POLAR ECOLOGY COURSE

SVALBARD 2011

report on Polar Ecology training course
on Czech research base in Petuniabukta,
Billefjorden, Svalbard

Centre for Polar Ecology
University of South Bohemia
Czech Republic

2 - Geosciences

The geosciences group was covering the main topics as listed: geology, geomorphology, glaciology, climatology, hydrology and limnology.

Figure 1. Lecturers and participants of the first part of the Polar Ecology field course. Standing from left: Alena Kodádková, Daria Tashyreva, Klára Večadlová, Kateřina Kopalová, Jan Kyselka, Jan Kavan, Zbyněk Klose, Jan Flašar, Tomáš Jagoš, Martin Hanáček, Hana Beitlerová, Pavel Prošek, Denisa Witoszová, Zbyněk Engel, Vojtěch Prošek, Linda Nedbalová and Otakar Strunecký; sitting from left: Kamil Láska, Blanka Pechačová, Lucie Klivanová, Oleg Ditrich, Hana Medová, Josef Elster; lying: Daniel Nývlt

2,1 – Geology

Instructor: Daniel Nývlt
Students: Jan Flašar, Martin Hanáček

Description of individual sediment types using clast shape and roundness and the reconstruction of debris transport history in the glacial system were undertaken beside meteorological and glaciological field measurements on the Bertilbreen glacier in the northwest part of Billefjorden, Spitsbergen.

Glacier bedrock is composed of Devonian Old Red facies sedimentary rocks, Carboniferous clastic sedimentary rocks and Carboniferous to Permian limestones. Cobble clasts from the right-hand lateral moraine, frontal moraine and proglacial glaciofluvial sediments were studied. The upper part of the lateral moraine is composed mostly of passively transported supraglacial debris (originally unmodified scree, snow and scree/rock avalanche deposits) with a small proportion of actively transported clasts or reworked glaciofluvial sediments. Clasts in the middle part of the lateral moraine originate predominantly from the frontal moraine of a small glacier in the lateral valley. The lower part of the lateral moraine and frontal moraine of Bertilbreen are rich in subglacially transported material, which is supported by isometric clast shapes, roundness degree and common clast surface striations. Coarse gravel forms longitudinal bars in the glaciofluvial stream flowing from the glacier front. In the southern mouth of the valley, the proglacial stream grades into a braided outwash fan. Clast nature is affected by the source from the surrounding glacial deposits and bedrock outcrops, the impact of glaciofluvial transport on the clast nature increases in the braided outwash fan. Clast shapes are primarily influenced by bedding and fractures of source rocks, but are also significantly influenced by the type and proximity of material sources. Striation is cleared away the clast surface during the glaciofluvial transport. A morphostratigraphically older glaciofluvial terrace formed by glaciofluvial sediments deposited during the glacier advance culminating during the Little Ice Age is located at the southern end of the valley. The comparison of active proglacial stream sediments and those from older glaciofluvial terrace was done using the coarse pebble fraction. Detailed description of results was published in Hanáček et al. (2011).

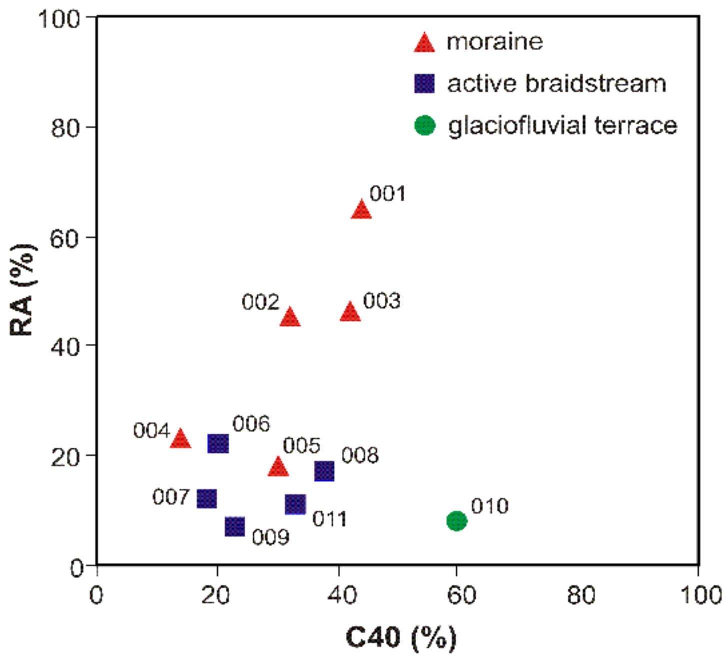

Figure 2. Covariant plot of C_{40} versus RA clearly discriminates sediments of lateral and frontal moraines from those of active proglacial braidstream.

