# Report on Czech research activities in Petuniabukta, Billefjorden, Svalbard, performed in summer season 2012

# RESEARCH ACTIVITIES SVALBARD 2012

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

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The scientific part of 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: Jan Kavan

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2012

# 1. Introduction

In 2012, we started our fifth season in Petuniabukta, Svalbard. Our research programme followed on previous research project *Biological and Climatic Diversity of the Central Part of the Svalbard Archipelago* (INGO LA341) in 2007-2010 and present project *Czech Polar Stations: Construction and Logistics Expenses* (LM2010009). Major part of the scientific activities was connected with a new 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.

As in previous years, thanks to kind permission of Articugol company, we occupied Russian hunting hut on the west coast of Petuniabukta and the containers located in Pyramiden port facility served for storage. Our cameraman Miloslav Dvořáček documented research activities in the field.

For more information visit http://polar.prf.jcu.cz please.

# 2. Season 2012 Research Programme

The field research started on June 25th, 2012, and was completed on August 31st, 2012. The list of expedition participants and their periods of stay is summarized in Tab. 2.1.

**Tab. 2.** List of expedition participants with their affiliations and their periods of stay. .

| | Affiliation(s) | Group | Dates |
|---|---|---|---|
| Alexandra Bernardová | JU | BOTA | 25/06-30/07 |
| Jan Blahůt | IRSM | GEO | 31/07-08/08 |
| Zuzana Chládová | UFA | CLIMA | 16/07-31/07 |
| Miloslav Devetter | ISB+JU | ZOO | 25/06-17/07 |
| Oleg Ditrich | JU | ZOO | 24/06-20/07 |
| Miloslav Dvořáček | JU | photographer | 06/07-08/08 |
| Martin Hais | JU | | 06/07-20/07 |
| Tomáš Hájek | JU+IBOT | BOTA | 30/06-20/07 |
| Josef Elster | JU+IBOT | MICRO | 23/07-31/08 |
| Karel Janko | IAPG+JU | ZOO | 24/06-16/07 |
| Roman Juras (s) | JU | HYDRO | 30/07-17/08 |
| Jan Kavan | JU | HYDRO | 25/06-31/08 |
| Jitka Klimešová | IBOT+JU | BOTA | 02/07-16/07 |
| Kateřina Kopalová | UK+IBOT+JU | HYDRO | 23/07-06/08 |
| Petr Kotas (s) | JU | MICRO | 30/07-31/08 |
| Jana Kvíderová | IBOT+JU | MICRO | 30/07-31/08 |
| Kamil Láska | MU+JU | CLIMA | 16/07-31/07 |
| Vincent Lesniak (s) | UBP+JU | MICRO | 23/07-31/08 |
| Linda Nedbalová | UK+IBOT+JU | HYDRO | 30/07-12/08 |
| Daniel Nývlt | CGS+JU | GEO | 23/07-06/08 |
| Václav Pavel | UPOL+JU | ZOO | 28/06-15/07 |
| Ekaterina Pushkareva (s) | JU | MICRO | 30/07-31/08 |
| Prashant Singh (s) | BHU | MICRO | 30/07-31/08 |
| Otakar Strunecký | JU+IBOT | MICRO | 25/06-10/07 |
| Marie Šabacká | JU+BAS | MICRO | 23/07-06/08 |
| Daria Tashyreva | JU | MICRO | 30/07-25/08 |
| Tomáš Tyml | JU+PARU | ZOO | 24/06-20/07 |
| Lukáš Veselý (s) | JU | MICRO | 30/07-31/08 |

Abbreviations:
Affiliations: BAS – British Antarctic Survey, Cambridge (GB); BHU – Baranas Hindu University, Varanasi, (IN); CGS – Czech Geological Survey, Brno (CZ); IAPG – Institute of Animal Physiology and Genetics AS CR, Liběchov (CZ); IBOT – Institute of Botany AS CR, Třeboň (CZ); IRSM – Institute of Rock Structure and Mechanics AS CR, Prague (CZ); ISB – Institute of Soil Biology AS CR, České Budějovice (CZ); JU – University of South Bohemia, České Budějovice (CZ); MU – Masaryk University, Brno (CZ); PARU – Institute of Parasitology, České Budějovice (CZ); UBP – Blaise Pascal University, Clermond-Ferrand (FR); UFA – Institute of Atmospheric Physics AS CR, Prague (CZ); UK – Charles University, Prague (CZ); UPOL – Palacký University, Olomouc (CZ).
Groups: BOTA - botany/plant physiology; CLIMA - climatology/glaciology; GEO - geology/geomorphology; HYDRO - hydrology/limnology; MICRO - microbiology/phycology; ZOO - zoology/parasitology.
(s) after name - student

Vincent Lesniak succeeded in defense of his MSc. thesis based on his scientific results from wet meadow study entitled *Diversity and ecophysiological performance of cyanobacteria in wet meadow, Petunia Bay, Central Svalbard* at Blaise Pascal University, Clermont-Ferrand (FR).

# 3. Field work progress reports

## 3.1. Geology and Geomorphology

### 3.1.1. Laser scanning techniques – case studies on Bertilbreen outwash plain and debris flow cone

***Jan Blahůt* & *Jan Kavan***

A study of fluvial dynamics of Bertilbreen River on the glacier foreland outwash plain has been carried out in the first week of August. This area has been identified as highly dynamic during the 2011 season field campaign. Hydrological monitoring system has been set up last year and continued throughout this season including manual discharge measurement. Two time-lapse cameras have been installed to monitor study area in regular intervals. Apart that, a detailed digital elevation model (DEM) was produced with help of laser scanning (LiDAR; Fig. 3.1.1.). This has been done in two time steps (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 characterized by very stable weather conditions and subsequently also the hydrological regime was very stable leading to almost no change in drainage system. Significant changes have been observed only from the time-lapse cameras in periods out of the LiDAR study. The only interesting change identified from LiDAR scanning was a small debris slide on the slope of dead ice core covered by moraine material (Fig. 3.1.2.).

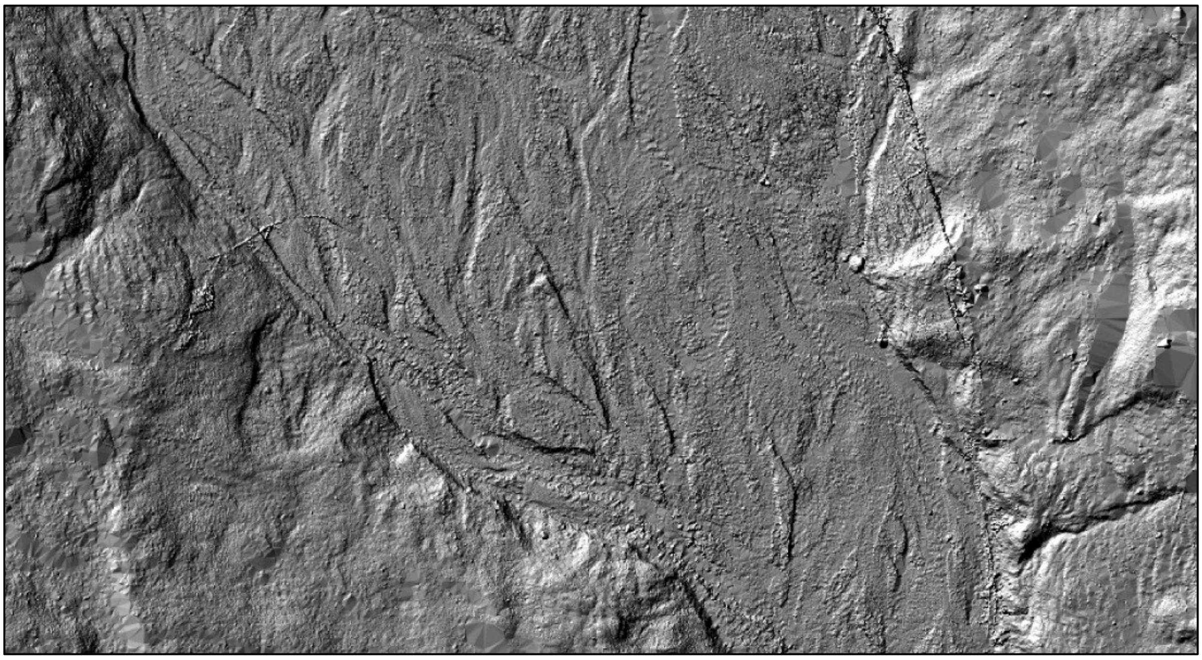

**Fig. 3.1.1.** DEM of Bertilbreen outwash plain produced by laser scanning.

A second part of LiDAR investigation was focused on monitoring debris flow cone (Fig. 3.1.3.) in the vicinity of Czech research station in Petuniabukta. The whole area was scanned and DEM produced. According to our experience and observations we expect movement of rock material during the spring melting period. We are planning to scan the area of interest next summer and to compare the changes in DEMs. Time-lapse camera has been set up to monitor large part of the debris flow cone. This will enable us to identify the precise timing of slope movements and relate it to local atmospheric conditions – AWS is situated in the upper part of the slope and complex climate station is located about 3 km north. The goal is to quantify the amount of material transported during one single season and identify climatic conditions leading to this process.

