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Future Forest Health
Early detection and mitigation of invasive pests

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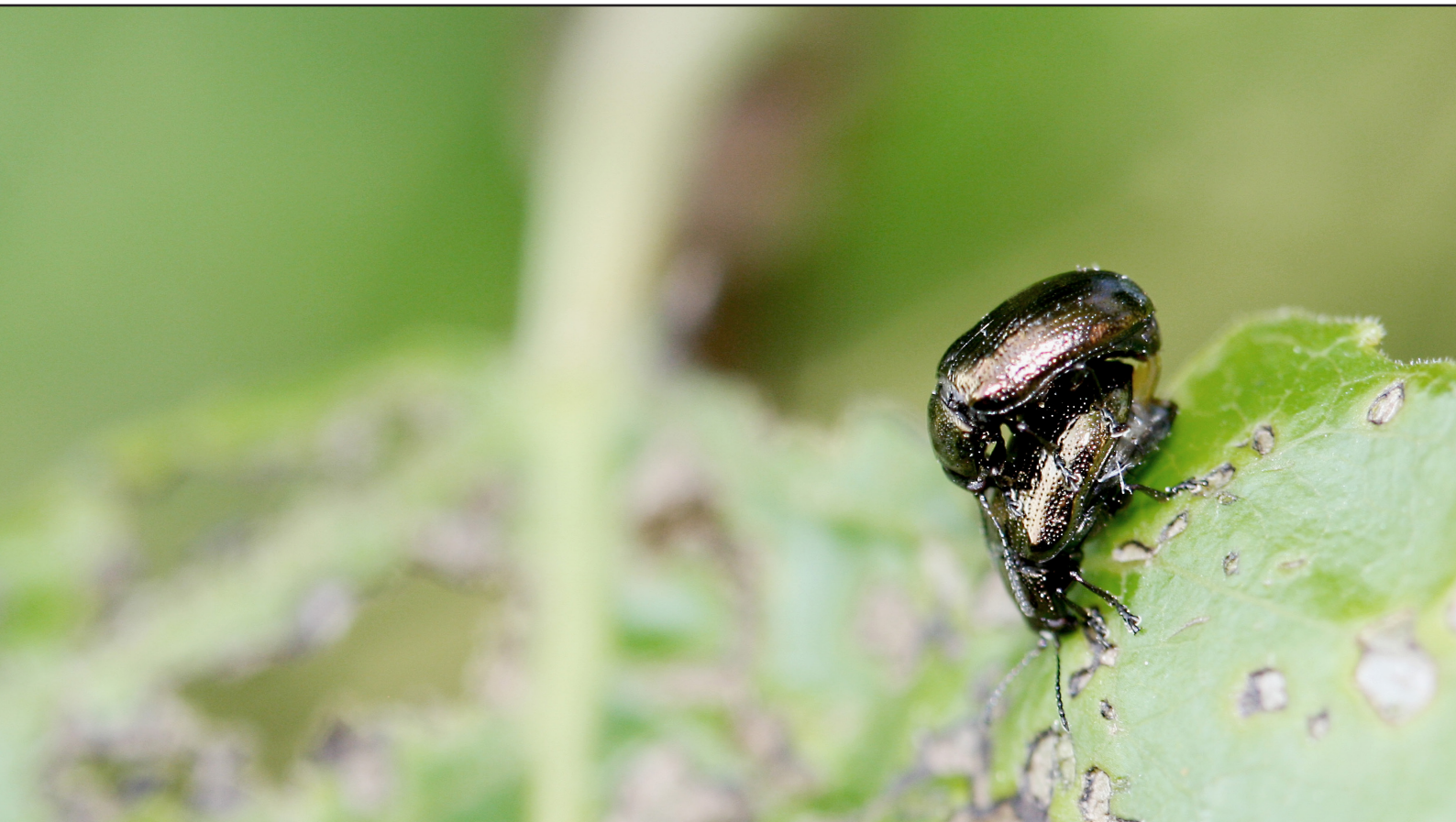
Workshop Abstracts



Invasive pests and diseases on birch in the Nordic countries: Iceland

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Workshop Abstract

Downy birch (*Betula pubescens* Ehrh.) is the only native forest forming tree species in Iceland (Aradóttir & Eysteinsson, 2005). Its present distribution is 1.5% of the land area, but is estimated to have been around 25% at the time of settlement. Downy birch is an important tree in Icelandic ecosystems and forestry and presently there are ambitious plans to increase its distribution.

