Our field studies on ornithogenic tundra in Spitsbergen

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Climate change will influence ocean circulation and the hydrologic regime, which will consequently lead to a restructuring of zooplankton communities, increase of fish-eating and decrease of plankton-eating seabird populations. Different bird species have different impact on the vegetation structure and chemical composition of the ornithogenic tundra, depending on locations of the colony (plankton-eating little auks –mild mountain slopes, far from the sea; fish-eating guillemots and kittiwakes – rocky cliffs at the coast), time of staying in the colony, physicochemical composition of guano, rate of washing-out minerals to sea and utilizing them by plants.

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- Intercollegiate Faculty of Biotechnology – dr Krzysztof Waleron (microbiological research)
- Centre for Ecological Research PAS – dr Izabela Olejniczak (identification of soil invertebrates *Collembola*)
- University of California, Irvine, USA – dr Nina Karnovsky (ornithological research)

Study area:

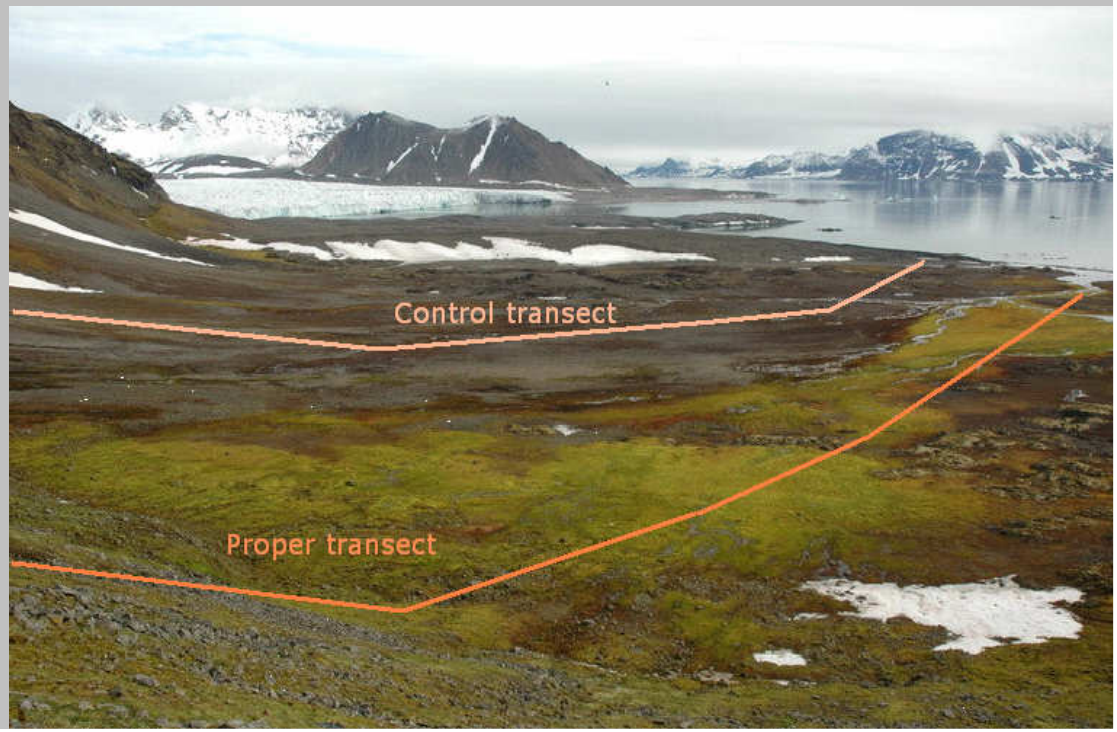
We study ornithogenic tundra in the vicinity of large seabird colonies in different parts of Arctic and Antarctic.
Here we present our study area in Hornsund (SW Spitsbergen), which consisted of:

1. Mixed colony of fish-eating Brünnich's Guillemot *Uria lomvia* and Kittiwake *Rissa tridactyla* (Gnalberget)



2. Planktivorous Little Auk colony *Alle alle* (Fuglebergsletta)

In each colony we mark out one proper transect down the slope – from the colony to the sea and in parallel – a control one – on the topographically similar site but without impact of seabirds.



Depending on the distance from the colony to the sea, one transect consist of 10 to 12 sample plots (squares 1,6x1,6 m, the distances between squares are estimated from the logarithm - Tab. 1) for physicochemical and plant structure analyses. Each square is divided for 6 smaller squares (Fig.1). The localizations of squares are described by GPS position (e -Treck Vista).

Table 1.

