Report on field activities of the Czech research group in the central part of the Svalbard archipelago (Isfjorden, Billefjorden, Petuniabukta) during the summer 2008

Research was conducted under the auspice of the "Biological and climate diversity of the central part of the Svalbard Arctic archipelago" project, sponsored by the Ministry of Education, Youth & Sport of the Czech Republic, INGO – LA 341 (2007-2010). It is an interdisciplinary (biology and climatology) research project, which is a member of the Network for ARCtic Climate and Biological DIVersity Studies (ARCDIV) - a multidisciplinary international research initiative. This initiative was prepared under the auspices of the International Polar Year (IPY 2007 - 2008).

In 2007, the first Czech expedition established the research station in the vicinity of Petuniabukta, in the northern part of Billefjorden, Isfjorden, in central Svalbard (Fig. 1). This research station offers accommodation for 6 researchers and for the storage of field equipment, including a Zodiac. The members of the expedition, in part, also used the Russian Hut "Petunia" (Fig. 2).

Fig 1

Fig 2

From July 4 to August 15, 2008 twelve researchers from four Czech and Slovak institutions (the University of South Bohemia in České Budějovice - Josef Elster, Oleg Ditrich, Roman Kuchta, and Vojtěch Komárek; the Institute of Botany, Academy of Sciences of the Czech Republic - Jitka Klimešová, Karel Prach, Jiří Košnar, Jiří Komárek, and Otakar Strunecký; Masaryk University in Brno - Kamil Láska, and Jan Gloser; and Comenius University in Bratislava (Lubomír Kováčik) conducted the field research (Fig 3 and 4).

Fig 3

Fig 4

During the 2008 season, the Czech field research activities covered the following disciplines:

1) botany (phycology, lichenology, bryology and phanerology, and plant ecology)
2) zoology (parasitology)
3) climatology

The first aim of the botanical fieldwork was vegetation mapping of the main plant communities in the Petuniabukta area (spatial distribution of the species diversity of algae-cyanobacteria, mosses, and vascular plants - on both the broad and fine scales). On the basis of this field reconnaissance, permanent study plots, microclimatic stations were installed with data-loggers for the monitoring of micrometeorologic parameters in the soil-water environment (these stations had sensors for soil temperature, soil humidity, soil water potential, air humidity, and temperature) (Fig. 5).

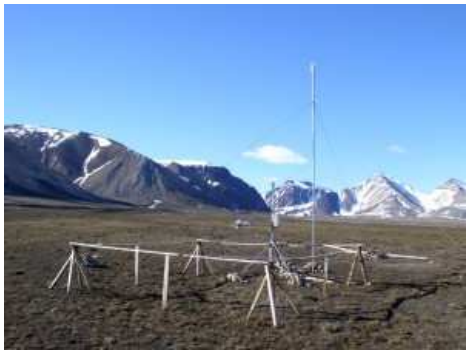


Fig 5

Within the context of the zoology - parasitology program, the diversity of the littoral fish fauna (and their parasites) within the study area were described. In the text that follows, each discipline has its results introduced in a separate chapter:

Botany

Phycology

Both the freshwater and soil algal microflora of Svalbard are scarcely known (tundra soils, streams, seepages, coastal puddles, moist rocks). Only a few papers on these exist, usually oriented toward specific groups; but are usually based upon the old systematics, and needing revision. Also, there is a deficiency of ecological data about these diverse species. The diversity of species / modern classification (eco- and morphotypes), ecological characteristics, spatial distribution, and abundance of both cyanobacteria and algae in the vicinity of Petuniabukta were studied. This data will be included in the vegetation map of the locality prepared.

The following habitats were studied:

a) Streams with a rapid throughflow of water (Fig. 6), moving stones; the dominant species:
   - diatoms (*Meridion circulare, Rhoicosphenia curvata*)

- cyanobacteria (*Schizothrix facilis* - Fig. 7 – waterfalls ++, green algae, epiphytic *Chamaesiphon rostafinskii, Ch. cylindricus*).