Outbreaks of native insects on birch, causing tree death, are well known from old annals and reports. These outbreaks were most likely caused by the larvae of *Acleris notana* and *Rheumaptera hastate*. Local outbreaks in southeast Iceland are known to have been caused by *Erannis defoliaria*, which is only found in this area.

Downy birch is host to two tree diseases, birch rust *Melampsoridium betulinum* and witch's broom *Taphrina betulina* and 31 arthropod herbivore species. Both diseases are native but about one third of the insect pests species (10) on birch were introduced after 1900, and are therefore listed as non-native. The effect of those herbivores on birch can be very variable. Some have caused total defoliation of large areas of woodland which has sometimes leads to tree death on significant areas (Halldorsson *et al,* 2013). Other only inflict minor damage but may reduce growth and can possibly increase plants susceptibility to other stresses. Four, out of the ten non-native pest species that feed on birch in Iceland, cause serious damage and may contribute to tree death (Halldórsson *et al,* 2013). The following species can, therefore, be ranked as invasive:

- Birch-aspen leafroller *Epinotia solandriana* was first introduced to Iceland in 1907, but is now found in lowlands all over Iceland. In Iceland the larvae feeds primarily on downy birch, although it can be found on other species as well. It has caused total defoliation of large areas of birch woodland and contributed to significant tree death (Hallgrímsson *et al*, 2006).
- Winter moth *Operophtera brumata* was first introduced in 1928 and feeds on various trees and shrubs and can cause serious defoliation (Ottósson, 1982). It is mainly confined to urban areas, except in southern Iceland where it can also be found in birch woodlands (Hallgrímsson *et al,* 2006).
- *Heringocrania unimaculella* is a small leafmining moth that feeds only on birch and was first recorded in Iceland in 2005. It has since introduction been spreading and has caused defoliation of downy birch in South, Southwest and North Iceland.
- *Scolioneura betuleti* is a leafmining sawfly that was first

recorded in Iceland in 2016 and feeds on some birch and alder species. Since then it has its distribution has been expanding fast and it has been causing severe damage, especially in the SW part of Iceland.

The six other non-native insect species which can be found feeding on birch are all polyphagous, except the bronze alder moth *Argyresthia goedartella*, which was first recorded in Iceland in 2012 and feeds on the catkins of alder and birch. It is not considered to cause any damage. Three weevil species: *Otiorhyncus singularis, Barypeithes pellucidus* and *Otiorhyncus ovaturovatus* were introduced in 1968, 1980 and 1987, respectively. The larvae feed on roots and the beetles on bark and leaves. All are limited to urban areas and cause little or no damage. The European crane fly *Tipula paludosa* was introduced in 2001 and has been confined to South and Southwest Iceland. The larvae feed on the roots of many plants and can cause local damage. The sixth species, the meadow spittlebug *Philaenus spumarius*, was introduced in 1983. It feeds on leaves of many plant species and is not considered to cause any significant damage.

In Iceland it has previously been shown that recent increase in introduction of insect pest species on trees as well as changes in outbreak patterns of various species are linked to increased mean annual temperatures (Halldórsson *et al*, 2013). Therefore, it is likely that we will see more serious insect outbreaks on birch in the near future, both from the invasive pest species listed above and new pest and diseases that have not been introduced yet.

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Threats posed to natural forests by international movement of pests and diseases

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Workshop abstract

Trees are subject to a wide range of biotic and abiotic factors that can result in damage and death if the balance of factors is altered to favour pest organisms, including both insects and pathogens. In a natural, co-evolved system, there is generally a series of opportunities and constraints affecting an organism that tends to maintain it at endemic levels. Disruption of this endemic status can arise for many reasons, acting either individually or, more usually, in concert. Examples of disruptors include:

- Invasion of an area by an exotic species
- Planting of exotic host tree species used by both invasive and native species
- Loss of natural enemy impacts that normally constrain population growth
- Stochastic events such as storms, droughts, fires, etc. that reduce the natural defences of trees making them more vulnerable to attack
- Climate change that can impact both the fauna associated with trees and the trees themselves.

