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Holocene changes in vegetation and climate at the Khatanga region, northern Siberia

- derived from a lacustrine pollen record -

Introduction

The northern Siberian treeline is supposed to migrate further north, due to climatic changes in the tundra-taiga ecosystem.
But inhibiting or strengthening factors are still not adequately known (Boike et al., 2012), thus the changes of the treeline ecosystem are still not totally predictable.

Therefore a field campaign in 2011 and 2013 collected information about the actual arctic vegetation, which will be used to reconstruct the conditions of the late Holocene for the tundra-taiga ecosystem.

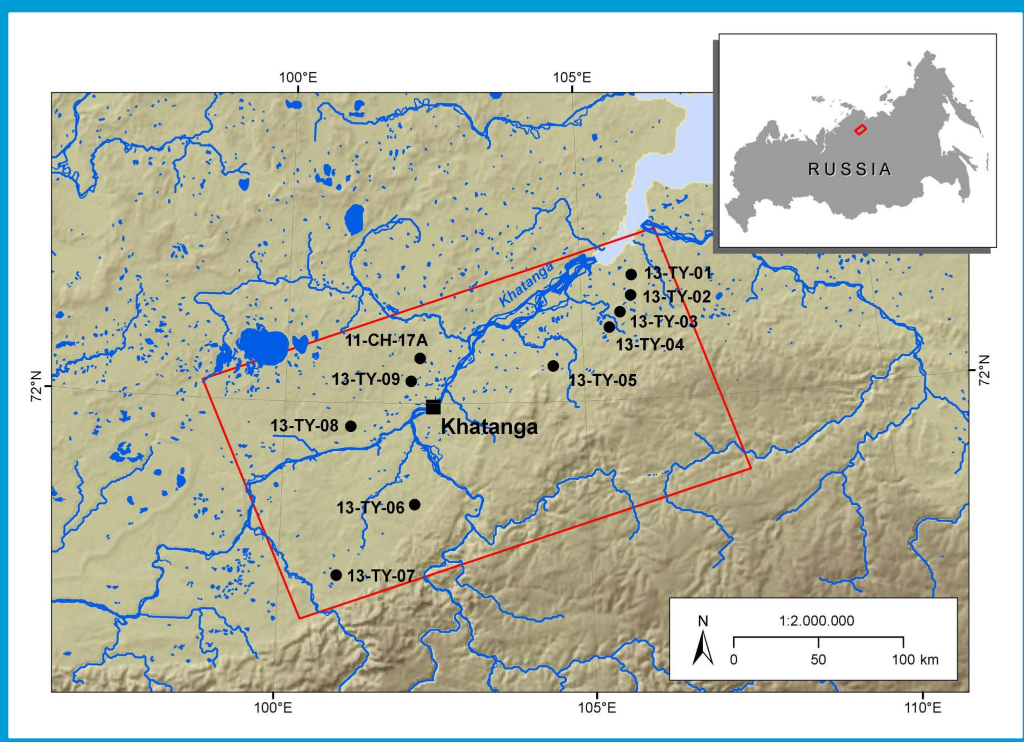


Fig.1: Study area at the Taimyr peninsula. The results of lake 11-Ch-17A (72°14'40.34''N, 102°14'8.57'' E) are presented in this work.

Study area

The study site is located in the northern lowlands at the Taimyr peninsula in the vacinity of the Khatanga river (Fig.1).
Field work was done within a joint Russian-German project at Arctic Siberia on a north-south transect from tundra to taiga and spans approximately about 300 km in length.
This study presents a pollen data set of the lake 11-CH-17A and gives insights of one local setting (Fig.2).

Fig.2: Location overview of Siberian Arctic treeline area at the Taimyr peninsula.