Fig 6

Fig 7

b) Coastal pools, streams, seepages (influenced by sea water); dominant species:
   - cyanobacteria (*Phormidium* type *autumnale* +++, solit.: *Spirulina* sp., *Oscillatoria* sp., diatoms, green algae (*Zygnema*, *Klebsormidium* - Fig. 8).

c) Streams in the tundra, seepages, moss tundra:
   - 2-3 morphotypes of *Nostoc* - Fig. 9, *Tolypothrix tenuis*, *Scytonema* sp., coccoid cyanobacteria (in smaller amount, *Aphanocapsa*, *Chroococcus*).

Fig 8

Fig 9

d) Wet rocks (wide diversity, small quantity); species from the genera:
   - *Gloeocapsa* sp. div., *Chlorogloea* sp., *Scytonema* sp. div., *Calothrix* sp., *Dichothrix* sp.

The following species were collected for detailed taxonomic studies:

Revisions were according to modern taxonomic criteria, and combined by molecular methods; in the first period:
- *Schizothrix facilis*
- diversity of the genus *Nostoc*
- diversity of the genus *Phormidium.*

Lichenology

Species diversity and abundance of lichens were studied on the west side of Petuniabukta, from Mimerbukta to Horbyadalen in different altitudinal zones, from the seashore to the summits of Pyramiden and Mumien. Fortunately enough, the region was protected from the destructive activity of inland glaciers in the past centuries; this facilitated formation of rather stabilize lichen communities on elevated coastal terraces, ridges, and stone deposits. It is also apparent that grazing reindeer have not frequently exploited the area, because the most sensitive fruticose lichens are quite abundant and well preserved. Mechanical disturbances limit lichen growth is only serious in the inundation zone of several brooks, cutting-across the terraces and depositing new gravel with larger stones.

Our fieldwork in July 2008 was mainly focused upon classification and mapping of the most important types of lichen communities, based primarily on the presence and abundance of macrolichen species. The most extensive and stabilized plant and lichen communities occur on flat terraces with a well-developed soil profile, situated about 10 - 50 m above sea level. The most abundant fruticose macrolichen species is *Cetrariella delissei*, in some places covering 10 - 20% of the total surface area. Its ecological amplitude is remarkable: from relatively wet stands with closed graminoid vegetation; to dry ridges, steep slopes, and polygonal soils. In some places, *Flavocetraria nivalis* accompanies the *Cetrariella* as a co-dominant. Only in relatively wet microhabitats (usually with mosses), *Stereocaulon botryosum*, *Thamnolia vermicularis,* and *Pseudohebe pubescens* could be found; but their abundance was always low. Very rarely, some small foliose lichens of the genera *Cladonia* and *Peltigera* were found growing on the bare soil surface in a terrain depression (snow-beds). In nearly all stands, these soil patches not covered with plants or fruticose lichens are occupied by leprose lichen species, dominated by *Ochrolechia frigida*. The total area that is covered with a thin layer of their thalli is very extensive (Fig. 10 and 11).

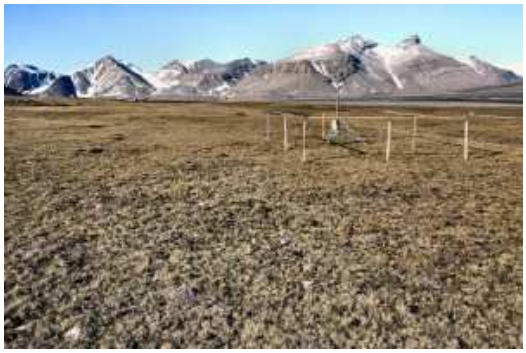


Fig 10

Fig 11

Epilithic lichens are less abundant, compared to some other (more westerly) regions of Svalbard. This may be caused by the relatively less-favourable climatic conditions (lower precipitation and temperature during the summer), and also by nutrient deficiency (because there are no nesting colonies of birds in the vicinity).

Only the most elevated large stones or boulders, used by some birds as observation points (and thus enriched by nutrients from their excrement) are colonised by a more abundant lichen community of some foliose species (*Xanthoria elegans, Caloplaca decipiens, Parmelia saxatilis, Physcia caesia, Umbilicaria decussata, U. virginis,* and *U. hyperborea*), as well as numerous crustose species, mainly of the genera *Lecidea, Acarospora, Buellia, and Rhizocarpon* (Fig.12). A satisfactory determination of the lichen samples from this taxonomically difficult group has not yet been completed.

