Tree pests and diseases – crisis and responses

On 7 November 2012 the Society held a national conference in the Jodrell Lecture Theatre at the Royal Botanic Gardens, Kew, on some of the threats facing trees not only in the United Kingdom but throughout the temperate world. Over 100 people attended, many from national organisations, local authorities and private gardens, some having travelled from the continent. Speakers presented results of the latest research into the causes and impacts of tree health problems and potential solutions. SARA OLDFIELD summarises in this article the information from the excellent presentations and the lively discussions at the conference.

Temperate tree species are facing an increasing onslaught from pests and diseases. In the UK, Dutch elm disease wreaked havoc in the 1960s and 1970s killing an estimated 200 million trees and profoundly altering the landscape. Since then, and especially over the past ten years, the number of UK tree species, native and introduced, that are suffering from new pests and diseases has risen dramatically.

This remarkable increase of pests and diseases impacting significantly on the UK's treescape is believed to result from two main factors. The first is global climate change. Differences in seasonality, temperature and water conditions alter triggers affecting the breeding of insect pests and the bacteria and fungi that cause tree diseases. More extreme weather conditions place stress on tree species rendering them more susceptible to the impact of harmful vectors. In addition, warmer temperatures are enabling the spread northwards of Mediterranean species that have an impact on tree health. The other factor is the huge increase of global trade in plants for horticulture and the weak regulatory framework to control this from a plant health perspective. The resulting scenario was described by Professor Clive Brasier, a speaker at the conference, as a "full-blown though largely un-trumpeted biosecurity crisis".

The problems

The latest disease to hit the headlines is ash dieback caused by a fungus *Chalara fraxinea* a species that may have originated in East Asia. Ash dieback emerged as an entirely new disease in Europe in 1990 and the causal agent was only named in 2006. Confusingly the fungus causing the disease is also known as *Hymenoscyphus pseudoalbidus*. This has a close relative *H. albidus* that is native to the UK and harmless to ash. Initially the disease had an impact in Poland, Lithuania and Scandinavia. *Chalara fraxinea* has never been designated as a quarantine organism and so there has been no compulsion to take remedial action. The first record in the UK was in March 2012 in a nursery on trees imported from the Netherlands. The next finding was in May and serious

concerns emerged when symptoms were found in wild trees in October. In early November, the Forestry Commission undertook an intensive survey that found the disease at 115 sites within the UK with further sites suspected. Fortunately there are some promising signs of resistance in native populations.

The native ash, *Fraxinus excelsior* is an abundant tree in the UK and is part of the country's folklore. The potential impact of *Chalara fraxinea* is causing concern on a scale not seen since Dutch elm disease. This concern may serve to raise awareness of the huge problems emerging in the spread of tree pests and diseases. The arrival of ash dieback was not widely anticipated with experts more fearful of the import of emerald ash borer, *Agrilus planipennis*, which has devastated ash trees in the US and has already been detected in Europe on imported plants. As in the UK, and elsewhere in Europe, ash trees are a significant component of North American forests both natural and urban. The emerald ash borer was first discovered in Detroit in 2002 and has killed 40 million ash trees in south Michigan alone. To combat the spread of the insect the Cooperative Emerald Ash Borer project has felled over 100 million ash trees but the attempt of containment has failed.

Other pests and diseases that have arrived in the UK over the past ten years or so include the bleeding canker and leaf miner affecting horse chestnut trees; chestnut blight, poplar rust; pear blister mite; conifer hedge decline caused by a combination of aphids, moths and mites; *Dothistroma* (red band) needle blight affecting *Pinus sylvestris*, and various species of *Phytophthora* including *P. austrocedrae* which is attacking native juniper and *P. alni* affecting *Alnus glutinosa*.

Globally there are around 150 species of *Phytophthora,* with probably a further 500 undescribed species. *Phytophthora* is arguably the most dangerous genus of fungal plant pathogens. The first symptoms of *P. ramorum,* causing sudden oak death were detected in the USA in the early 1990s and in Europe in 1993. In 2000/2001 this species of fungus was identified in the UK. There are two lineages of the species in North America and one in Europe. The UK's oaks are not susceptible to this pathogen but non-native oaks are, together with *Fagus*, *Vaccinium* and *Rhododendron* species and commercial conifers. Rhododendrons are the key hosts with spores produced in the leaves of these plants. Since 2009, there has been very worrying evidence of the threat to the commercially important Japanese larch on an enormous scale. *Phytophthora ramorum* attacks both the bark and needles of Japanese larch with prolific spore production in the needles including long-lived chlamydospores. All infected larch trees are felled but even in the worst areas, Devon and Cornwall, 70 percent of larch trees remain healthy. Timber from infected trees is not degraded. However a new lineage is showing up in Northern Ireland and western Scotland and it is not yet known where this originated. Research is now underway funded by the Government's Department for Environment, Food and Rural Affairs (Defra) to identify outbreaks of the disease.