Invasions of organisms that have become pests have been noted increasingly in the literature (Brockerhoff & Liebhold 2017) and the trend appears to be continuing despite international phytosanitary rules to minimise the risks of pest movements between countries and ecosystems.

As an island, the United Kingdom has a relatively impoverished fauna compared with continental Europe so that both the indigenous and invasive components of its fauna are smaller than its near neighbours. However, the long history of trading globally and the near proximity of the European landmass means that there is an increasing list of new pest associations in the UK. This will be described in more detail in the presentation, but some notable examples serve to illustrate the issue of opportunity for new pests to arrive or native insects to become pests when presented with exotic host tree species.

Defoliators

Most of the issues from defoliators have been caused by sawflies (Hymenoptera) and moths (Lepidoptera) with the majority of incursions being linked to importation of live plants for planting, a very high-risk pathway. Notable recent incursions have been gypsy moth, *Lymantria dispar* and oak processionary moth, *Thaumetopoea processionea* in the south of England, and pine tree lappet moth, *Dendrolimus pini*, in Scotland. In all cases initial populations were small and management efforts were focused on containment but not eradication. A variant on the theme of exotic associations applies to the major outbreaks and tree mortality caused to lodgepole pine (*Pinus contorta*) plantations in Scotland caused by the native pine beauty moth, *Panolis flammea*. This moth remains at

endemic levels on its native Scots pine (*Pinus sylvestris*) host but exploited the widespread planting of lodgepole pine leading to extensive tree mortality.

Bark and wood-boring beetles

Other notable examples of alien invasive pests are bark beetles in the family Curculionidae: Scolytinae. Following the establishment of *Ips sexdentatus* in the early part of the 20th century, there have been incursions of *Ips cembrae* in the 1950s and at the end of 2018, *Ips typographus*. The latter, in particular, has been intercepted frequently during inspections of imported wood and also in pheromone traps at the ports, but was only found breeding at a single woodland in Kent in November 2018. Other dangerous pests have also been found in Kent in recent years, including Asian longhorn beetle, *Anoplophora glabripennis* in 2012 which has now been declared eradicated after an intensive survey and felling campaign. More recently, the oriental chestnut gall wasp, *Dryocosmus kuriphilus* has been found in Kent and is spreading slowly to other areas in the south of England. The close proximity to the main channel ports and the warmer climate in that area are among the potential factors making the south east of England prone to new alien invasive species.

These, and many other insects and pathogens, illustrate that pathways for international movement of pests and their subsequent successful establishment in new locations has taken place and continues to take place, adding to the threats to forests across Europe. New threats are being recognised continually and can be illustrated by the two buprestid beetle pests that have been the subject of the Euphresco project PREPSYS

(www.forestresearch.gov.uk/prepsys). Emerald ash borer (EAB – *Agrilus planipennis*) is native to Asia but has established in North America with devastating consequences for both native and planted ash trees across the continent. It is easily carried on ash wood and wood products and has now been found on the western borders of Russia and into Ukraine. This poses a significant further threat to ash trees across Europe to add to the extensive mortality caused by the fungus *Hymenoscyphus fraxineus*. As evidenced by the experiences in North America, there is a high risk of a lag period of many years between initial invasion and eventual detection of infestations (Herms & McCullough 2014) and this requires development of optimal surveillance to determine where to place scarce survey resources. The closely related bronze birch borer (BBB – *Agrilus axius*) which is native to North America and regarded as a minor pest of weakened trees there, poses a much bigger threat to European birch forests. Although relatively little detailed study has been carried out on its biology and pest status, recent observations of rapid tree mortality on exotic plantings of *Betula pendula* in the USA, indicates that if it did establish in Europe the impact would be significant. Pathways for this pest would include any birch wood products, firewood and, potentially, plants for planting.

Whilst the list of invasive pests continues to increase, it is important to assess measures not only to attempt to reduce future incursions but, particularly, to develop a set of tools that can be employed to manage established populations of the pests. In many cases, there is a delay between establishment and detection which inevitably reduces the likelihood of eradication, although this also depends on the population growth rates of the pests. Whilst direct intervention through application of insecticides and

fungicides is a potentially valuable component of a pest management tool box, measures to attempt to restore the natural balance between the pest organism and its host tree and environment are needed for longer-term population suppression towards an endemic state. Among these measures, natural enemies can play an important part, as evidenced by the successful management of the invasive great spruce bark beetle, *Dendroctonus micans* by the host-specific predatory beetle, *Rhizophagus grandis* in the UK and also in parts of France and in the Georgian Republic (Fielding & Evans 1997). In other cases, natural suppression can be encouraged by managing site conditions and tree species mixtures to improve the capacity of trees to defend against attacks by pests. Such measures require a good understanding of why the pest is a problem and whether it is possible to alter the key factors to return to an endemic state and to an acceptable damage threshold.

