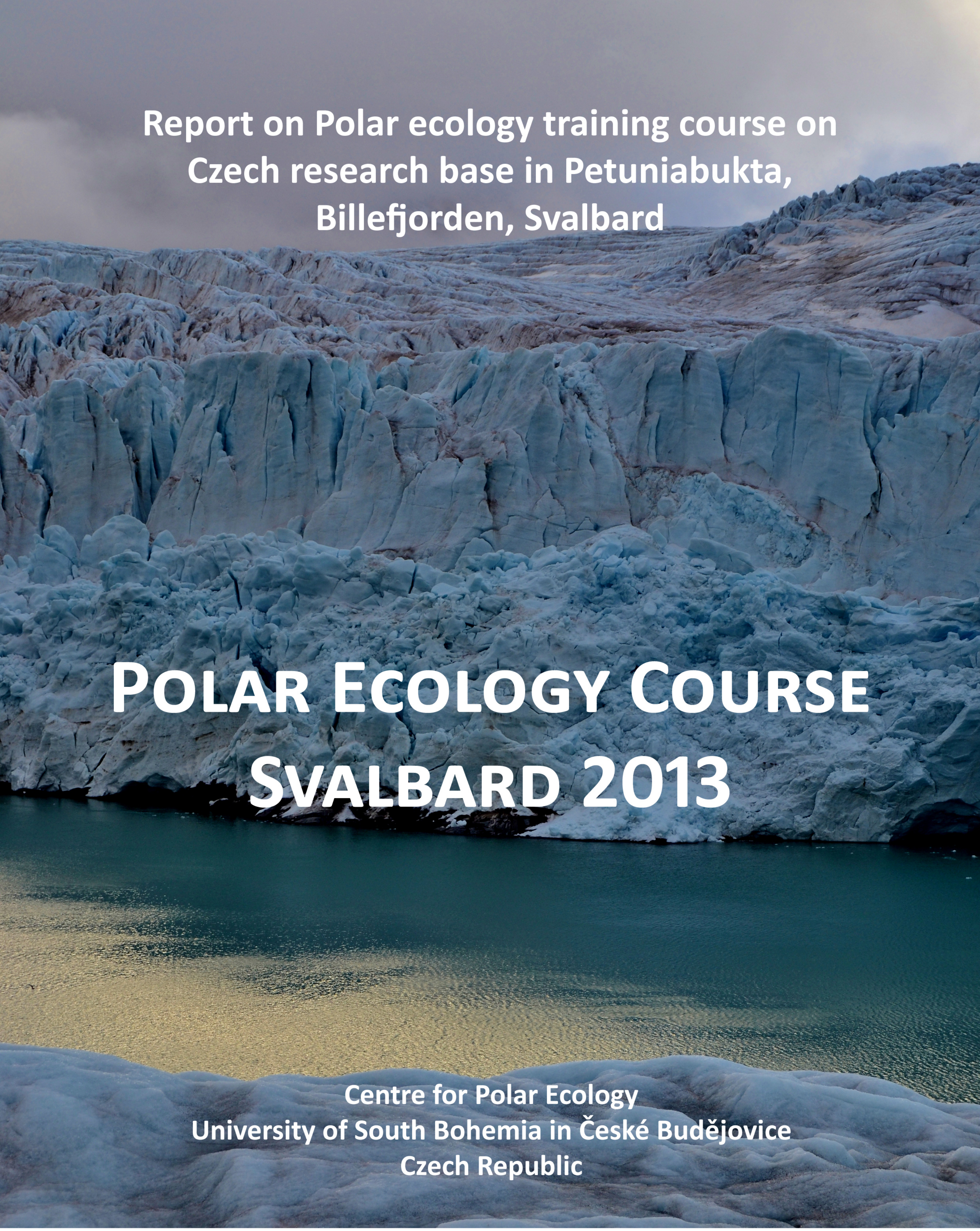

Report on Polar ecology training course on Czech research base in Petuniabukta, Billefjorden, Svalbard

POLAR ECOLOGY COURSE SVALBARD 2013

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

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Cover photo: Jan Kavan

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 12 days of field work at the Czech research station in Svalbard.

In 2013, 27 students were selected (Tab. 1.1.). The theoretical part of the course took place in CPE facilities in České Budějovice during spring semester (27/05 – 31/05 2013). 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 04/07-19/07 2013 (geology/geomorphology + climatology/glaciology), on 18/07-02/08 2013 (hydrology/limnology + microbiology/phycology), and on 01/08-16/08 2013 (botany/plant physiology + zoology/parasitology).

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	Zbyněk Engel	UK+JU	Michal Břežný	OSU
	Martin Hanáček	MU+JU	Iva Křenovská	MU/MEU
	Daniel Nývlt	MU+CGS+JU+UK	Barbora Procházková	UK
			Tomáš Uxa	UK
CLIMA	Zuzana Chládová	UFA+JU	Klára Ambrožová	MU
	Kamil Láska	MU+JU	Jan Bendl	UK
	Otakar Strunecký (MICRO)	JU+IBOT	Tereza Coufalová	MU
			Jan Husák	OSU
HYDRO	Jan Kavan	JU	Eliška Bohdálková	UK
	Kateřina Kopalová	JU+UK+IBOT	Petr Holík	MU
			Jakub Ondruch	MU
			Matěj Roman	UK
			Daniel Vondrák	UK
MICRO	Josef Elster	JU+IBOT	Barbora Chattová	MU
	Jana Kvíderová	IBOT+JU	Lucie Krajcarová	MU
	Ekaterina Pushkareva	JU	Kateřina Trnková	MU
	Jakub Žárský	JU+IBOT	Veronika Zbránková	OSU
BOTA	Alexandra Bernardová	JU	Jan Altman	JU
	Tomáš Hájek	JU+IBOT	Ilona Černá	JU
			Smyčka Jan	UK
			Ševčík Jan	UPOL
ZOO	Miloslav Devetter	ISB+JU	Jana Elsterová	JU
	Oleg Ditrich	JU	Petra Kokořová	JU
	Karel Janko	IAPG+JU	Petr Nguyen	JU
	Václav Pavel	UPOL+JU	Ondřej Otáhal	JU
	Tomáš Tyml	JU+PARU	Natalia Yakovenko	OSU
			Barbora Zdvihalová	JU

Abbreviations:
Groups: BOTA - botany/plant physiology; CLIMA - climatology/glaciology; GEO - geology/geomorphology; HYDRO - hydrology/limnology; MICRO - microbiology/phycology; ZOO - zoology/parasitology.
Affiliations: CGS – Czech Geological Survey, Brno; 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; MEU – Mendel University, Brno; 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 (Fig. 1.1.).

Fig. 1.1. Dr. Josef Elster, Head of the Centre for Polar Ecology, during preparation of instructional DVD. The movies recorded by Mr. M. Dvořáček.

2. Physical Sciences (Geosciences)

2.1. Geology and Geomorphology

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

Students: ***Michal Břežný*, *Iva Křenovská*, *Barbora Procházková* & *Tomáš Uxa***

Sedimentological research of glacial sediments

The research from 2011 and 2012 seasons has been extended from purely petrological study of gravel clasts of recent glacial sediments to facies sediment analysis including Late Pleistocene sediments.

We have studied an esker in Little Ice Age (LIA) Hørbyebreen proglacial zone (Fig. 2.1.1.), which is very well exposed allowing reconstruction of facies architectures. Individual facies and their mutual relationships have been documented and defined on six selected sections (Fig. 2.1.2.). Coarse gravely sediments deposited by high-energetic flow predominate. Quantitative analyses (petrology and clast shapes) of cobble fraction have been evaluated in most common facies.

Fig. 2.1.1. Hørbyebreen proglacial zone; arrows indicating LIA esker.

Fig. 2.1.2. Section through proximal part of an esker in Hørbyebreen forefield.

A fossil glaciomarginal delta has been studied in the forefield of Bertilbreen. Its origin is very probably connected with the sea level highstand during the deglaciation following the Last Glacial Maximum (LGM). Sections through the delta body have been exposed due to the downcutting of recent proglacial stream of Bertilbreen. Late Pleistocene subglacial and very probably supraglacial tills of Bertilbreen have been found at the base of the delta. We have studied their coarse pebble fraction (32–64 mm in b-axis). The analysis revealed high shares of striated clasts (Fig. 2.1.3.) and thus also the genetic interpretation of these sediments as subglacial tills.

