VILLUM
RESEARCH STATION, Station Nord

2019 ANNUAL REPORT

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Photo: Bjarne Jensen.

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INTRODUCTION

Dear Reader
Welcome to the Annual report of The Villum Research Station 2019.

This is the fifth time that I am writing the Introduction to the Annual Report of activities at Villum Research Station at Station Nord (Villum). The year 2019 has been a very difficult year for the station. We lost the waiver that we had for flying to Station Nord from Longyearbyen on Svalbard and we have used a lot of time and energy to solve this problem. Thanks to the strong effort of the head of logistic, Jørgen Skafte and support from the management of Aarhus University, it succeeded to find a solution, so it is possible again to fly from Svalbard to the station, thus we are back to normal operation.

Despite these difficulties, Villum Research Station hosted a series of research projects in 2019 and it is nice to see that the number of publications per year is increasing steadily and so far 22 peer reviewed articles and four scientific reports have been registered in 2019 (see references list at the end of the report).

The widespread activities carried out at Villum are also reflected in this years' report where we have articles dealing with atmospheric pollution, plate-techtonic-evolution, permafrost, soil fauna and two articles on ornithology

For the first time we had one of our three largest drones (Prion Mark3) flying at Villum. The drones will be soon used in a campaign for determination of the vertical profile of aerosol and black carbon concentrations, and, by that time, the last remaining part of the equipment belonging to Villum Research Station will be brought into use.

In 2019, ICOS (Integrated Carbon Observation System) was started up at Villum. ICOS is a European network and it is central for the understanding of carbon in the environment and how it affects climate. The transport of air pollution to high Arctic is continuously monitored as part of the Danish contribution to AMAP. As part of this activity, atmospheric mercury is studied and some selected results are presented in the present report.

Finally, I will thank all scientists that, despite the difficulty to visit Villum in 2019, have overcome the problems and carried out excellent research at Villum. Climate and environmental changes are the largest challenges humankind has so far encountered and I would like to thanks all the scientist that, through the great scientific work carried out at Villum Research Station, have contributed with describing and quantifying these changes and their effects on climate and environment.

Henrik Skov, Scientific Head of Villum Research Station, Station Nord

INTRODUCTION

Villum Research Station in snow. Photo: Christel Christoffersen.

MERCURY MONITORING AND EXPERIMENT AT VILLUM RESEARCH STATION

By Henrik Skov, Jens Hjorth, Jakob Boyd Pernov, Jesper Christensen and Rossana Bossi;
Department of Environmental Science, Aarhus University

MONITORING OF POLLUTANTS

Introduction

Mercury is a heavy element (Atomic no. 80), is a liquid at room temperature and it is toxic in all its different chemical forms. Mercury (Hg) is one of the first substances that have been identified as a pollutant in the food web worldwide, causing adverse effects for human health and to wildlife. On this background the Minamata Convention, aiming at reducing the exposure of human beings and the environment to mercury, was established in 2013; the convention entered into force in 2017.

As part of the Danish contribution to Arctic Monitoring and Assessment Program (AMAP), we have measured gaseous elemental mercury (GEM) since 1999 at Villum Research Station, Station Nord, Greenland.

The measurements provide important information about atmospheric concentrations, trends and load to the Arctic environment (Skov et al. 2020). The long time series is supplemented by shorter campaigns where specific processes (i.e., relationship between fluxes of GEM and CO_2) are studied (Kamp et al. 2018). A more recent study reports concentrations of Gaseous Oxidized Mercury (GOM) in summer 2019, outside of the spring period where several research groups have reported concentrations of several hundreds of picogram m^{-3}.

Instrumentation

GEM is measured by a TEKRAN 2537 mercury analyser (Fig 1.1). In the first years (1999-2002), funding was only available for six month per year of observations and thus the data coverage is limited to spring, summer and early autumn, except for the very first year. There are no measurements available for the years July 2002 to 2008 as the research station during that was closed. Several generations of the instrument have been used (A, B and X versions) but we estimate that the uncertainty of measuring GEM has remained unchanged during the years. The detection limit is 0.1 ng m^{-3} and the reproducibility for concentrations above 0.5 ng m^{-3} is within 20 % based on parallel measurements with two TEKRAN 2537A mercury analysers (at a 95 % confidence interval). The principle of the instrument is up-concentration of GEM in the air samples on gold traps followed by thermal desorption in a flow of argon and detection by cold vapor fluorescence spectroscopy (Skov et al. 2020).

GOM is measured using a Tekran 1130 in combination with a Tekran 2537. GOM in ambient air is initially sampled onto an annular denuder coated with potassium chloride that quantitatively traps GOM. Afterwards, GOM is thermally reduced to GEM and desorbed from the denuder, followed by analysis via the Tekran 2537.

Figure 1.1.
The instruments for mercury measurements in action in the air-monitoring house.
Photo: Christel Christoffersen.