Material & Methods

The lake was selected optically from helicopter (Fig.3), due to its vegetation surrounding, representing an arctic taiga ecotone with tundra elements. The location of the core was chosen after a bathymetry via boat during the field work in summer 2011. A 90 cm long core (Fig.4) was retrieved by an UWITECH gravity coring device and had been cut into two parts. The upper most 27 cm of the core were subsamples into 0,5 cm thin slices already in the field (Fig.5). $^{210}Pb/^{137}Cs$ dating was processed afterwards. The samples were treated following standard procedures for pollen preparation (Faegri & Iversen, 1989; Beug, 2004; Moore, Webb, & Collinson, 1991). Statistics were processed using the R-software (Team R, 2011) developing an RDA (Regularized Discriminant Analysis; Legendre, Oksanen, & Ter Braak, 2011; Fig.8).

Fig.3: The remote study area was reached by helicopter, it also enabled visual interpretation of lake system and sourrounding vegetation.

Fig.4: Two short cores in coring tubes, taken by UWITECH Gravity Corer.

Fig.5: Samples from one core in 0,5 cm slices, cut and stored in Whirlpaks already in the field.

Results

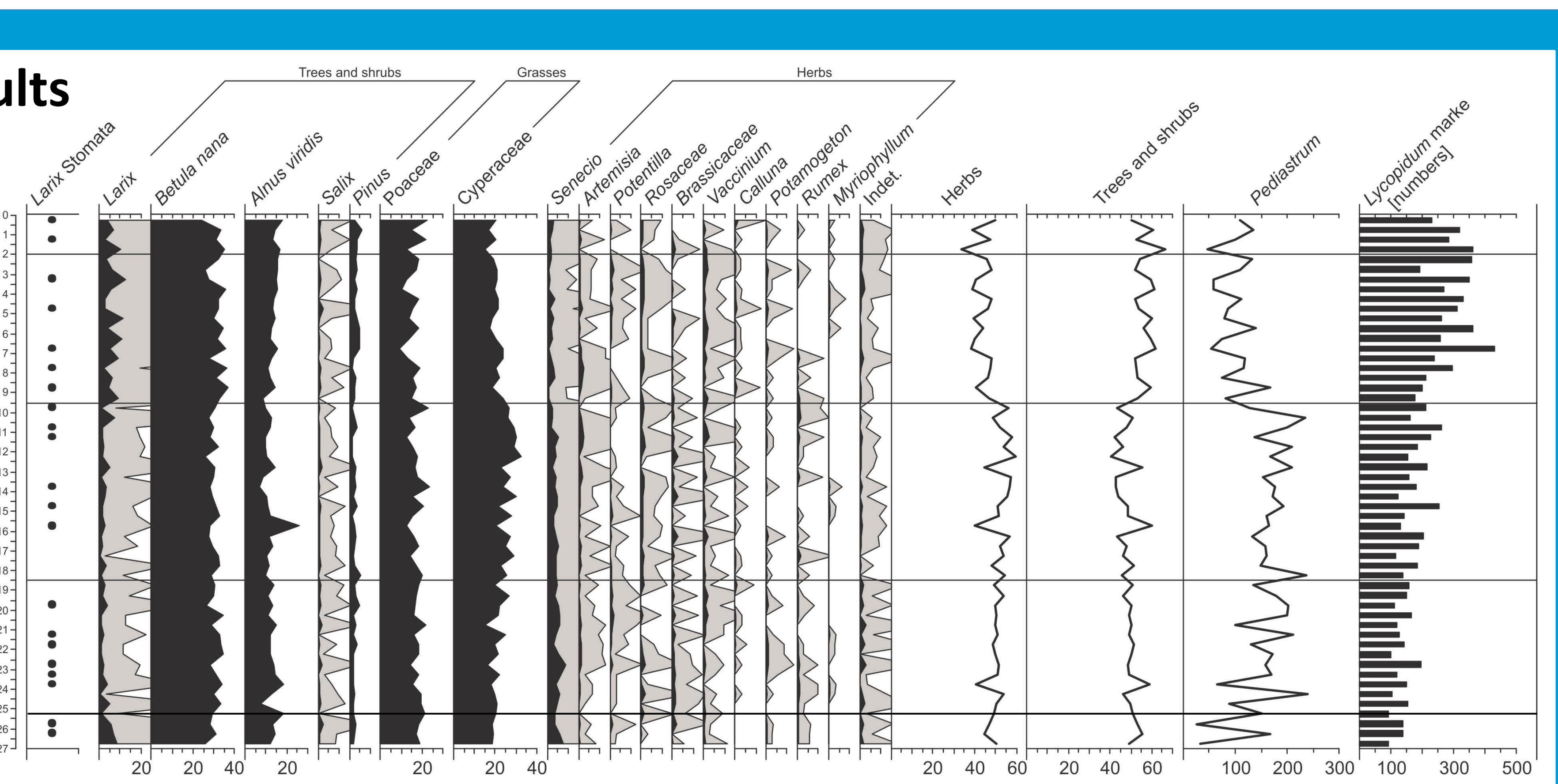
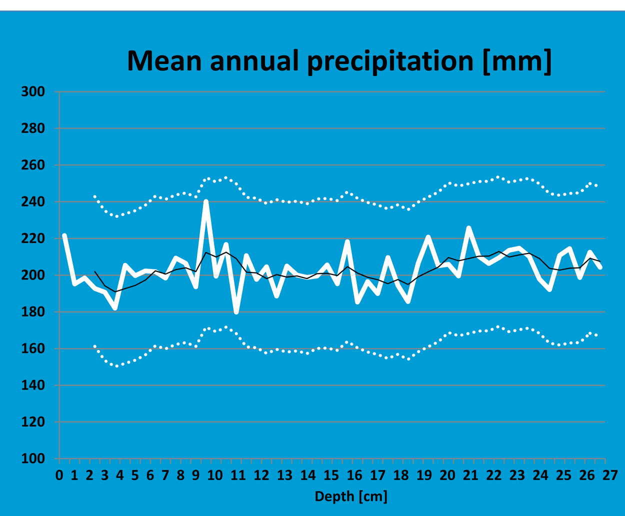