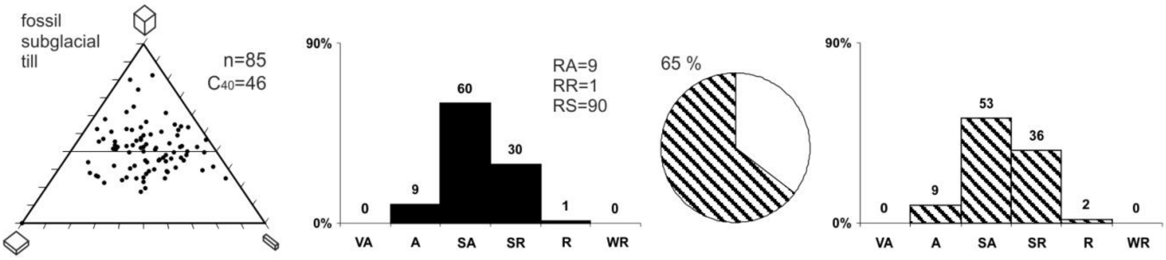


Fig. 2.1.3. Clast petrology, roundness, shape and striation for fossil subglacial till below glaciomarginal delta in front of Bertilbreen.

The deltaic sequence resting on tills consists of foreset (cross-bedded gravel and sand) and topset (horizontally bedded gravel); see Fig. 2.1.4.

Individual facies have been described and their petrology has been analysed. Fossils of marine bivalves have been found in foreset sand unit at one exposure. The following species have been found: *Mya truncata*, *Macoma calcarea* and *Hiatella arctica* (Fig. 2.1.5.). They usually live on sandy, gravely or rocky substrates of sublittoral zone. Foreset dips documents delta progradation towards the SE, i.e. to the present Mimerbukta.

Fig. 2.1.4. Fossil glaciomarginal delta foreset and topset in the Bertilbreen forefield.

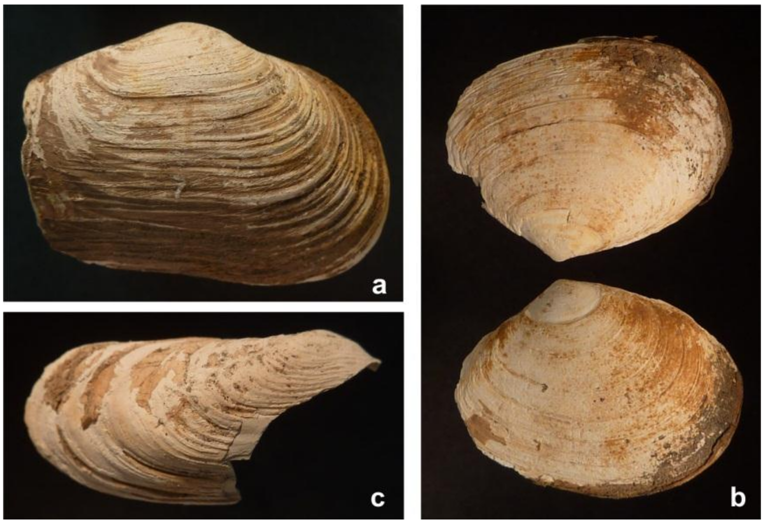


Fig. 2.1.5. Bivalves from sandy foreset of fossil glaciomraginal delta in front of Bertilbreen. **(a)** *Mya truncata*, **(b)** *Macoma calcarea*, **(c)** *Hiatella arctica*.

Research of periglacial processes and forms

This year's study followed the works undertaken in the 2011 season in western part of Petuniabukta. The aim of this study is to evaluate thermal regime of permafrost active layer. Field works focused on structural soils, solifluctional lobes and included the temperature monitoring of the upper active layer; sediments and soils sampling and structural soils' morphometry measurements. Temperature data originates from five dataloggers located in different types of structural soils – sorted circle/polygon, soil hummock; sorted stripe and two solifluction lobes (Fig. 2.1.6.).

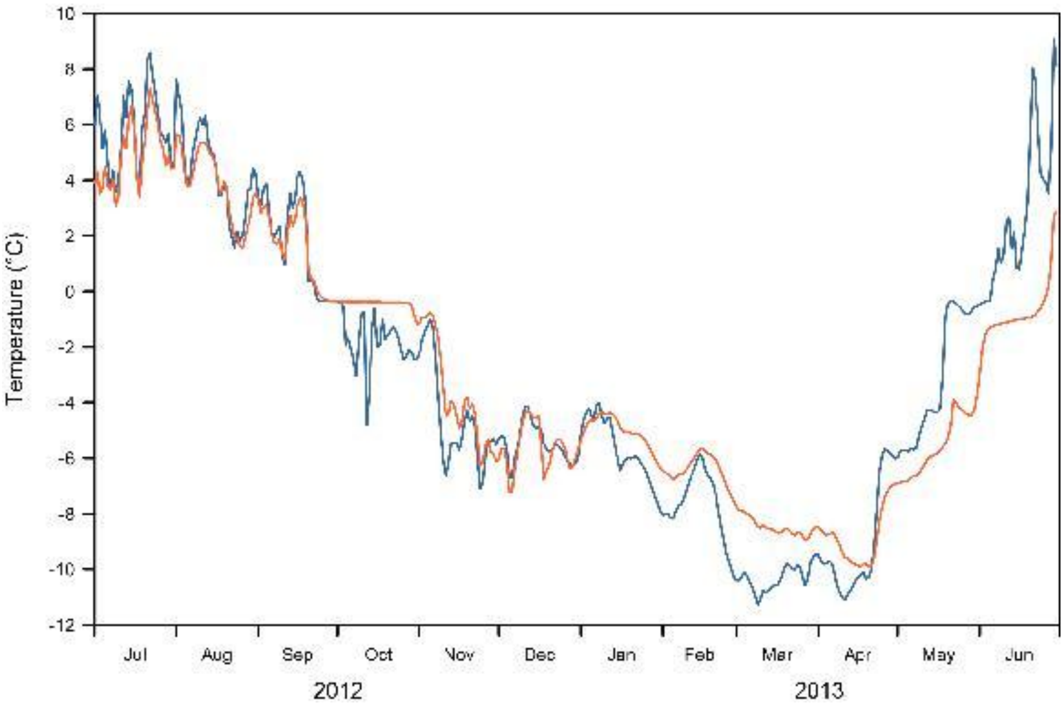


Fig. 2.1.6. Mean daily temperatures recorded in the depth of 15 cm in the permafrost active layer between 07/2012 and 06/2013 recorded in sorted stripe near Pyramiden Hill (blue line) and in sorted stripe between Ferdinandbreen and Svenbreen (orange line).

Three new sensors for continual temperature measurement of the active layer temperature in depths of 5, 15 and 30 cm have been installed to the sorted polygon located in the col south of the Mumien Peak (773 m a.s.l.). Morphology measurements, clasts' distribution and shapes of sorted structural soils have also been undertaken. Fotogrammetric evaluation of sorted stripes movement will compare the differences between summer seasons of 2011 and 2013 at the Ferdinanddalen and Svendalen sites (Fig. 2.1.7.).

Fig. 2.1.7. Sorted stripes flow monitoring between Fredinanddalen and Svendalen.

Students of the Geo Group attended field excursions to proglacial and terminoglacial zones of Nordenskiölbreen, Ebbabreen and Hørbyebreen glaciers and to the Munindalen valley. We have observed terminoglacial lakes, as well as LIA and pre-LIA erosional landscape of roche moutonnées and subglacial till morphology (fluted moraine) in front of Nordenskiölbreen. The natural exposure of ice-cored moraine sediments has been studied in Ebbabreen. Moraine-mound complex and remnants of proglacial zone have been visited in front of Hørbyebreen. Diverse morphology of proglacial zones of three glaciers, long glaciofluvial rivers and well-developed colluvial and alluvial landforms have been presented in the Munindalen valley. We have also visited the palaeontological site with in situ preserved trunks in Devonian Old Red facies in Munindalen.

2.2. Climatology and Glaciology

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

Students: ***Klára Ambrožová*, *Jan Bendl*, *Tereza Coufalová* & *Jan Husák***

In a frame of the Polar Ecology Course, meteorological observation and glaciological survey were performed in the coastal ice-free zone of Petuniabukta and selected glaciers in the period 4–19 July 2013. The main goal of the fieldwork activities was 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). We focused on evaluation of the relationship between present weather conditions, cloudiness, cloud genera, and atmospheric circulation pattern over the central part of Svalbard archipelago. 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. Especial attention was devoted to estimation of precipitation amount and occurrence of the selected phenomena, *e.g.* rain, drizzle, fog, photometeors, etc. (Fig. 2.2.1. and 2.2.2.).