Results and discussion

GEM concentrations are shown in Figure 1.2. There is a clear seasonal behavior. Every spring after polar sunrise, there is a period, where GEM is rapidly depleted within hours to levels below the instru-

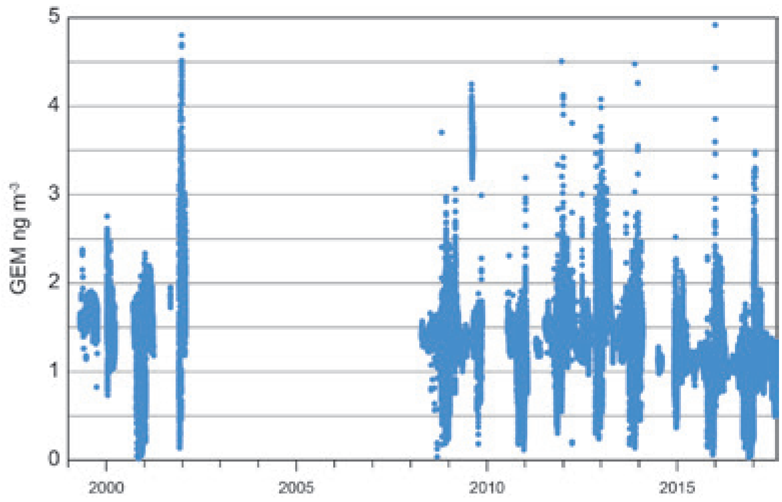

Figure 1.2.
GEM concentration at Villum Research Station from June 1999 to 2017, on a 1 hour time resolution.

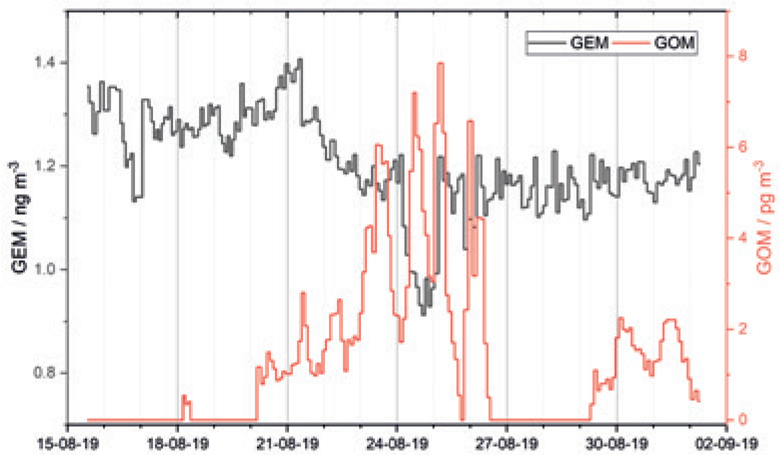

Figure 1.3.
GEM and GOM concentrations from 15th August to 2nd September 2019.

ments detection limit during atmospheric mercury depletion episodes (AMDE). This depletion is followed by abrupt re-emission leading to very high increases in concentrations; sometime of up to 12 ng m^{-3} (highest values not shown here). This period of re-emission is followed by a period with stable concentrations around 1.2 to 1.5 ng m^{-3} during the remainder of the year.

We analysed GEM data for possible trends both on annual and seasonal mean values. The main result is that we did not find any significant time trend in annual mean values, though there was a trend for the winter months (December to February) that was counteracted by a weak increase during spring and summer (non-significant). We also looked into the frequency of depletion episodes and their duration and we could not observe any trend (Skov, Hjorth et al. 2020).

The chemistry of the depletions was also investigated. Ozone and GEM is highly correlated during depletion and in 2004, we published two papers on the reaction kinetics, where we assumed relative rate conditions meaning that GEM and ozone are removed by a mutual sink. We identified the compound to be Br atoms as the reaction rate constant agreed with a rate constant determined by theoretical chemistry study we also carried out (references to those articles are to be found in Skov et al. 2020). We could reproduce the reaction kinetic result looking only on data 2008 and onwards.

Interpretation of data was also made by comparison with model calculations, see (Skov et al. 2020).

Many studies focus on GOM production during spring. In 2019, we carried out a campaign where GOM was measured in summer months outside the mercury depletion period, see Figure 1.3. In summer, we observed that GEM is reduced by 200 pg m^{-3} and GOM is at the same time increased to 8 pg m^{-3}. Work is ongoing on the interpretation of the results. Preliminary analysis shows that the depletion occurred when air mass is coming from a loft (Pernov et al. 2020 manuscript under preparation).

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ACPD doi.org/10.5194/acp-2019-912

LITTLE AUK COLONY SURVEY IN EAST GREENLAND

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LITTLE AUK COLONY SURVEY

One of the research activities of the Strategic Environmental Study Program for the Northeastern Greenland area 2016-2019 (a background study program related to the now relinquished oil exploration licences in the Greenland Sea and funded by the companies through the Greenland government) was focused on the little auks breeding along the coasts of the Scoresby Sound polynya (text box) in East Greenland. The breeding colonies are found in screes and are very difficult to survey, because the nests are concealed below rocks and boulders and due to the immense numbers (literally millions) of birds breeding in them.

We therefore tried a new approach to estimate the breeding numbers

Figure 2.1.
The two cameras mounted in the photo bay of the Twin Otter.