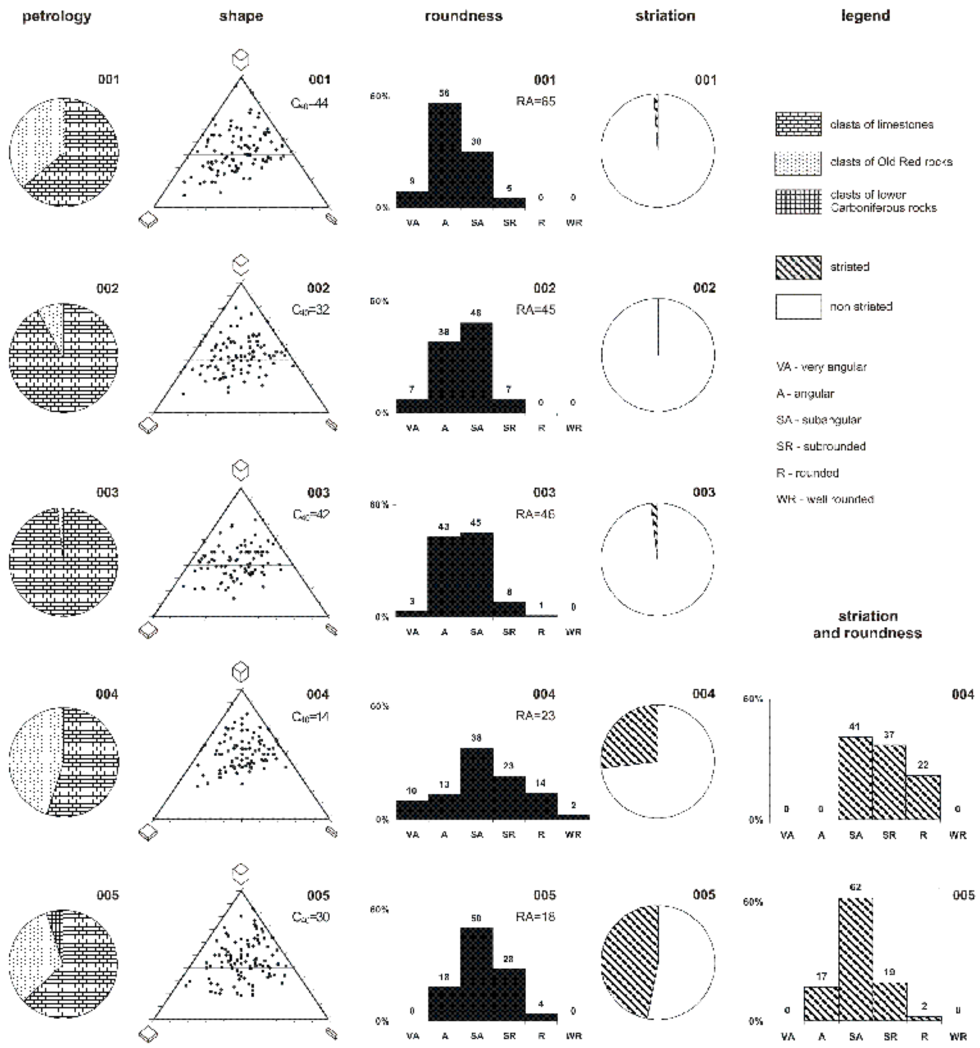

Figure 3. Petrology, shape, roundness and striation of the clasts in the lateral and frontal moraine, for further details see Hanáček et al. (2011).

2,2 – Geomorphology

Instructor: Zbyněk Engel
Students: Blanka Pechačová, Klára Vočadlová

On the Bertilbreen glacier in the northwest part of Billefjorden, Spitsbergen, a glacier mass balance network was established. The observational network of 22 stakes was designed following the recommendations by Fountain and Vecchia (1999). Bamboo stakes were drilled into the glacier covering both the accumulation and ablation zones. Mass balance measurements were initiated by stake readings and snow surveying. The position of the stakes was measured using static GPS measurements. In adition, the stakes were surveyed using a reflecting prism and an infrared rangefinder of a total station fixed on the lateral moraine. The location will be checked each year and re-established if the distance from the original position will exceed 50 m. The observations of glacier motion started using 48 observational points placed at the glacier surface. In addition to 22 bamboo stakes, 26 wooden stakes were placed in the ablation zone of the glacier to better constrain the flow rate. The wooden stakes were fixed about 300 m apart along five transverse sections (Fig. 4.).