Fig. 2.2.1. Three main types of high-, middle- and low-level clouds (*cirrus*, *altocumulus and stratocumulus*) occurring at Petuniabukta on July 12, 2013.

Fig. 2.2.2. Irisation on the high-level clouds at Petuniabukta (Billefjorden, Spitsbergen).

Short study of spatiotemporal variation of surface wind speed and wind direction has been undertaken in the coastal zone of Petuniabukta and surrounding valleys. New meteorological station was installed at the top of Mumien Peak at the height of 770 m a. s. l., where the measurement of air temperature and relative humidity were supplemented by the wind monitoring instruments (Fig. 2.2.3.a). Additional two anemometers were installed in the forelands of Hørbyebreen and Ragnarbreen (Fig. 2.2.3.b). We compare 3 weeks of wind data from 4 AWSs to estimate an effect of local orography and relationship between surface air flow and geostrofic winds above the Svalbard archipelago. Strong winds frequently occurred during the north-eastern and eastern cyclonic situations at the foreland of Ragnarbreen, although the wind speed at the top of Mumien Peak was relatively high.

Fig. 2.2.3. Service and replacement of the meteorological instruments. **(a)** Mumien Peak, **(b)** Ragnarbreen frontal moraine.

Glaciological observation on Bertilbreen, which is situated north-westward from Petuniabukta and Pyramiden settlement, continued also during this year (Fig. 2.2.4.). Additionally, we carried out similar glaciological survey on Elsabreen – small glacier westward from Petuniabukta. Two methods were applied on the selected glaciers to obtain surface area and their ice volume. The data for construction of topographical maps have been produced using dual-frequency differential GPS receiver and electronic total station. The observational network consists of 1250 points placed in both ablation and accumulation zones of Bertilbreen. Furthermore, ground penetrating radar (GPR) survey was conducted on Bertilbreen during field campaign. Glacier volume and subglacial topography were then derived from these data. The data allow us to estimate areal and volumetric changes and thus monitoring these changes is an important task in the study of sensitivity of the glaciers to global warming.

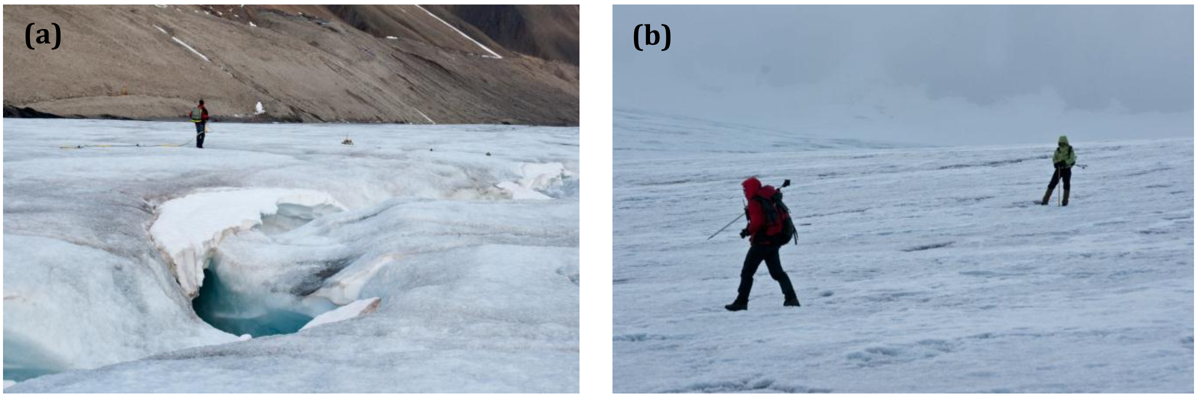


Fig. 2.2.4. (a) GPR measurement **(b)** glaciological survey on Bertilbreen in July 2013.

The ratio of small particles (0.02–1 μm) was measured by P-track instrument above different types of ground surface (coastal zone, mountain area, wet hummock tundra and glaciers) in Petuniabukta near the Czech polar station (Fig. 2.2.5.). The amount of ultrafine particles was studied with dependence on different synoptic conditions and on the daytime. The data measured in Petuniabukta were compared with data obtain in Longyerbyen, which is more exposed by emissions from the local sources of the pollution.

Fig. 2.2.5. Measurements of ultrafine particles by P-track instrument in the coastal area of Petuniabukta.

2.3. Hydrology and Limnology

Instructors: ***Jan Kavan* & *Kateřina Kopalová***

Students: ***Eliška Bohdálková*, *Petr Holík*, *Jakub Ondruch*, *Eveline Pinseel*, *Matěj Roman* & *Daniel Vondrák***

The main goal of hydrology/limnology group (Fig. 2.3.1.) was to demonstrate specific features of polar aquatic ecosystems and how these can be studied directly in the field. All students have participated on two common long-term research projects that are carried out by the research team. 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 have their own specialised projects focusing on one particular hydrological and limnological features 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 two seasons. 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. Biological samples were then examined using microscopy techniques directly at the research station.

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. This has been done together with other team members – D. Nývlt (geology) and A. Bernardová (botany). Samples and data collected during this study will serve for Master thesis of M. Roman and E. Pinseel as well.

Discharge measurements have been done on chosen water streams to demonstrate different reactions of catchments to climatic forcings. 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. Special focus has been made on demonstrating fluvial activity of polar water ecosystem especially in highly glaciated and thus variable Bertilbreen catchment, where J. Ondruch and P. Holík elaborated their individual research project.

Fig. 2.3.2. Working on the sea near Nordenskioldbreen.

Marine environment has been studied as well. A gradient from Nordenskiold tidewater glacier towards deep sea environment was examined (Fig 2.3.2.). 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. Basic features of tidal movement and ocean currents and wave erosional force was demonstrated during several field trips.

Lakes and their ecosystems – paleoenvironmental study

Matěj Roman together with Eveline Pinseel have studied general characteristics of lake ecosystems and their relationship to lake origin (Fig. 2.3.3.). The goal of the study is to bring basic information about the present state 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.

These measured features will be then used also for a paleoenvironmental study that will be done on the lake sediment core from Garmaksla locality. 3 sediment cores have been taken with the gravity corer from the central part of the lake basin. Matěj Roman will process different sedimentological/geological techniques to describe the sediment material, detailed diatom study with reconstruction of past environmental conditions will be done by Eveline Pinseel.

Fig. 2.3.3. Taking sediment core from the shallow marshes in Ebbadalen.

Fluvial dynamics of Bertilbreen outwash plain

Jakub Ondruch and Petr Holík 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 and further investigated in 2012 by Iveta Kodádková. Hydrological monitoring has been set up in 2011 and continued throughout this season including manual discharge measurement. Time-lapse camera has 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 2012 and repeated again this season in collaboration with Jan Blahůt.

Bedload sediment transport has been monitored with help of set of sediment traps. These were installed in the main stream but also in some of the side streams to evaluate and compare the transportation capacity of selected river profiles. The hydraulics of the selected parts of water streams was studied with help of flotating particles that were regularly photographed and then analysed (Fig. 2.3.4.).

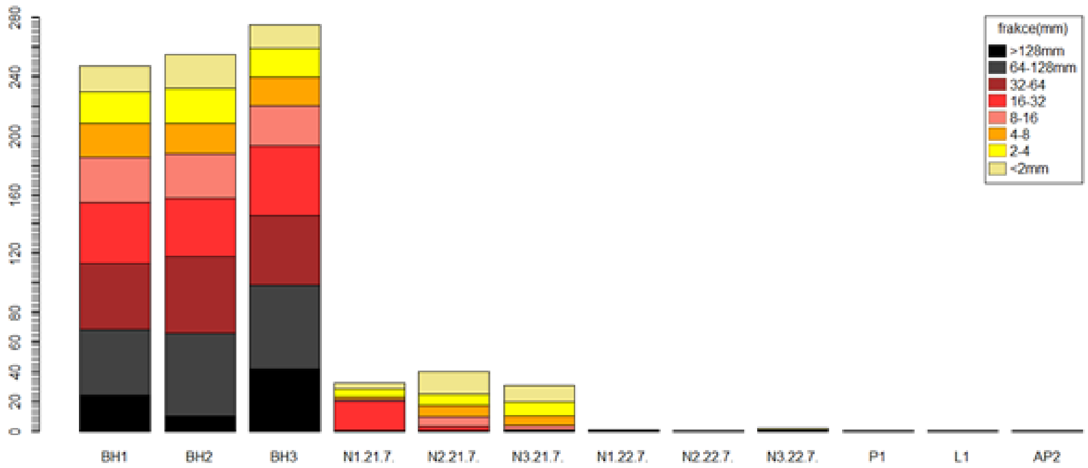


Fig. 2.3.4. Total weigth and size distribution of bedload material for all measured localities.