Fig.6: Pollen diagram of core 11-CH-17A. A increasing trend of a *Larix* is visble from approximately 70-80 year BP. Pollen percentages were calculated by sum of terrestrial pollen grains (aboreal and non-aboreal) , also including wetland herbs like Cyperaceae or *Potamogeton*, due to their major roll within ecosystems (Pokorný, 2002), especially their appearance also in drier parts of the taiga. According to limited amount of grains, a total number of 300 grains per sampled seemed appropriate for statistical analyses.



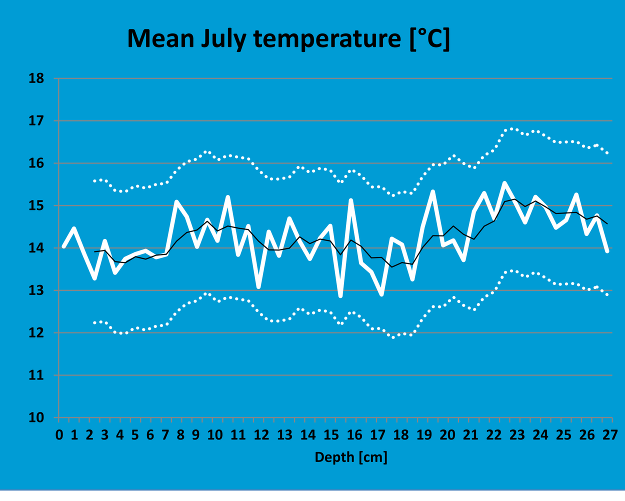


Fig.7a&b: Results of the WA-PLS model. Whilst the precipitations does not change much, a decreasing trend of the mean july temperature ia visible. Error lines are plottet in dashed lines (white), solid lines indicate reconstructed values (white) and the smoothed mean trend (black)