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Biological control options for invasive species using insect pathogens

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Workshop abstract

Upon arrival of invertebrate invasive species, the management may include the use of insect pathogens. In my talk, I will introduce the different groups of insect pathogens and their biological characteristics, for example transmission, ability to establish epidemics etc. Thereafter, I will discuss considerations to be made, exemplified by the potential of using fungal pathogens from Entomophthorales to control an invasive aphid species, green spruce aphid *Elatobium abietinum*. We have found insect pathogenic fungi occurring on a number of aphid species, including green spruce aphids. Further, we studied the prevalence of these fungi in green spruce aphids in Iceland and we have compared the ITS 1 region of the fungus Entomophthora planchoniana found on different aphid species. The implications of our results will be discussed.

Invasive pests and diseases on birch in Finland

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Workshop Abstract

Birches are economically the most important broadleaved trees in Finland. Silver birch (*Betula pendula*) grows in the whole country excluding the northernmost Lapland, instead, downy birch (*Betula pubescens*) manages also in the North. The third native birch species in Finland, dwarf birch (*Betula nana*), is a marshland shrub. Finnish forests of silver and downy birches are planted with nursery-produced genetically improved seedling material and the typical rotation varies between 40 to 60 years.

The Finnish nurseries and forests have common pathogens and pests affecting birch growth and wood quality. However, large damage and destruction have been avoided. In nurseries, leaf and stem lesion-causing oomycete, *Phytophthora cactorum*, is the most serious problem against which fungicides are used. Occasionally, seedlings need to be treated with pesticides targeted to thrips and aphids. In the forests, birch rust and dieback by *Melampsoridium botulinum* and *Marssonina betulae*, respectively, are observed annually at some extent. Among pests, winter moth (*Operophtera brumata*) and northern winter moth (*Operophtera fagata*) can sometimes cause notable leaf loss and wood quality is commonly affected by birch stem miner, *Phytobia betulae*.

Invasive pests and pathogens are a serious threat for birch production in Finland. They include species which are able to cause serious damage and destroy and kill trees in large areas. In addition, unpredictable problems may occur with species which are not harmful in their native environment and whose host species range and virulence can be affected by factors such as climate. At the moment, insects dominate the group of known invasive spices threatening Finnish birch production.

In 2015, Asian longhorned beetle (*Anoplophora glabripennis*) -affected birches and goat willows were found in the southern Finland. The beetle had arrived with imported Asian stone material and was assumed to occupy the area for several years. Although, the pest was successfully eradicated, the incidence demonstrated the survival and breeding abilities of invasive species in very different climate compared to their native environment. Global trade, especially concerning plants and wood-connected materials, is an important pathway for invasive species and along that in 2017 two additional findings (one larva and one dead insect) of the Asian longhorned beetle were made in connection with stone import in southern Finland.

Another invasive insect encountered occasionally in the South coast of Finland is gypsy moth (*Lymantria dispar*). The moth is native to South and Central Europe but considered as one of the main defoliators of deciduous trees in the northern hemisphere. Some other birch-threatening invasive insects are bronze birch borer (*Agrilus anxius*) not yet present in Europe and citrus longhorned beetle (*Anoplophora chinensis*) observed in South Europe.

Currently, the major group of invasive pathogens threatening birch forests in Finland is oomycetes of *Phytophthora* genus. *Rhododentron*s affected by *Phytophthora ramorum* are annually found in nurseries and plant stores. The first occurrence of *P. ramorum* outside nurseries was in 2018 on a *Rhododendron* plant grown in a park. The pathogen was eradicated but because of international plant trade there is continuous threat of new incidences of *P. ramorum* and other, partly unknown, birch-infecting *Phytophthora* species.

Altogether, Finnish birch forests containing only two *Betula* species which have evolved without the pressure of highly destructive pests are seriously threatened by invasive forest pests affecting broadleaved trees.