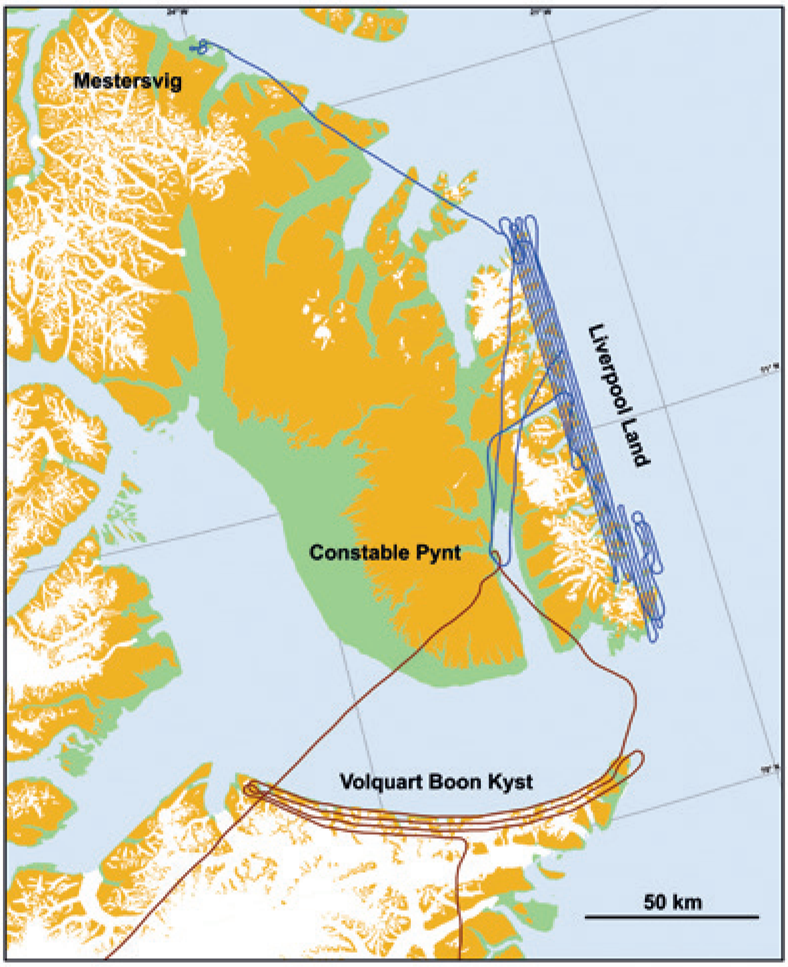

Figure 2.2.
The transects flown on 30 (blue) and 31 (red) July 2019. The blue along the Liverpool Land coast in an altitude of 4500 feet and red along the Volquart Boon Kyst in 7000 feet.

in the area. From studies within the colonies, we know the density of nests in the study site. If we could measure the area of all breeding colonies combined, this density can be applied to the entire region and an extrapolation made.

The breeding colonies have an indicative combination of colours. High density sites are pale grey due to the bird's faeces and some particular lichens. Below screes slopes with breeding birds the vegetation is lush and appear bright green, due

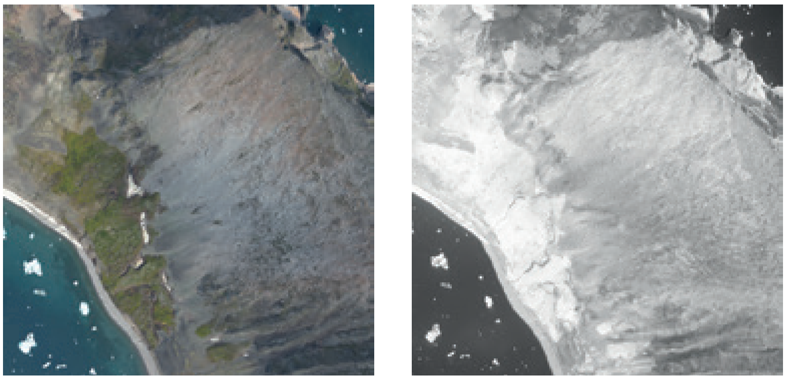

Figure 2.3.
Images of a specific colony of breeding little auks on Reynolds Island. The RGB-image is at left, to the right is the NIR-image. Note on the RGB-image the green vegetation at the foot of the scree and the orange lichens in the upper part, while the green parts appear white on the NIR-image.

to nutrients from the guano washed down by precipitation. Above the colony sites, the rocks often are coloured orange by another lichen *(Caloplaca elegans)*, which thrives upon airborne nutrients. Snow drifts near the colonies can also have a red hue, due both to snow algae and bird droppings coloured by the red shells of the crustaceans they feed upon.

Our idea was to carry out a photo survey of the coastlines where these bird breed in high densities. The system comprised of a standard Nikon D850 operating in tandem with a Phase One iXU1000 camera on loan from the Villum Research Station. The latter obtained high resolution near infrared (NIR) images for identification of chlorophyll in vigorous vegetation (Fig. 2.1). From this combination of four colour bands our hypothesis is that we can identify such high density nesting sites in an automatic way. However, no results are yet available.

The surveys at Liverpool Land and Volquart Boon Kyst were flown on 30 and 31 July 2019 at altitudes of 4500 and 7000 feet respectively (dictated by the topography). The transects flown are shown in Figure 2.2.

Figure 2.3 shows two images of a typical colony on Reynolds Island. One with the visible RGB channels and one with the NIR channel.