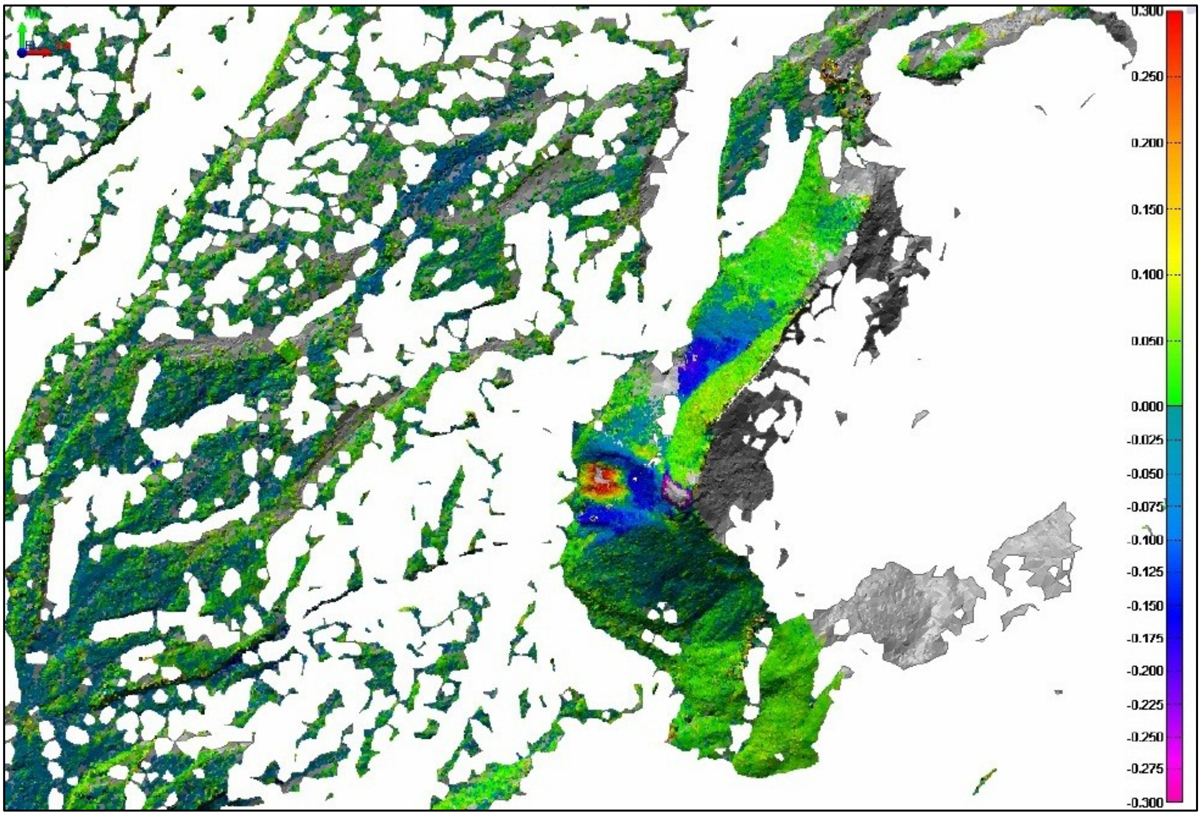


**Fig. 3.1.2.** Small debris slide occurred during the 7 days interval and identified by comparison of the two DEMs.

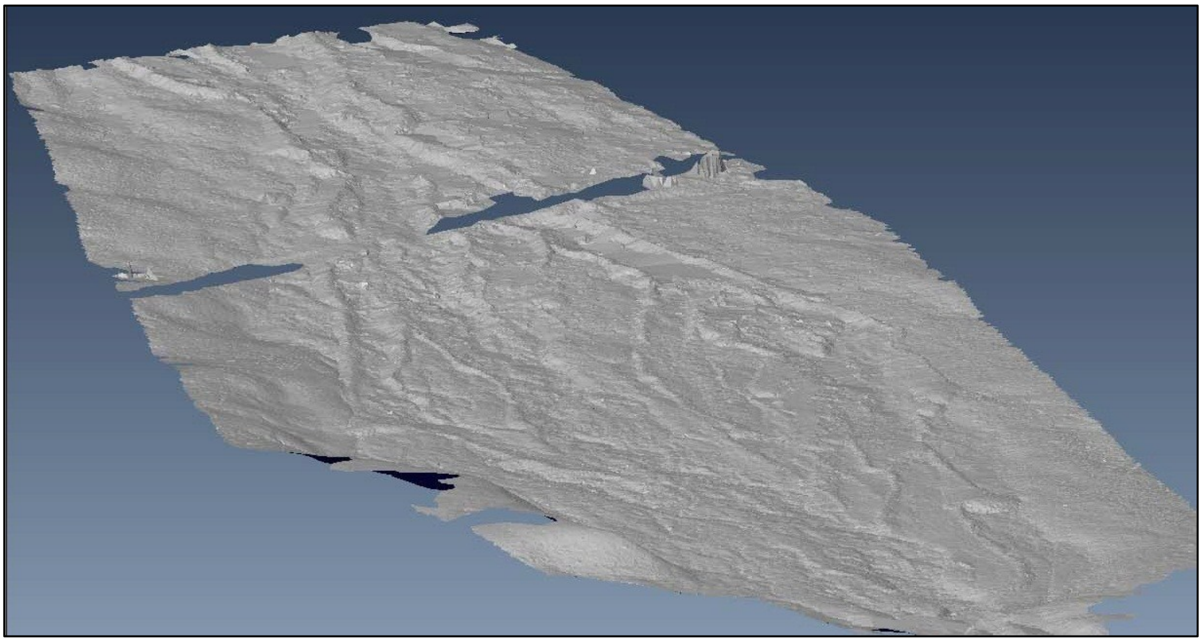

**Fig. 3.1.3.** Laser scanning of the debris flow cone near Czech research station in Petuniabukta.

# 3.2. Climatology and Glaciology

## 3.2.1. Meteorology and climatology

*Kamil Láska, Zuzana Chládová*

The meteorological measurements and climate research were performed in the coastal ice-free zone of Petuniabukta, northern branch of Billefjorden in July–August 2012. Eight automatic weather stations (AWS) were operated along the north-western and eastern coast of Petuniabukta (Fig. 3.2.1.) in the following locations:

- AWS1 – old marine terrace at an altitude of 15 m a.s.l. (operated from 2008)
- AWS2 – old marine terrace at 25 m a.s.l. (operated from 2008)
- AWS3 – head of Hørbyebreen at 67 m a.s.l (operated from 2008)
- AWS4 – mountain ridge of Mumien Peak at 475 m a.s.l. (operated from 2008)
- AWS5 – hummock tundra – thufur field at 8 m a.s.l. (operated from 2009)
- AWS6 – the Pyramiden Peak at 935 m a.s.l. (operated from 2009)
- AWS7 – the Bertilbreen at 464 m a.s.l. (operated from 2011)
- AWS8 – the Fortet at 265 m a.s.l. (operated from July to August 2012)

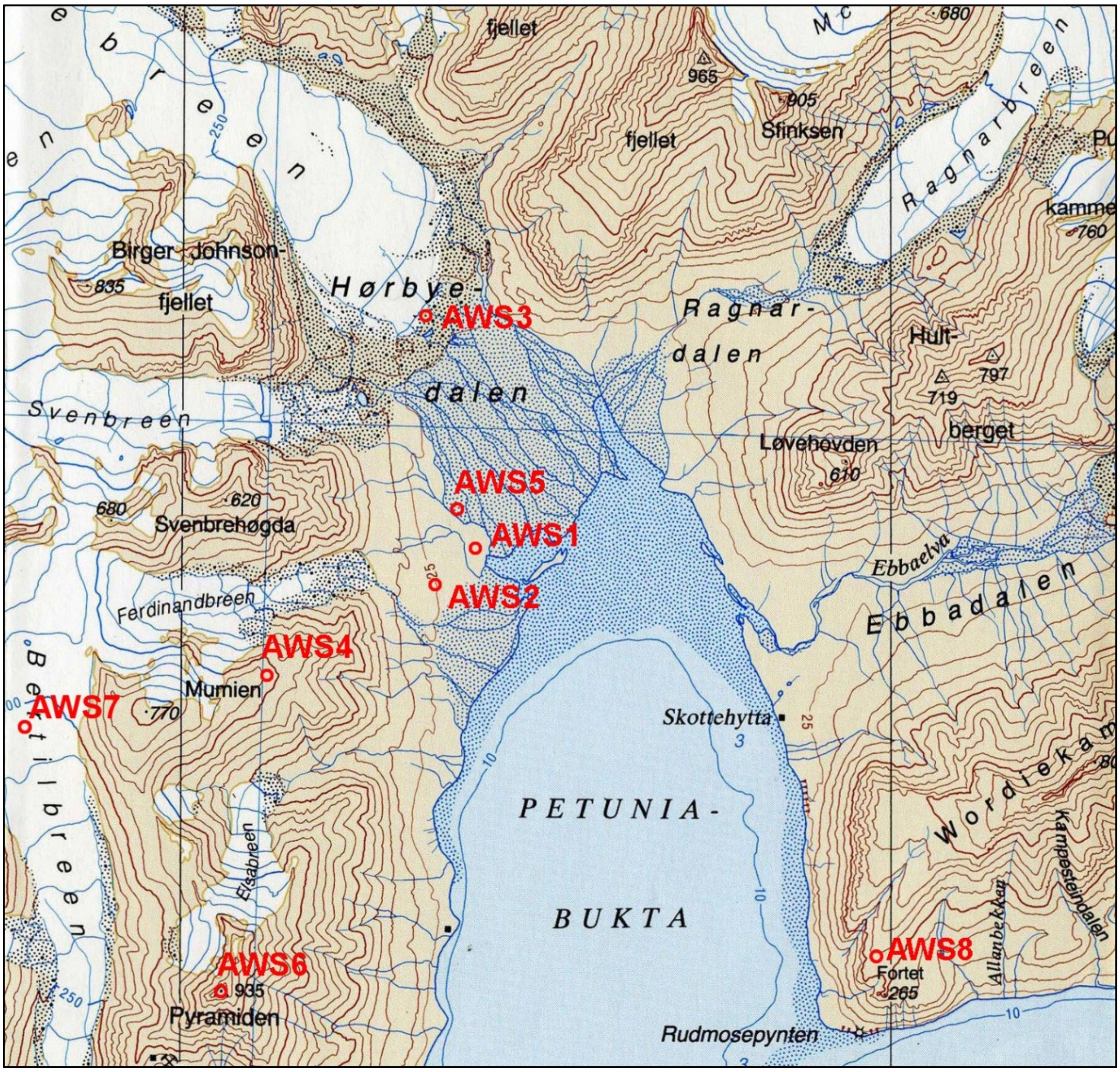


**Fig. 3.2.1.** Location of the automatic weather stations in the vicinity of Petuniabukta (Billefjorden, Spitsbergen) in July–August 2012.

The main objectives of the fieldwork activities were:

- Tundra Surface Energy Balance Experiment 2012 (TUSEB 2012)
- Surface Wind Field Experiment 2012 (SUWIN 2012)
- Evaluation of atmospheric circulation and summer weather conditions in Petuniabukta
- Maintenance and calibration of the meteorological instruments (Fig.3.2.2.)

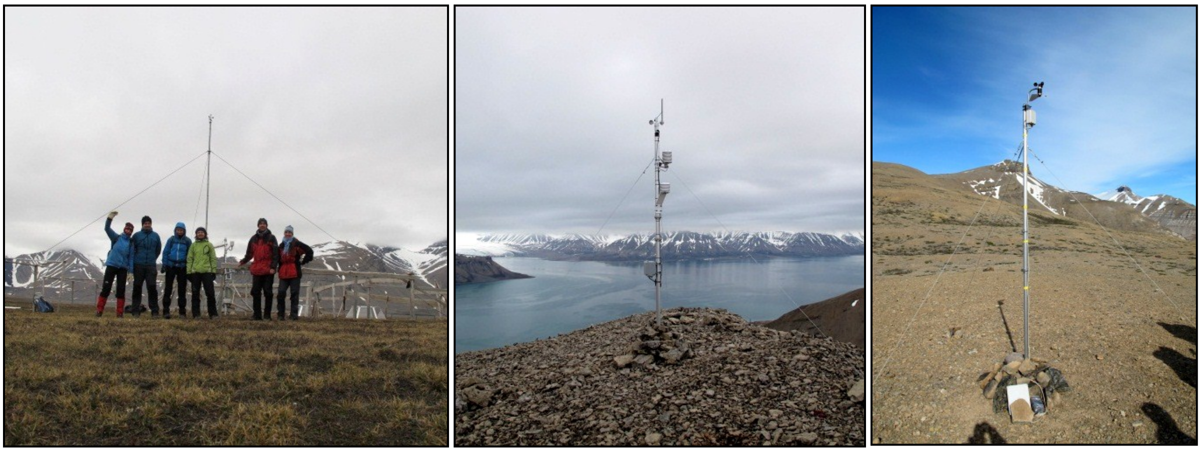

**Fig. 3.2.2.** Automatic weather stations in the vicinity of Petuniabukta (AWS1 – marine terrace, AWS4 – mountain ridge of the Mumien Peak, AWS8 – near the Fortet Peak).

TUSEB 2012 experiment consisted in measurement of surface energy balance and estimation of the individual fluxes by different methods. For this reason, micrometeorological station with very precise instruments was temporarily installed on the permanent tundra vegetation plot in the period 18 July–23 August 2012.

SUWIN 2012 experiment consists of calculation of wind characteristics, and creating a mean wind map of Petuniabukta at the 10 meters above ground surface. Summer wind data from the three meteorological stations (AWS4, AWS6, and AWS8) were used and compared with the AWS1 reference station. Subsequently, data quality control and time synchronization for the 5 min intervals were done before creating the wind rose and wind map based on the WAsP model (Figs 3.2.3. and 3.2.4.). Calculation of the wind map was performed individually for each AWS position and averaged from the four model outputs. For graphical representation of the wind map, the ESRI ArcMap software was used.

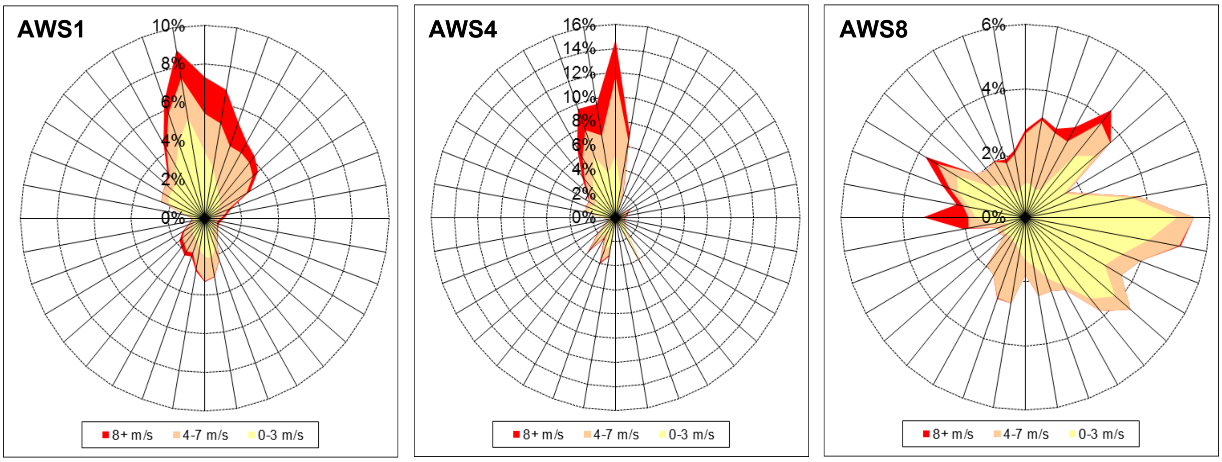


**Fig. 3.2.3.** Wind frequency distributions at the selected automatic weather stations in the period July–August 2012.

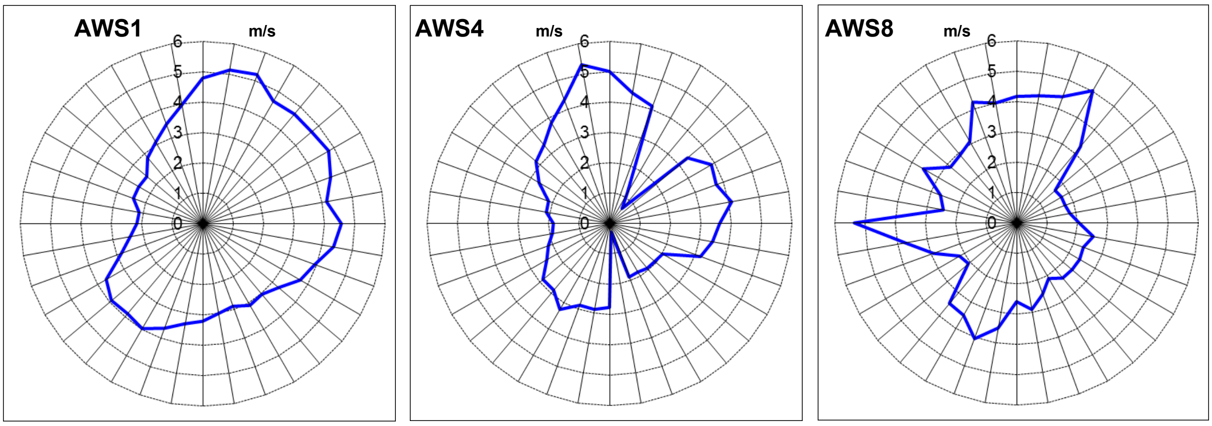


**Fig. 3.2.4.** Wind speed distributions at the selected automatic weather stations in the period July–August 2012.

Maintenance of the AWS, calibration and replacement of the meteorological sensors was carried out in July 2012. At the same time, data downloading and quality control of individual meteorological parameters was performed at all AWS. In August 2012, micrometeorological station was winterized; part of high sensitivity instruments was dismounted and transported to the Czech Republic (Masaryk University, Brno) for calibration and technical service.

