Tree health

On 21 October 2021 at the Yorkshire Arboretum Director, John Grimshaw, Jonathan Burton and Charles Lane led a study day on pest and diseases of trees. **ELIZABETH BALMFORTH** writes about the highlights and learnings.

We arrived at the arboretum on a beautiful crisp autumnal morning and made our way to the new Tree Plant Health Centre entrance, past a lovely *Sorbus pseudohupehensis* laden with berries, caught in a shaft of light.

This training day was to raise awareness, explain more about threats, tree pests and diseases and educate all stakeholders in tree health who have a responsibility for caring for trees. In a wider sense it was to make us think about how we can secure and preserve the trees of the future.

We took to our seats in the classroom with a panoramic view of the arboretum. Laid on tables were real life examples of branch damage to trees, some by cankers and others by the Asian longhorn beetle, a sobering sight. There was a range of useful pamphlets and key cards to take away, one such being the 'Disease signs and symptoms calendar' which can be downloaded from www.observatree.org.uk.

Our morning began with a key lecture from Jonathan Burton (Science, Education & Ray Wood Collection Manager) where we learned about the statistics within the Botanic Gardens Conservation International report, *State of the World's Trees*, which explains that currently 17,500 of the globe's 60,000 tree species are at risk of extinction, and of those native to Europe 58% are threatened with extinction in the wild. Sadly whitebeams and the genus *Sorbus* are the most threatened species of trees in Europe.

We then looked at an overview of the threats that we were likely to encounter, those that are already present in the UK, those not, and the industry and governmental initiatives and the organisations that are endeavouring to stem the ever increasing flow of pest and disease entry to the UK. From 1900 to 2015 the number of pest and disease introductions climbed significantly, due to multiple factors: the growth in trade of plants and plant products;

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The fruiting body of southern bracket, Gonoderma australe on oak; one of many pests and diseases that were discussed during the tree health study day at the Yorkshire Arboretum in October.

packaging such as transportation crates; air freight for rapid movement of goods and a growth in countries wishing to export. Climate change is also allowing pests' ranges to expand, coupled with a lack of natural predators or pest controls in the new regions where there has been an outbreak. Trees have increasingly stressful environments, whether due to decline in air, water and soil quality, climate change or land-use change, allowing pests to establish more easily.

In economic terms it was also interesting to note that the eradication and surveillance of the Asian longhorn beetle outbreak in Kent cost an estimated £2 million and the cost of managing and slowing of the spread of *Phytophthora ramorum* in the UK (2009–2014) was £23 million. Setting these in context against the wider environmental, economic and social benefits of trees where their estimated annual value is £4.9 billion with an asset value of £175 billion gives a useful reference point. The estimated annual social and environmental value of ash trees has been put at £230 million per year.

There have been a number of Tree Health and Plant Biosecurity strategies from the Department for Environment Food and Rural Affairs (DEFRA), beginning with the Expert Taskforce report in 2013, followed by the Plant Biosecurity Strategy in 2014, Tree Health Management Plan 2014 and the Tree Health Resilience Strategy in 2018.

We split into groups to consider what else might be affecting our trees before considering disease. Environmental factors might include soil health, compaction, waterlogging, pollutants and mineral deficiencies, livestock, monoculture, rainfall, previous land use, hard landscaping, the list was extensive. A useful reference for this was the 'Decline Spiral Concept'. (Manion, Houston & Sinclair https://www.researchgate.net/figure/Manions-spiral-of-tree-decline-modified-by-Mrkva-1993_fig1_290046846).

We then discussed agents that damage trees. Pathogens were first listed, these are 'infectious microorganisms that cause damage or abnormal functioning of plants leading to a disease'. Insects and other non-infectious harmful organisms are called pests in a narrow sense.

Next up were fungi and friends: mushrooms and brackets; rusts, powdery mildews, downy mildews; *Oomycetes*, *Phytophthora*, *Pythium*. These can directly infect healthy tissues (some of course are symbiotic), entering via wounds and natural openings. Symptoms can range from leaf, fruit and flower spots to cankers, lesions, dieback wilts, soft rots to decay. They spread by producing spores, air or water borne or transported in contaminated soil, plants, and footwear. Specialist survival spores can exist for up to 25 years or more in plant debris and soil.

Bacteria are not as numerous as fungi due to our climate but those which have adapted make a big impact, these include fire-blight, bacterial canker of *Prunus*, horse chestnut and poplar, slime fluxes from wet wood, acute oak decline and the EPPO Priority quarantine pest *Xylella* species.

