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Holocene vegetation change and turnovers of treeline forming species

Siberian treeline forests

- ***Larix sibirica***, ***Larix gmelinii***, ***Larix cajanderi*** - distributed from west to east (Fig 1a)[1].
- Larch species **separated geographically and ecologically**.
- Future and past **northward treeline shift & species distribution** changes (Fig 1b)[2, 3].

➢ **Investigate species-specific responses and competitive dynamics for more realistic projections**

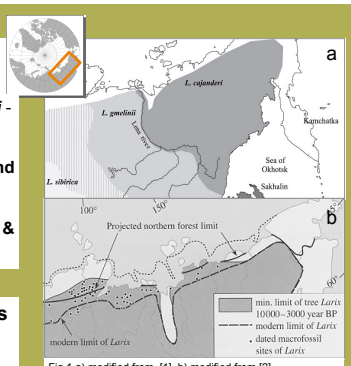
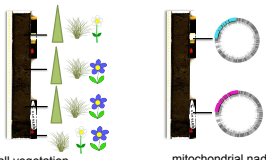


Fig 1 a) modified from [1], b) modified from [2]

Approaches

- **Lake sediment cores**: ancient DNA & pollen

DNA metabarcoding / pollen | **mt-DNA marker**



overall vegetation, no discrimination of *Larix* species

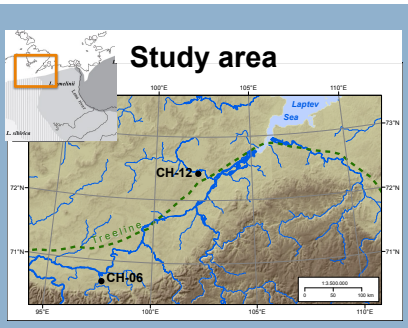
mitochondrial nad4-3/4 - proxy for *L. sibirica* / *L. gmelinii* [cf. 4]

- **Modelling:** incorporate the two species ***L. sibirica*** **and** ***L. gmelinii*** into the **larch population dynamics model LAVESI** (see poster by Kruse *et al.*)

	Larix sibirica	*Larix gmelinii*
Minimal thawing depth	100 cm	10-20 cm
Endured winter temperatures	-33 °C	-45 °C
Growth rate	1.08 mm/year	0.38 mm/year
Seed weight	10 mg	3.5 mg
Seed dispersal distance	Low	High
Longevity of seeds in the soil	10 years	1-2 years

parameters compiled from literature sources by N. Kath, available upon request

Study area



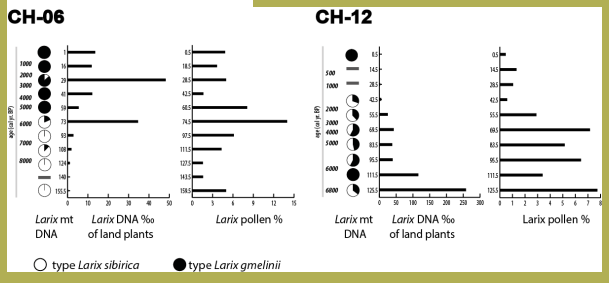
Two lake sediment cores from the southern Taymyr peninsula – pronounced changes in forest cover.
Boundary and hybrid area of *Larix sibirica* and *Larix gmelinii*.

Lake sediment cores

DNA metabarcoding

- 195 authentic taxa total, 20 – 94 per sample
- 139 terrestrial plants, 40 aquatics/riverine, 16 bryophytes

Zoom in on *Larix*



- denser forest cover, fluctuation
- nearly complete turnover of haplotypes

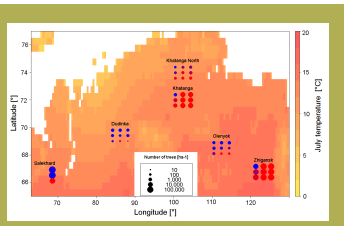
- sparse forest cover, one strong decline
- no clear turnover in the record

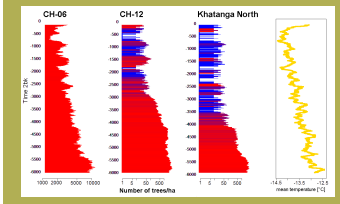
Modelling

Simulated current populations

- different points – different insertion of the species.
- larger points – more trees/ha.

➢ simulations mostly reflect real distribution



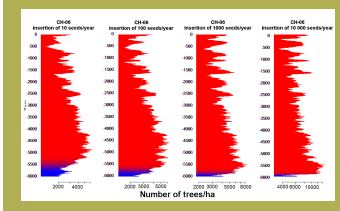


Temporal distribution of trees

- at CH-06, CH-12 and Khatanga North
- insertion of both species.

➢ Southern population dominated by *L. gmelinii*

➢ Northern populations experience serial local extinctions and turnovers with cooling temperature.



Turnover rates

- at CH-06
- simulations run starting with population of *L. sibirica*
- insertion of different numbers of seeds, both species.

➢ Rapid species turnover simulated

Larix sibirica — *Larix gmelinii*

Conclusions

➢ Congruent picture from ancient DNA and model simulations.

➢ Contrary to expectations, *Larix sibirica* occurs frequently at northern sites.

➢ Competitive interactions very important at higher stand densities.

References
[1] Polezhaeva MA, Lascoux M, Semerikov VL (2010) Cytoplasmic DNA variation and biogeography of *Larix* Mill. in Northeast Asia. *Molecular Ecology* 19, 1239-1252.
[2] MacDonald GM, Kremenetski KV, Beilman DW (2008) Climate change and the northern Russian treeline zone. *Philosophical Transactions of the Royal Society B-Biological Sciences* 363, 2285-2299.
[3] Tchebakova NM, Rehfeldt GE, Parfenova EI (2010) From Vegetation Zones to Climatypes: Effects of Climate Warming on Siberian Ecosystems. *Permafrost Ecosystems: Siberian Larch Forests* 209, 427-446.
[4] Semerikov VL, Semerikova SA, Polezhaeva MA, Kosintsev PA, Lascoux M (2013) Southern montane populations did not contribute to the recolonization of West Siberian Plain by Siberian larch (*Larix sibirica*): a range-wide analysis of cytoplasmic markers. *Molecular Ecology* 22, 4958-4971

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