Investigating diatom communities on the gradient of Herbyebreen

Eliška Bohdalková focused in her study on investigation of succession rate of diatom assemblages on the recently deglaciated area in front of Herbye glacier (Fig. 2.3.5.). This is situated in the northern part of Petuniabukta and is characterised by the high velocity of its retreat from LIA. In last 100 years the glacier retreated by more than 2.5 kilometers leaving plenty of lakes and small pools on the former basal moraine. Six groups of lakes were chosen and sampled to cover the whole age gradient from frontal moraine (approximately 100 years old) to the very front of glacier with recent lakes. Diatom species composition was then analysed and described. Preliminary results show relatively well the pattern of gradual colonisation and increasing species diversity correlated with age of lakes.

Fig. 2.3.5. Sampling at Herbyebreen foreland.

Zooplankton community in lakes of Billefjorden area

Daniel Vondrák was interested in species composition of zooplankton in all visited lake localities and also marine zooplankton. All visited lakes were sampled using classic plankton net with 40μm net density. Diversity in selected lakes was compared to the lakes characteristics, origin and age in order to find significant features affecting its zooplankton population. Most common zooplankton species found in Billefjorden area were: *Lepidurus arcticus*, *Cyclops abyssorum* gr., *Daphnia middendorffiana*, *Chydorus sphaericus* (Fig. 2.3.6.). Similar sampling has been done also in cryoconites for example with surprisingly high diversity of animal species such as tardigrada and rotifera.

A special emphasis was also put on the paleoenvironmental study of Garmaksla lake. Daniel Vondrák is going to participate on this paleoenvironmental study with his contribution on species abundance and distribution of selected Diptera – these could be also used for paleoenvironmental reconstruction. At the moment two species were found in the sediment core: *Micropsectra radialis*, *Orthocladius trigonolabis*.

Fig. 2.3.6. *Chydorus sphaericus*.

3. Life Sciences (Biosciences)

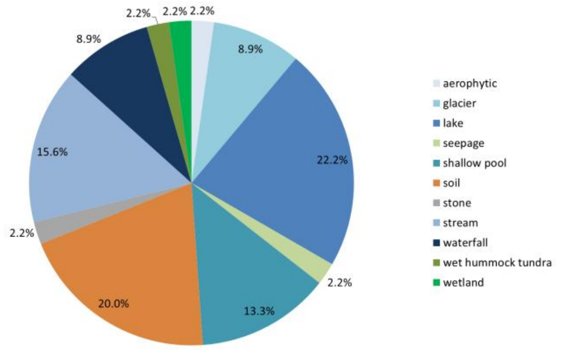
3.1. Microbiology and Phycology

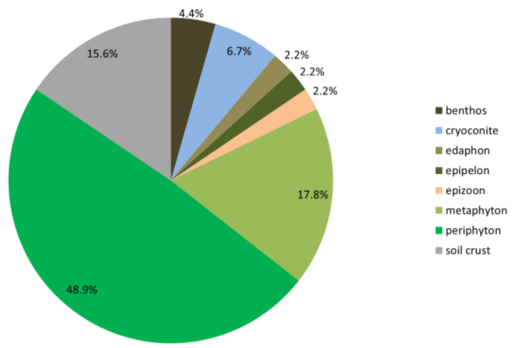
Instructors: ***Josef Elster, Jana Kvíderová & Ekaterina Pushkareva***

Students: ***Barbora Chattová, Lucie Krajcarová, Kateřina Trnková & Veronika Zbránková***

The long-term aim of the microbiology/phycology group is 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). We focus not only on taxonomical diversity, but also on diversity in ecology and physiology.

In 2013, total of 45 samples were collected at 25 different localities during the course and we found 75 species/genera identified at species or genus levels. The proportions of sampled habitats, communities and abundance of individual classes of algae and cyanobacteria are summarized in Fig. 3.1.1.





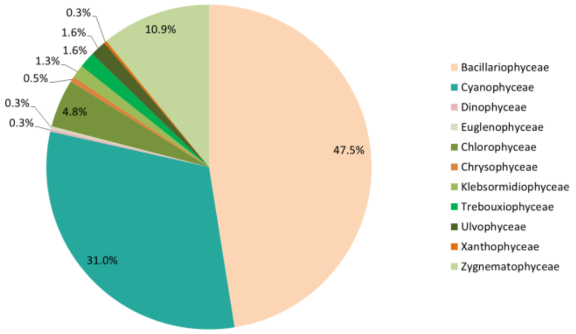


Fig. 3.1.1. The proportions of sampled habitats and communities and abundances of individual algal and cyanobacterial classes.

Diversity of phototrophic microorganisms

In total we found 75 genera of organisms, including 26 genera of algae, 20 genera of cyanobacteria and 29 genera of diatoms. 34 genera were found for the first time in Svalbard (12 algae, 2 cyanobacteria, 20 diatoms).

As in previous years, cyanobacteria *Phormidium* (19 samples) and *Nostoc* (17 samples), and diatoms *Cymbella* (18 samples), *Denticula* (16 samples) and *Pinnularia* (14 samples) were the most abundant in our samples. The frequent species, i.e. observed in more than 10 samples, included cyanobacterium *Gloeocapsa*, desmid *Cosmarium*, diatom *Meridion circulare* and filamentous conjugatophyte *Zygnema.*

In one sample, we observed formation of akinetes in *Anabaena sedovii* (Fig 3.1.2.), for the first time in Petuniabukta area. The akinete formation is very rare in the polar regions, since it is very energetically costly. In ice and snow samples we found desmids *Mesotaenium berggrenii* and *Ancylonema nordenskioeldii* accompanied by red cysts of *Chlamydomonas* cf. *nivalis. Mesotaenium berggrenii* was observed for the first time in Billefjorden area (Fig. 3.1.3. and 3.1.4).

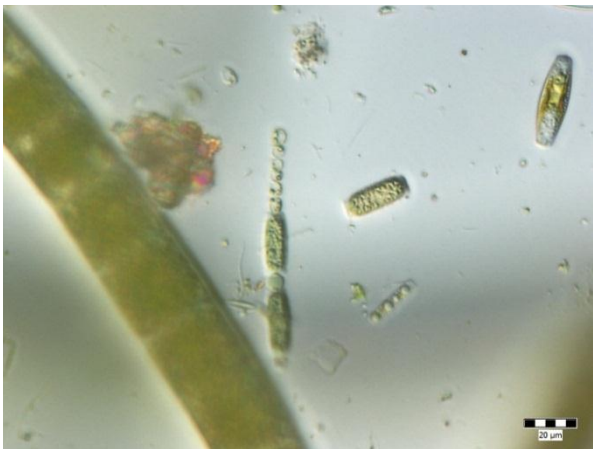


Fig. 3.1.2. Rare akinete formation in *Anabaena sedovii.*

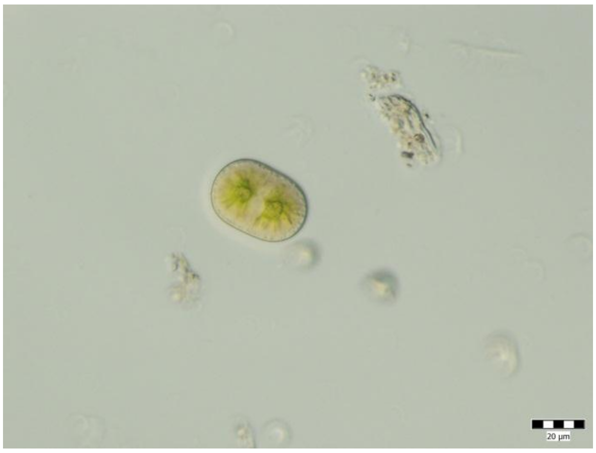


Fig. 3.1.3. Ice alga *Mesotaenium berggrenii.*

Fig. 3.1.3. Students approaching the upper part of transect across eastern part of Jotun glacier.

