x factor threat

Peter Jones and Daphne Comfort look at the threat to Britain's trees and wider landscapes posed by the *Xylella fastidiosa* bacterium

Italian olive trees infected by the *Xylella fastidiosa* bacterium

During the past 50 years a number of tree diseases have had a major impact on many British landscapes. In the late 1960s and the 1970s a new, aggressive strain of Dutch elm disease spread very rapidly within Britain, killing millions of elm trees and causing great changes in the appearance of many landscapes.[1] More recently, acute oak decline has affected thousands of both of Britain's native oak species oak trees across East Anglia, the Midlands and the South of England,[2] and concerns have been expressed that ash dieback has the potential to cause significant damage to the UK's ash population.[3]

As their names imply, all three of these diseases attack specific types of trees, but the *Xylella fastidiosa* bacterium can cause a number of diseases in a wide range of woody commercial plants, including grapevine, citrus and olive, many herbaceous plants, and several species of broadleaved trees, and it is increasingly seen as posing a possible threat to urban and rural landscapes, and more widely to the agricultural and horticultural economy within the UK.

The bacterium, originally largely confined to South and North America, has been identified in France and Italy during the past five years, and while to date there have been no reports of the bacterium in the UK there is a risk that it will accidentally be introduced. With this risk in mind this article describes the characteristics and vectors of the bacterium, outlines its current geographical distribution and impact, reports on current control measures in the UK, and speculates on the possible landscape and economic impacts if the bacterium becomes established within the UK.

Characteristics and vectors

Xylella fastidiosa is a bacterium which is restricted to the xylem, one of the two types of transport tissues in vascular plants. It is a complex species in that it appears to have different strains and it causes a number of diseases on a range of plant species. The bacterium essentially restricts or blocks the movement of water and nutrients within its host and causes a number of symptoms, including wilts, die-backs, stunting, and leaf scorch, often followed by plant death.

More specifically, for example, *Xylella fastidiosa* has been identified as the cause of Pierce's disease of grapevine, phony disease of peach, variegated citrus chlorosis, quick decline syndrome of olive trees, and leaf scorch in almonds, coffee and many broadleaved trees. In the case of Pierce's disease, for example, the bacterium causes the death of the plant normally between one and five years after the plant becomes diseased.

More generally, the bacterium has a wide range of natural hosts, including as many as 350 species,

and this number is expected to increase as the bacterium spreads to new areas. However, some of the diseases may take months or even years to develop significant symptoms, and such diseases may remain undetected for some time while providing reservoirs for the continuing spread of the bacterium.

A variety of vectors can be responsible for the spread of *Xylella fastidiosa,* and in theory virtually all sucking insects that feed on xylem can transmit the bacterium; but leafhoppers and froghoppers in North America and cicadas and meadow spittle bugs in Central and Southern Europe seem to be the most common vectors.[4] The insects generally acquire the bacterium, which adheres to their mouthparts, within two hours of feeding, and it is transmitted by them when they feed again. Leafhoppers, for example, can travel up to 180 metres within a two-hour period, although all insect vectors can be carried much further by the wind and can feed on, and thus infect, plants and trees over a large area during their normal lifespan of 40 and possibly up to 90 days.

The bacterium can also be spread in planting material, although in North America this is generally considered to be a minor source of establishment and transmission.

While the natural spread of the bacterium is localised, it can also be transported to previously *Xylella fastidiosa* free areas and across international borders on imported plants.

Climate is also seen to be an important or significant factor in the spread of the bacterium, but its effect seems to differ according to the strain and the host plant. Here a key factor is the occurrence of mild winters which may allow the sucking insects to overwinter as adults and thus carry the bacterium through the winter months and infect plants in the spring. As such, climate change and global warming may foster the more extensive spread of the bacterium, not least into new host species.

There is some evidence, for example, that water stress may exacerbate the severity of bacterial leaf scorch.[5] At the same time, while the conventional thinking had been that *Xylella fastidiosa* could not survive in Britain because of the climate, the recent discovery of a cold-hardy variety of the bacterium in Corsica and mainland France may make the UK more vulnerable than was previously thought.

Geographical distribution and impact

Xylella fastidiosa is found primarily in North and South America. In the US it has been reported as being present in 28 states, ranging west to east from California to New Jersey and north to south from Washington to Florida. It is widespread in five of these states: Alabama, Florida, Georgia, Mississippi, and Texas. In some areas, the bacterium has been known for well over a century. In California, for example, Pierce's disease of grapevine can be formally traced back to the 1890s, while phony disease of peach was reported in Georgia in the late 1890s. It is also present in three Canadian provinces (British Columbia, Ontario, and Saskatchewan) and in Mexico.