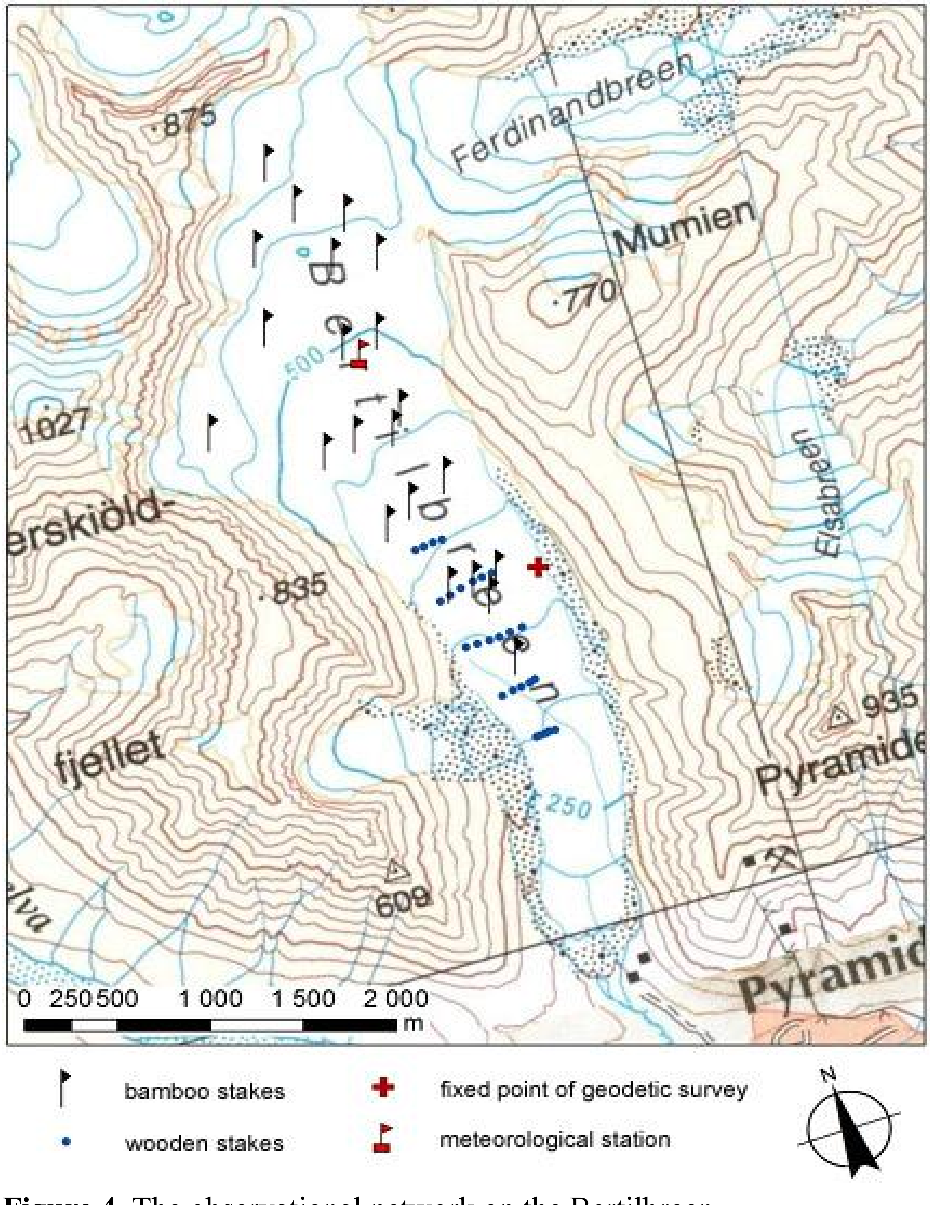

Figure 4. The observational network on the Bertilbreen.

Solifluction lobes and patterned grounds were selected for the observation of ground temperature variations and recent activity of the most common periglacial landforms in the northwestern coast of Billefjorden. Temperature sensors with data loggers were buried at shallow depths (15 and 30 cm) in seven solifluction and three sorted polygons/stripes to monitor a ground temperature regime. The data allow for an evaluation of a daily frost regime and shallow penetration of the freezing front in the shallow ground, which controls most of the frost action processes.

Two methods were applied to the selected landforms to obtain quantitative data on the solifluction process. Plastic pegs were injected along vertical profiles (50 cm) into solifluction lobes and painted rocks were placed along the cross sections on the surface of sorted stripes. Position of the painted rocks will be recorded each year, whereas vertical profiles should be excavated in three to five years. The grain size distribution of the ground was measured by sieve analysis to asses the frost susceptibility of the material which built the studied landforms. The particle-size analysis suggests that the material from most of the study sites (Fig. 5) is not frost-susceptible according to frost-susceptibility limits of Beskow (1935).

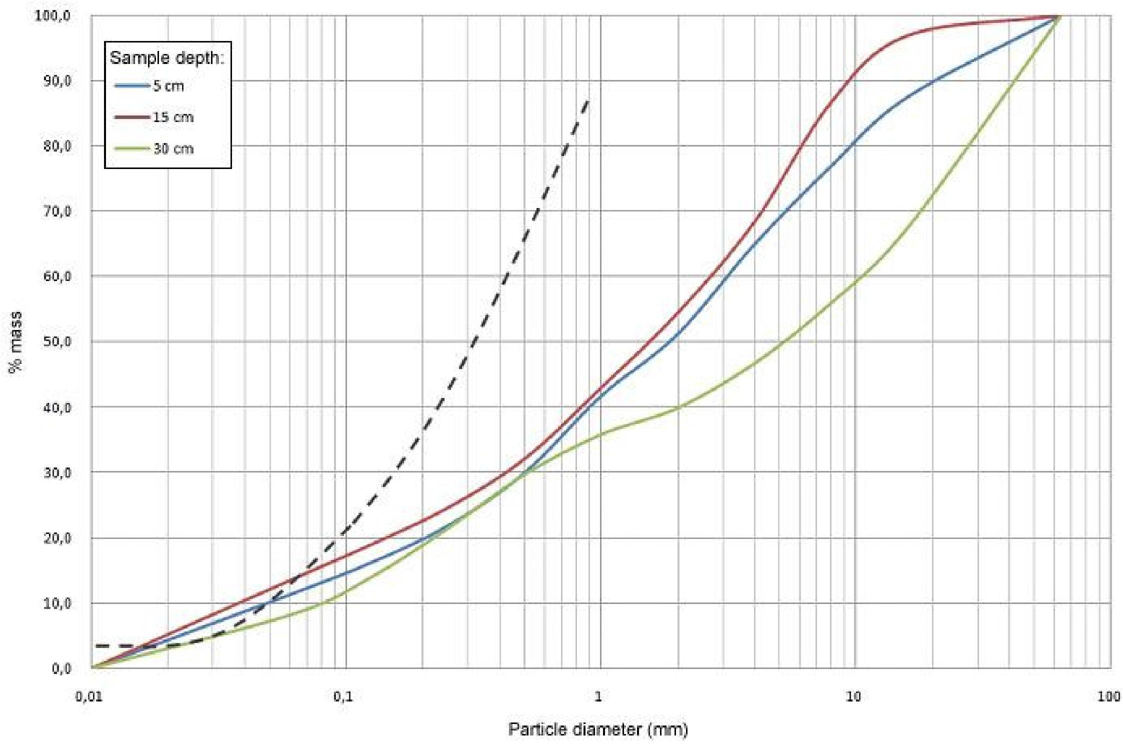

Figure 5. Particle size distribution of the ground from one of the tested solifluction lobes. Dashed line limits the range of particle size distribution for frost susceptible material.