Above, oak processionary moth (OPM) showing from *left*, egg plaque and emerging caterpillars; nest on underside of the branch; nest removal with a special vacuum.

The oak processionary moth, *Thaumetapoea processionea* is one of the new threats to native and introduced oaks–and a species that causes health problems for humans. During the conference, Tony Kirkham spoke about the oak processionary moth (OPM) and the essential steps that must be taken to prevent its spread.

The oak processionary moth is indigenous to southern Europe and has spread northwards throughout continental Europe. Over the past ten years, male moths have occasionally been seen along the south coast of the UK and the Channel Islands. The first recorded breeding population in the UK was located in west London in 2006. The introduction is thought to have

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Oak processionary moth on the move along branch, and *inset*, the mature moth

Above, oak processionary moth shed skins of early instars; LS stage.

been through nursery stock imported from the Netherlands, where it was first recorded in 1991. Oak trees in the Royal Botanic Gardens, Kew were subsequently infected within the first year of the moth's introduction to the UK causing potentially serious problems for visitors to the Gardens but also providing an excellent opportunity for carefully controlled research. The moth has a complex life cycle. Egg plaques are laid in July / August on young wood. The tiny emerging caterpillars migrate along the stem and burrow into the terminal buds feeding on the unopened leaves. The caterpillars go through six stages known as instars before they pupate in June and emerge as moths in July – August. Male moths can fly 25 to 30 miles whilst females only

Bartletts spraying for oak processionary moth, Royal Botanic Gardens, Kew

fly up to one mile. The caterpillars have highly toxic barbed hairs that cause skin and breathing problems. For oaks, defoliation is the damage caused and the trees can recover.

Oaks are generally experiencing a range of diseases in the UK including ink disease caused by *Phytophthora cinnamomi*, root rots, heart rot/decay, powdery mildew and secondary diseases such as twig cankers. In addition several forms of acute oak decline occur, a foliage form first seen in the 1920s and stem form that was first reported in the 1980s, together with chronic oak decline. Declines are a particular type of disease caused by a set of factors or syndromes. Complex interactions between factors make research into declines problematic. Biotic factors can be native species but reacting differently when other environmental conditions change. Once a decline begins, relationships between the host and infecting agent may change. There are two key agents in the stem form of acute oak decline, bacteria and a native beetle *Agrilus biguttatus* that was prized in Victorian times for women's brooches. The relationship between the bacteria and the beetle is not fully understood. Acute oak decline affects both native species of oak and mainly affects mature specimens. The decline is seen over a period of three to five years with symptoms of stem bleeding and bark necrosis. Bacterial lesions may be the cause of death or there may be multiple causes. The foliar form of acute oak decline has as its causes a combination of powdery mildew, the green oak moth *Tortrix viridana*, drought stress and, in some cases, root pathogens have also been implicated.

Chronic oak decline takes ten to 50 years to impact on the tree affecting root health. Poor environmental conditions and fungi such as *Armillaria* and *Collybia* are thought to be the causes. Chronic and acute oak decline can act together. There have been no formal surveys of the extent of oak declines. Since 2006, there has been a significant increase in reported cases of acute oak decline, probably as a result of increased awareness. Records are mainly from the Midlands and East Anglia with growing numbers in the southeast of England. The declines are spreading suggesting microbial involvement.

Finding solutions

In the UK, FERA is the executive agency of Defra with statutory responsibilities for delivering policy and inspectorate functions in relation to plant health. The Forestry Commission also has a statutory responsibility for inspection of wood imports at ports around the country to minimise the risk from foreign pests and diseases. Where outbreaks do occur Forestry Commission experts work with local authorities and landowners to contain and control any spread. The Commission licences tree felling across the UK to protect woodlands from further infection.

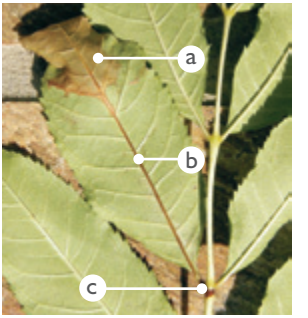
Felling is a legal requirement for trees infected with certain notified diseases as part of quarantine measures but is not a guaranteed solution to

stem the spread. Further research is urgently required to understand the diseases and declines that are threatening trees in the UK. In some cases the causes are not understood particularly where interactions between infecting agents occur. The mechanisms involved in the spread of diseases also need further research. Monitoring the spread of each disease and decline is crucial. Botanic gardens can monitor the presence and behaviour of infecting organisms helping to gain a better understanding of the problems. Sharing information on pests and diseases is extremely important both nationally and internationally. There is much to learn from experiences in other countries.