The PhaseOne camera was also used during a survey of walrus haul-outs, but this time in true color RGB mode. These sites were overflown at an altitude of 1500 feet with the camera running. Walruses usually rest very close to each other so they can be difficult to count during an overpass. Moreover, they often enter the water during the pass, so it is not possible to repeat the count. The high altitude combined with the high resolution camera therefore gives a more accurate count of the animals present (Fig. 2.4).

Little auk

The little auk is the most numerous seabird in the northern Atlantic with the main colonies in Franz Josef Land, Svalbard (> 1 million pairs), East Greenland at the Scoresby Sund Polynya and northwest Greenland at the North Water Polynya (33 million pairs). It breeds in huge colonies placed in screes close to the waters where they feed. In East Greenland, the colonies are found along the coasts of Liverpool Land and along the Volquart Boon Kyst. In 1985, these colonies were estimated at 3.5 million pairs. The little auk feeds mainly on copepods of the genus Calanus, which occur in high concentrations in the polynyas.

Little auks in their breeding colony. Note the orange lichens on the cliff face behind the birds.

Figure 2.4.
A PhaseOne true colour image of a walrus haul-out overflown at 1500 feet altitude. The high resolution of the image makes it possible to zoom-in and count the individuals with precision and determine if there are calves among them. Here there are 21 adult walruses (insert).

CIRCUM-ARCTIC STRUCTURAL EVENTS IN NORTHEAST GREENLAND

By Karsten Piepjohn, Martin Blumenberg, Felix Goldmann, Lutz Reinhardt and Antonia Ruppel; German Federal Institute for Geosciences and Natural Resources

CIRCUM-ARCTIC STRUCTURAL EVENTS

Since 1992, the German Federal Institute for Geosciences and Natural Resources (BGR) has carried out more than 20 geoscientific terrestrial expeditions in the Arctic within the framework of the CASE-project (Circum-Arctic Structural Events). Major subject of CASE is the Mesozoic-Cenozoic re-organization of the plate-tectonic constellation during the Eurekan deformation and the opening of the Arctic Ocean. In this context, the Wandel Sea Mobile Belt in Northeast Greenland represents an important element of the plate-tectonic evolution before the separation of Greenland and Svalbard during the Paleogene.

The establishment of the Villum Research Station at Station Nord in Northeast Greenland in 2014 was an important precondition for geoscientific fieldwork in this remote place of the world. Using the Villum Research Station as logistic base, the expedition "CASE 20-Northeast Greenland" took place between 15th of July to 10th of August 2018 in northeastern Kronprins Christian Land (Kilen, Nakkehoved, Prinsesse Ingeborg Halvø) and the islands northwest of Station Nord. The seven participants of BGR, the University of Bremen and of UNIS in Longyearbyen housed comfortably at Villum Research Station, heading for fieldwork by helicopter.

The major task of CASE 20 was the geoscientific observation of the structures, tectonic history and timing of the NW-SE striking fault zones of the Wandel Hav Mobile Strike-Slip Belt and its relation to the West Spitsbergen Fold-and-Thrust Belt situated on the corresponding continental margin of the Barents Shelf across Fram Strait. The multi-disciplinary geoscientific fieldwork comprised:

Figure 3.1.
View from Kap Rigsdagen towards Thyra Ø. Photo: Karsten Piepjohn.

Figure 3.3.
Sensor and helicopter for the aeromagnetic survey. Photo: Karsten Piepjohn.

- Structural studies on the architecture and kinematics of the dominating fault zones and the blocks between them;
- Sedimentological, paleontological, geochemical, and geochronological studies, which will provide new data for the reconstruction of Paleogene paleoclimate and age-relations of the Paleogene deposits;
- Coal geology and geochemistry for the comparison of the coal seams in Northeast Greenland with the coals of the Central Tertiary Basin on Svalbard;
- Collecting samples for thermochronological studies concerning the Mesozoic and Cenozoic uplift history of Northeast Greenland;
- An airborne aeromagnetic survey across the study area gaining to provide information about the continuation of geological units and structures into areas, which are covered by the sea and ice or by glaciers. At the same time, this geophysical survey is intended as a pre-site survey for planned aeromagnetic surveys in the offshore areas northeast of Station Nord.

The terrestrial studies of expedition CASE 20 were complemented by a marine seismic survey of the BGR-lead expedition with the research icebreaker "POLARSTERN" PS 115/1 GREENMATE that focused on the continental margin of Northeast Greenland towards the area north of Kap Morris Jessup. This combination of onshore geological/geophysical and offshore geophysical studies will help to gain new insight into the structural history and architecture of the mostly unknown continental margin of Northeast Greenland and its relation to the corresponding opposite continental margin of the Barents Shelf.

The Villum Research Station as a new logistics base in Northeast Greenland, facilitates access to one of the most remote land area of the world, which is geologically important to understand the evolution of Arctic plate-tectonics and the opening of the Arctic Ocean, as we know it today.

Figure 3.2.
View from the top of Nakkehoved towards Fram Strait. Photo: Karsten Piepjohn.

EXPLORING THE PERMAFROST MICROBIOME IN NORTHERN GREENLAND

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WSL, Switzerland

PERMAFROST MICROBIOME

Permafrost is defined as soil that remains below 0 °C for two or more consecutive years and is overlain by seasonally frozen soil called the active layer. Permafrost soils represent 20-25% of the world land area and are mainly found in the Arctic, Antarctic and High-Alpine regions. They constitute a large reservoir of organic carbon and represent unique ecosystems with a highly diverse and active microbiota.