Temporal variations of 2-m air temperature and other meteorological parameters were evaluated and compared with atmospheric circulation conditions in the study area. Anticyclonic circulation with prevailing sunny weather and high-level clouds (*Cirrus, Cirrocumulus*) was observed in the period 19–21 July 2012 (see Figs. 3.2.3. and 3.2.5.). There were convective clouds of *Cumulus humilis* and middle-level orographic clouds of *Altocumulus lenticularis* which formed in the evening on 20 July and in the afternoon on 21 July. High-level clouds were accompanied by the occurrence of spectacular phenomena called a little halo visible on 20 July from 11 to 15 UTC. In these days, ground surface temperature of the tundra vegetation reached up 19°C, while 2-m air temperature was around 10°C shortly after noon (Fig. 3.2.5).

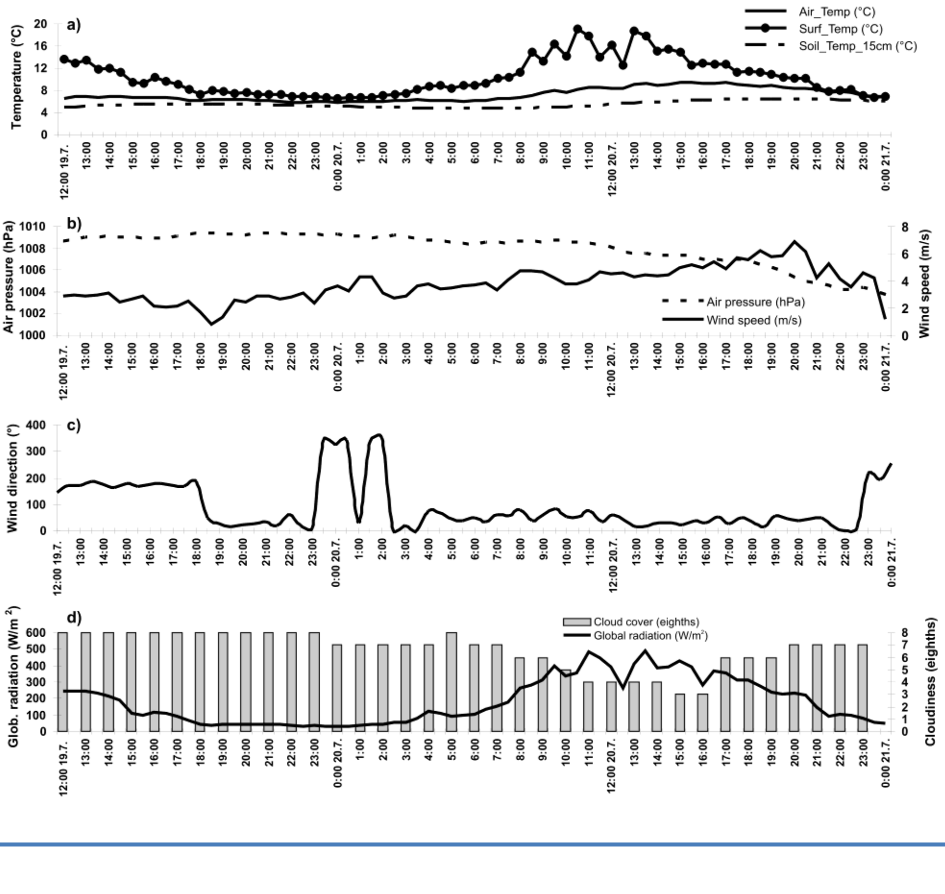


**Fig. 3.2.5.** Diurnal regime of the selected meteorological parameters at Petuniabukta (Billefjorden, Spitsbergen) in the period 19–21 July 2012. Time axis in UTC (Coordinated Universal Time).

## 3.3. Hydrology and Limnology

### 3.3.1. Hydrological monitoring in Petuniabukta

***Jan Kavan***

The monitoring system on 4 river streams that has been set up in 2011 has been checked and data downloaded. All sensors were working after its defrost usually in the middle of June. Only the „Waterfall creek" sensor was not possible to check and download due to large snow accumulation on the river bank. Monitoring on Bertilbreen River is used for study of fluvial dynamics and glacier mass balance.

Beside the 4 sensors from 2011 season a new ones have been set up. Svenbreen River (78.7276° N, 16.3995° E) was previously monitored by research team from Adam Mickiewicz University in Poznan. After serious troubles with their sensors during last two seasons we establish a common monitoring with our more reliable equipment. Together with Jakub Malecki (AMU+UNIS) we installed water level sensor and have carried out a discharge measurement campaign (June 20th, August 17th and September; Fig. 3.3.1). This will be used for assessing glacier melt water runoff in the complex Sven glacier mass balance study.

New sensors have been installed on the Ragnar lake (78.7421°N, 16.6347°E ), small lake on the moraine of Nordenskioldbreen (78.6386°N, 16.8292°E ) and downstream from Pollockbreen (78.6810°N, 16.7671°E).

All these are part of long-term hydrological monitoring system of selected rivers in Petuniabukta area. This should enable us to observe changes in hydrological and thermal regime related to climate change and consequent retreat of glacier in the area.

**Fig. 3.3.1.** Jakub Malecki measuring discharge on Sven river (July 20th 2012).

### 3.3.2. Isotopic composition of $\delta^2H$ and $\delta^{18}O$ for hydrological purposes

***Roman Juras & Jan Kavan***

A first attempt to investigate isotopic concentration of $\delta^2H$ and $\delta^{18}O$ for hydrological purposes was made during the 2012 summer season. Elsa river catchment was chosen as a representative area. River stream is approximately 3 km long with quite high elevation gradient. This represents an example of braided river typical for this Arctic region. This means that the river flows in unstable channel/channels and carry large amounts of sediment load.

Two sampling and measuring campaigns were carried out to study the flow rate changes and diurnal regime of the river flow. The largest changes in discharge in the catchment are related to precipitation events. Significant changes - especially strong diurnal regime - are however related to air temperatures and radiation level (Fig. 3.3.2.). 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. Employing of isotopic changes analysis of $\delta^2H$ and $\delta^{18}O$ composition is very suitable tool for identification of main sources contributing to runoff. Results of the Elsa river sampling are shown on Fig. 3.3.3. Isotopic concentrations are expressed as V-SMOW values.

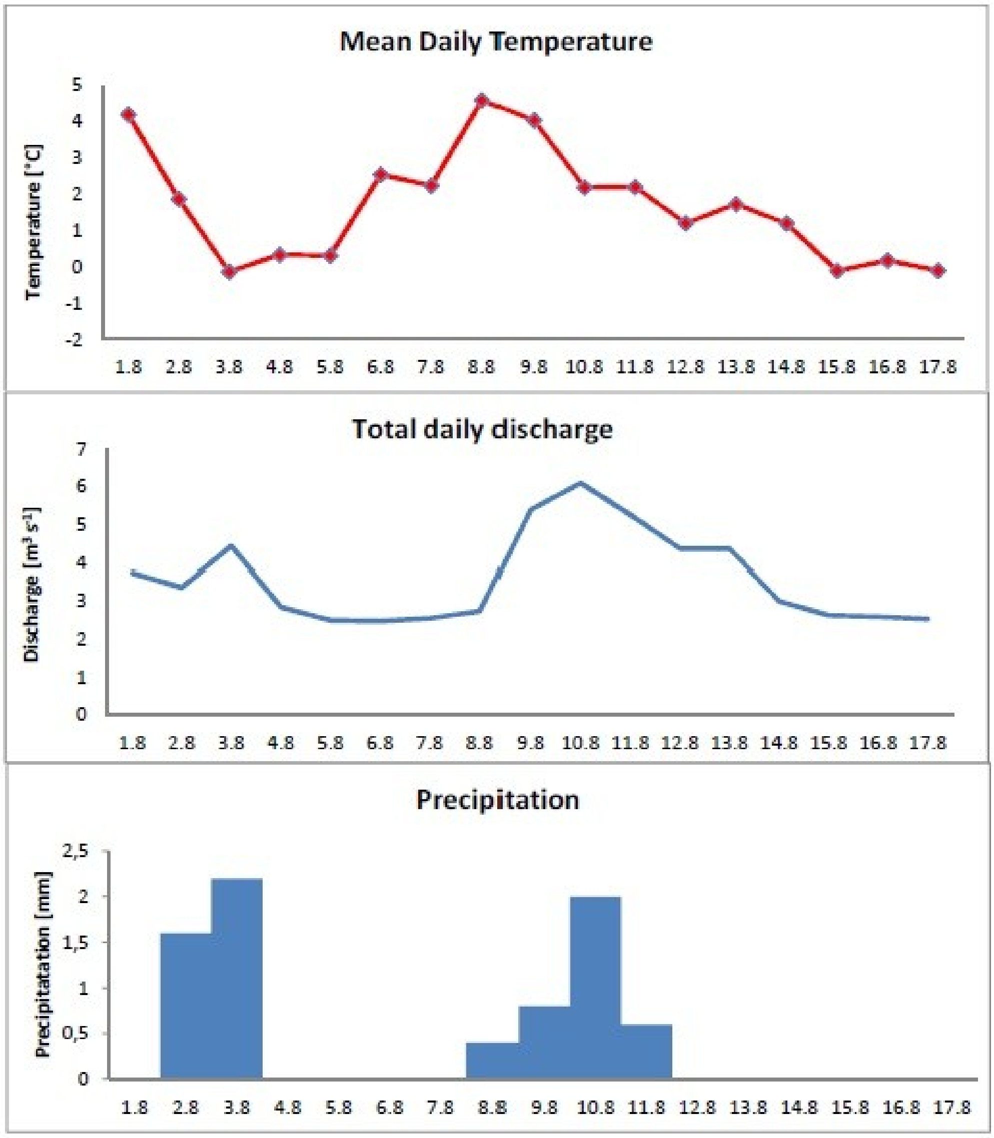


**Fig. 3.3.2.** Climatic parameters and flow rate during the study period; temperature measured on the AWS at the 560 m a. s. l. Altitude in the upper part of catchment, precipitation amount by the automatic rain gauge at the sea level.

