How can we prepare Nordic forests for the future?

- **Inventory of the spread of invasive pest and pathogen species**
- **More efficient phenotype screening methods need to be developed to find resistant tree individuals**
- **Faster access of improved tree materials can be achieved via vegetative propagation**
- **In spruce, application of somatic embryogenesis for mass-propagation still requires incorporation of automation to achieve cost-efficiency required**
- **Interdisciplinary and international collaboration strengthened.**

Photo: The Icelandic Forest Research has a breeding program on poplar (Populus trichocarpa) with emphasis on resistance for poplar leaf rust (Melampsora larici-populina)/ Halldor Sverrisson

Introduction

Forest ecosystems worldwide are challenged by climate changes and increased international plant trade. In the Northern European countries, the annual temperatures and rainfall are predicted to increase but also longer periods of drought during the summertime are foreseen. The altered climatic conditions will favor many pests and pathogens already recognized in the region and increase the possibility that organisms dispersing from the south may be able to establish themselves in the now suitable habitats in the North.

Increased global plant trade will further raise the risk that novel pests and pathogen unintendedly will become introduced to the region posing additional pressure on the local plant community. An alarming example is the invasion of the Asian Longhorn Beetle, the Emerald Ash Borer, in North America and in Russia causing severe tree mortality and with great economic losses to follow.

To meet the future challenges of our Nordic forests there is a need for interdisciplinary collaborations across the Nordic regions in order to identify and establish durable solutions.

The threats of invasive pests and pathogens

Globalizations and international trade are the primary sources for the introductions of non-native species. Climate changes may facilitate establishment and support their development into invasive species. However, climate changes may also influence local ecosystems and create new opportunities for native species. The Dutch elm disease and the Ash dieback exemplify two diseases caused by invasive fungal species that have spread in the Nordic region during the latest years, and the recent discoveries of *Dothistroma* needle blight and *Sphaeropsis* blight in Scots pine regenerations has raised concern about the risk for a larger outbreak. The wide spread outbreak of Scots pine blister rust in Scots pine regenerations across large areas in northern Scandinavia represents a good example of an uncontrolled spread of a native pathogen. The total area of infected young pine forest stands in northern Sweden was estimated at 130,000 hectares. It is of the utmost importance to create resources for inventory of the spread of invasive species.

The genetics and possibilities of resistance breeding

Fortunately, there exist genetic variation in the tree populations in the resistance to various pests and pathogens, and individuals showing higher resistance can be found, although they may be rare. For example, recent studies have shown a large genetic variation among families in the resistance to Scots pine blister rust, and account has been taken to the susceptibility to the fungus in the Swedish breeding activities. Active breeding is also going on e.g. for resistance against poplar leaf rust in Iceland, and trees showing high resistance have been obtained. Development of genetic markers for resistance – as in the case of root-rot causal agent *Heterobasidion* - provides further possibilities both for breeding and deployment. More efficient phenotype screening methods need, however, to be developed.

Faster access to improved genetic material

Vegetative propagation can enhance the access to improved genetic material from tree breeding programs, and allows a faster adaptive response given the challenges Nordic forests are facing due to the climate change, both in terms of abiotic stresses and the spread of new pests and pathogens. E.g. in poplar, clonal propagation is already utilized. The development of somatic embryogenesis for vegetative propagation of conifer tree seedlings has also preceded, Finland having the first lot of tissue-cultured Norway spruce materials registered as forest regeneration material and available for commercial propagation. However, the technology is still costly and labor intensive, and may be feasible only for mass propagation of specific clones for selected areas. New research, incorporating technological progresses for automation should be supported. Also, the short and long-term gains and risks associated with vegetative propagation need to be investigated further.

International and interdisciplinary collaboration

There is a need for international and interdisciplinary collaboration to prepare our Nordic tree species to the pest and pathogens that they continuously face. The Nordic cooperation stands as a good example for the rest of the world of an extensive form of regional cooperation, where HelGenCAR illustrates a good example of an interdisciplinary collaboration between forest genetics, pathology, entomology and breeding in the Nordic region. However, broader international co-operation and networking is also needed. Initiative for a new COST action would be rewarded. It is also crucial that the governmental authorities and private stakeholders participate in the networks.

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