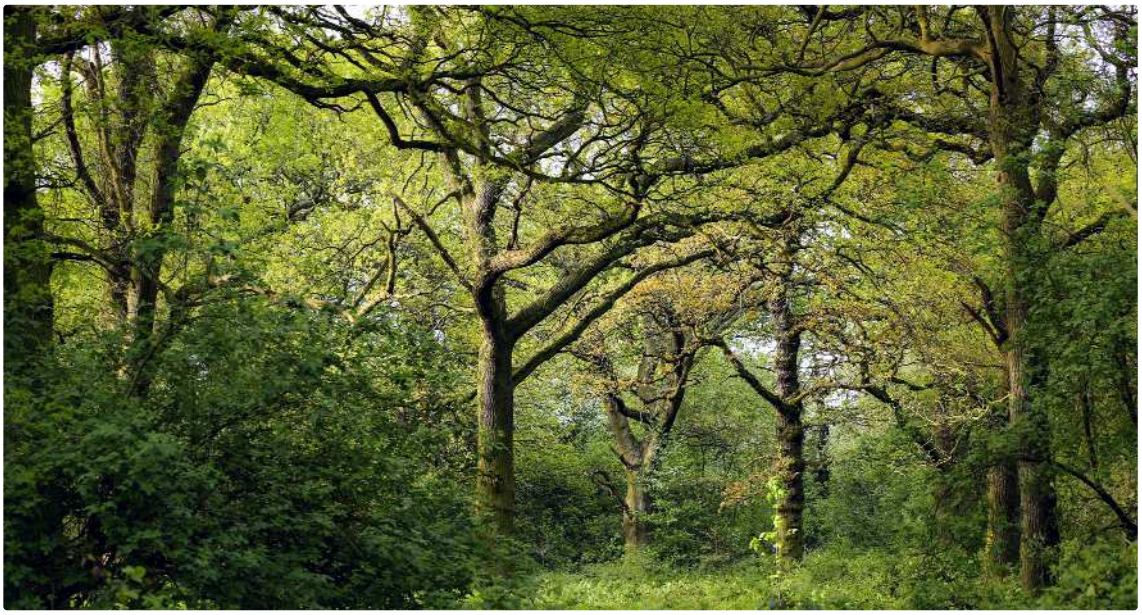
The bacterium has also been identified as present in Argentina, Brazil, Paraguay and Venezuela in South America, as well as in Costa Rica and Puerto Rico in Central America.[4] In Brazil variegated citrus chlorosis, caused by *Xylella fastidiosa*, was first reported in the Sao Paulo and Minas Gerais provinces in 1987 and had spread to North East Brazil within a decade.

Within Asia the bacterium has also been reported in Iran, where its distribution is restricted, and in Taiwan.

In many areas within the US *Xylella fastidiosa* has had a dramatic impact. Since its establishment in California some 20 years ago the bacterium has posed a major threat to the state's winegrape and almond growing and processing industry, and there are concerns that it may also threaten the citrus industry. Here, Timber *et al.*,[6] for example, have reported that the disease threatened an industry with a farm value production of over $3 billion per annum; that it was imposing significant costs on the industry through losses of vines and the costs of programmes to mitigate the problem; and that further costs were being borne by the wider community in an attempt to contain the problem and develop long-term solutions.

While the economic impact of diseases caused by *Xylella fastidiosa* has been severe in some areas of the US, the bacterium has also damaged urban forests and landscape trees and has led to important losses of amenity as well as economic costs in a number of US cities. Sherald,[7] for example, has reported that some 30-35% of oak species exhibited symptoms of leaf scorch in several communities of New Jersey, while the economic impact of the disease in these areas was estimated at between $0.7 million and $1.6 million over a ten-year period. More recently, Harris *et al.*[4] reported finding evidence of bacterial leaf scorch in 12 different urban tree species in the District of Columbia, including oak, elm, sycamore, and maple, and Nunney *et al.*[8] reported that *Xylella fastidiosa* was known to affect over 40 species of landscape trees.

Within Europe *Xylella fastidiosa* was first recorded in 2013 on olive trees in the Puglia region of Southern Italy. In 2015 the bacterium was reported on Corsica and then in mainland France, initially in the Nice and Mandelieu-la-Napoule municipalities and subsequently in the Alpes-Maritimes and Var departments. In 2016 *Xylella fastidiosa* was detected in a garden centre in Majorca, and the bacterium has since been reported on other islands in the Balearic archipelago, namely Formentera, Ibiza, and Menorca. There have also been reports of the detection of *Xylella fastidiosa* on



The UK's oak woodlands and landscapes could come under threat from the bacterium

an individual plant in both Germany and the Czech Republic.