Fig 12

Bryology

Research was predominantly focused on the gathering of floristic data. Bryophyte taxa recognized in the field were recorded; unidentified items were collected for herbarium specimens, a portion of which had already been determined microscopically at the field station. For each specimen the GPS coordinates of the locality were taken, as well as some essential ecological parameters of their habitat. These included the type of substrate (mineral soil, peat soil, or various types of geological substrate), as well as rough estimates of the humidity, exposure, and slope.

The area of Petuniabukta, where most of the research time was expended (ca. 12 days), was fully investigated for bryophytes (probably for the first time). In Petuniabukta, both vegetation mapping and vegetation sampling was also carried-out (including vascular plants, macrolichens and bryophytes). Intensive floristic research (2 days) was also carried out in the vicinity of the Brucebyen settlement (S part of Adolfbukta), where repeated vegetation mapping of the area had already been investigated by both Summerhayes & Elton (1923), and Acock (1940).

A half-day excursion was focused on both the ruderal and human-influenced habitats in the region of Pyramiden, the former Russian settlement. Also, a one-day excursion was held in the vicinity W of the settlement, which mostly included natural habitats. Most of the field

trips were focused on less-extreme habitats at somewhat lower altitudes, where both the highest bryophyte cover and diversity were recorded. Although, several mountain habitats (up to ca. 750 m a.s.l.) were also visited.

Despite the fact that most of the collected herbarium specimens have not yet been identified, the occurrence of approximately 110 bryophyte taxa could be estimated within the area of interest. This represents ca. 30% of the taxa presently known to occur on Svalbard (Frisvoll & Elvebakk 1996). The bryophyte flora consists predominantly of mosses; only 12 liverwort taxa were recorded. Because the geological bedrock in the greatest part of the territory is built-up of basic rocks (gypsum, limestone, dolomite), most of the recorded taxa belong to the basiphilous bryophytes. This explains e.g. the high diversity of recorded *Bryum* taxa, as well as the high abundance of species such as *Ditrichum* sp. div., *Distichium* sp. div.. or *Encalypta* sp. div. The only exception was the area W of Pyramiden, with the occurrence of acidophilous taxa, such as *Aulacomnium turgidum, Dicranum laevidens,* or *Racomitrium* species. Another important factor influencing the distribution of bryophytes in Petuniabukta is the moisture gradient. In lowland locations, were locally abundant wetland habitats (often with high bryophyte cover) contain *Scorpidium cossonii, Catoscopium nigritum, Bryum cryophilum,* or *Campylium* sp. div. as the dominant taxa (Fig. 13). The other extreme of this gradient is represented by dry slopes in the higher mountain altitudes, especially in exposed and unstable habitats. Such sites often have only a sparse bryophyte cover, consisting of a few *Encalypta, Ditrichum,* or *Distichium* taxa. Under mesic conditions, species with broader amplitude such as *Orthothecium chryseon,* and *Tomentypnum nitens* prevailed. From the bryological point of view, also of interest were bird cliffs, with locally abundant covers of typical epilithic species such as *Didymodon johansenii,* or *Grimmia anodon*; both being rather rare on Svalbard (Fig. 14). Another peculiar habitat represents deglaciated areas with species of bare soils, specifically *Aloina brevirostris, Bryum* sp. div., *Henediella heimii, Funaria arctica,* or *Desmatodon* sp. div.

Fig 13

Fig 14

Vascular Plants

The main results of the research, focused on vascular plants, are represented by (1) a vegetation map of Petuniabukta Bay, (2) a description of the changes in vegetation, on a smaller scale after 70 years (Brucebyen), and (3) a morphological study of the growth forms of about 90 plant species from the area.

The pictures that can be seen in Fig. 15 show the same view of a slope above Brucebyen taken more than 70 years earlier. They illustrate the absence of changes in the composition and structure of the vegetation here. Our study supports the theory that changes of vegetation, due to climate change, might either be difficult to detect (either due to ecological plasticity of resident species, of to the paucity of incomers which could benefit from an improved environment), or perhaps even due to the negligible effects of climate changes, as such.