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Jonathan Burton presents on the global threats to trees, and measures in place to combat these.

Bacteria colonise natural openings, wounds and insect feeding damage. Bacteria cannot be seen with the naked eye, unless aggregated together, in slime and sticky gum for instance, symptoms can be leaf spots, mosaics, pustules, cankers and lesions, wilts and dieback and soft rots. Bacteria spread through infected propagating material, seed, splash dispersal and contaminated surfaces, wind-blown soil and debris, water (rain, irrigation and rivers).

The symptoms of a virus on the other hand are galls and tumours, leaf rolling and curling, mosaics, ringspots and vein clearing. They are dependent on being within hosts to survive, they invade and take over the genetic machinery of plant cells and need to be vectored to new hosts.

Nematodes are threadlike, microscopic creatures living in soil or in plant tissue that may cause rot, distortion, decay up to 1 m and dieback. They can spread in contaminated soil and plants, or be vectored by insects e.g. pine wilt nematode carried by *Monochamus* beetles.

We then looked at bark beetles and borers, and longhorn beetles. Munching, sucking and galling was the activity used to collectively refer to aphids, whiteflies, scale insects, thrips, mealy bugs, psyllids and mites; indications of their existence were in reduced vigour, mould growth, evidence of honeydew, discolouration and distortion, skeletonisation, leaf mining and rolling.

With all these possibilities of transmission we then moved on to how to report and assess the tree problems. The accepted practice is to submit a report through 'Tree Alert', inform the regional Forestry Commission Team, ensure the area is safe and isolate/contain the infected tree. If you suspect a notifiable organism wait for the plant health inspector or Forestry Commission's instructions; consider the potential repercussions before acting to remove or manage the problem; review good biosecurity practices around the area to

prevent further spread of the suspect notifiable organism.

Having covered these points we were then ready to take a tour of the arboretum but not before we had been versed in the 'Keep it Clean' campaign which uses the slogan 'Don't give tree pests and diseases an easy ride' and the definition of Biosecurity, 'A series of precautions that aim to prevent the introduction and spread of harmful organisms'.

Above, spangle gall (*Neuropterus quercusbaccarum*) on oak leaves was discussed by members during the walk round the Yorkshire Arboretum (**below**).

We went out to scrub our footwear with 'Cleankill' before making our way into the arboretum. We assembled under a good-sized *Quercus robur* to inspect a bracket fungus; the oak's leaves were also covered in galls.

Southern bracket, *Ganoderma australe*, uses the oak tree by packing tannins into the heart wood and zoning it off. Each year it will increase in size, a new ridge will grow, some can reach over 60 cm across as they age. They are nearly as hard as the wood from which they grow and have the ability if their host tree dies or falls over to produce a new shelf from the old one and change their orientation to continue to be able to disperse their spores effectively.

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The group stopped to examine the damage on *Aesculus hippocastanum* caused by horse-chestnut leaf miner. This species is also affected by the fungus that causes leaf blotch and bleeding canker, the result of a bacterium.