The European and Mediterranean Plant Protection Organisation reported[9] that 'quick decline symptoms were observed on olive trees' in Puglia and that almond and oleander plants growing in the vicinity of the olive groves, which were showing symptoms of leaf scorch, also tested positive for the presence of *Xylella fastidiosa*. Leveille and Cheriguene[10] reported that many farmers in Southern Corsica were concerned about the discovery of *Xylella fastidiosa* on myrtle-leaf milkwort grown within a commercial zone, and since the initial discovery the number of outbreaks on Corsica has grown.

More generally, some 20 plant species have been confirmed to host the bacterium and, while many of these species are ornaments, cherry, plum, maple, sycamore, cork and oak trees are also hosts.

Control and management measures in the UK

All the evidence currently available suggests that *Xylella fastidiosa* cannot be eradicated and there is no control method currently available to cure diseased plants in the field. Indeed, the Food and Agriculture Organisation of the United Nations and the International Plant Protection Convention[11] have emphasised that managing the problems caused by *Xylella fastidiosa* in the field 'is very difficult due to the complexity of hosts and diseases'.

While there have been suggestions that changes to cropping systems – fertilisation irrigation and pruning, for example – could have some impact on the progress of the contracted diseases, such changes will not cure infected plants. Furthermore, CABI[4] reported that field trials of the chemical control of *Xylella fastidiosa* had not been successful, although there was evidence that tetracycline drenches had produced the temporary remission of some symptoms in potted grapevines. CABI also reported that the intensive use of pesticides to limit the spread of diseases caused by the bacterium and to control the insect vectors could have far-reaching and uncertain environmental consequences, not least the modification of food chains and webs.

In 2015 the European Commission advised member states to establish demarcated areas consisting of an infected zone and a buffer zone, and apply containment measures designed to minimise the amount of bacterium in that area and keep the vector population at the lowest level possible. It also advised all member states to carry out regular official checks on specified plants being moved out of a demarcated area, or from an infected zone to a buffer zone.

That said, and looking to the future, the European Commission has argued[12] that the control strategy has to be focused on the insect vectors and on the removal of infected plants that, if left in situ, can act as a reservoir for the bacterium. To control the vector population proper phytosanitary treatments are required, such as the removal of weeds needed for the accomplishment of the lifecycle of the insect, and also the targeted use of plant protection products, especially prior to the removal of infected plants. Sherald has argued[7] that the most practical solution would be to find disease-tolerant tree species, but that screening for tolerance is difficult, not least because of the complex nature of the bacterium.

At the time of writing, in July 2017, *Xylella fastidiosa* was not known to be present in the UK, but the Forestry Commission recognises[13] that there is a heightened risk of it being accidentally introduced since its discovery in Italy and France. The current control strategy aims to keep the bacterium out of the UK if at all possible.

To that end, the Department for Environment, Food and Rural Affairs (Defra) has issued a guidance document on the implications of *Xylella fastidiosa* for importers and users of trees, shrubs, and herbaceous plants.[14] The document stresses that the discovery and establishment of *Xylella fastidiosa* 'has the potential to have huge implications for the UK horticultural industry'. From April 2016, growers, suppliers, landscapers, designers, retailers and any persons directly importing plants into the UK all now need to ensure that they have a valid plant passport confirming that they have been sourced from disease-free areas. Prior to landings of host species such as plane, elm and oak plants, the UK plant health authorities must be formally notified to enable inspection.

Defra's guidance document also stresses the need to develop a contingency plan for dealing with *Xylella fastidiosa* if it were to be introduced into the UK. It suggests that there are two ways any disease caused by *Xylella fastidiosa* will be dealt with, depending on whether it is intercepted or an outbreak. An interception is deemed to occur when a 'disease is found on a plant but unlikely to have spread to other plants', and here the focus will be on destroying the host plant and any potential hosts in close proximity.

An outbreak occurs when a disease caused by *Xylella fastidiosa* is found on a plant and has spread and any such outbreak can be compounded – for example, when the origin of the infected plant is unknown, when a diseased plant is found on site with potential host plants from other sources, or when the presence of insect vectors is detected.

Where an outbreak is formally declared, four measures are to be implemented. All known *Xylella fastidiosa* hosts, plus any other plants that might be infected within 100 metres of the infected plant, will be destroyed and statutory movement restrictions will be put in place within a 10 kilometre radius range for a minimum of five years. At the same time insecticides will be applied within the 10 kilometre radius range in an attempt to control the insect vectors, and even plants which do not show any disease symptoms will be tested to ascertain if they are infected with the bacterium.

More generally vigilance, and the immediate reporting of any possible sightings of diseased plants, is seen to be vitally important in monitoring for the potential introduction and spread of disease caused by *Xylella Fastidiosa*, as is the co-operation of the horticultural, agricultural and forestry industries.