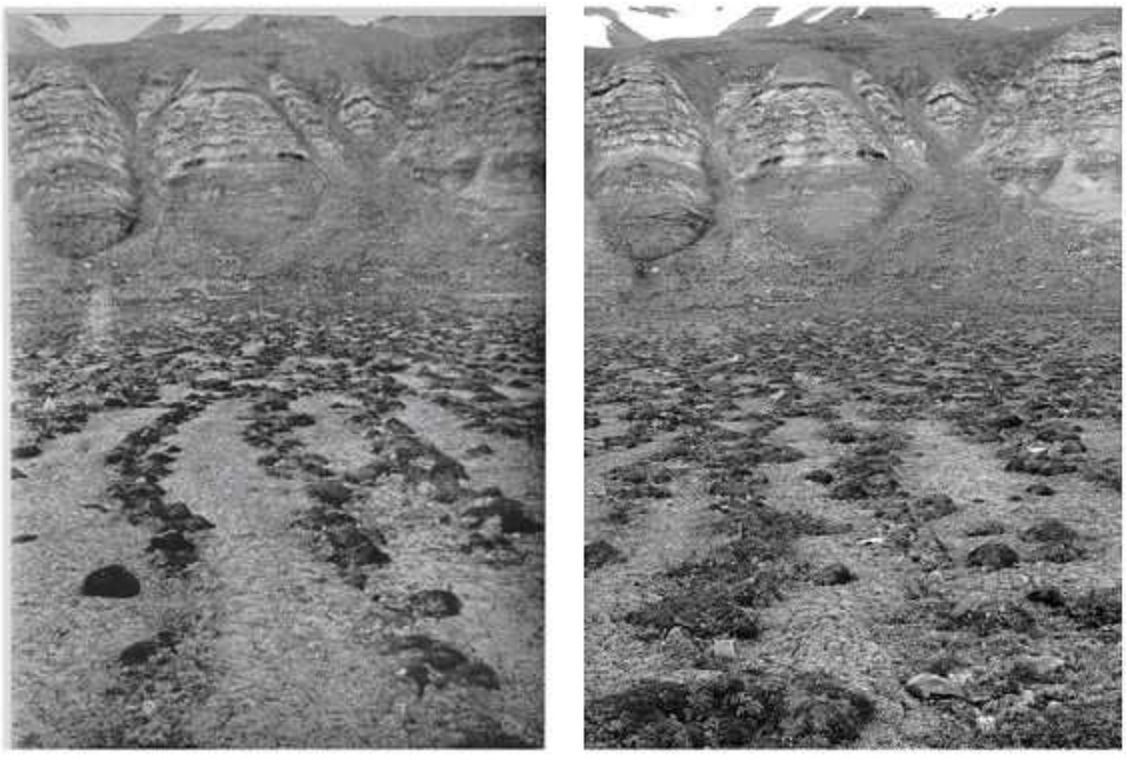


Fig 15

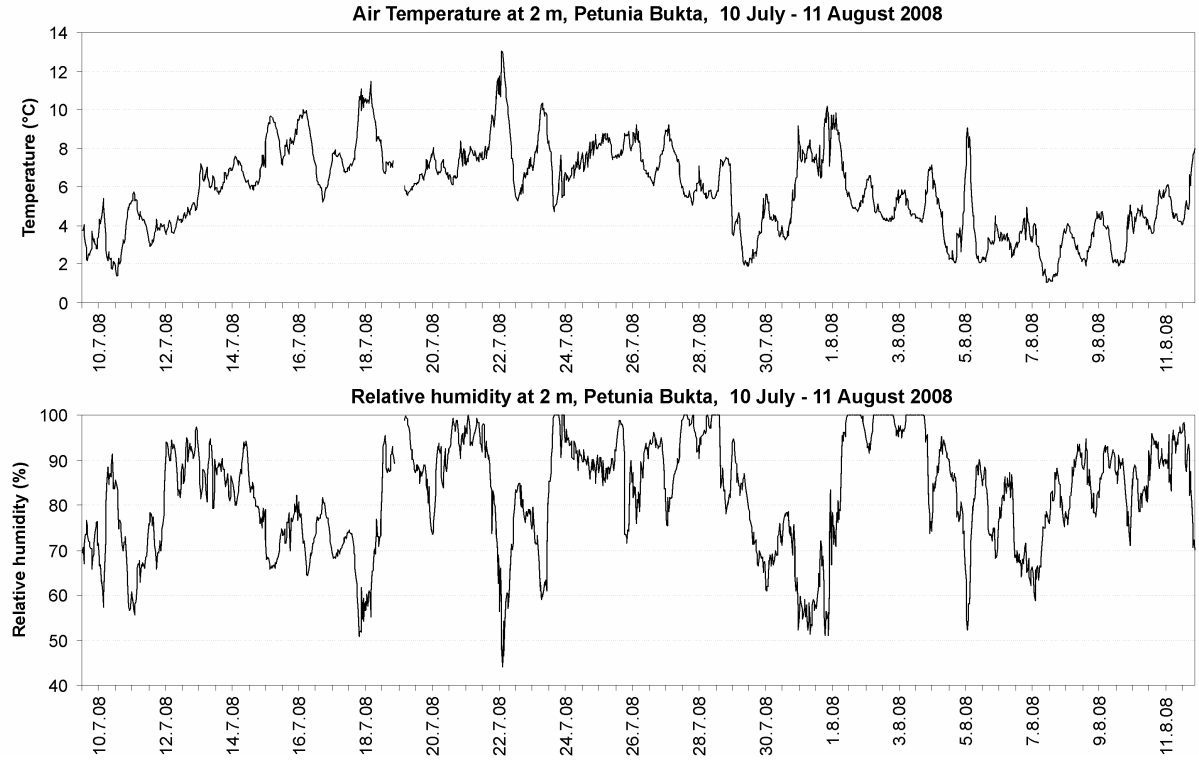
Climatology

Four meteorological stations were established on the northern coast of Petuniabukta (northwestern branch of Billefjorden), during the period July-August 2008. At the location of the automatic weather stations (AWS) specific descriptions of the localities, their altitudes, vegetation compositions, cover distributions, and distances from the glacier terminus were considered. The AWS were installed in four typical locations: 1) an old marine terrace at an altitude of 15 m a.s.l.; 2) an old marine terrace at the altitude of 25 m a.s.l.; 3) a mountain ridge on Mumien peak at 469 m a.s.l.; and 4) the terminus of the Hørbye glacier at 66 m a.s.l. Measured at all localities, were the basic meteorological parameters, such as: air temperature and humidity at 2 m above the ground, soil temperature, and soil moisture (volumetric water content) at depths of 5 and 15 cm. Apart from that, an extended monitoring program was launched at the main AWS, which is located on the southeastern slope at an altitude of 15 m. This included the measurements of both incoming and outgoing global solar radiation, PAR, atmospheric pressure, surface temperature of the vegetation cover, wind