Global warming is causing thawing of the permafrost and the increase in plant biomass (greening) in the Arctic. These processes directly impact the composition and functions of the resident microbial communities, here referred to bacteria and fungi, with still unclear consequences on mineralization of organic matter and greenhouse gas production. Extensive research on the Arctic permafrost microbiome has been conducted in waterlogged areas, but little is known about dry and oligotrophic permafrost such as the one in High-Arctic polar deserts.

In August 2018, we were able to collect soil samples of High-Arctic permafrost and active layers soils at Villum Research Station. The land around VRS is an adequate representative of a High-Arctic polar desert. There, mean annual temperatures fall below 20 °C, mean annual precipitations are below 200 mm and permafrost are found at shallow depths of around 30 cm.

Briefly, we excavated soil profiles at three different locations in the vicinity of the station from which we collected active layers at various depths and permafrost soils at a depth of 40 cm (Figs. 4.1-4.2). A part of the samples was used to establish in vitro incubation experiments to address the question of how the permafrost microbiome responds to warming under controlled conditions back home in the laboratory. Another part of the samples was used to characterize the soils at their native conditions.

Soils in the area of Villum Research Station were found to be sandy (around 90% of sand content) and poorly developed, with a neutral pH and with relatively low contents of carbon (< 6%) and nitrogen (< 0.5%) that decreased with depth. Microbial communities were found to be spatially heterogeneous and microbial composition clearly changed from the active layers to the permafrost.

Figure 4.1.
A. Excavation of the soil profiles.

Figure 4.2.
A. Collection of active layer samples at different depths.
B. Collection of permafrost samples. Samples are sieved at 2 mm.

A

B

Figure 4.3.
Permafrost transplanted in metal containers to the top soil.

Figure 4.4.
Overview of the samples transplanted to the top soil in the field experiment.

Figure 4.5.
Soil samples amended with *Ledum groenlandicum* dried leaves.

In 2018, we also started a cross-factor field experiment with active layer and permafrost soils collected from the profiles to study the responses of the soil microbial communities to warming and plant input. To test the effects of warming on the permafrost, we transplanted permafrost soils in metal containers to the top soil (Figs. 4.3 -4.4). To test the effects of increased plant-derived carbon and nutrients in the permafrost and active layers, we amended aliquots from the transplanted permafrost and the collected active layers with *Ledum groenlandicum* dried leaves (Fig. 4.5). We also installed temperature sensors to monitor the temperatures variation in active layer and permafrost soils.

In August 2019, we returned to VRS and collected soil aliquots from the field experiment to evaluate changes in bacterial and fungal communities and soil chemical properties after one year of incubation. We analyzed the microbial community compositions by high throughput sequencing of ribosomal markers; the 16S rRNA genomic region that allows identifying the bacterial members and the internal transcribed spacer region 2 (ITS2) that allows identifying the fungal members.

First analyses showed that permafrost transplantation (warming) only slightly altered microbial composition and function. However, plant input decreased bacterial and fungal diversity and significantly changed the composition of the microbial communities in both permafrost and active layer soils. Moreover, we measured the release of CO_2 over time in the experimental soils and we observed that respiration rates were enhanced in the litter amended soils compared with unamended controls.

We will continue to monitor the field experiment at VRS over the next years for as long as possible. Long-term monitoring is crucial to discriminate what changes in the soil microbial communities will persist over time and thereby will be relevant in the future warmer and greener Arctic.

Acknowledgements
We are thankful to Damian Bölsterli for making the field campaign of 2019 successful and enjoyable. We also thank for the financial support of the Polar Access Fund grant (Swiss Polar Institute- BNP Paribas Swiss Foundation initiative) and the Swiss National Science Foundation (SNSF) under the grant IZLSZ2_170941 for the two field trips of 2018 and 2019.

DETECTION OF ARCTIC BIRDS USING A DRONE CAMERA SYSTEM

By Won Young Lee, Mijin Park, Chang-Uk Hyun;
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DETECTION OF ARCTIC BIRDS

There are several limitations when studying bird habitats in the polar regions, and one of the challenges is low accessibility to the habitats. This is especially true for the habitats near the sea ice. Another challenge is that many wader birds are very well concealed as their feathers are of similar colors and patterns as their background, so that even the skilled researchers often miss their nests at a short distance. To address these difficulties, we adopted a drone mounted with RGB-camera capturing red, green and blue light – and thermal camera systems. Our idea was to use thermal imaging to distinguish warm bird body surfaces from their cold environments, so that we could identify birds on seawater and in cryptic bird nests.

We visited Sirius Passet in July 2018 on the eastern shore of J.P. Koch Fjord in North Greenland. This is a far north Arctic area, which is located at latitude 82°47.6'N and longitude 42°13.7'W. By taking a twinotter from the Villum Research Station, it took approximately two and half hours from the station to the northwest. This area is known to be an area with a high cover of vegetation with many birds in the summer. Large populations of moulting pink-footed geese were near the seashore on the ice or on the melted water. Four breeding common ringed plovers were found near the streams with rocks. As expected, the geese were hard to observe because they were sensitive to approaches and the plovers were well camouflaged to avoid possible predators.