2,3 – Glaciology and Climatology

Instructors: Kamil Láska, PhD., Prof. Dr. Pavel Prošek
Students: Tomáš Jagoš, Lucie Klivanová, Zbyněk Klose, Denisa Witoszová

In a frame of the Polar Ecology Course, climatological and glaciological fieldworks of the students were performed in the coastal ice-free zone of Petuniabukta and Bertilbreen (Bertil Glacier) in the period 8–17 July 2011. The main goal of their fieldwork activities was:

1) to carry out the standard meteorological measurements and observations at Petuniabukta according to the Guide to Instruments and Methods of Observations reported by the World Meteorological Organization (*e.g.* WMO No. 8),
2) to study the relationship between present weather observations, cloudiness, cloud genera, and atmospheric circulation pattern in the central part of Svalbard archipelago,
3) to estimate an effect of the surface wind speed and direction on air temperature stratification in the deglaciated coastal area,
4) to estimated the components of surface energy balance of typical tundra vegetation of Petuniabukta,
5) to lunch a measurement of the glacier mass balance and ice-flow velocity of the Bertil Glacier by a dense array of the ablation stakes.

Short-term measurement of surface energy balance on the permanent tundra vegetation plot was done by micrometeorological station in the period from 11 July to 16 August 2011. Bowen ration method was applied for estimation of the individual heat fluxes. As seen in Fig. 6, diurnal course of the net radiation and other fluxes was almost symmetrical, with a peek at solar noon. The highest net radiation of 436.5 $W.m^{-2}$ was recorded on 15 July 2011, when small cloudiness occurred at the study site. The most significant component was turbulent heat flux exceeded mean value of 100 $W.m^{-2}$, while latent and soil heat fluxes represented minor parts of the surface energy balance varied between 30 to 40 $W.m^{-2}$ during daytime.

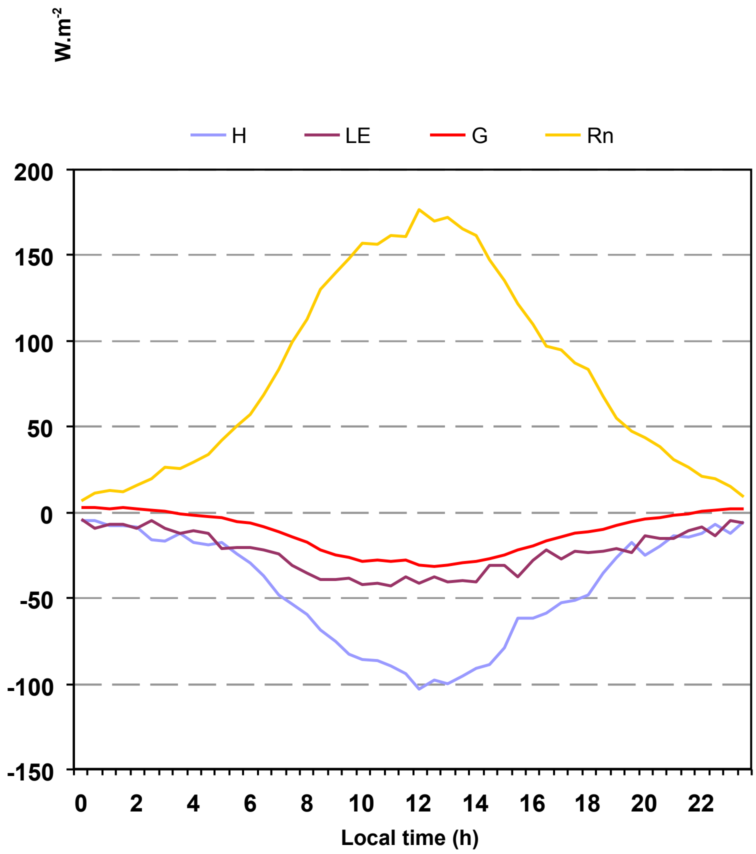

Figure 6. Mean daily course of surface energy balance components: net radiation (Rn), sensible heat flux (H), latent heat flux (LE), and soil heat flux (G) on the tundra vegetation at Petuniabukta in the period from 11 July to 16 August 2011.

2,4 – Hydrology and limnology

Instructors: Linda Nedbalová, Jan Kavan
Students: Hana Beitlerová, Kateřina Kopalová, Jan Kyselka, Hana Medová

The main goal during the hydrology and limnology fieldwork was to demonstrate specific characteristcs of the polar ecosystem and how they differ from the conditions that we know in temperate regions.

Therefore, discharge measurements have been done on chosen water streams to demonstrate different reactions of catchments to climatic forcings (see figures 7a and 7b as an example). Highly glaciated catchment was compared with catchment without ice cover at all. Instalation of continous monitoring of water level have been done on these selected water streams. Students had an opportunity to study this data after the data has been downloaded at the end of expedition.