Threats to landscapes in the UK

If *Xylella Fastidiosa* were to be introduced into the UK and then to attack existing and potentially new hosts, the impact on the landscape could become progressively dramatic and certainly could have major implications not only for many traditional and cherished landscapes but also, although to a lesser extent, for the creation and development of new landscapes. More generally, diseases caused by *Xylella fastidiosa* could also render many trees more vulnerable to many of the other tree diseases that present a contained problem in many parts of the UK. Elm trees weakened by bacterial leaf scorch caused by *Xylella fastidiosa*, for example, may be more attractive to the beetles that transmit Dutch elm disease.

Leaf scorch caused by *Xylella fastidiosa* is a problem for a number of species of oak within the US, and there are particular concerns that the estimated 200 million oak trees in the UK could be vulnerable to the disease. Such a scenario would have a major impact on potentially thousands of landscapes, in that English oak is the most common tree species in the UK, particularly in central and southern deciduous woodlands, and it is arguably the best known and most loved of all the British native trees.

Furthermore, oak forests provide valuable habitats, and in supporting more life forms than any other native trees they play an important role in maintaining biodiversity. They host hundreds of species of insect, for example, supplying many British birds with an important food source, and mammals such as badgers and deer take advantage of the falling acorns in autumn. Given the growth pattern of oak trees, if the disease takes hold then all the leaves on a branch will be affected at the same time, and thus the visual impact will be more dramatic, and each year leaf scorch, die-back and crown reduction will progressively affect more and more of the tree.

A wide variety of landscapes could be affected. Richmond Park is one of the largest open spaces in London, housing some 1,000 oak trees including many ancient oaks that date back well over 500 years. Ancient oak trees are also an important part of the landscape in Hampstead Heath and at Bucklebury Oaks, a mile-long avenue of oak trees on Bucklebury Common in Berkshire. A number of individual oaks, including the Bexley Charter Oak in Danson Park and the Fulham Palace Oak in the grounds of Fulham Palace, are also characteristic landscape features in a number of parts of London.

In many areas oak trees, along with other species, play an important role in a range of landscape settings. In the Trent Washlands in the Newark and Sherwood district of Nottinghamshire, for example, oak is one of a number of hedgerow trees that enhance the enclosed nature of the landscape and give it structure and form, and the Trent Trench oak

is one of the tree species in the wooded bluffs that form a dramatic backdrop to the river. In a similar vein, in the Ribble Valley in Lancashire many mature oak trees are striking silhouettes against the open landscape.

Other major tree species in the UK, including sycamore and plane, are also potentially vulnerable to the diseases caused by *Xylella fastidiosa*. Within the UK there are some 70,000 hectares of woodland in which sycamore is the dominant species. Within sycamore trees the symptoms of bacterial leaf scorch appear in the summer months, with leaves initially developing an olive discolouration which quickly turns brown. These symptoms progress from the older to the younger and usually appear first in a single branch or limb of the tree, spreading through the whole canopy over several years and leading to progressive dieback. In many areas sycamores make handsome shade trees for large landscapes, and were such trees to host leaf scorch in large numbers it would lead to a considerable loss of landscape amenity.

Plane trees not only add to the grandeur of Whitehall and parts of the West End in Central London but also line roads in many towns and cities, and here again substantial losses to leaf scorch would lead to major losses in visual amenity within built-up environments.

Diseases caused by *Xylella fastidiosa* also threaten the development of new landscapes. Here the use of a variety of plants and shrubs in the developing soft landscapes within newly constructed urban environments could be threatened. The Forestry Contracting Association,[15] for example, has suggested that if *Xylella fastidiosa* were to be discovered at Canary Wharf in East London, leading to the destruction of all host plants within 100 metres and a five-year embargo on the movement of plants within 10 kilometres of the outbreak, it 'could result in the near shutdown of landscaping work in the capital'. In a former mining landscape once scarred by derelict open-cast mines and clay quarries and spoil tips, oak trees are an important element within the developing 500 square kilometre National Forest, which spans Derbyshire, Staffordshire and Leicestershire, and could be threatened in the years ahead.

Conclusion

While trees and tree diseases per se merit little or no explicit attention in the current National Planning Policy Framework (NPPF), they are important for the planning profession, not least in that enhancing valued landscapes, halting the decline in biodiversity and preserving habitats are all formally part of the NPPF's aims. Planners, in both the public and private sectors, and other urban and rural landscape design and management professionals will want to keep a watching brief on the changing geography and behaviour of *Xylella fastidiosa*, and more particularly on its potential introduction into the UK.

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Notes

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