Plot (No)	1	2	3	4	5	6	7	8	9	10	11	12
Distance from the colony [m]	0,0	6,0	15,0	28,5	48,8	79,1	124,7	193,0	295,5	449,3	680,0	1026,0

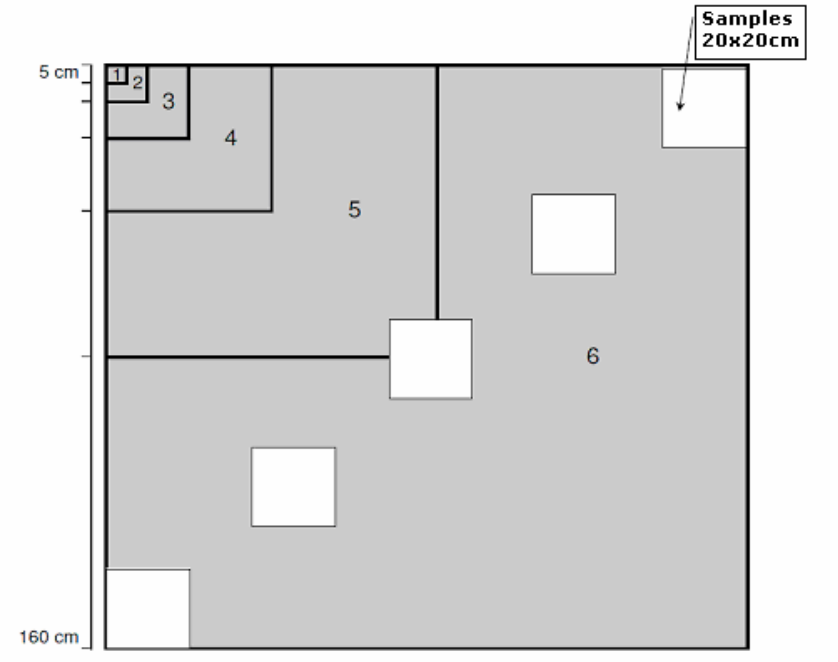
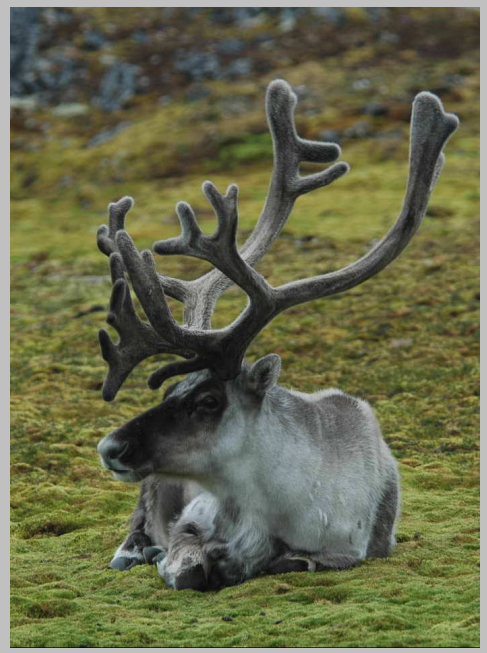


Fig.1. The square for taking samples for physicochemical, invertebrates, plants and isotopes analysis

Field works:



- evaluation of the extent of fertilizing soil by herbivores (geese, reindeers) on the control transects;
- counting herbivores on the transects;
- counting tundra nesting birds (Snow Bunting *Plectrophenax nivalis*, Purple Sandpiper *Calidris maritima,* Arctic Skua *Stercorarius parasiticus*) on the transects.

Sampling:

● Plant community structure and biomass with the estimation of the higher plants', mosses' and lichens' cover

In each square (160x160cm) we use a rope mesh, dividing it for 6 nested squares (5x5cm) for estimating the plant community structure and we take 5 square samples (20x20cm) on the diagonal of the square (Fig.1) to estimate the biomass of plants.

- Soil invertebrates

From 3 points on the diagonal of the square we take soil samples (Ø 6 cm and depth 5 cm) for quality and quantity analyses of *Collembola*. Each sample we put to the plastic box (500ml).

- Physicochemical soil analyses

We take 3 samples of soil from each square (Ø 6 cm and depth 5 cm) to analyse the ion content (NO^{3-}, $NH4^{+}$, PO_4^{3-}, K^{+}), pH, soil solution conductivity and soil dry mass.

- Carbon and nitrogen stable isotopes

From each square we collect samples of higher plants, mosses and lichens (3 samples of each taxa from each square) for isotope analysis. Additionally we collect all found dead birds, bones, pellets in the vicinity of the colony.

● Soil micro-organisms

Sampling by sterilized shovel, 3 soil samples (100 cm^3) from each square.

● Birds' excreta analysis

To estimate deposition of bird's excreta we use two methods:

- Black square sheets (1,6x1,6m) - amount and localization relative to squares for plant and soil sampling. After every 24h exposition we take pictures of each foil. The pictures of plastic sheets are analyzed with a computer (SigmaScan Pro 5.0). After each control the sheets are cleaned.