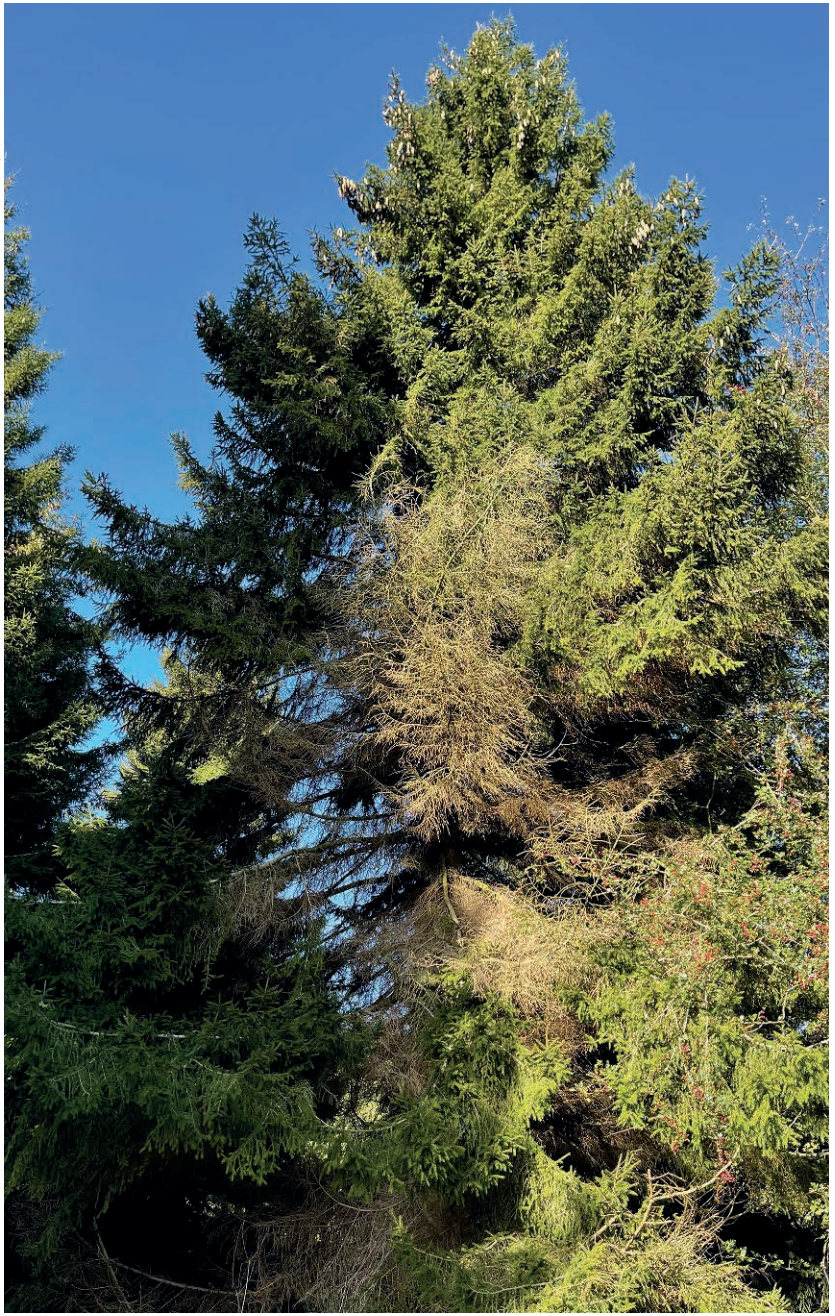
The climate this year has really worked in the galls' favour, the image, *opposite top*, shows a type of spangle gall; there are four types of spangle gall in the UK caused by different gall wasps. The wasp lays her eggs on new leaves in spring, the galls are formed and the larvae emerge over the summer months. They only affect growth and reserves if the oak was already limited in terms of photosynthesis and are very much part of the natural environment.

We also discussed the phytopathogenic bacterium *Agrobacterium tumefaciens* which is the causative agent of crown gall disease.

Then we were led to an *Aesculus hippocastanum* to examine damage caused by horse chestnut leaf miner moth (HCLM), *Cameraria ohridella*, an invasive pest of trees in the *Aesculus* genus. The larvae mine, and feed on the tissue in the interveinal areas; if you hold the leaf up to the light earlier in the year, you can see them moving.

It was common 30 years ago in the Balkans. Damage is minor as most of the leaf tissue is lost late in the season when the tree has completed most of its photosynthesis, though it can make the tree much more susceptible to bacteria and canker evidenced by a ruddy brown coloured bleed on the tree and a loss of weight in its conkers and general vigour.

To combat it, mow the leaves harbouring the pupae which can help clean up the situation or allow cattle out to crunch up the leaves with their feet;



Opposite and **above**, the damage caused by the great spruce bark beetle, *Dendroctonus micans*, on *Picea orientalis*.

there is also some evidence that the 'Ivermectin' that is used to treat worms in cattle (antiparasitic medication) transports into the manure and acts as a biocide, which is taken up by the tree and subsequently kills the leaf miner. There was mention of the fact that although the HCLM also feeds on other *Aesculus* species in addition to the European species the damage is not as severe, particularly in *Aesculus turbinata*, *A. pavia*, *A. indica* and *A.* × *carnea*; any information from IDS members' own collections would be interesting and useful. It does not affect trees in the genus *Castanea*. It was noted that garlic injections would require remarkable concentrations and more frequency.

We went further on to view the 'feathering' of a *Picea orientalis*, caused by *Dendroctonus micans*, known as the great European spruce bark beetle. *Dendroctonus micans* is found in spruce trees throughout mainland Europe and in parts of Great Britain. The beetle causes damage by tunnelling into the tree and laying its eggs under the bark. The larvae then emerge and use the inner woody layers as a food source, this can weaken and sometimes kill the tree over several years. The beetles don't however use the wood itself. *Picea* put out significant amounts of resin to fill the hole and the holes can be used to date the infection, the resin starting white, turning yellow and then moving to purple. The size of the female beetle (8 × 3 mm) enable them to withstand a resin flow attack. There can be a characteristic browning of the whole crown or individual branches can be affected.

