined 1671 larvae and 368 adult females of *Aedes nigripes*. He found bunyavirus in 8 samples and alphavirus in 2 samples. No larva, but all all adult females were positive for flavivirus, that has been found in the tick *Ixodes uriae* (Fig. 3.3.3.).

Fig. 3.3.3. *Ixodes uriae*.

Predation of bird nests

Ornitologists Jan Havlíček and Kamil Hromádka observed the predation of bird nests. They used boile quail eggs for preparation of artificial nests and followed their predation (Fig. 3.3.4.).

Fig. 3.3.4. Artifical nest.

The predation has been significantly higher in the vicinity of bird colonies than in other localities.