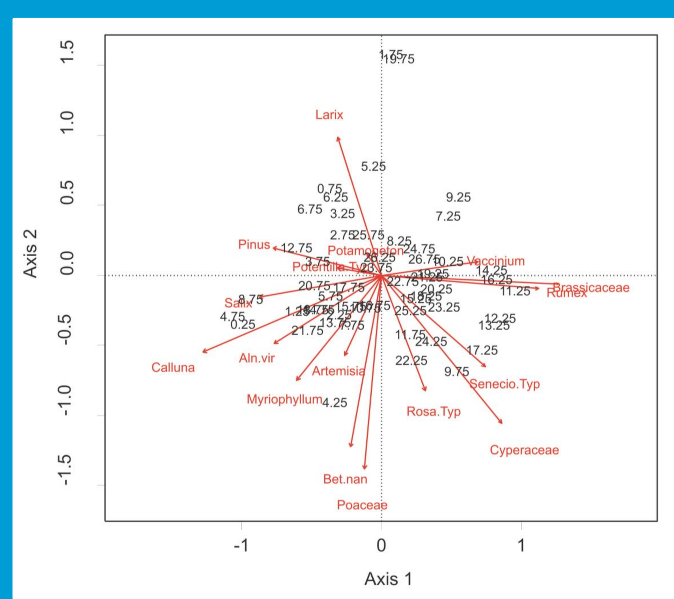


Fig.8: Results of the RDA. Taxa with highest influences are displayed as vectors (red), while the mean depths of the samples are ploted accordingly to their sample variety distance (black)

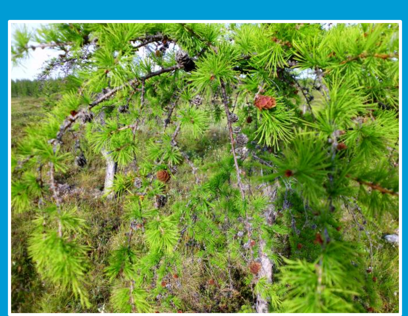


Fig.9: Close-up on *Larix* branches with cones.

Fig.10: Vegetation grid (white lines), genetic sampling equipment and survey sheets (front) and active layer rod (right) in field.

The diagram (Fig.3) shows the development of the vegetation within the last 270 years. The composition of the taxa changes slightly over time. An increasing trend of *Larix* becomes visible within the last 70 years. A decrease of the Cyperaceae seems simultanious thus a change to drier conditions can be assumed.
A WA-PLS (Weight Avarage Partial Least Square) model, as shown in Ter Braak & Juggins (1993) and Klemm et al. (2013) was calculated (by J.Klemm) based on the pollen data set. It gives insight of a possible weather regime at a local scale for the coring site. The mean annual precipitation varies slightly and a trend is not obvious. However a decreasing trend (about 1°C) in mean july temperature is visible (Fig.7). The RDA shows slight differences within the samples, indicating smooth changes in vegetation composition over time.

Conclusions

- The vegetation changed from a *Larix* influenced taiga with shrub elements (*Betula* & *Alnus*) to a vegetation with less Taiga elements and more herbs like Brassicaceae or Cyperaceae
- Afterwards *Larix* increased, thus at least taiga became abundant again
- Changes within the ecosystem of the arctic treeline are present and visible within the last 300 years. They probably underlay climatic conditions, wherof the vegetation shifts due to changes of these conditions
- *Larix,* as the dominant element of the landscape, is actually present within the treeline area and had been there since three centuaries, in different amounts

Outlook

Further analyses will use genetic methods to give insight into migrational processes of Larch trees within the treeline area. These and advanced vegetation data will help to understand, reconstruct and simulate the changes of this arctic ecosystem more and more.

Additional information will be provided by the talk of **Laura Epp** („*Analyzing arctic-boreal treeline changes using ancient sedimentary DNA*") and the posters of **Kathleen Stoof-Leichsenring** („*Accessing the ancient sedimentary DNA archive to analyze species´ histories and past biodiversity*"), and **Stefan Kruse („*LaVeSi - An individual-based model for simulating vegetation dynamics at the arctic tree line in Siberia*").**

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