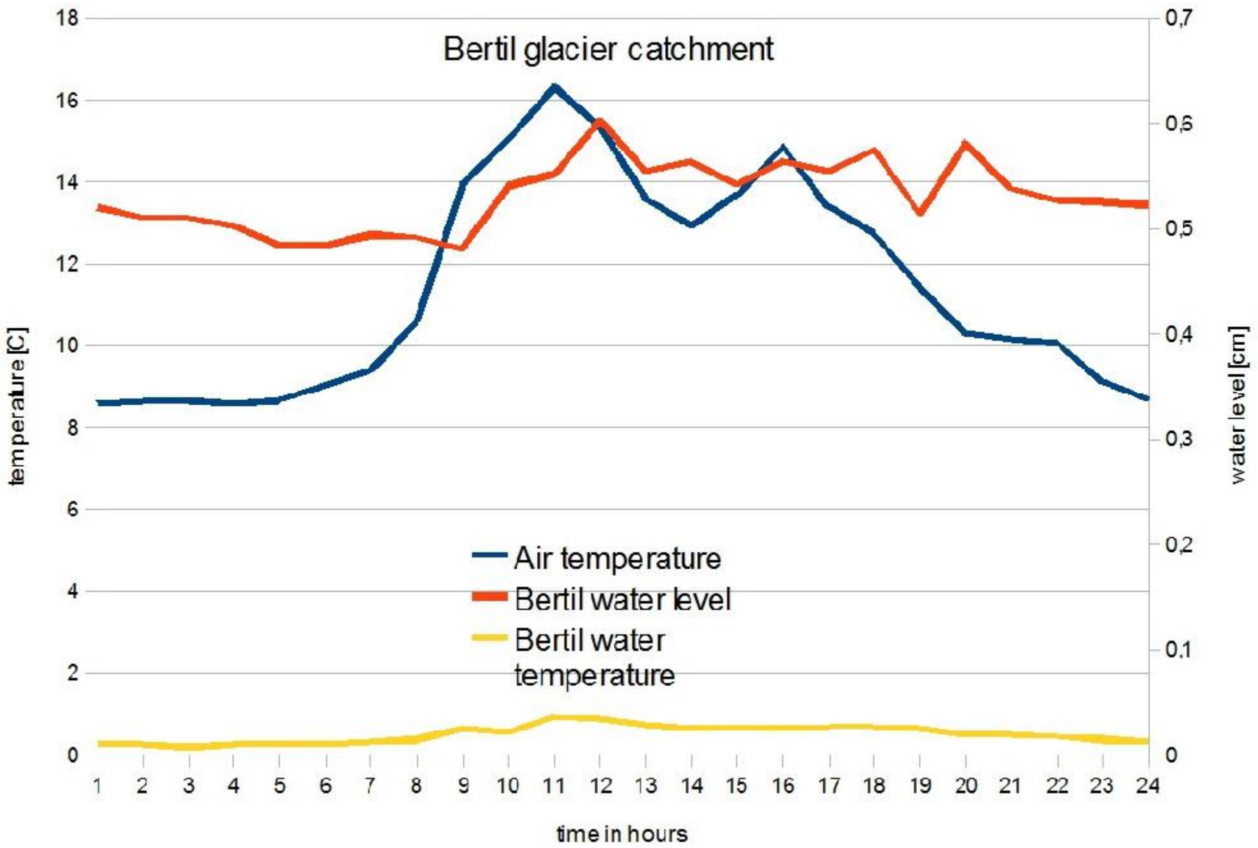

Figure 7a. Bertil glacier catchment diurnal cycle from 22/07/2011.

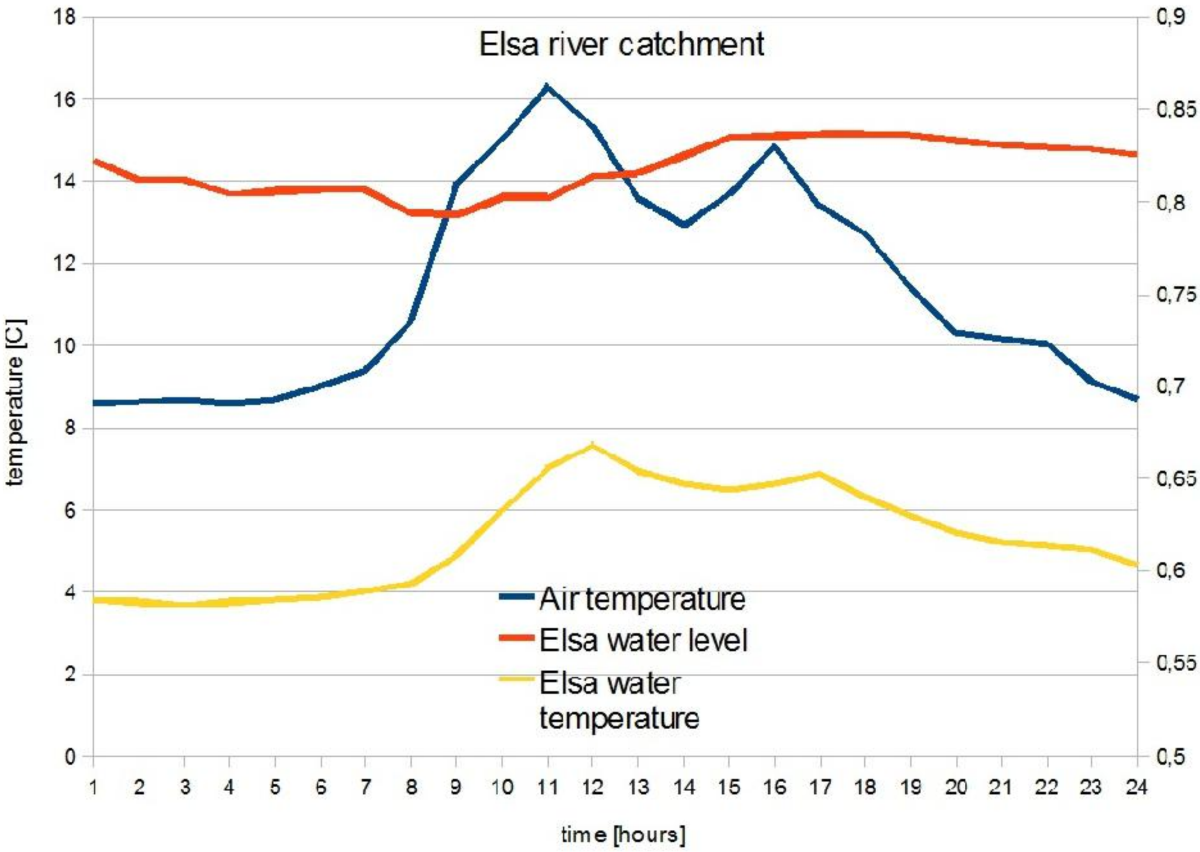

Figure 7b. Elsa river catchment diurnal cycle from 22/07/2011. Compare with figure 6a, where the hydrological reaction on significant increase of air temperature was much faster and pronounced.