There is an effective biological control, the predatory beetle *Rhizophagus grandis* which has an exceptional ability to locate the spruce beetle even when they are few in number. Suspected sightings should be reported immediately via the Tree Alert pest reporting tool and in Northern Ireland using Treecheck.

We then moved on to view the effects of *Sirococcus tsugae* which is a blight amongst trees within the *Tsuga* and *Cedrus* genera, evidenced by defoliation and a rather severe blight on the shoots. It was first reported in the UK in 2014 in a range of locations in England, Scotland and Wales. Susceptible species are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all *Cedrus* species particularly *C. atlantica* 'Glauca' and C. *brevifolia*, and *Tsuga heterophylla, T. mertensiana and T. canadensis*.

The dead needles are quite distinctive as they have a pink tinge to them, the branch diameter can reduce slightly and the bark can change colour from green to purple or dark red; this can be accompanied by a resin bleeding from the bark. *Sirococcus tsugae* has fruiting bodies which can be seen on cankers during winter and spring.

Spread of the disease can be attributed to plant stock, seeds of cedar and hemlock from countries where the fungus occurs and in some instances cut foliage. Unfortunately there is no effective control other than good biosecurity measures and hygiene in order to minimise the spread.

We were then put to work on a woodland challenge in observation, looking at how pest damage can progress through a woodland, observing which trees in a mixed woodland had been predated upon. Noting type and frequency of pest exit holes (supplied for our benefit) builds an overall picture of how much each pest had spread. Then we discussed traps available for control.

Opposite, *Cedrus brevifolia* affected by *Sirococcus tsugae*.
Right, Jonathan Burton showing us the multi-funnel trap used for surveying Cerambycidae.


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Jonathan showed us a multi-funnel trap which is used for surveying Cerambycidae (the longhorn beetle family). A discussion followed with an Asian longhorn beetle (*Anoplophora glabrispennis*) cast in resin being passed around for observation; the words beautiful and horrifying were used in equal measure.

After lunch we looked at which different types of plant material could be the most infectious from rooted plants in pots, seeds to bulb and tubers, budwood/graftwood to in vitro culture.

Next came a lecture on emerging pests and diseases by Dr Charles Lane (Plant Health Consultant at Fera Science). We covered *Phytophthora ramorum*, ash dieback, emerald ash borer, *Xylella fastidiosa*, rose rosette virus, *Sirococcus tsugae* (noted above), and the frighteningly named eight-toothed spruce bark beetle. I have included some interesting points in summary for reference.

Phytophthora ramorum Known as ramorum disease it is an algae like organism causing extensive damage and death in over 150 tree species. The genus *Larix* is particularly susceptible but it has also been found on *Castanea sativa*. Ramorum disease on oak trees is known as 'sudden oak death' particularly in the United States where it has caused significant damage to the North American native oak (*Quercus*) and the tanoak (*Notholithocarpus*) though this is genetically different from the organism present in the UK which has had little effect on *Quercus robur* or *Q. petraea*. Please refer to the list of tree species affected by going to the UK plant Health Information Portal.

Ash dieback, *Hymenoscyphus fraxineus* (causal agent) *Hymenoscyphus fraxineus* is a fungus of eastern Asian origin and is highly destructive in *Fraxinus* species particularly our native *Fraxinus excelsior*. The asexual phase of the fungus' life cycle was known as *Chalara fraxinea* and the sexual phase was called *Hymenoscyphus pseudoalbidus*, thus some reference material is still using both names. *Fraxinus ornus* has only been found with affected foliage and *F. chinensis* and *F. mandshurica* appear to tolerate the infection having evolved with it, and their leaves drop earlier.

Phillyrea and *Chionanthus virginicus* in Oleaceae have also been reported as

carriers of the fungus. The Tree Council has published detailed guidance in its Ash Dieback Action Plan Toolkit for councils and other organisations who manage trees.

Emerald ash borer *Agrilus planipennis* is an exotic beetle pest of *Fraxinus* species, native to China, Korea, Taiwan, Japan and Far East Russia, at present there have been no sightings in the UK but it is important to remain vigilant. It was accidentally introduced into Detroit with wood packaging material from China during the early 1990s. It is now in 24 US states and two Canadian provinces, and spread across the Eurasian landmass to the Ukraine in 2020. If it became established here it would complicate the work being done in trying to establish ash tolerant of *H. fraxineus* as they would also need to be tolerant of the emerald ash borer beetle. Emerald ash borer needs stress factor such as drought, bark damage or *Chalara fraxinea* to establish. Adults emerge from mid-May to July exiting through D-shaped holes. In the USA, they have girdled ash trees to attract ovipositing females for early detection, they are known as 'detection trees'.