Anthropogenic influence on polar soil vegetation

To assess the anthropogenic influence on polar soil vegetation, total of 13 soil samples were collected in an abandoned city of Pyramiden and surroundings. Plots were selected during the fieldwork. The habitats included plots in the city- the city centre, unmanaged sites on the periphery, recently disturbed site and also tundra with typical tundra vegetation 1.5 and 3 km far from the city centre (Figs 3.1.4. and 3.1.5., Table 3.1.1.).

Fig. 3.1.4. ALGO 2013 group during sampling in Pyramiden, Billefjorden.

Table 3.1.1. Detailed description of sampling sites in Pyramiden.

Site	Description	GPS	Transect
A	Lawn near Lenin bust	N 78° 39' 20.6" E 16° 18' 35.4"	Starting point
B	Area near hospital	N 78° 39' 17" E 16° 18' 44"	Lenin bust → Mimerbukta
C	Rock field, almost no vegetation	N 78° 39' 11.8" E 16° 18' 36.4"	Lenin bust → Mimerbukta
D	Rock dune	N 78° 39' 29" E 16° 10' 30.7"	Lenin bust → Pyramiden mt.
E	Wet area near football stadium, by a gutter	N 78° 39' 24.8" E 16° 18' 35.5"	Lenin bust → Pyramiden mt.
F	Area at children playground	N 78° 39' 37.1" E 16° 18' 45.2"	Lenin bust → Petuniabukta
G	Tundra outside the town	N 78° 39' 18" E 16° 16' 57.3"	Lenin bust → Mimerdalen
H	Tundra, ca 1.5 km from the town	N 78° 39' 25.1" E 16° 14' 56.3"	Lenin bust → Mimerdalen
I	Tundra, terrace over the sea	N 78° 39' 35.1" E 16° 25' 26.2"	Lenin bust → Petuniabukta
J	Terrace over the sea, bellow incinerator, close to sea, gradually changing to ruderal	N 78° 39' 26.2" E 16° 24' 15.2"	Lenin bust → Petuniabukta
K	Abandoned dump at the edge of the town	N 78° 39' 24.1" E 16° 23' 30.4"	Lenin bust → Petuniabukta
L	Tundra at slope	N 78° 39' 35.6" E 16° 18' 26.2"	Lenin bust → Pyramiden mt.
M	Semi-ruderal area near the sea	N 78° 38' 57.9" E 16° 19' 22.3"	Lenin bust → Mimerbukta

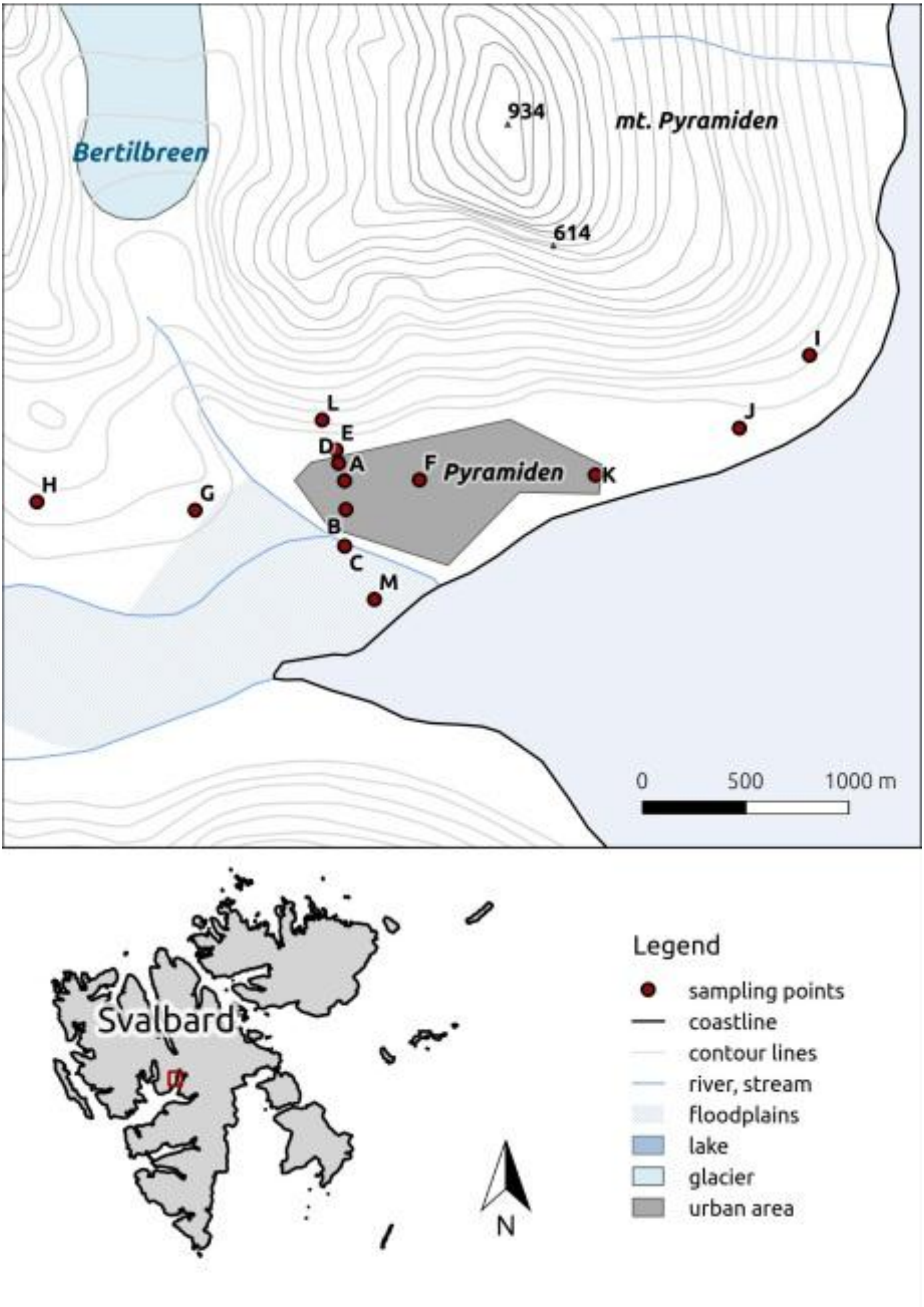


Fig. 3.1.5. Map of the sampling sites. See Table 3.1.1. for detailed description.

For chemical analysis, the top soil layer (upper 5 cm) and the lower soil layer (5 to 10 cm) were taken at each place by Lucie Krajcarová. The plant coverage of all sampling points was determined and some plant samples were collected too. In the laboratory, soil samples were air-dried at 25°C and sieved through 2 mm nylon sieve (Linker Industrie-Technik, Germany). The soil samples were then digested using aqua regia according to ISO 11466. Plant samples were divided to leaves and stems separately, dried in common laboratory drier (ECOCELL) at 60°C and mineralized with 4 ml concentrated HNO_3 and 2 ml 30% H_2O_2 in microwave mineralizer (Berghof MSW3+ speed wave, Germany). To determine selected elements ICP-OES spectrometer iCAP 6500 Duo (Thermo, Great Britain) was used for both soil and plant digestions.

Higher contents of Cd, Cu and Mo in comparison with limits in agricultural soils [1] in both upper and lower soils were detected. In soils strong positive correlations in contents of Fe-Cd and Ni-Co and negative correlation of Mg-Co were found (Fig. 3.1.6.). Generally, stronger correlations of elements were observed in the lower soil compared to the topsoil. In samples of *Salix polaris* excessive amount (in comparison with the generalized values [2]) of Fe and Zn in both leaves and stems was detected. Some elements show correlations between contents in soils and plant parts (e.g. Al, Ca, K and Mo have negative and Mg positive correlation between content in the topsoil and stems). These correlations are the strongest between the topsoil and plant stems in comparison to the lower soil and plant stems and leaves. Plant/soil transfer factors (TF) for some elements were calculated and compared with usually published values [1]. Higher TF of Zn and lower TF of Cd was observed. Results were also compared with that in other publications dealing with samples from Svalbard [3, 4].