For the detection of geese, we operated the drone to the seashore at around 100 m height and took RGB and thermal images. The pictures from the drone provided us enough evidence to identify the birds and count their numbers. For the detection of plovers, we used the same drone near the stream at 20 m height. It required high-resolution images to find the exact nest sites.

Figure 5.1.
Pink-footed geese near the J.P. Koch Fjord in July, 2018.

Figure 5.2.
Thermal image by drone camera system indicate the number of birds.

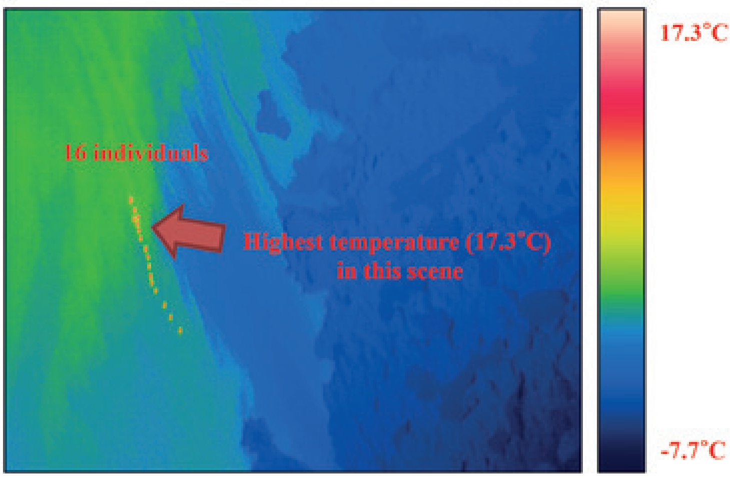

Figure 5.3.
An incubating common ringed plover near the J.P. Koch Fjord in July, 2018.

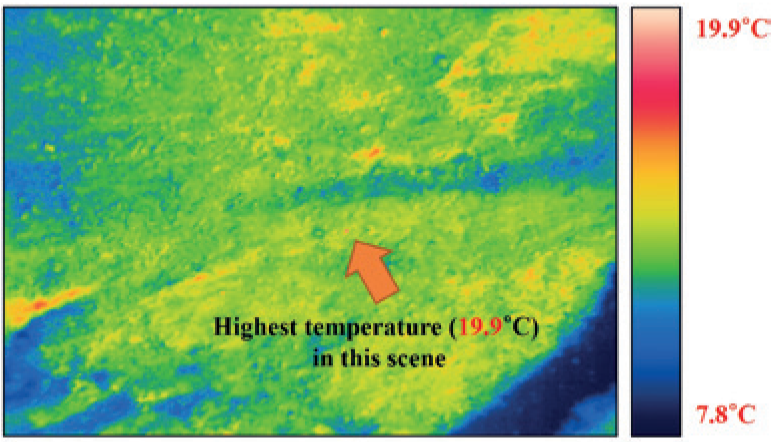

Figure 5.4.
Through thermal imaging, we were able to detect the body surface temperature of an incubating plover, which helped us to identify the location of the nest.

Our results showed that the RGB and thermal pictures taken using drones could be used to monitor polar seabirds in harsh environments. In addition, it can be applied to find highly cryptic bird nests. However, we do not think that the drone will replace conventional surveying with binoculars by humans. Instead, it can be a supplementary tool to identify species, their exact numbers and for location of the nests.

Lastly, it is important to consider the ethical issues when using drones to approach birds. Recent studies reported that although the distances varied among each species, most of the birds had strong reactions to close approach of drones. Thus, it will be necessary to develop measures and guidelines for safe utilization of drones in bird research.

Reference

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PLoS ONE 14(9): e0222088.
https://doi.org/10.1371/journal.pone.0222088

SOIL FAUNA OF PRINCESS INGEBORG PENINSULA

By Paul Henning Krogh, Peter Gjelstrup, Oskar Liset Pryds Hansen and Toke Thomas Høye;
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SOIL FAUNA

Introduction

Microarthropods consist mostly of mites and collembolans of lengths between ½ to 5 mm (Fig. 6.1). They participate in the peat soil food web of the arctic tundra of Princess Ingeborg Peninsula.

In the high arctic North Greenland, above 79° latitude, abundance and diversity of mites and Collembola are particularly unknown, so we sampled the soil fauna within an area of 3 km × 5 km, 5 km south of the Villum Research Station, from August 3-6, 2016, in ten plots of 1,000 m^2 (Fig. 6.2). Plots were selected to represent the variation of the area 3-7 km south of the Villum Research Station and thus cover broadly the current species pool. Ten soil cores of diameter 7 cm and depth 5 cm were collected in each plot and the plant coverage were determined in 10 circles per plot. Soil cores were extracted in a MacFadyen high gradient extractor at Aarhus University, Department of Bioscience.

The surface of most plots were characterized by less than 20% vegetation cover, while only two plots, characterized by either Papaver or Salix together with moss turf, had 50% and 40% vegetation cover, respectively (Fig. 6.3).