The second part of the course focused on lake ecosystem research and represented also a kind of interdisciplinary approach to study such environments (see figure 8). Beside the classical hydrological methods, such as batymetry mapping, physical and chemical parametres measurement also a biological samples have been collected and further analysed in laboratory. Samples of bacteria and diatoms have been taken from about 10 lakes in the Billefjorden region.

Apart from the specialised hydrological and limnological work, students have also participated on the common geosciences project focusing on monitoring mass balance of Bertil glacier. Hydrological group ensured monitoring of runoff outflow from the glacier and installation of the continous monitoring in that catchment.

During the fieldwork, considerable amount of data and biological samples were collected. These were than analysed after coming back from Svalbard.

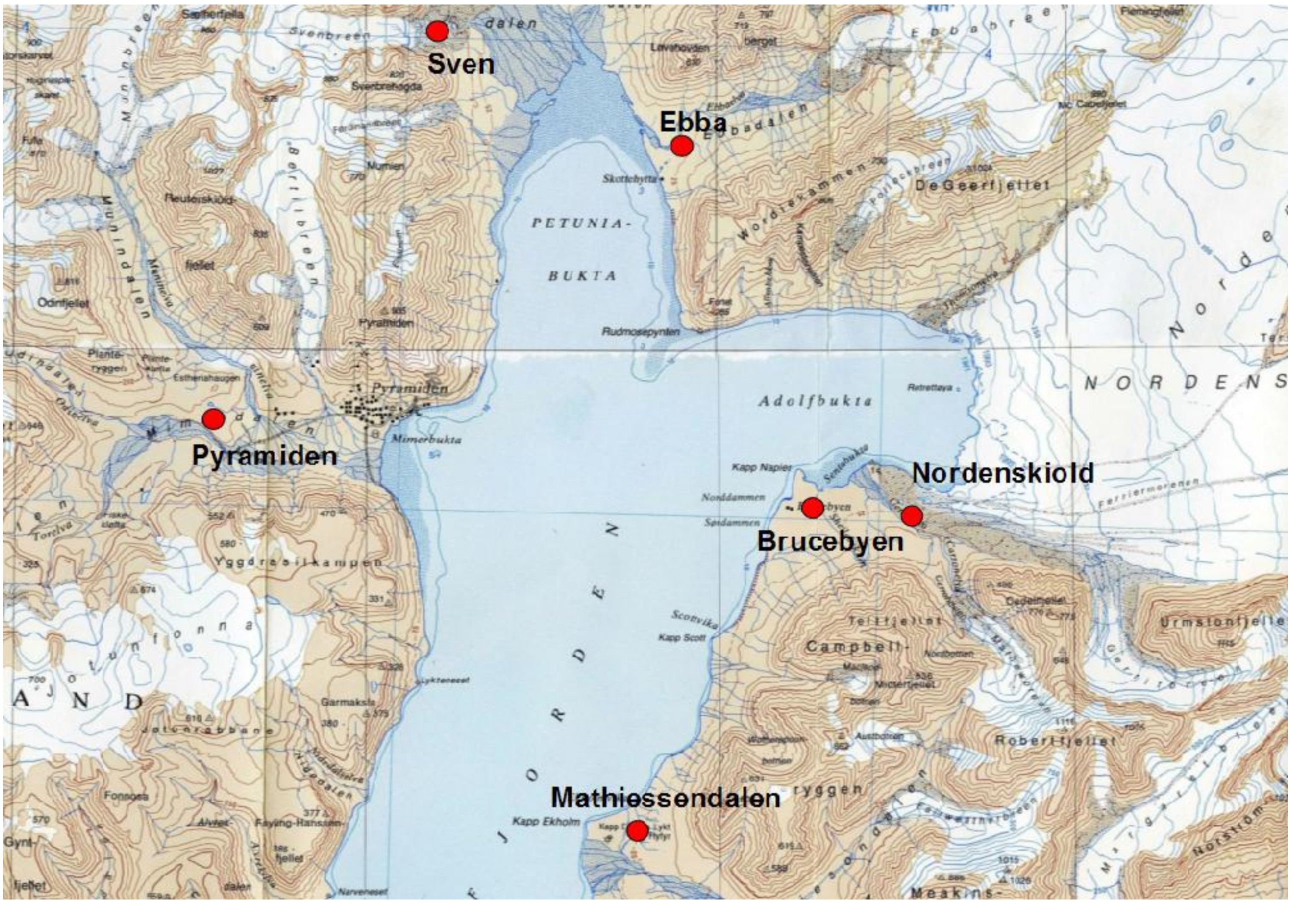

Figure 8. Study area with lake ecosystems, where the research was carried out.

3 – Biosciences

Biosciences students group consisted of several different specialisation: algology, microbiology, botany, zoology and parasitology. All the instructors and participants can be seen on the photo below.