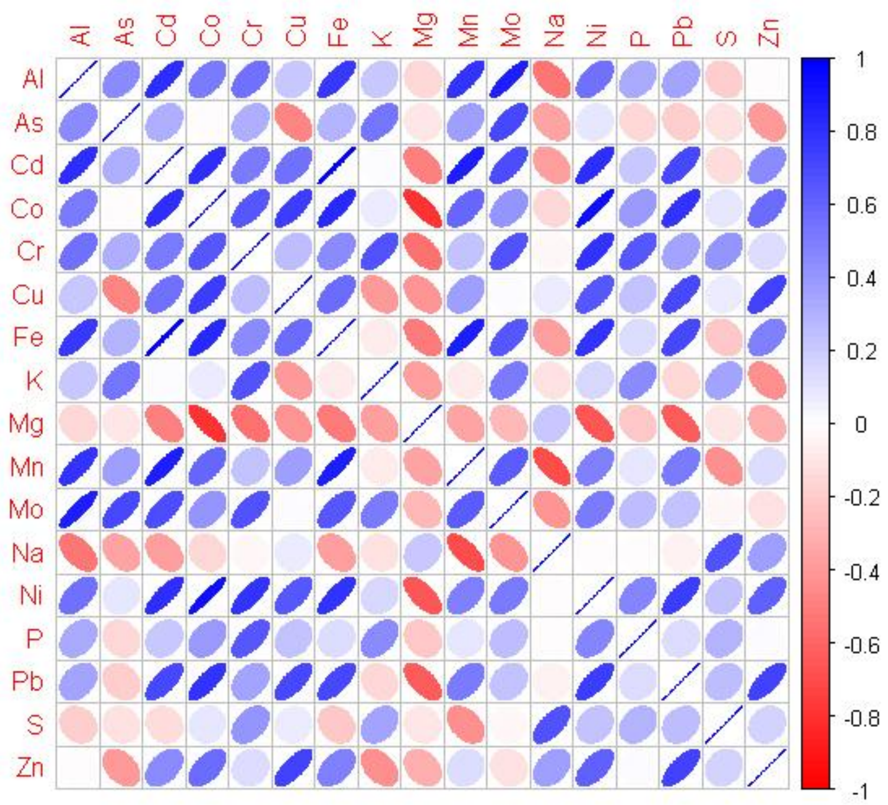


Fig 3.1.6. The correlation matrix of elements of all soil samples. The color scale indicates the correlation coefficient, ranging -1 (strong negative correlation) → 0 (no . correlation) → 1 (positive correlation.

For analysis of diversity of soil diatoms, Barbora Chattová took four soil samples from each sampling site. After removing the vegetation cover the upper 3 cm of the soils were collected in 50 ml PVC bottles and plastic bags.

So far 61 diatom taxa (including species, varieties and forms) were identified from 13 soil samples from different habitats, which is quite high for soil samples. The genera that showed the highest species diversity were *Pinnularia* with 8 representatives, the second was *Nitzschia* with 6 members and the third was *Luticola* with 5 taxa. The most abundant taxa were *Hantzschia amhioxys*, *Pinnularia obscura*, *Navicula cincta*, *Pinnularia borealis* and *Luticola mutica*. The highest number of taxa (24) was recorded in a sample "H", taken in the tundra. By contrast, only two taxa were identified in a soil sample "A" taken in the city centre of Pyramiden. The mean number of taxa per sample is 12. The most species diverse samples came from the tundra sites (H, I, J) and from the wet areas (E).

A surprisingly diverse soil diatom flora was found in the soil samples from tundra and urban habitats of Svalbard, dominated by the genera *Pinnularia*, *Hantzschia*, *Navicula*, *Nitzschia* and *Luticola*. The main parameter, which seems to be responsible for the species diversity is the distance from the city, the moisture and the type of vegetation of the site, where the soil samples were collected. At the moment the environmental parameters such as soil pH, conductivity and nutrient content are being measured. Further research is necessary to understand all the conditions involving the soil diatom flora.

At present, algal biomass from each sampling side is cultivated by Veronika Zbránková in order to get a sufficient amount for the isolation of DNA and systematic classification of organisms by DNA sequencing, like *Cladophora* (Fig. 3.1.7.) or *Stichococcus* (Fig. 3.1.8.).

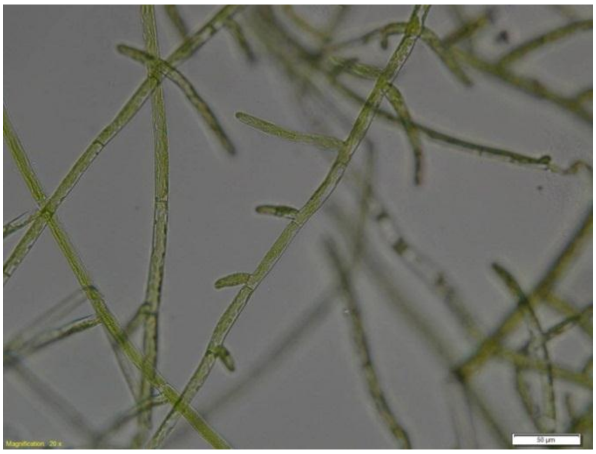


Fig. 3.1.7. Macroscopic green alga *Cladophora.*

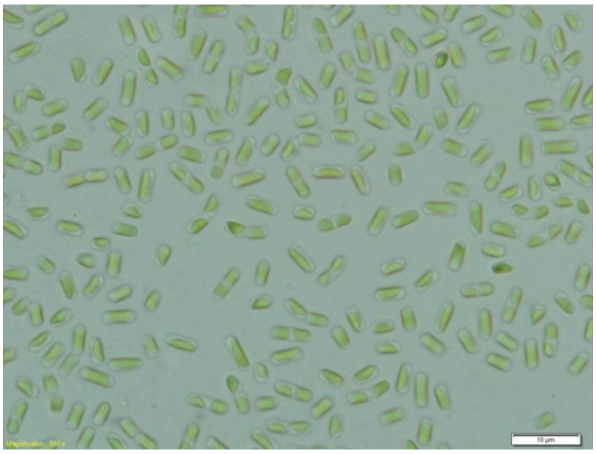


Fig. 3.1.8. Microscopic green alga *Stichococcus.*

Soil crusts

We collected soil crusts from different sites, supposedly with microalgal and cyanobacterial abundance (Fig. 3.1.9.). Well-developed soil crust communities are usually dark in color. However, sometimes lichen cover of well-developed soil crusts make it less dark. The general appearance of crusts varies in terms of color, surface topography, and surficial coverage. For example, the dark color of a soil crust is due to the density of soil crust organisms, mainly the dark color of the microalgae, lichens, and mosses. A low biomass of microalgae is associated with a colorless soil surface. On the contrary, a higher microalgal biomass, including lichenised communities and mosses, results in the soil surface being usually more colored. Such types of crust have a higher photosynthetic activity, because of high pigment content.

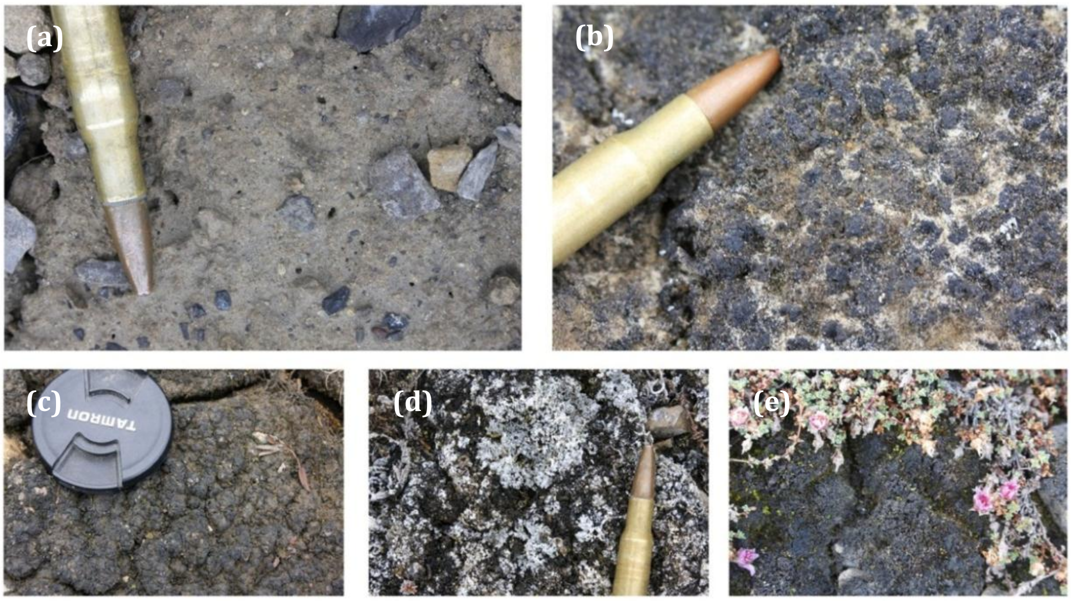


Fig. 3.1.9. Different types of soil crust in Petunia Bay, Svalbard. **(a – e)** from less-developed (a) to well-developed (e) soil crust.