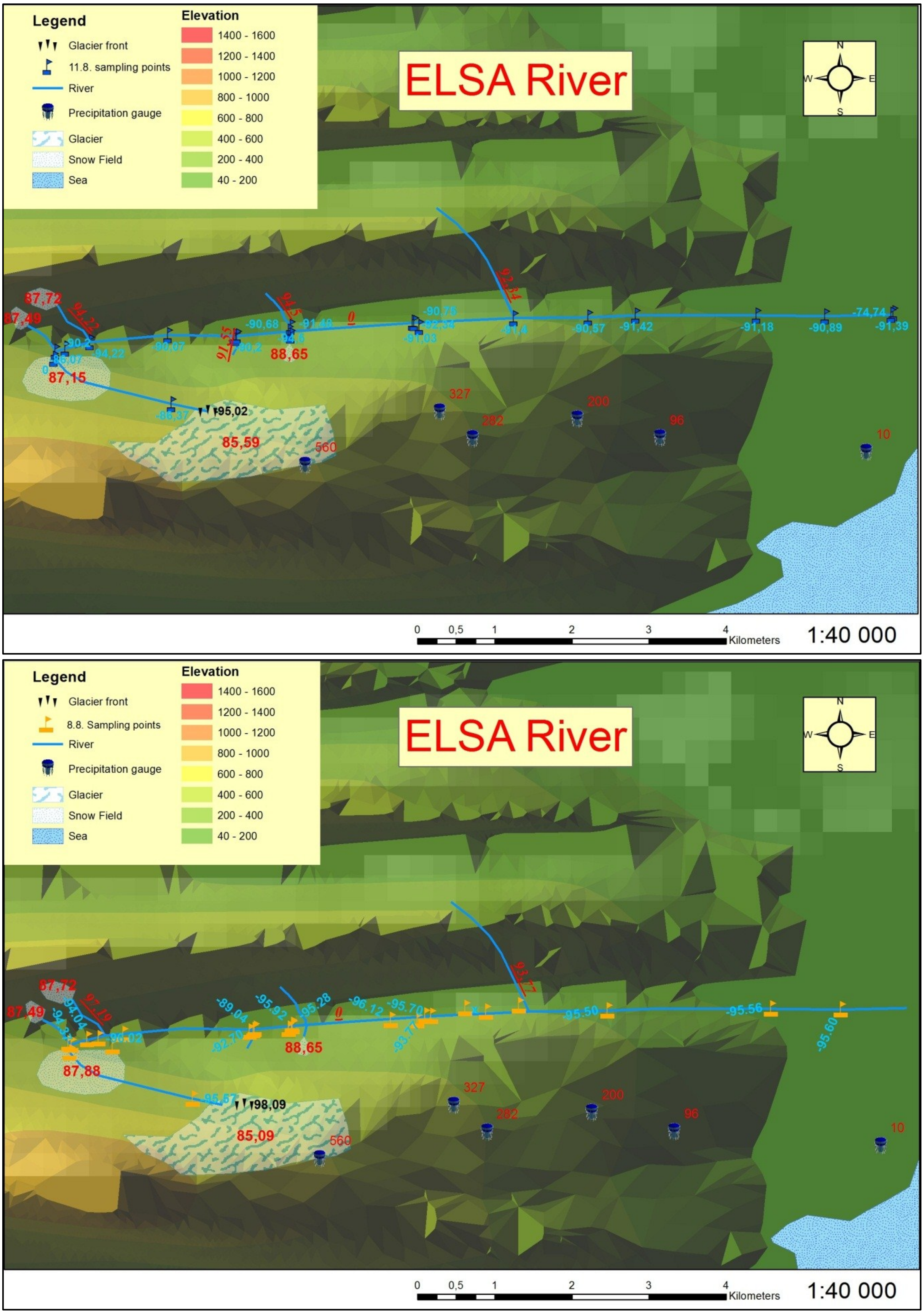


**Fig. 3.3.3.** Results of two field campaigns on Elsa River.

Water samples were collected daily during the whole summer season from a brook situated next to our research station. The goal was to observe change in isotopic composition throughout the summer melting period and estimate main sources of runoff and changes in their relative contribution to runoff. A time series of more than two month has been collected. Result is shown in Fig. 3.3.4. Shape of the curve suggests that mostly recently accumulated snow is melted in the beginning of the season, whereas relatively „old“ water flows later in the summer. This may be related to melting of permafrost being probably a major source of water during late summer.

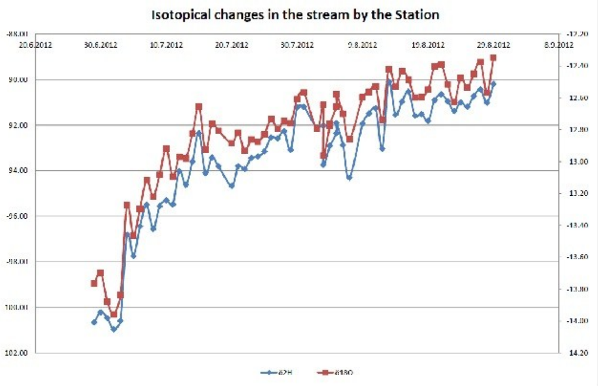


**Fig. 3.3.4.** Isotopical changes of the water samples from a study catchment.

The same analysis has been made on samples from snow pit in a vertical profile – see Fig. 3.3.5. The snow pits were made on the Elsa glacier in the altitude of 480 m a. s. l. During the Elsa River sampling campaigns.

Precipitation samples were taken on the altitudinal gradient on the slope of Pyramiden Mountain. The analyses of isotopic composition was mostly not successful because of degradation of samples due to evaporation, which proved calculation of deuterium excess (D = $\delta^2H - 8\ \delta^{18}O$).

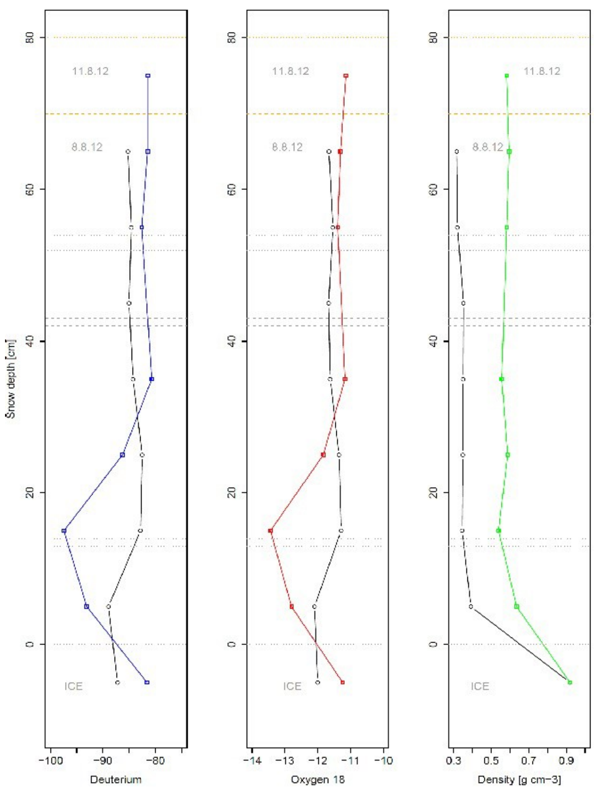


**Fig. 3.3.5.** Isotopic and snow density changes between the two sampling campaigns on Elsabreen – snow pits on Elsa glacier.

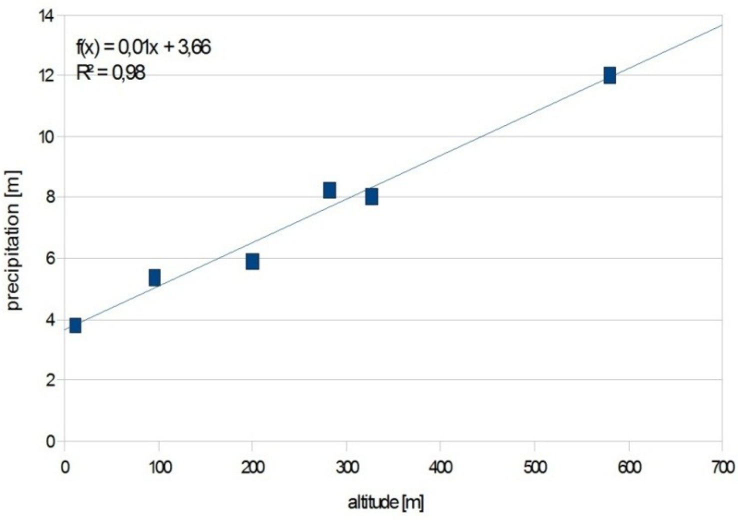


**Fig. 3.3.6.** [altitude X precipitation amount] relationship on the east slope of Pyramiden mountain; position of rain gauges on Fig. 3.3.3.

However a general relation between precipitation amount and altitude has been set up. This is shown in Fig.3.3.6. A part of the precipitation samples was given to Mark Hermanson (UNIS) for further heavy metals analysis, which are important atmospheric pollutants transported to the Arctic area.

### 3.3.3. Environmental changes of freshwater and terrestrial ecosystems of High Arctic

***Linda Nedbalová, Daniel Nývlt, Kateřina Kopalová & Jan Kavan***

Diatoms (*Bacillariophyta*) are one of the most abundant algal groups in polar ecosystems and they proved to be very useful indicators of environmental and climatic changes in polar region. During polar summers 2011 and 2012 several lakes and terrestrial ecosystems in the vicinity of Petuniabukta (Central Spitsbergen) were sampled. Both physico-chemical parameters and variety of biological markers were studied. We drilled several sediment cores from seepages, marshes and lakes to study terrestrial and freshwater ecosystems from paleoecological point of view (Figs. 3.3.7 – 3.3.9.).

Freshwater and terrestrial diatom composition will be analysed in the samples, using light microscopy and, when appropriate, scanning electron microscopy techniques. Transfer functions for the significant environmental parameters will be developed on the basis of specific diatom composition. The longest sediment core from the landslide-related lake Garmaksla will be analysed for the diatom succession. The obtained transfer functions will be used for reconstruction of the environmental history of the lake and in combination with results obtained by other research teams, an attempt will be made for a climate reconstruction of the area.

Further proxies, such as magnetic susceptibility, organic and inorganic carbon, sulphur and basic elements content, together with grain-size will be analysed in the laboratories in Czech Republic to complement the ascertained ecosystem changes.

**Fig. 3.3.7.** Sediment sampling from a marsh in Ebbadalen.

**Fig. 3.3.8.** Cleaning the sediment core.

**Fig. 3.3.9.** Sediment core lithological description and sampling.

### 3.3.4. Snow and sea ice monitoring system

***Jan Kavan***

Our knowledge of local snow conditions in Petuniabukta is rather limited. However, the characteristics of snow cover are crucial for most of the environmental processes taking place during summer season. These characteristics influence soil and permafrost properties, hydrological regime but also all the terrestrial biota.

Therefore a simple monitoring system was established. Two time-lapse cameras have been installed on the top of old unused Russian geodetic tripods. System of ablation stakes is installed in their field of vision (see Fig. 3.3.10.). With the 4hours shooting interval we will be able to reconstruct height of snow throughout the winter period. The advantage of this system is its relative simplicity and especially ability to cover larger area of interest comparing to classical acoustic snow depth measuring devices. The cameras are equipped with IR mode, which ensure its functioning even during polar night.

The same system is used for sea ice extent monitoring. A camera has been mounted on a rock in the Sfinksen massif. It is facing towards south in the axis of Petuniabukta and Billefjorden. We expect a better and precise knowledge of sea ice onset and spring thawing together with its spatial extent as well as coarse snow cover conditions in the area. This will help us to explain some atmospheric features measured on our AWS monitoring network. We are of course aware of possible threats that are joined with using time-lapse cameras, such as possible condensation of water and freezing on the camera lenses. However even with some part of material being unusable, we expect to have a clear image of winter conditions in Petuniabukta.

**Fig. 3.3.10.** Location of snow monitoring system on the marine terraces near open top chambers experimental site.

# 3.4. Microbiology and Phycology

## 3.4.1. Diversity of cyanobacteria in Petuniabukta, Central Svalbard

***Prashant Singh***

Cyanobacteria represent an ancient and crucial lineage of photoautotrophic group of organisms. They are one of the most unique and adept group of prokaryotes, possessing the capability of oxygenic photosynthesis. In the present scenario of climate vulnerability and huge focus on the microbe-climate interactions, study of cyanobacterial diversity and phylogeny is necessary to assess the possible impact of these changes on polar ecosystems. More than 100 cyanobacterial strains from the Arctic from the wet hummock tundra in Petuniabukta (Green Meadow), below the glacier in Brucebyen and from Pyramiden were collected and were processed in the Laboratory of Microbial Genetics, Centre of Advanced Study in Botany, Banaras Hindu University, India. The genetic diversity at the structural and the functional levels, the population genetic estimates and finally phylogeny and evolution of *Nostoc* spp. collected from Svalbard, Norway, was estimated using molecular techniques and bioinformatics tools. Phylogeny of *Nostoc* spp. using the structural gene 16S rRNA gave some insights into the relatedness of Arctic Cyanobacteria with each other. Analyses of the *nif*H gene that encodes dinitrogenase reductase enzyme further gave some crucial leads into the phylogeny and evolution of the nitrogenase machinery along with the relatedness of cyanobacteria. Our population genetics analyses points out towards clear cut evolutionary tendencies of arctic cyanobacteria thus providing substantial proof towards the phylogenetic and evolutionary significance of the cyanobacteria of one of the most extreme environments. The arctic microbial diversity needs to be investigated at the molecular and genetic level because the site and landscape experiences some phenomenal extremes of climate and temperature along with huge topographic variations. In spite of all this, the cyanobacteria were found to be growing very luxuriantly along with a range of green algae etc. and this shows that it is the genetic architecture that actually needs to be investigated to assess this growth of cyanobacteria. The work, thus throws some critical light into the phylogenetic relationship and evolutionary tendencies of arctic cyanobacteria. More elaborative molecular assessment is the needed for further strengthening the current phylogeny and evolutionary status of arctic cyanobacteria.