Figure 9. Biosciences group of students and lecturers: upper row from left: Jitka Klimešová, Jiří Komárek, Otakar Strunecký, Miloslav Dvořáček, Václav Pavel, Miloslav Devetter, Jan Kavan, Karel Janko, Edita Drdová, Jakub Těšitel, Oleg Ditrich, Josef Elster, Lenka Bučínská, Tomáš Tyml, Šárka Mašová, Michal Tušer, Jana Kvíderová; sitting from left: Eva Kašparová, Magdalena Lučanová, Alena Kodádková, Veronika Špátová, Tamara Malinová, Alexandra Bernardová, Lenka Raabová, Iva Lacmanová.

3,1 – Algology and microbiology

Instructors: Josef Elster, Jiří Komárek, Jana Kvíderová, Otakar Strunecký
Students: Lenka Bučinská, Iva Lacmanová, Lenka Raabová, Veronika Špátová

Microbial community composition and structure was studied in seven different habitats (glaciers, wet walls, glacier streams, soil crusts, wet thufur tundra, seepages and lakes) and the microenviroment temperature variation was evaluated in four of them (glacier stream, soil crust, wet thufur tundra, seepage). The temperature was recorded in selected habitats for approximately one month. The list of dominat cyanobacteria and microalgae species is shown in Table 3.


Figure 10. Algology group during sampling on the shore of Petuniabukta.

The highest temperatures and the largest variation were observed in the soil crusts and in surface of tundra, while the temperature was most stable in the seepage and the glacier stream (Figure 11).

Glaciers	**Soil crusts**	**Seepages**	**Lakes**
Phormidium sp.	*Nostoc commune*	*Zygnema* sp.	*Chlorosarcina* sp.
Pseudanabaena sp	*Gleocapsa atra*	*Porphyrosiphon* sp.	*Anathece* sp.
Leptolyngbya sp.		*Klebsormidium* sp.	*Nostoc commune*
Chlamydomonas nivalis			*Chroococcus* sp.
			Aphanothece microscopica
Glacier streams	**Wet walls**	**Thufur tundra**	*Rivularia* sp.
Hydrurus foetidus	*Gleocapsa* sp.	*Nostoc commune*	*Wilmottia* sp.
Meridion circulare	*Nostoc* sp.	*Anabaena jonssonïi*	*Merismopedia turfosa*
Ceratoneis arcus	*Calotrix* sp.	*Woronichinia gracilis*	*Pediastrum boryanum*
Klebsormidium sp.	*Scytonematopsis starmachii*	*Cosmarium* sp.	
Schizotrix facilis	*Schizotrix septentrionalis*	*Closterium* sp.	
Phormidium sp.			
Chamaesiphon sp.			

Table 3. Species abundance according to typical environment that can be found in Billefjorden area.

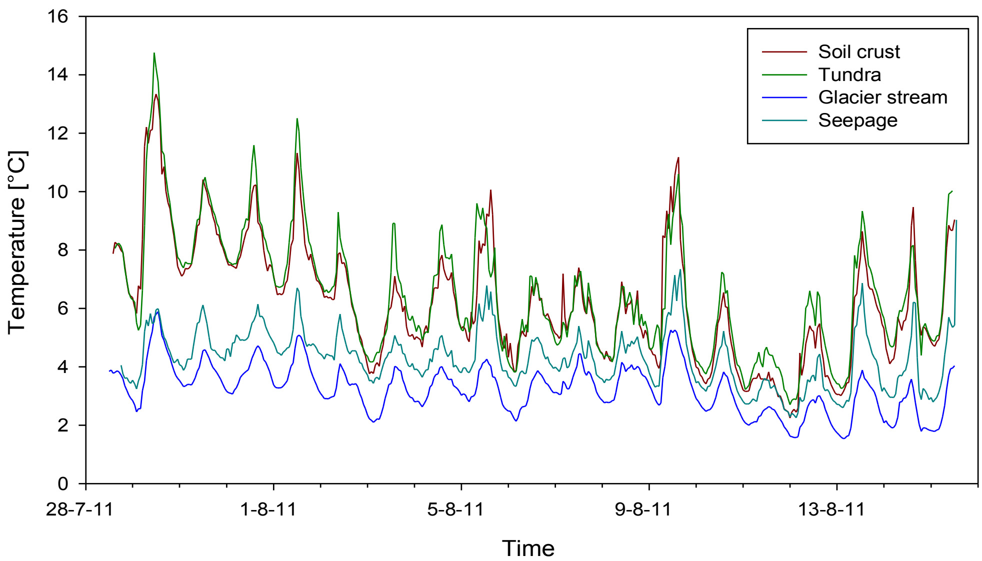

Figure 11. Measured temperature in selected environments, where the samples were collected.

In order to evaluate diurnal changes in photochemical performance of the seepage community, three samples of the *Zygnema* sp. biofilm were kept in Petri dishes for four days (Figure 12). For photochemical performance assessment, the method of rapid light curves (the dependence on photosynthesis on light determined from variable chlorophyll fluorescence measurements) was used.

While the maximum quantum yield (MQY) values responded quickly to the irradiance (I) changes, the saturation irradiance (irradiance at which the photosynthesis becomes light saturated) was kept relatively stable (Figure 13). The low values of the saturation irradiance indicate acclimatization to low irradiances.

Figure 12. Petri dishes with collected samples during the experiment.