The diversity of cyanobacteria and microalgae from collected soil crusts was studied using a stereomicroscope and light microscope. Dominant species of cyanobacteria were *Scytonema* sp., *Nostoc* sp., *Gloeocapsa* sp., *Microcoleus* sp. and of microalgae – *Hormotila* sp., *Trebouxia* sp., *Myrmecia* sp. and *Coccomyxa* sp. (Fig. 3.1.10.).

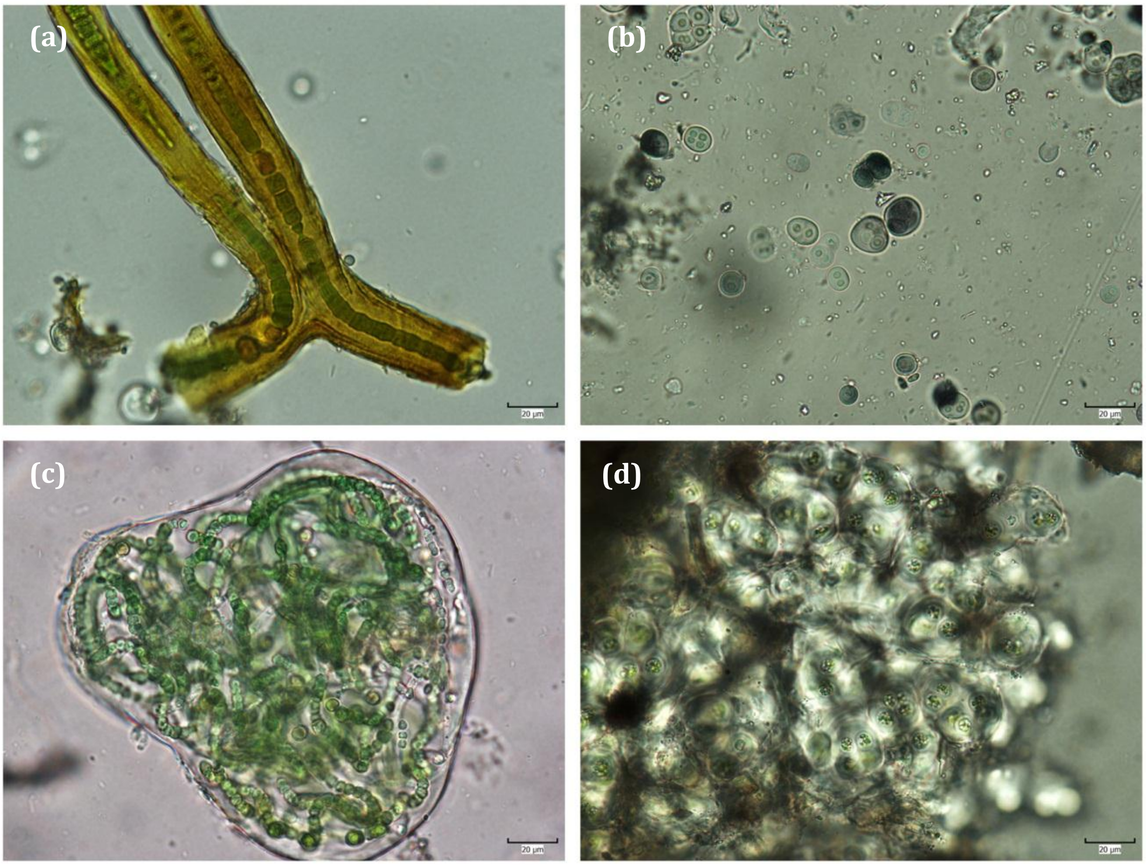


Fig. 3.1.10. Algal and cyanobacterial biodiversity of soil crust ecosystem. Some representatives of common species/genera **(a)** *Scytonema sp.*, **(b)** *Gloeocapsa* sp., **(c)** *Nostoc* sp., **(d)** *Hormotila* sp.

Ecophysiology of *Nostoc* sp. and *Zygnema* sp.

Kateřina Trnková performed two ecophysiological experiments. The first experiment evaluated photosynthetic responses of *Nostoc commune* thalli to desiccation while the other concerned daily courses of photosynthetical activity in *Zygnema* sp. In both experiments, changes in function of PSII were measured utilizing fast chlorophyll fluorescence approach (OJIP curves). Additionally, spectral indices were used as a measure of changes in pigment content.

The OJIP curve means recording of rapid nonlinear increase of fluorescence of a dark-adapted sample after illumination. The curve contains 4 waves (0, J, I and P) which represent outflow of electrons from PSII. From the curve, 19 fluorescence parameters can be calculated, for example widely used potential quantum yield (F_V/F_M) or the rate of absorbed photons per reaction centre (Abs/RC) and trapping rate per reaction centre(TR_0/RC).

Two spectral indices – Photosynthetic Reflectance Index (PRI) and Normalized Difference Vegetation Index (NDVI). PRI is an index calculated from the ratio of the amounts of reflected light of two wavelengths – 531 nm and 570 nm. The reflected light of the wavelength 531 nm is related to the content of carotenoids, while the wavelength of 570 nm is unaffected by carotenoids. The more carotenoids are in the thallus, the lower the value of PRI is. According to previous studies, PRI is highly correlated with dehydration and many more stress situation.

NDVI calculated from the ratio of red and near-infrared parts of spectrum. It's related to the content of chlorophyll and partly carotenoids and it has also been used in many studies as an indicator of stress.

The experiment with *Nostoc* was held in semilaboratory conditions on a table close to the base. *Nostoc* thalli in Petri dishes were exposed to natural dehydration caused mainly by southern wind. The experiment took 26 h before the thalli were completely dehydrated. Every 2 h measurements (weight, OJIP, PRI, NDVI) were taken. Temperature and irradiance was measured simultaneously. Later, relative water content was calculated from the change of weight.

The mean OJIP recorded during desiccation showed alterations that indicated decay of electron transport in PSII and a drop of potencial photosynthesis. However, there was an intrathalline difference. In some thalli, F_V/F_M calculated from OJIP curve reached the value of 0,3 in relative water content of 2%, which means the thalli are still capable of photosynthesis in severe state of desiccation (Fig. 3.1.11.).

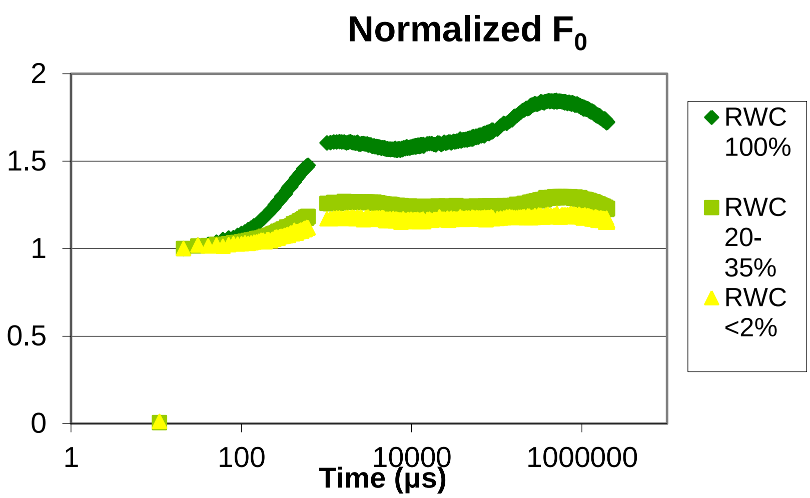


Fig. 3.1.11. Normalized OJIP transient indicating decay in electron transport in PSII in *Nostoc* during desiccation. RWC – relative water content.

PRI rose during desiccation which can be interpreted as a decrease of carotenoid content. It should be noted, that in higher plants, PRI drops during desiccation because of increase in carotenoid content. NDVI decreased not only in severely dehydrated thalli (which was expected), but also in fully-hydrated thalli.