Xylella fastidiosa, also known as Pierce's disease, became established in vineyards in southern California in the 1990s; symptoms appear when significant blockages occur within the xylem vessels due to the growth of the bacterium. *Xylella fastidiosa* is also responsible for alfalfa dwarf disease and almond leaf scorch in California; the insect vectors for Pierce's disease belong to the sharpshooter (Cicadelliade) and spittlebug (Cercopidae) families.

There are a minimum of four subspecies of *Xylella fastidiosa*, subpecies *fastidiosa*, *pauca*, *mulitplexa* and *sandyi*. Multiplex has a wide host range in the USA affecting plane, oak and elm. Subspecies *sandyi* affects oleander in the United States, the hosts of subsp. *pauca* include coffee and citrus and it is found in Brazil, Costa Rica, Paraguay and Argentina. The decimation of the olives in Italy is related to subspecies *pauca* and has been intercepted in coffee plants imported into Holland, France, Germany and Italy. The most recent outbreaks of the multiplex subspecies have affected *Polygala* and *Spartium junceum*.

Rose Rosette Virus First identified as a disease in 1940s around the Eastern Rocky Mountains, USA in *Rosa multiflora*.

The disease was then observed in surveys in two gardens in India, West Bengal in 2017. The host species *Rosa multiflora* was widely planted for erosion control cattle 'fences' and crash protection. It has spread through the midwest, southern and eastern USA on wild rose. Transmitted by the eriophyoid mite *Phyllocoptes fructiphilus*. Added to the UK Plant Health Risk Register in October 2016 it was decided that statutory action would be taken in the event of an outbreak and new legislation introduced in 2019 to control importation on *Rosa* species. Rose rosette virus was initially used as a biological control to limit the spread of *R. multiflora* in the United States after it became regarded as a weed, having been overused for hedging.

Symptoms are bright rich-red leaves, leaf distortion and twisting. Ends of canes may proliferate (witches' broom) as may leaves. Stems grow slowly and produce excessive thorns. Thorns may be soft and are often red-tinged. It may be similar in appearance to nutrient deficiency or herbicide damage. The virus can be variable in terms of its incubation and can take up to a year to become obvious; death can take from one to five years.

Eight-toothed spruce bark beetle, *Ips typographus* Present in spruce particularly *Picea abies*; an outbreak (breeding population) was found in a woodland in Kent in the UK in December 2018, and is currently subject to statutory eradication action. The beetles have also been observed in *Abies*, *Pinus* and *Larix* species.

'Ips' are known as the engraver beetle owing to the engraved appearance of their larval galleries, where the females lay their eggs, the pattern being unique to the species and, 'typographus' refers to the art of engraving. The adult beetles hibernate over winter under bark and leaves and re-emerge in spring when the temperature rises above 20 °C.

In 2018 the Forestry Commission conducted enhanced surveillance across the South East including the use of a network of traps and have routinely caught beetles which are thought to have been blown in from mainland Europe. In 2021 a number of other outbreaks of *Ips typographus* have been found in Kent and East Sussex.

The UK Chief Plant Health Officer confirmed two breeding populations in two woodlands in Kent on 25 June and 1 July 2021 following routine Forestry Commission plant health surveillance. On 9 July three further outbreaks were confirmed also in Kent and East Sussex. Refer to https://www.gov.uk/government/news/forestry-commission-acts-on-bark-beetle-tree-pest.

For further information on recent attacks on familiar genera and other pests and diseases Observatree have excellent visual indications and summaries of priority pests and diseases as do Forest Research, the Defra plant health portal, EPPO, CABI and USDA.

Despite the rather depressing catalogue of pest and diseases that continue to befall our beautiful woodlands, specimens and gardens, I did feel it was an excellent opportunity to establish the overall picture of progression and the assuredness that comes with good observation.

We then enjoyed a lecture from Dr John Grimshaw which covered tree choices for a changing climate and which in part has been covered in a previous IDS study day[1]. This was an essential rounding off to our day given it encouraged us, if that were needed, to look at some stunning suggestions for greater diversity but also how best to go about addressing the needs of future tree stocks in the UK with a view to how our woodlands and street scenes will continue to evolve.

[1] Tupper, H. (2020). Trees for the future, report of a study day held at the Chelsea Physic Garden on 17 October 2019. *IDS Yearbook 2019*, pp. 202–209.