Twelve strains from the Petuniabukta Green Meadow, Brucebyen and Pyramiden (Tab. 3.4.1.) have already been analysed at the molecular level using the 16S rRNA (Fig. 3.4.1.) and the *nif*H gene (Fig. 3.4.2.) as molecular markers. The samples along with the NCBI accession numbers are being provided in the Tab 3.4.1.

**Tab. 3.4.1.** Arctic cyanobacteria along with the 16S rRNA and the *nif*H accession numbers.

| S. No. | Cyanobacteria | 16S Accession Number | *Nif*H Accession Number |
|---|---|---|---|
| 1. | Nostoc_sp_ARC1 | JX862182 | JX862194 |
| 2. | Nostoc_sp_ARC2 | JX862183 | JX862195 |
| 3. | Nostoc_sp_ARC3 | JX862184 | JX862196 |
| 4. | Nostoc_sp_ARC4 | JX862185 | JX862197 |
| 5. | Nostoc_sp_ARC5 | JX862186 | JX862198 |
| 6. | Nostoc_sp_ARC6 | JX862187 | JX862199 |
| 7. | Nostoc_sp_ARC7 | JX862188 | JX862200 |
| 8. | Nostoc_sp_ARC8 | JX862189 | JX862201 |
| 9. | Nostoc_sp_ARC9 | JX862190 | JX862202 |
| 10. | Nostoc_sp_ARC10 | JX862191 | JX862203 |
| 11. | Nostoc_sp_ARC11 | JX862192 | JX862204 |
| 12. | Nostoc_sp_ARC12 | JX862193 | JX862205 |

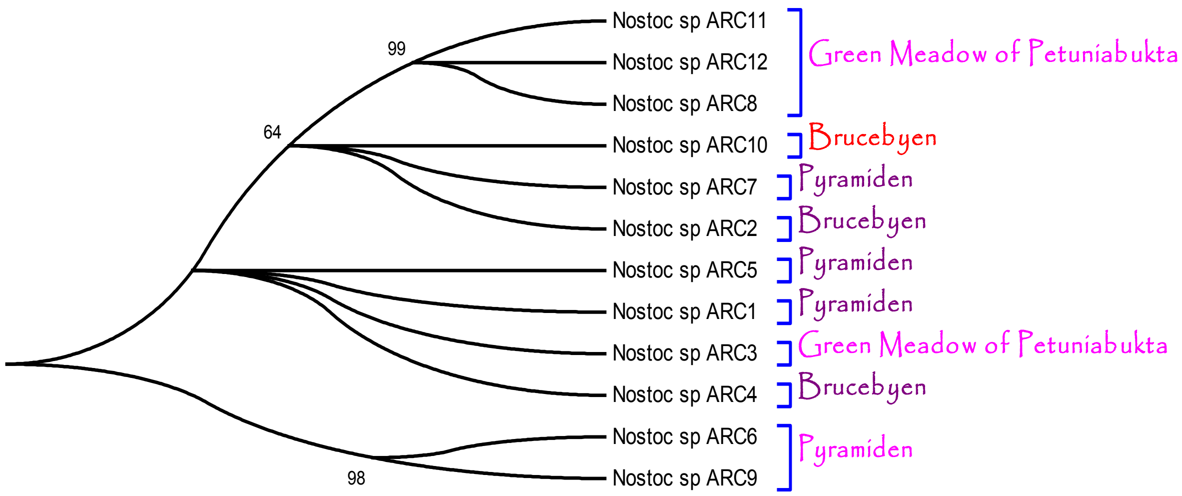


**Fig. 3.4.1.** 16S rRNA gene sequences based dendrogram using the Neighbour Joining method. The optimal tree with the sum of branch length = 0.15286100 is shown. The evolutionary distances were computed using the Jukes-Cantor method and are in the units of the number of base substitutions per site. The analysis involved 12 nucleotide sequences. All positions containing gaps and missing data were eliminated. There were a total of 129 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

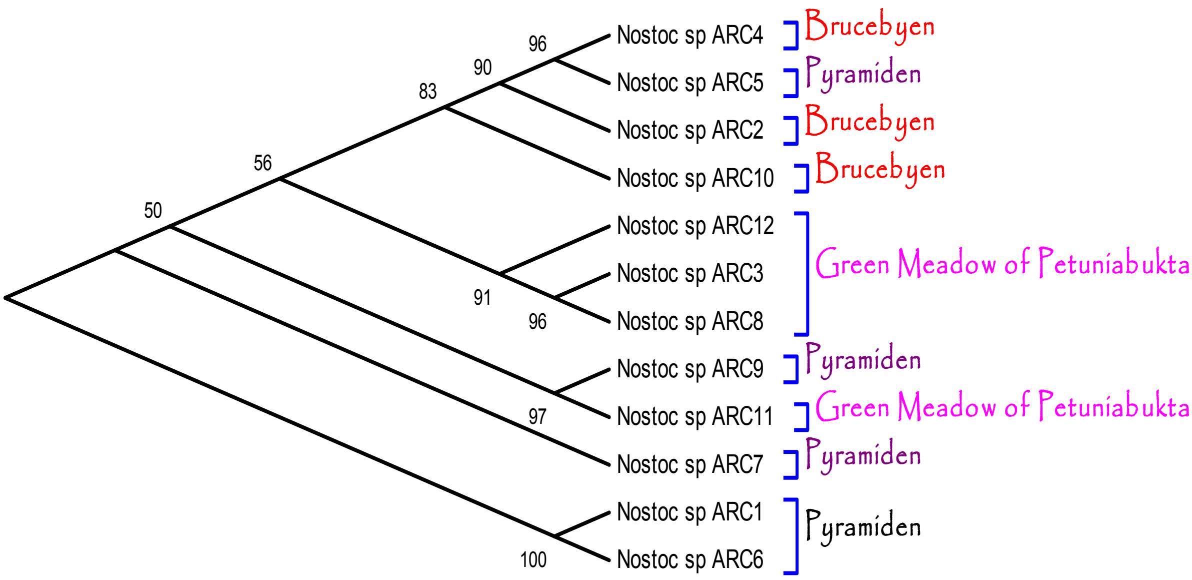


**Fig. 3.4.2.** *nif*H gene based dendrogram using the Neighbour-Joining method. The optimal tree with the sum of branch length = 51.46875000 is shown. The evolutionary distances were computed using the number of differences method and are in the units of the number of base differences per sequence. The analysis involved 12 nucleotide sequences. Codon positions included were 1st+2nd+3rd. All positions containing gaps and missing data were eliminated. There were a total of 195 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

### 3.4.2. Diversity and ecophysiological performance of cyanobacteria in wet meadow, Petuniabukta, Central Svalbard

***Vincent Lesniak***

The Petuniabukta wet meadow, Svalbard (N 78°43'49" E 16°26'41"), was studied during the months of July and August 2012, in order to establish its biologic activity. According to ecological conditions (water level, vegetation cover aspect) this meadow was

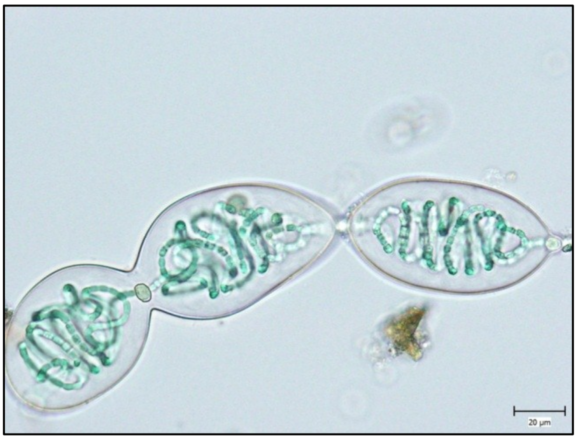

**Fig. 3.4.3.** Dividing colony of *Nostoc commune s.l.*

divided into 5 different areas. The comparison of each areas and components (mosses, metaphyton and *Nostoc commune s.l.*) will define which elements vary most. In this respect ecological diversity (specific richness, abundance) of meadow and metaphyton species were measured. The nitrogenase activity (by acetylene reduction assay) was performed on all components, and ecophysiological performances of *Nostoc commune s.l.* (organic carbon, chlorophyll fluorescence) were recorded as well. The meadow diversity is low (only 11 species), and dominated by mosses. *Nostoc commune s.l.* obtains 6% of abundance (Fig. 3.4.3.). Their ecophysiological performance did not show any differences between areas and suggests that they are adapted to the moisture gradient present in their environment. Concerning metaphyton, approximately 25 species of cyanobacteria and diatoms were recorded. According to water factor, specific richness and diversity of diatoms is different according each sampling sites of metaphytons.

### 3.4.3. Biogeographical and temporal diversity of cyanobacteria

***Otakar Strunecký***

This season on Svalbard was focused on two main scientific topics. The first one was collection of cyanobacteria from warmer sites, especially the southern slopes of mountains. The initial cultivation of cyanobacteria from various orders (Nostocales, Oscillatoriales) was done directly in Svalbard. The primary goal of this project was to extend the consortium of various strains suitable for biogeographic purposes. The second topic consisted of pilot cultivation of ancient cyanobacteria from lake coring. The various types of cyanobacteria were cultivated from lakes, including the deeper layers of deposited layers of sediments (Fig. 3.4.4.).

**Fig. 3.4.3.** Sampling the lake sediments for the study of ancient cyanobacteria.

### 3.4.4. Lacustrine systems

***Lukáš Veselý***

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. An artificial substratum (fiberglass nets), which were installed on the bottom of streams, pools and/or lakes, was used for this study. After fourteen days of incubation the nets were collected and evaluated for diversity of cyanobacteria, microalgae and invertebrates. It was 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 streams was different (Fig. 3.4.4.). Relatively the most abundant species was diatom *Hanea arcus,* which was followed by chrysophyte *Hydrurus foetidus* and filamentous cyanobacterium *Phormidium* sp. (Figs. 3.4.5. and 3.4.6.). Only two species of herbivores with different abundance in each stream were found.

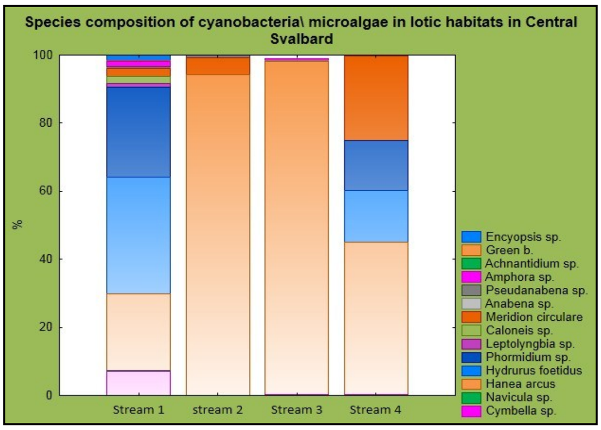


**Fig. 3.1.4.** Species composition of cyanobacteria and microalgae in four streams in Petuniabukta.

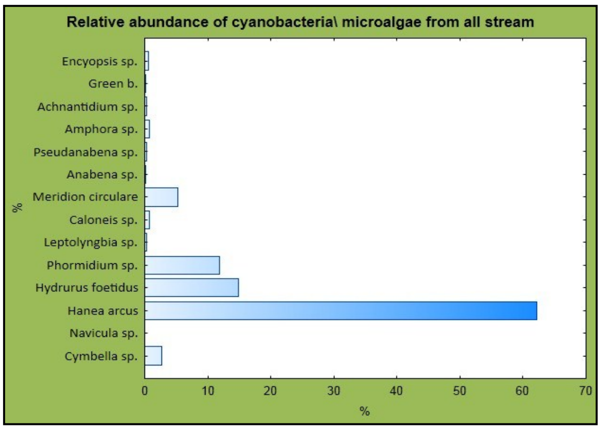


**Fig. 3.1.5.** Relative abundance of cyanobacteria and microalgae in all studied streams in Petuniabukta.

**3.1.6.** Dominant species of Arctic streams. Diatom *Cymbela* sp., cyanobacterium *Phormidium* sp., diatom *Hannea arcus*, diatom *Meridion* sp.