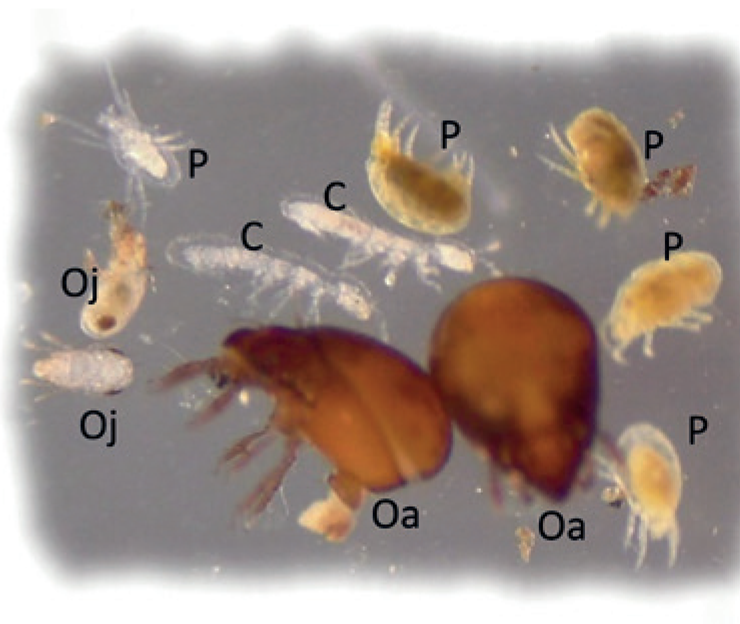

Figure 6.1.
Mites found at Princess Ingeborg Peninsula: *Actinedida (prostigmatids)* (P), juvenile and adult oribatids (Oj and Oa) and the collembolan *Folsomia palaearctica* (C) from the moss turf.

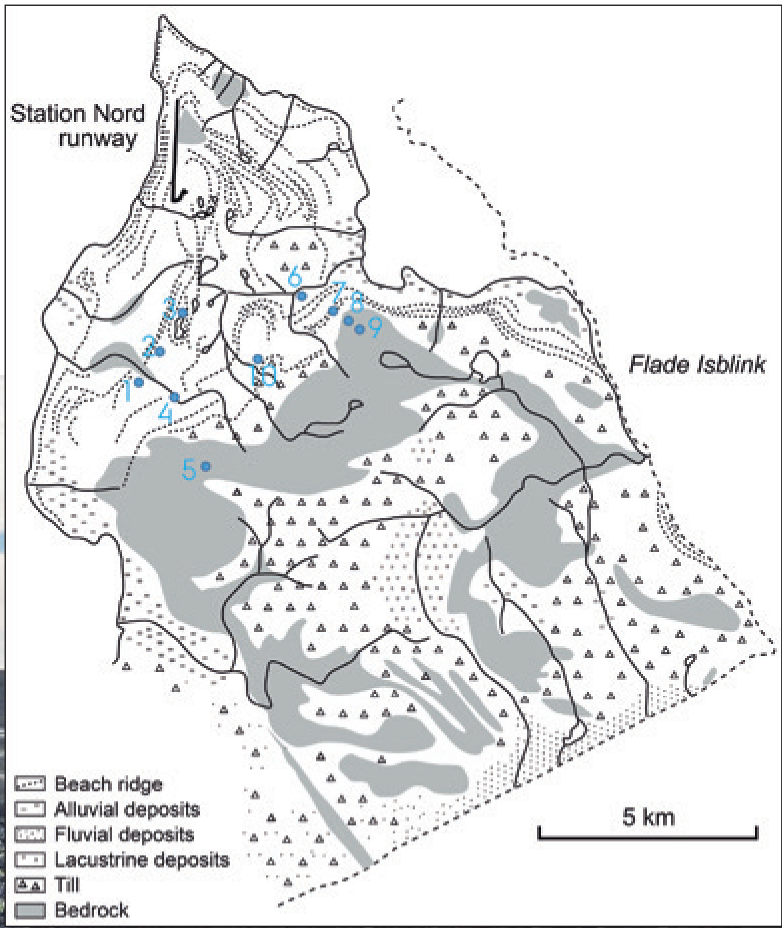

Figure 6.2.
Position of the ten 1,000 m[2] plots, at Princess Ingeborg Peninsula.

Figure 6.3.
A vegetated area with spots of Salix.

Figure 6.4.
The dominant oribatid mite *lugoribates gracilis* and the springtail *Desoria olivacea.*

The oribatid community
Oribatid mites dominated the microarthropod fauna with an average of 3,000 individuals m^{-2} or ≈15 mg m^{-2} when converting to dry mass according to Petersen (1982). The abundance of total microarthropods and enchytraeids were 4,100 m^{-2}. However, the population densities ranges from zero to about 1·10^{5} individuals per m^{-2} in vegetated spots, hence the dry biomass could be as high as 0.5 g m^{-2} (Petersen 1982). The oribatid species assembly, include species all known from the arctic: *Lugoribates gracilis, Liochthonius muscorum, Tectocepheus tenuis* and *Camisia lapponica. I. gracilis* made up 75% of the oribatids. *I. gracilis* (Fig. 6.4) and *L. muscorum* were found in sites with Arctic poppy, *Papaver radicatum*, grasses, lichens and mosses. *C. lapponica* was abundant in the Salix plot.