speed, wind direction, and soil temperature profile (down to 75 cm below ground). All AWS were adjusted for measurement at Greenwich Mean Time with the sampling interval of 10 s (solar radiation) - or 30 min in the case of the other meteorological parameters.

Meteorological instruments at the main AWS, Petunia Bukta, 15 m a.s.l.

Parameter	*Instrument*	*Sampling interval*	*Recording interval*	*Height above ground (m)*
Downward short-wave radiation	Shenk 8101, Austria	10s	30 min	1.5
Upward short-wave radiation	Shenk 8101, Austria	10s	30 min	1.5
PAR	EMS12, CZ	10s	30 min	1.5
Atmospheric pressure	CRESSTO 518, CZ	30 min	30 min	1.7
Air temperature	EMS33, CZ	30 min	30 min	2.0
Air humidity	EMS33, CZ	30 min	30 min	2.0
Wind speed	MetOne 34B, USA	30 min	30 min	6.0
Wind direction	MetOne 34B, USA	30 min	30 min	6.0
Surface temperature	OS36-2, Omega, USA	30 min	30 min	0.0
Soil temperature	TC-5, EMS, CZ	30 min	30 min	-0.02
Soil temperature	TC-5, EMS, CZ	30 min	30 min	-0.05
Soil temperature	TC-5, EMS, CZ	30 min	30 min	-0.15
Soil temperature	TC-5, EMS, CZ	30 min	30 min	-0.30
Soil temperature	TC-5, EMS, CZ	30 min	30 min	-0.50
Soil temperature	TC-5, EMS, CZ	30 min	30 min	-0.75

Soil moisture	10HS, Decagon, USA	30 min	30 min	-0.05
Soil moisture	10HS, Decagon, USA	30 min	30 min	-0.15