### 3.4.5. Soil crusts

***Ekaterina Pushkareva***

In polar desert soil algae can produce distinct visible biotic crust layers on the ground surface which are called cryptogamic crusts. They consist of water-stable, surface soil aggregates held together by algae, fungi, lichens and mosses. Therefore, biological soil crusts are important to maintain ecosystem structure and functioning in dry lands. The objective of this study was to describe various types of Arctic soil crust that were collected in Petuniabukta, Svalbard. The fluorescent area of different samples was estimated by Fluorescence imaging camera FluorCam 700MF (Photon Systems Instruments, Czech Republic). Biodiversity of cyanobacteria and microalgae from collected soil crusts was studied using stereomicroscope analyses and light microscopy observation. In most cases cryptogamic crusts were dominated by cyanobacteria as *Gloeocapsa*, *Nostoc*, *Microcoleus*, *Scytonema*, *Komvophoron* and green algae as *Coccomyxa*, *Hormotila*. There was a high amount of *Trebouxia* in soil covered by lichens which have this alga as photobiont. Soil crust that is located in conditions with high humidity, usually was covered by *Nostoc*. By these methods soil crust from studied area can be divided into 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 3.4.7.).

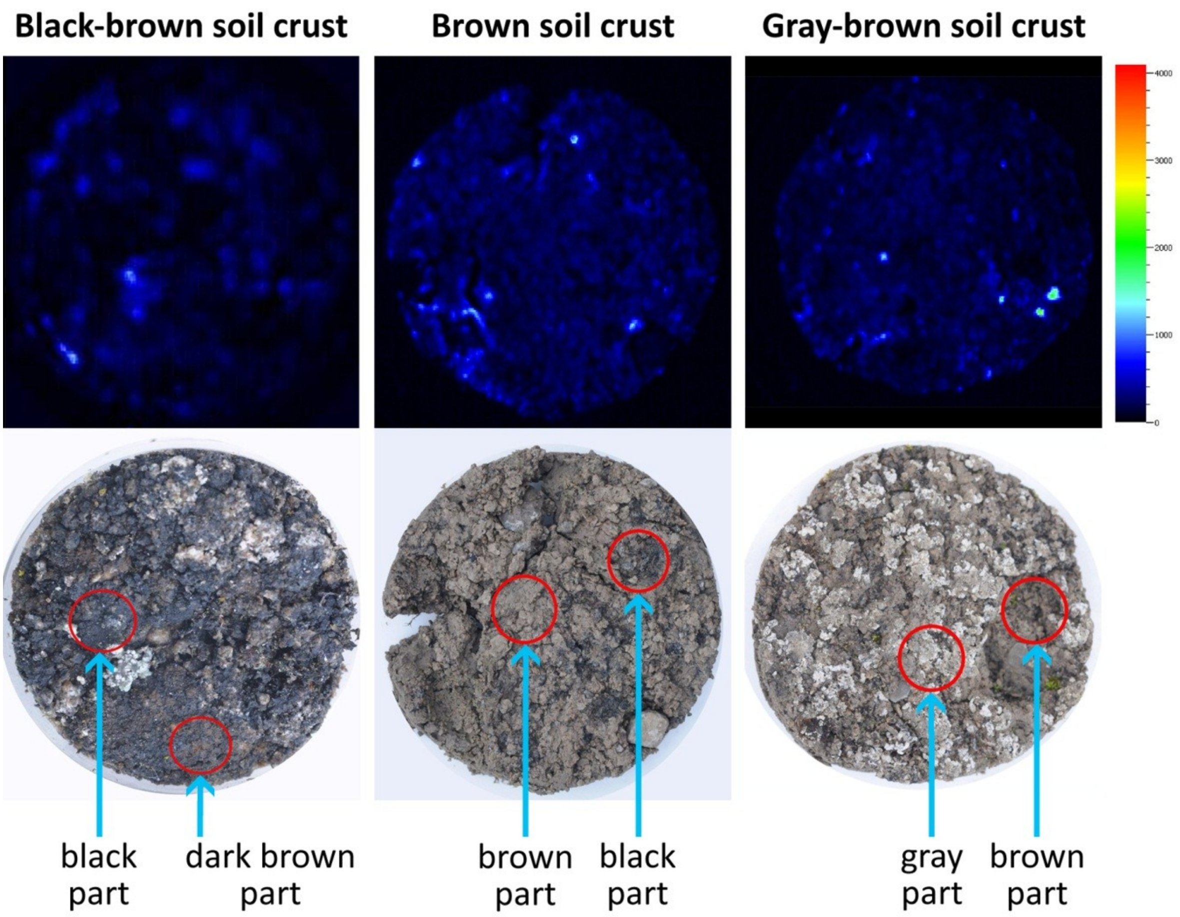


**Fig. 3.4.7.** The types of soil crusts. The upper row shows the 2D epifluorescence images of the crust visible using FluorCam 700MF fluorescence imaging camera (Photon Systems Instruments, Czech Republic). The false colour scale is at right. The bottom row shows the crust image taken by normal digital camera.

Also the same types of soil crust were compared in different gradients. The result has shown that various heights don’t affect on biodiversity of algae. However, amount of them increases with increasing of altitude.

### 3.4.6. Differences in the microbial community structure along altitudinal gradients in Arctic mountains

***Petr Kotas***

The four altitudinal soil transects were sampled during the summer season in 2012 in the offshore area near Petuniabukta, Svalbard ($78^0$ N, $16^0$E) to understand how the biogeochemical properties of soils change with increasing altitude. The study was conducted in order to 1) describe geochemical properties of soils in different altitudinal levels (pH, the availability of nutrients) and 2) understand how the microbial diversity and community structure changes with increasing altitude. Transects consists of 4 altitudinal levels at approximately 50, 250, 500 and 750 m above sea level. Sampling was conducted as follows: three soil subsamples taken by corer were combined to obtain one of three mixed samples representing each altitudinal level (Figs. 3.4.8. and 3.4.9.) Samples were homogenized by sieving and frozen as soon as possible. Moreover, part of each sample was conserved by RNA later immediately after processing. For the characterisation of the microbial community composition both phenotypic and genotypic diversity will be evaluated. The latter determined by 16 sRNA gene analysis using PCR-DGGE, the former by PLFA profiling.

**Fig. 3.4.8.** The illustration of the typical soil surface appearance in altitudes of approximately 50, 250, 500 and 750 m a. s. l. (clockwise).

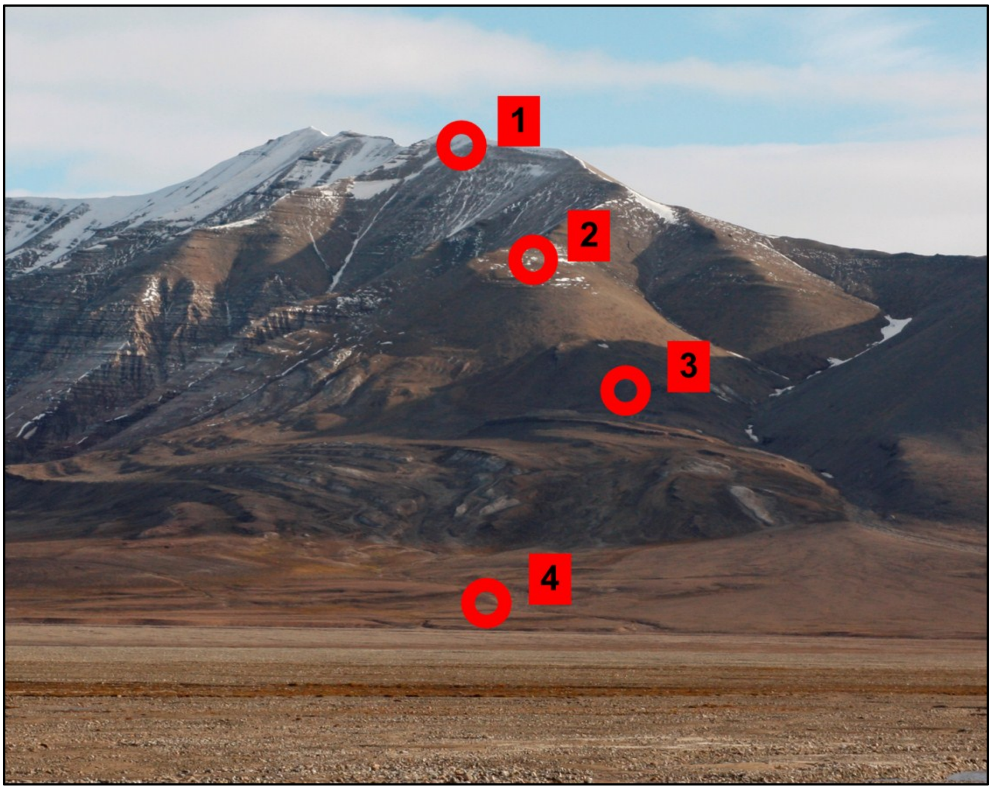


**Fig. 3.4.9.** Western transect on Hultberget peak, Petuniabukta, Svalbard.

## 3.4.7. Cryoconites

***Marie Šabacká***

Glacier and ice sheet surfaces have only recently been considered as habitats supporting life and therefore our knowledge of biological processes occurring in these icy ecosystems is extremely limited. Melting occurs annually on the surface area of glaciers, producing the liquid water necessary for active life and so making glacial surfaces habitable. Debris and aerosols from areas in the vicinity of the glacier are deposited on glacier surfaces and redistributed and reworked by meltwater flow. They can provide a source of nutrients and/or viable microbial cells, which can become active under suitable environmental conditions. As a result, active microorganisms grow and reproduce both within the surface debris (called 'cryoconite') and the surrounding meltwater.

Samples of cryoconite sediment from five major glaciers in Petunia Bay were collected and basic physical and chemical parameters were measured. These samples are currently subjected to detailed molecular analysis for the presence of small Metazoa (Tardigrades, Rotifers and Nematodes), algae (diatoms and green algae) and prokaryotes (cyanobacteria and bacteria). The goal is to investigate what mechanisms control the formation of these habitats and which environmental and/or ecological conditions govern the diversity distribution of the microbial communities found within. In subsequent years, we aim to build upon the dataset in order to provide a comprehensive overview of the diversity, ecology and productivity of these important yet fragile ice-bound ecosystems (Fig. 3.4.10.) .

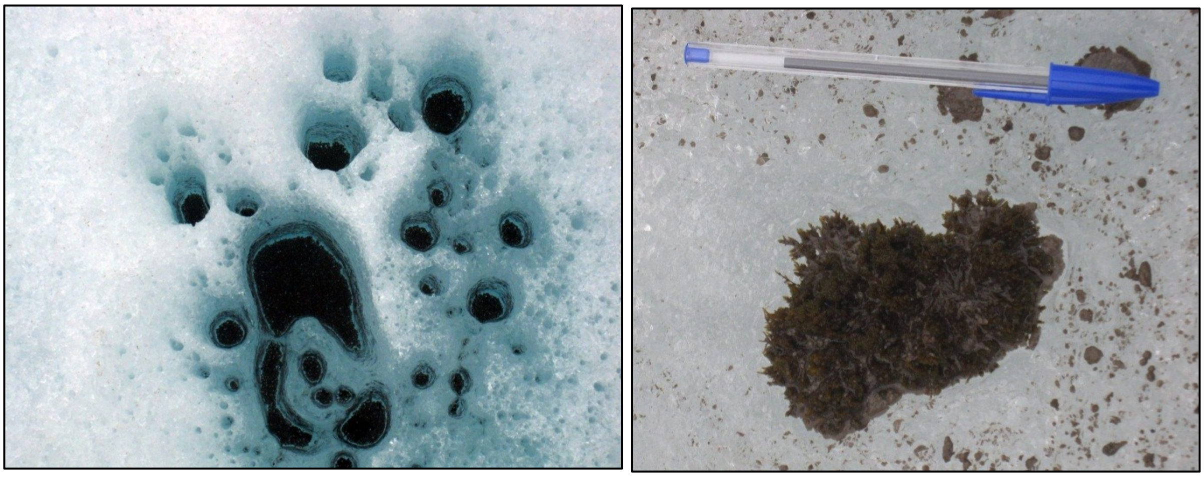

**Fig. 3.4.10.** Cryoconite hole. Cryoconite community with mosses.

### 3.4.8. Simulation of climatic change in modified OTCs in wet hummock tundra

***Josef Elster* & *Jana Kvíderová***

The long-term experiment in OTCs in wet hummock tundra continued in 2012. In August 2011, the OTCs in Svalbard were modified to close-top chambers (CTCs) to increase the temperature at hummock bases (Fig. 3.4.11.). The vegetation period 2011 was prolonged in the CTCs for approximately two weeks. The winter was characterized by warming event in beginning of February 2012 when the soil temperature had reached 0°C and the volumetric water content data had indicated presence of liquid water. The warming effects were observable for one month in the CTCs, but only for two weeks in the CBs, indicating thus prolonged favourable conditions with respect to temperature and water availability. The light conditions under the snow cover during the warming event remind unknown, and presence of photosynthetic activity of the *Nostoc* colonies is uncertain.