-Plastic sheets (1x1m) with a thin foil, which is weighed before and after exposition and also photographed to count the number of smudges.

Physicochemical composition:

From each plot we collect fresh samples of feaces of the most numerous birds (Little auk, Brunnich's guillemot, Kittiwake, Barnacle goose) and mammals (reindeer).

● Faeces deposition of Barnacle geese and reindeers foraging on tundra

Every 7-10 days we count, collect, measure, weight and dry faeces of the herbivores from the squares (20x20 m or 10x10 m) situated among the transects and describe the humidity, % of plant cover and note the dominative plants on the squares.

- Birds concentration

We carry out few control counting of Snow buntings, Purple sandpipers and Arctic skuas nesting sites on the study area.

Snow bunting

Purple sandpiper

Arctic skua

- The number of tundra herbivores

We count Barnacle geese and reindeers on the plots.

- The size of bird colonies

On each plot we do the panoramic photographs of the birds colonies (with 200mm lens and the tripod).

Laboratory work during the expedition:

Collected observation data, measurements and samples are preparing for the further analysis, taxon marking and results elaborating.

- Soil invertebrates samples

Samples are weighed and put to plastic funnels with thick gauze on the top, thinner on the bottom, small boxes with 96% alcohol underneath and light bulbs (60W) in the upper part (Tulgren funnel).
They stay for 48 hours and afterwards the boxes with organisms in alcohol are closed, described and transported to Poland for taxa analysis.

- Chemical analyses of soil and water

Soil samples are immediately prepared for further analyses. From each sample we take 3 portions of soil (80 cm^3), weigh them and analyze:

- the percent of dry mass (soil is crumbled, dried in 40-60^o for at least 24 hours and weighed). After that soil is packed and used for stable isotopes analysis.

- conductivity, salinity and pH of soil solution (we mix the soil sample with 160 cm^3 distilled water, shake it from time to time for 20 minutes and pass it through the mesh sieve with 0,5 mm openings. Prepared sample we measure in a versatile device CPS-401).

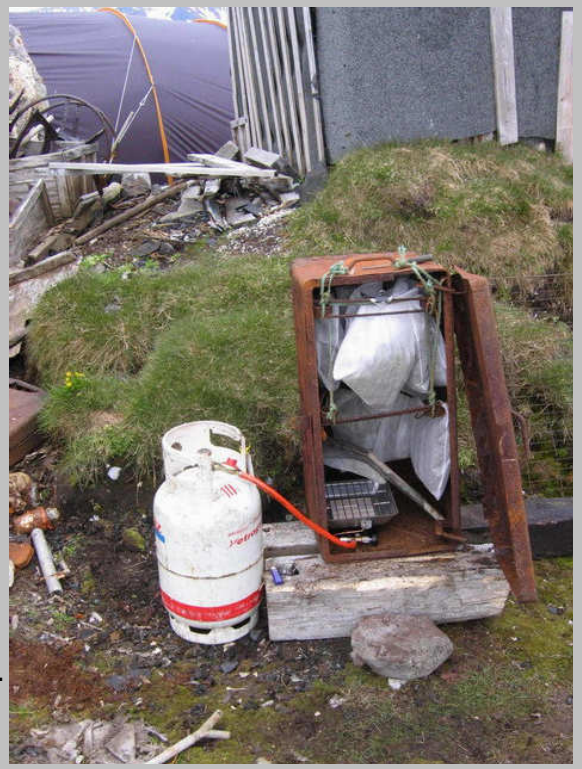
- Estimating NO^{3-}, NH^{4+}, PO_4^{3-}, K^{+} content in the soil samples

Soil samples are mixed with 200 ml 0.03 N acetic acid, put away for 60 minutes, shaken from time to time. Then the solution is passed through the mesh sieve and through the tissue paper filter. Finally the sample is analyzed with the colorimeter (Slandi LF205) following the standard procedure.

- Samples for carbon and nitrogen stable isotopes

All plants taxa are separated and dry in plastic boxes. Birds remains are also dried.

Conservation and storage of samples



- Vegetation samples

Samples for estimating the biomass we dry in 60°C and close in hermetic bags.

- Soil invertebrates

After 48 hours exposition to light we storage the samples of invertebrates in boxes with 96% ethanol.

- Physicochemical soil analysis

Samples used for estimating the dry mass of the soil we put into bags to estimate the organic and mineral matter, further chemical analyses and isotopes analyses afterwards. Soil solutions after analyses are packed and transported to Poland.

- Soil microorganisms

Samples are storaged in a cool place and then put in the freezer (in temperature -20°C)

- Birds feaces

Plastic foils and faeces we pack and storage in the freezer (in temperature -20°C). Further analysis are finalized in the laboratory in Poland.

All data with full description, photographic documentation and GPS localization are recorded in the computer.