Collembola, prostigmatids and enchytraeids
Collembola was the second largest microarthropod taxon with an estimate of about five species (Fig. 6.1 and 6.4). The prostigmatid mites (Fig. 6.1) are expected to consist of more than five different species. Enchytraeids, though not extracted by specific methods and therefore underestimated, had the biggest mean biomass of at least 37 mg m^{-2} (Petersen 1982).

Barcoding of the oribatid *I. gracilis*
We did COI barcoding in collaboration with NorBOL (Norwegian Barcode of Life) of 27 adults and nymphs of *I. gracilis* and their COI sequences were compared with the COI sequences in the BOLD database. Thus, the same species, as verified by the COI barcode, was found in the artic Canada at Ellesmere Island, Victoria Island and Bylot Island and they all belong to the BOLD BIN: BOLD:AAN6609 (Fig. 6.5). A synonym species was found in Manitoba and Victoria Island differing by 9% from the latter and assigned to BIN BOLD:AAH6608, and therefore is supposed to be a separate species.

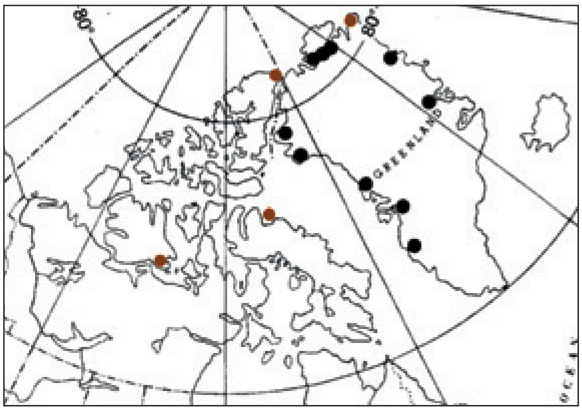

Figure 6.5.
Distribution of *I. gracilis* as reported by Hammer (1955) and added (orange dots) recent sampling locations, where the species identity was verified by COI barcoding, where the COI sequences were retrieved from the BOLD COI database.

Conclusions

- About 20 species of mites and collembolans are expected to be found in the inland area of Princess Ingebord Peninsula.
- The average soil fauna population density in the harsh environment of Princess Ingeborg Peninsula is scarce by its average of 4,000 indv. m^{-2}. However, in the vegetated spots they could easily reach in the order of $1 \cdot 10^5$ indv. m^{-2} similar to what is reported from Low arctic Greenland (Aastrup et al. 2014) and from Zackenberg by Sørensen et al. (2006).
- To support the present pilot-study we recommend doing a complete investigation of the total soil biota from the different plant communities.
- There is a need to sample and barcode the circumpolar mites and collembolans to reveal their species identity and ascertain previous identifications.

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DRONE ACTIVITIES AT VRS FOR MEASURING VERTICAL DISTRIBUTION AND PROPERTIES OF AEROSOLS

DRONE ACTIVITIES

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Unmanned Aerial Vehicles (UAVs), also known as drones, are a quickly developing technology with a wide range of potential applications. As they become more powerful, reliable, and cheaper to produce, they are expected to be valuable in fields including civil and commercial infrastructure, military uses, and many scientific applications.

Drones have very promising implications for scientific research, as they allow airborne measurements to be made without the need for manned aircraft. In comparison, drones are much cheaper, require less experience to fly, and emit less pollution into the air. This is particularly promising for atmospheric research. The atmosphere is not uniform with height, so to get a full picture of the atmospheric properties and processes, we must investigate them at different altitudes. The use of drones is also ideal for map-

ping and imagery, offering long flight times and thus a large area covered in a single flight.

In 2020, both the UAVE Prion Mk 3 and the UAV Factory Penguin-B drones will be flown at Villum Research Station. The Prion Mk 3 is a 3.8-metre wingspan Unmanned Aerial Vehicle capable of holding a payload of around 10 kg. This model has been fit with two instruments to measure properties of aerosols, namely a Mixing Particle Condensation Counter (MCPC) and a Single-channel Tricolor Absorption Photometer (STAP).

The MCPC is used to measure the total particle number concentration in air, able to detect particles with diameters as low as 7 nm. Vertical profiles of particle number concentration can give information about how aerosols are transported to and from the Arctic, and these measurements are useful to compare against other atmospheric data. The STAP pulls ambient air through a filter onto which aerosol particles are deposited, while a light is shone through the filter. This measures how strongly the captured aerosols absorb light, which is an important property when discussing climate effects. A highly absorbing aerosol, such as black carbon from combustion, will directly warm the atmosphere by absorbing sunlight. It also can deposit in snow and ice, decreasing the surface reflectivity, and therefore increasing the rate of melting.

Figure 7.1.
The Prion Mk 3 drone at Station Nord on the day of the first test flight.
Photo: Daniel Charles Thomas, August 2019.

In August 2019, the first flight of a Prion Mk 3 drone was completed at Villum Research Station, marking a first for a drone of this size (Fig. 7.1). This was done as a proof-of-principle flight, and a test for the campaign flights taking place in March this year.

The 3.3-metre wingspan Penguin-B drone will also be flown in the summer of 2020, equipped with a camera as well as GPS and Lidar technology. It will be used to measure and map the ice with an accuracy of a few centimetres, giving further insight into the changing Arctic environment.

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