**Fig. 3.4.11.** The modified OTC – CTC in wet meadow, Petuniabukta, Svalbard.

The visit in April 2012 revealed that the experimental site was covered by at least 1.5 m of snow (Fig. 3.4.12.). The vegetative season started in CTCs and CBs in mid-June 2012 at the same time. The temperature in CBs during the vegetative season 2012 was comparable to vegetation seasons 2010 and 2011, however the mean temperature difference between the CTCs and CBs reached 1.1 °C at hummock base and 3.8 °C at hummock top. The vegetative season 2012 was also wetter than in 2010 and 2012. The mid-June locality desiccation observed in 2010 and 2011 was not observed; only minor decrease, approximately 10%, in volumetric water content was found at CTCs bases.

The ecophysiological parameters of the *Nostoc* were measured twice during the season and data are being evaluated now (October 2012).


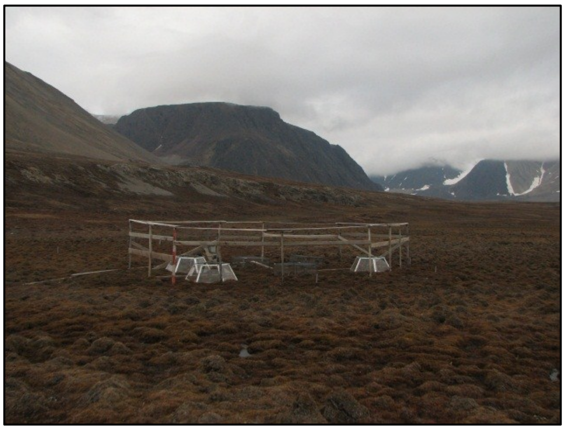

**Fig. 3.4.12.** The snow cover at the experimental locality in April 2012. The same locality in summer.

### 3.4.9. Diurnal cycles of photochemical activity of *Nostoc commune* s.l.

***Jana Kvíderová***

Colonies of cyanobacterium *Nostoc commune* s.l. are common in terrestrial and hydro terrestrial ecosystems in Petuniabukta. Besides being important primary producers there, they provide significant nitrogen input to the ecosystem due to their ability to fix atmospheric nitrogen. For estimation of their contribution to C and N cycling, it is necessary to know their annual and diurnal cycles of photosynthesis and nitrogen fixation. In this summer season, the first experiments focused on diurnal cycles of photochemical activity were performed.

The maximum quantum yield ($F_V/F_M$) and rapid light curves (RLC) parameters, maximum relative electron transfer rate ($rETR_{max}$), efficiency (α) and saturation irradiance ($E_k$), were measured in 4 hrs intervals together with environmental variables (temperature, photosynthetically active radiation, PAR, and UV radiation, UVR). The RLCs were recorded using pre-set protocol in FluorPen portable fluorometer (Photon Systems Instruments, Czech Republic).

The measurements revealed diurnal variations in environmental factors, however actual weather conditions affected amplitude (Fig. 3.4.13.).

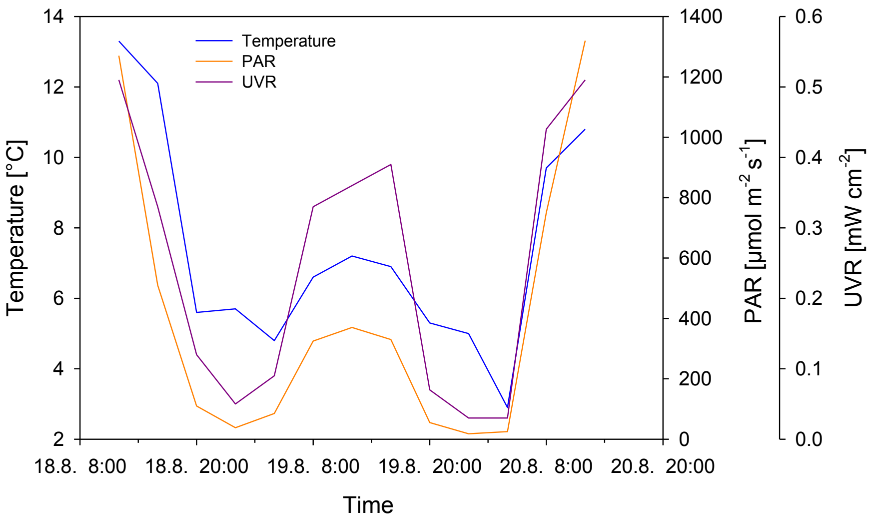


**Fig. 3.4.13.** The diel course of temperature, PAR and UVR during the experiment.

The $F_V/F_M$ decreased at higher PAR and UVR and the minimal values were observed in late afternoon. The diurnal course of $rETR_{max}$ followed those of PAR and UVR reaching maximum between noon and 4 p.m., however α seems to be insensitive to any irradiance changes. The $E_k$ is probably increased in higher irradiances, indicating thus presence of light acclimatization processes. The data also indicate that the response is proportional to incoming irradiance, however further investigation are necessary (Fig. 3.4.14.).

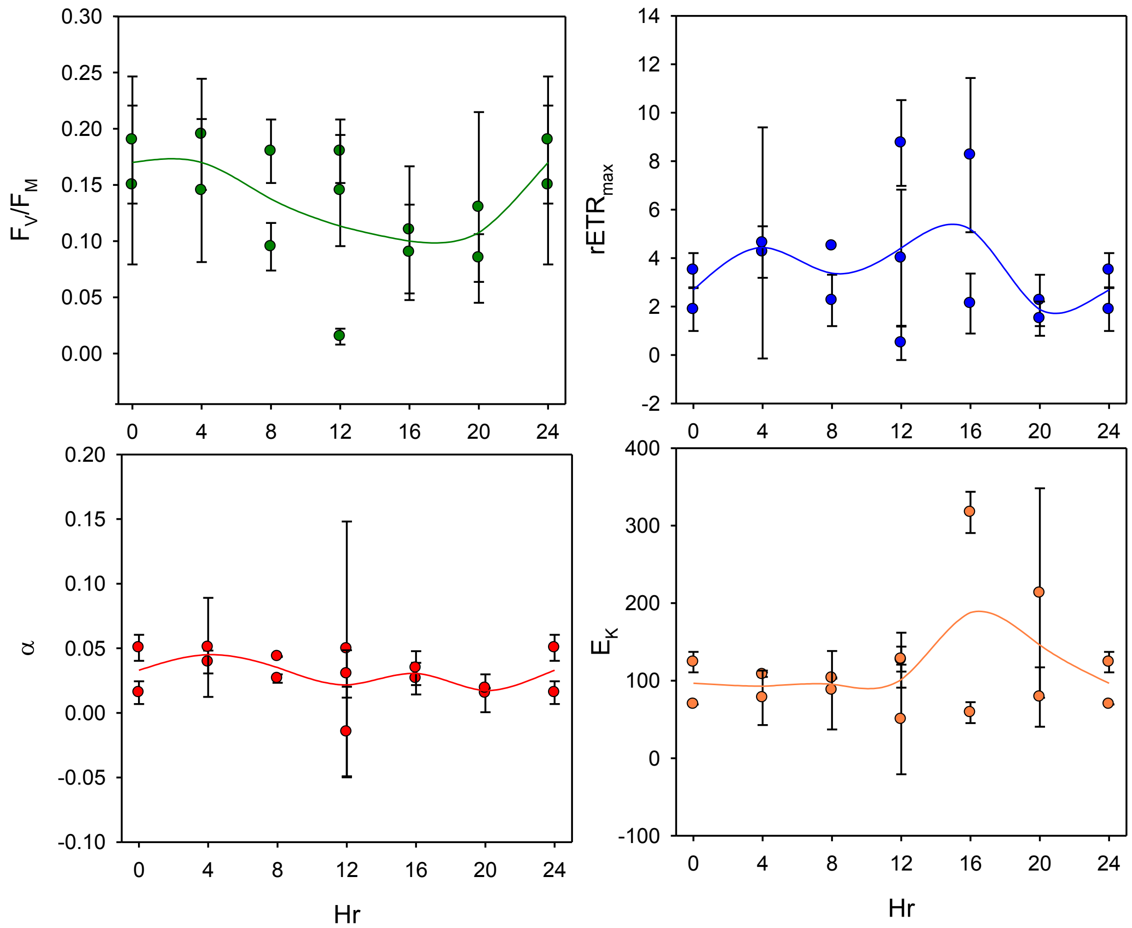


**Fig. 3.4.13.** Diurnal changes in $F_V/F_M$ and RLC parameters of *Nostoc* colonies.

### 3.4.10. *In situ* monitoring of seasonal changes in development of *Phormidium* populations

***Daria Tashyreva***

Cyanobacteria belonging to the genus *Phormidium*, especially those which inhabit polar regions, are known for their capability of tolerating stresses of different kind, e.g. freezing and freezing-melting cycles, desiccation, starvation, and long-term light unavailability. They are well adapted to these stressful conditions and often form macroscopic populations. In the Arctic, *Phormidium* occupies various types of wetlands, including seepages, shallow pools, streams, and wet soils and rocks. They are one of the most abundant photosynthetic organisms, and often accumulate high biomass in form of thick biofilms and crusts. For our study we selected two *Phormidium* populations in close proximity to the Czech Polar Research Station (Petunia bay-Billefjorden-Isflorden, Fig. 3.4.14.). The selected populations inhabit shallow pools (namely, seepages) that represent quite unstable environments that can be exposed to numerous drying-rewetting cycles during summers and short freezing episodes during spring and autumn.

In this study we observed seasonal development of these populations based on the macroscopic community structure, morphology of cells and filaments including the production of sheaths and description of the accumulated inclusions that were followed by studies of ultrastructure with the help of electron microscopy. The assessment viability and metabolic activity of cells was performed *in situ* by staining with fluorescent dyes according to the cells' plasma membrane integrity (cell-impermeant nucleic acid dye SYTOX Green), nucleoid localization/ presence (cell-permeant nucleic acid stain DAPI), and respiration activity (redox dye CTC). This approach helped to reveal the state of cells in heterogeneous communities of cyanobacteria. The study gave some clues for understanding of cyanobacterial dormancy and stress resistance since the properties of cells which are responsible for their survival have not yet been described.

**Fig 3.4.14.** The *Phormidium* community in a shallow seepage

## 3.5. Botany and Plant Physiology

### 3.5.1. Botany and paleoecology

***Alexandra Bernardová***

Paleocological research followed up last year sampling – samples were taken from lacustrine sediments - small lakes, pools or limans. Sediments were obtained at localities of Petuniabukta, close to the wet tundra with OTC chambers, from a lake in Ebbadalen and a lake at Ragnar glacier. We also cored Garmaksla lake in the elevation more than 300m. Cores were taken from liman in Adolfbukta, close to the houses of Brucebyen settlement. The cores were obtained undisturbed, by multisampler. The cores were subsampled precisely for fine analysis of fossil pigments, chemical composition, for pollen, macrofossils and other proxies (Fig. 3.5.1.).

The second project was focused on the seed dispersal possibilities in the Arctic which began last year. The study will try to estimate potential of animals to serve as seed distributors via their faeces and thus enhancing the colonisation of deglaciated, disturbed or newly emerged areas. The faeces were collected systematically in the area of Petuniabukta in various distances from the glacier and various stands. The samples are going to be evaluated by the mean of analysis of macrofossils.

**Fig. 3.5.1.** Core extracted from the lake in Brucebyen.

# 3.6. Zoology and Parasitology

## 3.6.1. Parasitology

***Oleg Ditrich & Tomáš Tyml***

Group of parasitologists continued with examination of fish and marine invertebrates for unicellular and multicellular parasites Tab. 3.6.1.).

Tab 3.6.1.Number of dissected fish and invertebrates

| | |
|---|---|
| **Fish dissected** | |
| *Myoxocephalus scorpius* | 121 |
| *Gymnocanthus tricuspis* | 20 |
| *Clupea harengus* | 1 |
| *Gadus morhua* | 6 |
| *Lumpenus lampretaeformis* | 1 |
| **Invertebrates dissected** | |
| *Euspira pallida* | 8 |
| *Coleus* | 1 |
| *Buccinum polare* | 15 |
| *Buccinum undatum* | 19 |
| *Serripes* | 5 |
| *Mya truncata* | 20 |
| arrow worms | 109 |
| | 258 |
| spirorbid polychaetes | 5 |

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

1. Unidentified cercariae from the family Opecoelidae in *Buccinum undatum*, *B. glaciale* and *Colus kroeyeri* (Gastropoda, Caenogastropoda, Buccinidae; Figs. 3.6.1. – 3.6.4.). Their occurrence is dependent on the season and in the end of August the prevalence reached almost 40 %. The definitive hosts are fishes, most probably sculpins.