In the UK, the Royal Botanic Gardens, Kew has strict policies on biosecurity to prevent import and export of harmful organisms. The safe movement of plant material includes risk assessment of imports before they arrive; use of specified points of entry; overseas fieldwork vetting; procedures for handling/treatment/sharing and disposal of material; training to all staff and surveys and monitoring. All material whether for the herbarium, seed bank or living collections is subject to control. A new quarantine facility opened in 2011 operates under licence to FERA and the Forestry Commission.

At the same time hard choices need to be made with urgency about controlling outbreaks of pests and diseases. Stringent measures need to be taken to control the oak processionary moth, for example, because of its adverse impact on human health. Control is a statutory requirement in the UK. At the Royal Botanic Gardens, Kew a form of asbestos-lined vacuum cleaner is used to remove the caterpillars from infected trees and the caterpillars are subsequently incinerated. Special sticky bands are used to girdle the trees preventing the march of caterpillars to other specimens. Chemical control methods are also being applied with different products used at different stages of the life cycle of the moth. Monitoring of the impact of products on other forms of wildlife, including beneficial insects, is carefully carried out. Kew's oaks have not been infected for the past three years but spraying of around 450 trees is undertaken each year as a preventative measure and there is constant vigilance to capture the few moths that do fly in every year.

Various chemical control products have been registered to control insect pests and are available commercially for spraying on trees. Bandu (deltamethrin), a synthetic form of pyrethrum, is a quick and long-lasting product but causes collateral damage to benign organisms that may not be considered acceptable. More benign products such as horticultural oil and Savona (soap) are also effective but not as persistent so that repeat applications may be required. Injection technology has improved markedly since the days of Dutch elm disease and trials are being undertaken under experimental licensing. No products are yet licensed for use in the UK. The use of chemical control methods is highly controversial because of the impact on biodiversity more generally. Integrated solutions are likely to be needed with chemical protection of key plants, along with felling of diseased plants and monitoring



Ash dieback disease
(*Chalara fraxinea*)
Leaf necrosis (a) extending into leaflet vein (b) and rachis (c).

Left
Fraxinus excelsior sapling affected by ash dieback with main stem showing sunken bark canker as a result of infection by *Chalara fraxinea*.

Below Acute oak decline - profuse stem bleeding. *Agrilus* cf. *biguttatus* larvae. Adult *Agrilus biguttatus* (two spot oak buprestid).

Above *Phytophthora ramorum* affecting larch trees (*Larix decidua*) in South West England. Plym Woods, east of Plymouth and is infected - the trees should all be a healthy green (as in foreground), not the dingy brown as the infected trees in the middle distance.

Below *left*, *Pseudomonas* bleeding canker at branch and trunk; *top right*, horse chestnut leaf miner and *bottom right*, anthracnose damage on a willow branch.

being parts of the strategy.

Biological control of insect pests that are attacking trees is currently much more common in the US than in the UK. The use of natural predators provides control rather than eradication. The options for application in the UK are still largely unexplored. One example is the product, Dipel, live bacteria, used to control oak processionary moth.

Conclusions

The global spread of invasive alien species is considered the second major cause of biodiversity loss. Tree pests and diseases are causing huge environmental and economic problems and also have a social impact. Current problems in the UK are serious but there are further risks on the horizon. Future pests that may cause problems include pine processionary moth, emerald ash borer, Asian and Citrus long horn beetle, bronze birch borer and new species of *Phytophthora*.

According to Clive Brasier, the large number of exotic tree pathogens, some new to science, is arriving because of serious flaws in international plant health protocols. The emphasis has been on promoting free trade rather than environmental protection. Whilst international cooperation and control is tightened up through regulatory controls, it is vitally important for all organisations to work together to understand the threats to our trees and the wildlife dependent on it. The development of practical solutions will require integrated action. It is too late to rely on government and legislation alone. At a practical level, land managers should avoid planting monocultures as these can potentially lead to huge build-up of pests. We need to consider planting home-grown trees rather than imported stock. It is important to adopt a precautionary approach in terms of employing careful sanitation, restricting transport of firewood, careful monitoring and remaining well informed.

Further reading and sources of information

Brasier C. 2008. The biosecurity threat to the UK and global environment from international trade in plants. *Plant Pathol* 57:792–808.

Liebold, A. M., Brockerhoff, E.G., Garrett, L.J., Parke, J.L, and Britton, K.O. 2012. Live plant imports: the major pathway for forest insect and pathogen invasions of the US. Front. Ecol. Environ> 10(3):135-143 (published online 5 March 2012).

Just-Green.com (products for biological control of landscape pests)

Bartlett.com (company providing tree health diagnostic and control services)

FERA/Defra websites consultation documents, www.fera.defra.gov/plants/planthealth

Forestry Commission website, www.forestry.gov.uk

IDS website, www.dendrology.org

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