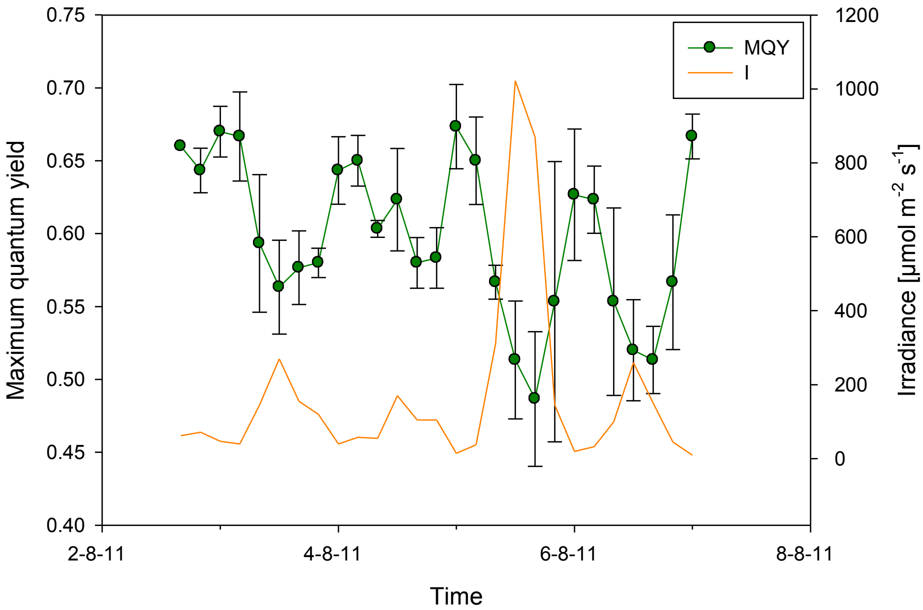

Figure 13. Relationship between irradiance changes and maximum quantum yeald on *Zygnema sp.*

3,2 - Botany

Instructors: Jitka Klimešová, Alexandra Bernardová
Students: Jakub Těšitel, Tamara Malinová, Magdalena Lučanová, Edita Drdová

The aim of the course was to introduce students to plant ecology in high Arctic. We visited all glacier forelands in Petuniabukta and other interesting localities in surroundings to learn flora of the area. We specifically focused on two species occurring as the earliest colonizers of deglaciated area: *Saxifraga oppositifolia* and *Braya purpurascens*. We assessed growth and flowering of the selected species along successional gradient in four glacier forelands. Our results revealed that while *Saxifraga* is long lived species having maximum development (size and flowering) 60 – 80 years after deglaciation, *Braya* is short lived species restricted on newly disturbed places and its growth show no pattern along succession gradient.

Figure 14. *Saxifraga oppositifolia*

Figure 15. *- Braya purpurascens*

3,3 – Zoology and parasitology

Instructors: Oleg Ditrich, Miloslav Devetter, Karel Janko, Tomáš Tyml
Students: Alena Kodádková, Eva Kašparová, Šárka Mášová, Michal Tušer

Figure 16. group of zoologist – students and part of instructors

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

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

Figure 17. working with microscopes

Figure 18. working with microscopes

Figure 19. fishing nets in the Petunibukta

Figure 20. Fresh-water fauna (Crustacea, Insecta, Rotifera) has been studied in lakes and streams.

Figure 21. Soil fauna (Nematoda, Rotifera, Tardigrada) has been studied in samples from different altidudes.

Measurements performed:

1. Quantification of scavenger activity of *Gammarus* sp. in litoral zone.
2. Manipulation of behaviour *Mya truncata* infected with the trematode *Gymnophalus* sp.
3. Fitness (expressed as the weight of gonads related to the size of fish (index GSI)
4. Three gradients of soil fauna in various altitudes from glacier to seacoast

Representative result:

Occurrence of trematodes (family Opecoelidae) and cestodes (*Diplocotyle olricki*) in the gut of *Myoxocephalus scorpius* did not influence the fitness, while the occurence of the nematodes in the host tissues (*Anisakis, Contracaecum, Pseudoterranova* and *Hysterothylacium* – molecularly confirmed) slightly decreases their GSI.

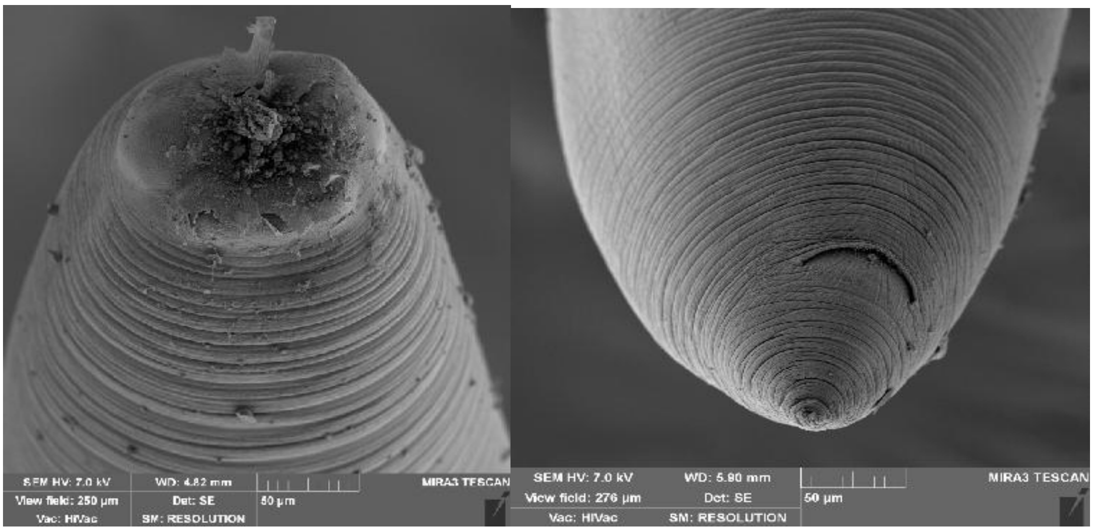

Figure 22. SEM micrograph of anisakid larva from *Myoxocephalus scorpius*.