BETUMICS

Towards more efficient Arctic research using dominant *Betula* species, spectromics and genomics

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Introduction

The impact of climate change on the northern ecosystems, and particularly on the forests growing in their northern extreme limits, is one of the most demanding challenges today. The climate change scenarios for Finland predict longer growing seasons, increased effective heat sums and increased precipitation. *Betula* species (Fig. 1) are among the key species that are likely to control the response of Arctic ecosystems to the climate change.

Figure 1. *Betula pubescens* subsp. *czerepanovii* is one of the key species growing in the sub-Arctic area

Photo: Tarmo Virtanen

Objectives

The main research objectives of our project are to study the **acclimation and adaptation capacity of northern trees and arctic woody shrubs** to the changing environment and to develop novel imaging techniques (spectromics) and environmental omics (genomics in particular) to **detect and understand the ongoing changes in the arctic areas**.

We conduct

- **Common garden experiments** (Fig. 2) with several ecologically and economically important birch species - *B. pendula*, *B. pubescens*, *B. pubescens* subsp. *czerepanovii* and *B. nana* - ranging in distribution from temperate to boreal, sub-arctic and arctic areas (Fig. 4).

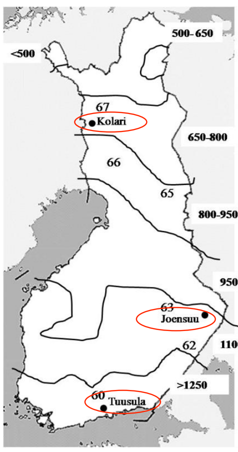

Figure 2. Existing common garden sites (red circles) across Finland with 26 genotypes of *Betula pendula* originating from 6 provenances (indicated by latitudes° 60-67) with temperature sum regions (mean daily temperature >5°C = thermal growing season).

New experimental sites will be established in Kilpisjärvi/Kevo with warming treatments and in Italy with several *Betula* species

- **Laboratory experiments** with a combination of environmental factors relevant to the environmental change in the Arctic region.

- *In situ* application of novel **hyperspectral imaging techniques** (Fig. 3) in environmental research, phenotyping and genetics.

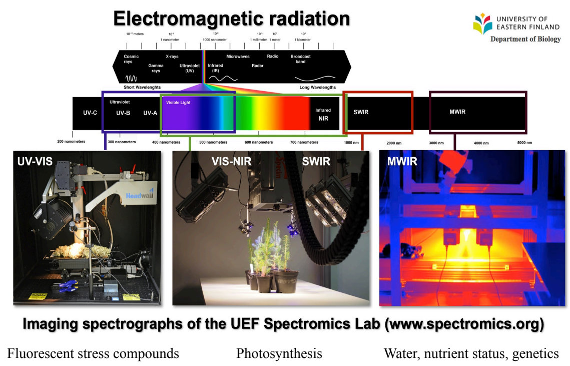

Figure 3. New imaging techniques are available in our spectromics laboratory, producing non-destructively spectral data that can be correlated with various leaf traits and early stress detection, such as chemical quality, water status, nutrient deficiency, incipient pest damage, vitality and phenotyping.

- **Genetic studies**: Genome sequencing and genetic association analyses for genetic relationships of birch genotypes within and between populations, degree of hybridization and introgression (repeated backcrossing of an interspecific hybrid to its parent species). The introduced genetic variation potentially promotes their adaptation to arctic environments (Fig. 4).

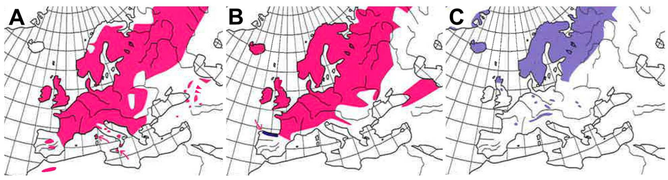

Figure 4. Distribution maps of A) *Betula pendula*, B) *B. pubescens* (including the northern sp. *czerepanovii*) and C) *B. nana* overlap. This enables their hybridization and eventual introgression. Modified from Ashburner K and McAllister HA, 2013 (*Kew Publishing, Royal Botanic Gardens, Kew, UK. 431 p.*)

Outcomes

- The consortium brings together researchers, methods and knowledge from ecophysiology, ecology, forestry, genetics and photonics.
- The project will produce new knowledge on the hybridization of the northern birches, their acclimatization capacity to drastic climatic changes, and potential of spectromics in environmental and genetic research.
- The project and results have high socio-economic value through improved risk assessment, support for decision-making and EU policies, climate change mitigation, sustainability of silviculture in the Arctic, gene reserve protection, and research training.