The plots illustrate the general climatic conditions in Petuniabukta (Billefjorden), recorded by the main AWS from July 10 to August 11, 2008. During the investigation period, the air temperature fluctuated between 1 and 13°C, while the mean air temperature was 5.8°C. Additionally, semidiurnal fluctuations of air temperature can also be found during the high-summer season, due to the effect of katabatic winds (when temperatures may suddenly drop by 5 - 8°C). Generally, the oceanic character of the atmospheric circulation is also evident from the mean relative humidity, which was 82.4%. Correspondingly, as was the case with the air temperature, short-time fluctuations of the relative humidity were documented during several events (e.g. on July 27 and August 5).

Zoology

Parasitology

The parasitological portion of the project aims to study the litoral biocenoses, and host - parasite relations. The following partial goals were achieved:

1. Biodiversity mapping was aimed at the occurrence of potential hosts and intermediate hosts of parasites (especially trematodes) in the littoral biotopes of Petuniabukta.
2. Examination of fish and selected invertebrates for the presence of parasites (especially endohelminths).

Sampling

1. The localities in Petunia Bay were reached using the Zodiac. Scuba diving was utilized for sampling (the team members have both Special Open Water Diving and Advanced Open Water Diving licenses).
2. The fish were captured using drift nets and during dives
3. The invertebrates were sampled both individually during diving (to max. of 30 m depth) and by sieving of the bottom sediments. Special attention was paid to mollusks.

Parasitological examination:

The fish (and birds accidentally captured in the net) were dissected parasitologically, with special attention to flukes and tapeworms. The mollusks were individually placed into vessels, and kept for 24 - 48 hours. They were then dissected using the compression method, like invertebrates from other taxonomical groups. The numbers of animals dissected are in Tab. 1.

Tab. 1: Numbers of animals parasitologically dissected in Petuniabukta, Svalbard in 2008

hosts	**N$^{o.}$ species**	**N$^{o.}$ dissected**	**N$^{o.}$ positive**
Pisces	6	19	14
Aves	2	1	1
Mollusca	20	593	40
Polychaeta	4	30	1

Crustacea	4	748	14
Other Invertebrates	6	12	1

Parasites found during dissections were fixed in hot formaldehyde solution for morphological studies; some were fixed by ethanol for molecular studies. Selected samples were fixed by glutharaldehyde for the ultrastructure studies, using electron microscopy. Selected hosts (or parts of them) were fixed and stored for detailed determinations. The shells of the sampled mollusks will serve as a comparison collection for forthcoming determinations.

Interesting findings and topics selected for future research:

The benthic fish *Myoxocepalus scorpinus* was dominant in the area studied. Tapeworms *Diplocotyle olrikii* (Cestoda: Spathebothriidea), plerocecoids of Tetraphyllidea gen. sp., intestinal flukes (Digenea: family Lepocreadiidae), and nematode larvae (Nematoda: Anisakidae) were found in this host. Parasites of *M. scorpinus* will be studied in detail in the future.

The bivalve *Mya truncata* was found as the most interesting intermediate host. Parasitic flatworms (Rhabditophora: Graffillidae), nematode larvae, and especially flukes of the family Gymnophalidae with partenogenetic metacercariae (very probably a new species) were found in most of them. These flukes try to simplify their life cycles, due to the lack of a wide-spectrum of intermediate hosts in the extreme conditions

The next intermediate host that will be studied in detail is *Buccinum undatum.* In seven specimens out of 5 dissected, the sporocysts and cercarie, somewhat resembling *Cercaria neptuni* Lebour, were recorded. Another intermediate hosts that should be studied are the bivalves *Lacuna* sp., and *Macona balthica*; since sporocysts were found in them. On the other hand, there are some dominant mollusk species (such as the bivalve *Astrate sulcata,* or nudibranchiate *Dendronotus frondosus*) that were completely negative, and which probably play no role as intermediate hosts for the flukes.

Among other findings, were the recording of the flatworm *Mecynostomum* cf. *pallidum* (Acoela: Convolutidae) in the sea cucumber of the genus *Myriotrochus* (Holothuridea: Apoda), and the find of the intestinal acanthocephales in the common eider *Somateria mollissima*; accidentally trapped in the fishnet.