The experiment with *Zygnema* was held in situ in a shallow pond between the base and seashore. It lasted 52 h and every 4 h measurements (OJIP, PRI, NDVI) were taken. Water temperature and global radiance were measured simultaneously. (Fig. 3.1.12.).

Fig. 3.1.12. The experimental setup for measurements of diurnal cycles in *Zygnema* sp. mats.

F_V/F_M calculated from the OJIP curves showed some daily courses according to changes in irradiance and temperature during days. During overcast days, in midday hours the Abs/RC and TR_0/RC were both rising with radiation. But in sunny weather, when global irradiance reached the value of 500 µmol (photons) m^{-2} s^{-1} (PAR around 250 µmol (photons) m^{-2} s^{-1}) Abs/RC increased with radiation, while TR_0/RC dropped, which indicates, that the radiation was too high for *Zygnema*, and mechanisms of non-photochemical quenching were activated

Spectral indices didn't show any clear relationship with radiation. From the fact that PRI didn't drop during maximum irradiation we can conclude that although this value of irradiation causes photoinhibition, it is not necessary to synthetize more than usual amount of carotenoids to deal with the light.

References:
[1] Kabata-Pendias A., Pendias H. (1992). Trace Elements in Soils and Plants. Florida: CRC Press, Boca Raton., 315 p.
[2] Kabata-Pendias A., Mukherje A. B. (2007). Trace Elements from Soil to Human. Springer-Verlag Berlin, 561 p.
[3] Gulínska, J. et al. (2003). Soil Contamination in high arctic areas of human impact, Central Spitsbergen, Svalbard, Polish J Envi Studies 12, 701-707.
[4] Józwik, Z. (2000). Heavy metals in tundra plants of the Bellsund in West Spitsbergen , investigated in the years 1987-1995, Pol Polar Res 21, 43–54.

3.2. Botany and Plant Physiology

Instructors: ***Alexandra Bernardová* & *Tomáš Hájek***

Students: ***Jan Altman*, *Ilona Černá*, *Jan Smyčka* & *Jan Ševčík***

The aim of the course was to introduce students to plant ecology in high Arctic. We visited all characteristic habitats in the area of Billefjorden, namely in Petuniabukta, Adolfbukta, Mimerdalen, or Mathiesondalen. We studied flora and the plant life strategies and adaptations in glacier forelands, riverbanks, wet and dry tundra, hilltops, bird manured sites, but also the glacier environment at Bertilbreen or ruderal habitats of the town Pyramiden. Students worked on their own projects dealing with plant–insect interactions (continuing our last-year experiments), genetic diversity of willow species at small-scale, and they collected samples of selected herbs and also of beached driftwood for herbochronological or dendrochronological screening.

Plant–insect interactions

Ilona Černá and Jan Smyčka (Fig. 3.2.1.) focused on plant–insect interactions in various habitats, such as wet hummock tundra, heath tundra, stony glacial moraines or alluvial cones. In 42 plots, we collected vegetation relevés and abiotic data, and installed white cups filled with water for trapping insects. We collected 2112 individuals of dipterous and hymenopterous insect, potential plant pollinators. The insect will be determined, for the preliminary analysis we split the dipterans into suborders, larger Brachycera and smaller Nematocera. Ordination analysis revealed that the quantity of living plant biomass is dominant factor affecting the abundance and composition of insect communities, followed by the composition of vegetation and character of soil. It seems that plant pollination mediated by insets may be rather occasional, non-selective.

Fig. 3.2.1. Student Jan Smyčka looking for mature pollen grains in non-native *Barbarea vulgaris*.

Genetic diversity of willow species

Jan Ševčík studies genetic diversity of dwarf willow species in alpine zone of Central European mountains, where they represents glacial relicts, therefore he asked about the genetic diversity of such species in their characteristic polar habitats. We established 100 m long transects and small plots in characteristic habitats of the dwarf willows *Salix polaris* and *S. reticulata* and mapped there their reproduction strategies (Fig. 3.2.2.). Several hundreds of leave samples for morphometric analysis and DNA extraction to assess the genetic diversity within the populations were collected. These data will be compared with that of southern relict populations.

Fig. 3.2.2. Sampling of *Salix* in the harsh conditions.

Herbochronology and dendrochronology

Jan Altman's specialization is dendrochronology, i.e. tree-ring dating. Because of the very limited diversity of woody species we focused on herbochronology – we collected samples of perennial herbs that also form annual growth increments similar to tree-rings, allowing age estimation. The collections will be also presented in the anatomical atlas of polar plant stems.

Driftwood can be found along the shore of many parts of Svalbard (Fig. 3.2.3.). The logs were usually cut, probably in Siberian forests, and came with Siberian rivers to the Arctic ocean. We collected more than one hundred log samples for dendrochronological analysis (count of tree-ring widths, species determination), which will reveal the origin (area and time) of the driftwood based on comparison with large data sets that are available from the whole world.

The principle of the dendrochronological analysis may be also used for dating other organisms which show annual increments, such as mollusc's shells. We sampled shells of recently spreading bivalve mollusc *Serripes groenlandicus* in order to verify whether the mollusc growth follows climatic factors as in plants.

Fig. 3.2.3. Drift-wood in the bay. Sometimes is very easy to find out, where the trunks comes from...

Zoology and Parasitology

Instructors: ***Miloslav Devetter, Oleg Ditrich, Karel Janko, Václav Pavel* & *Tomáš Tyml***
Students: ***Jana Elsterová, Petra Kokořová, Petr Nguyen, Ondřej Otáhal, Natalia Yakovenko* & *Barbora Zdvihalová***

The field part of the course was focused firstly on giving the students introduction to animal diversity in the area of polar station. Secondly teaching them about important groups of organisms here and also showing them various methods of sampling in the field. And also we demonstrated some of the caught invertebrates in tanks for educational purposes. Great part of the course students also worked on individual projects under our guidance.
Representatives of a macrozooplankton (e.g. *Clione limacina*, *Limacina helicina* and *Mertensia ovum*) were collected by plankton net and various macrozoobenthos (e.g. *Buccinum* spp., *Mya truncata*, spirorbid polychaete and *Strongylocentrotus* spp.) were sampled during scuba diving. The most common fishes (e.g. *Myoxocephalus scorpius*, *Gymnocanthus tricuspis* (Fig. 3.3.1.), *Clupea harengus* and *Boreogadus saida*) were caught using gill nets laid in littoral habitats.

Fig. 3.3.1. *Gymnocanthus tricuspis*.

Ondřej Otáhal has begun with sampling of material for his bachelor thesis focused on life cycles of opecoelid trematodes. He is involved in long term project of parasitological group. Just this season it was the experiments with hosts of these trematodes that were the greatest achievement of parasitological group. The life cycle of *Podocotyle* has been completed and exceptional strategy of second host (amphipods) infection was found. Ondra obtained enough material for morphological and molecular characterization.

Bára Zdvihalová has been focused to micromycete occurred on bird feathers. She collected material for their isolation and currently she cultures several genera of micromycete (e.g. *Cladosporium*, *Aureobasidium*, *Mucor* and *Acremonium*). The main goal of the project is to compare micromycete composition from bird species with different behaviour.

Petr Nguyen was interested in the species *Diplocotyle olrikii* (Cestoda: Spathebothriidea). He is specialist in cytogenetic methods and *D. olrikii* from sculpin *Myoxocephalus scorpius* was chosen by Petr to karyotype characterization and to study of chromosome translocation (Fig. 3.3.2.).

Fig. 3.3.2. Sculpin (*Myoxocephalus scorpius*) dissection - Petr and Oleg.

Miloslav Devetter, Karel Janko and their student Natalia Yakovenko have been studied metazoan animals living in cryoconites of surrounding glaciers and found regular populations of bdelloid rotifers and tardigrades. The sediment from cryoconites was sampled, dried and should be subjected to genetic analyses of such populations (Fig. 3.3.3.).

Fig. 3.3.3. Cryoconites with a visible layer of sediment.

Petra Kokořová focussed her activity on spatial changes of soil mesofauna on gradients of deglaciation after three glaciers in Petuniabukta. She found that oribatid communities are most abundant and rich in species in sites far from glacier forefront and are pure or absent in recently deglaciated sites. RNA analyses of such oribatids will be done in close future.

Jana Elsterová has been continued with a searching for arboviruses which was initiated by Jiří Černý, last-year participant (Fig. 3.3.4.).

Fig. 3.3.4. Jana catching mosquitoes.