**Fig 3.6.1.** Redia of the family Opecoelidae from *Buccinum undatum.*

**Fig. 3.6.2.** Cercaria of the family Opecoelidae from *Buccinum undatum.*

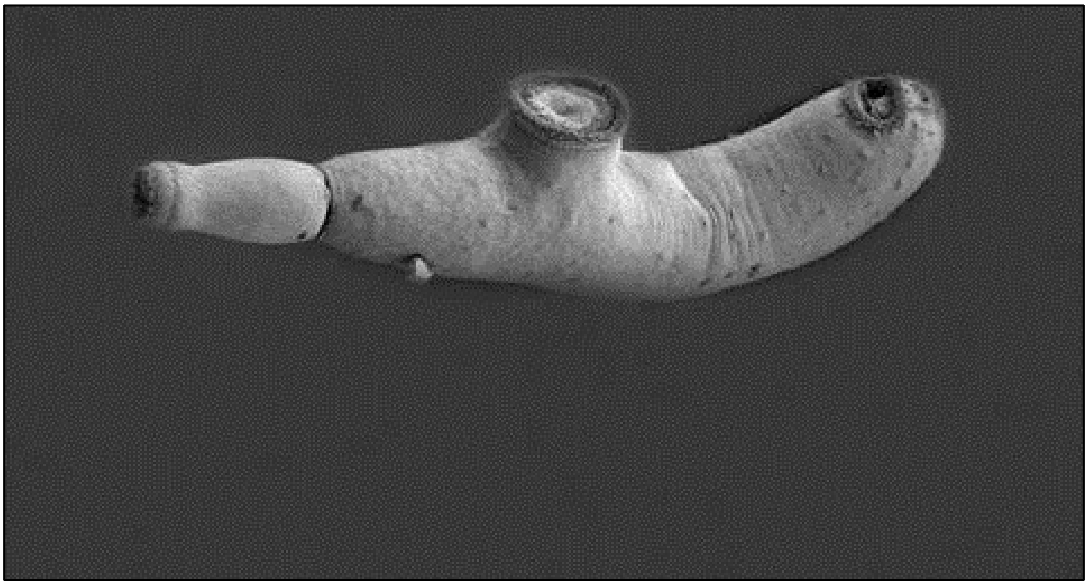

**Fig. 3.6.3.** SEM of the same cercaria.

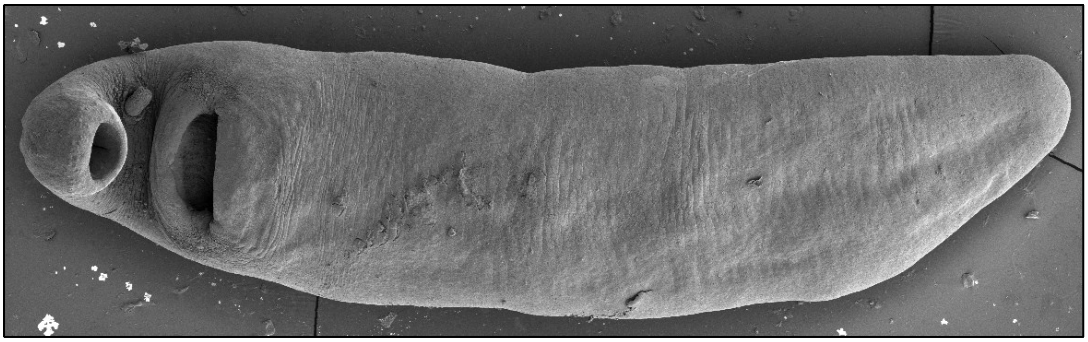

**Fig. 3.6.4.** SEM of adult fluke of family Opecoelidae from the sculpin *Myoxocephallus scorpius.*

The molecular analyses will reveal, whether the cercariae are conspecific with some of the three unidentified species of trematodes belonging to the family Opecoelidae (probably genera *Helicometra* and *Neohelicometra*) that have been found in the intestine of 2 species of sculpins (*Myoxocephallus scorpius* and *Gymnocanthus tricuspis*) in high prevalence.

2. Cercariea belonging to the genus *Gymnophalus* (Gymnophalidae) was found in *Mya truncata* and *Hiatella arctica* (Bivalvia, Myoidea) (Fig. 3.6.5.). The prevalence in *M. truncata* reached over 70 %. The larvae of this trematode most probably manipulate the behaviour of its intermediate hosts to increase the probability of their predation by definitive hosts that are most probably the common eiders (*Somateria mollissima*).

**Fig 3.6.5.** Cercarieaum of the genus *Gymnophalus* (Gymnophalidae) from *Mya truncate.*

3. Cystophorous cercariae resembling *Derogenes varicus* (Hemiuridae) was found in *Euspira pallida* (Gastropoda, Caenogastropoda, Naticidae; Fig. 3.6.6.) with prevalence almost 20 %. The definitive hosts of this species is fish and progenetic metacercariae found in arrow worms *Eukrohnia hamate* (Chaetognata) may belong to its life cycle, too.

**Fig 3.6.6.** Cystophorous cercariae from *Euspira pallida*.

**Fig 3.6.7.** Spirorbid polychaetes *Circeis spirillum*

A myxosporid parasite we found in spirorbid polychaetes *Circeis spirillum* with an unusually high prevalence (up to 86%). Morphology of spores (**Fig. 3.6.8.**) and phylogenetic analysis (**Fig. 3.6.9.**) based on SSU rRNA gene sequences assigned all our findings to *Gadimyxa sphaerica*, for which is known only myxosporean stage in urinary system of cod *Gadus morhua*. We also confirmed *G. sphaerica* in cod (*G. morhua*). Distinct seasonal dynamic has been observed in life cycle of *G. sphaerica*. Whereas the actinospores (in polychaetes *Circeis spirillum*) were in the middle of July fully mature, in urinary system of cods (*G. morhua*) we found at the same time developmental stages without recognizable myxospores.

It is the first finding of *Gadimyxa* sp. in *Circeis spirillum* as well as in Svalbard area.

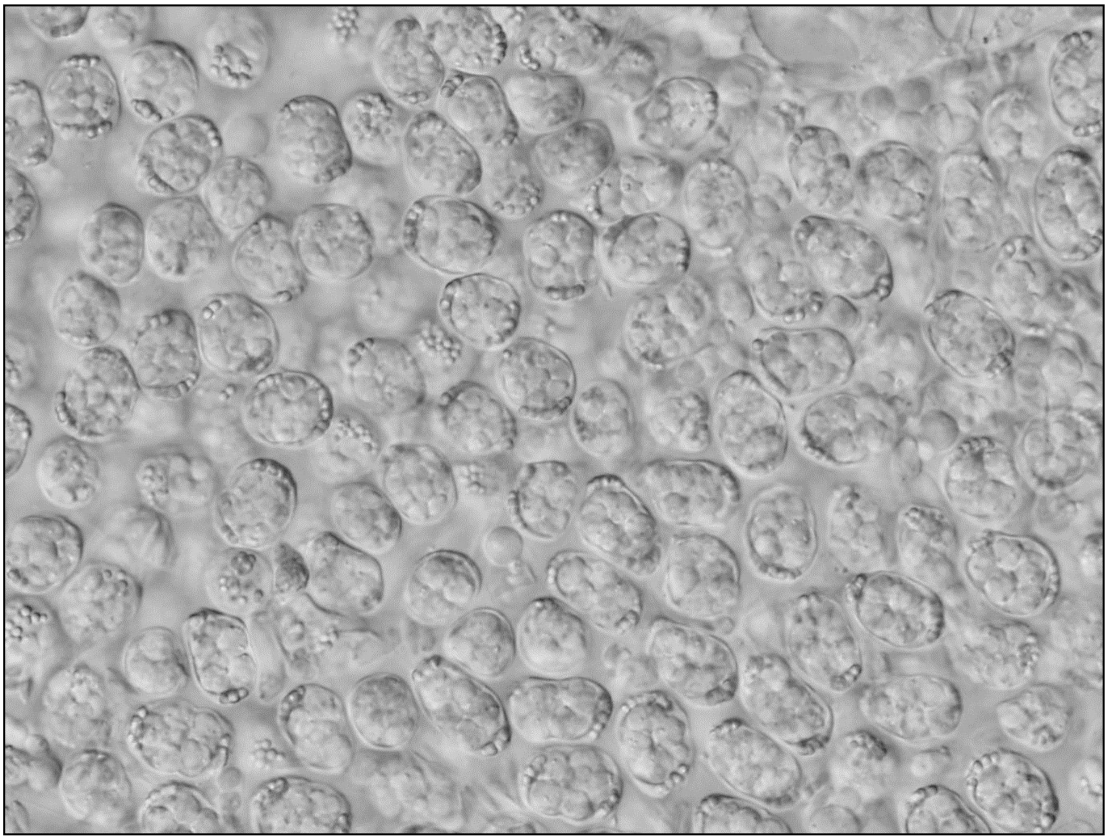

**Fig. 3.6.8.**: Actinospores of *Gadimyxa sphaerica* as seen in Nomarski DIC.

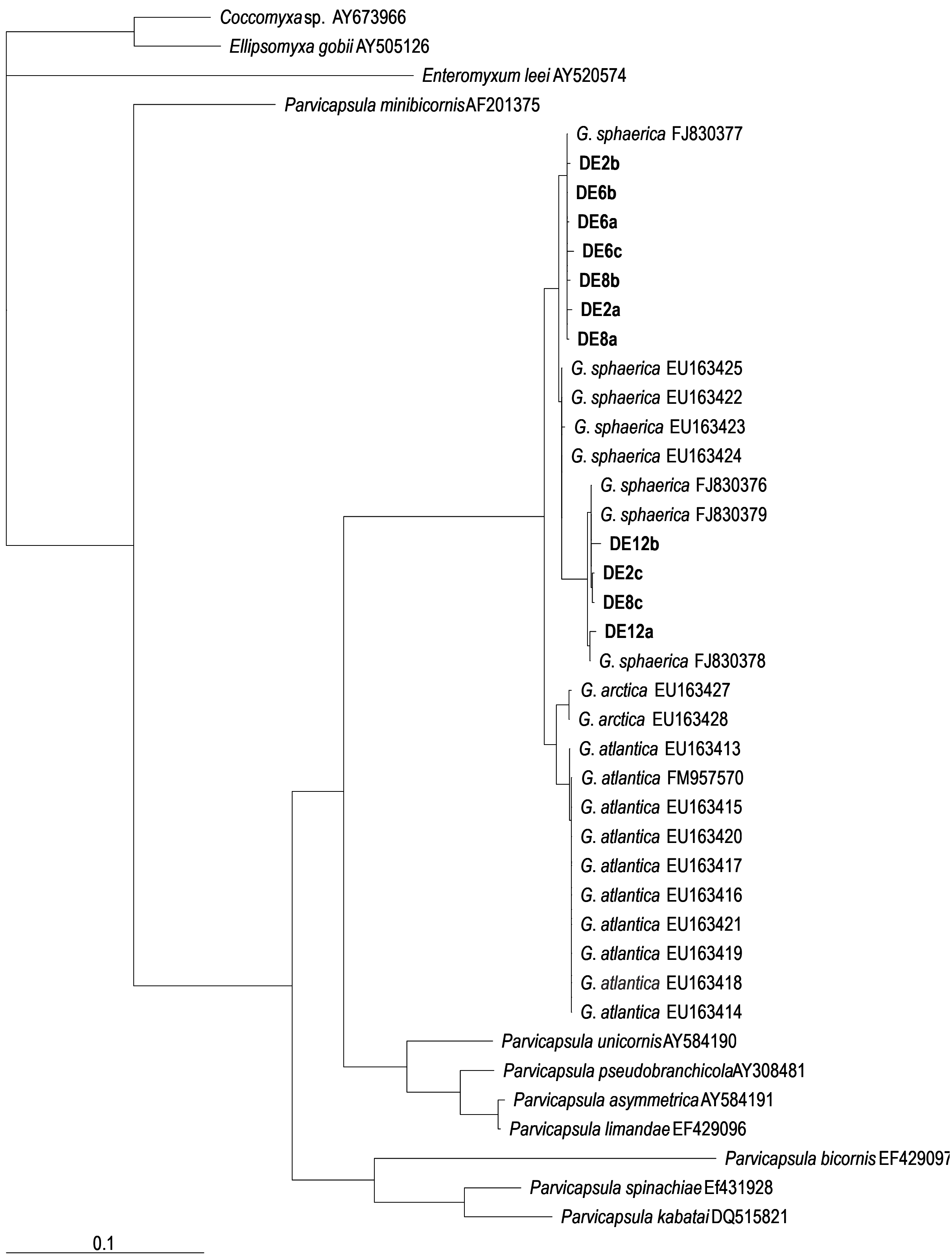


**Fig. 3.6.9.**: Maximum likelihood tree based on SSU rRNA gene sequences. The new sequences are in bold.