Introduction Part 3: Other Invasive Tree Pathogens

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The outbreak of ash dieback, caused by the spread of *Hymenoscyphus fraxineus* in Europe has caused much excitement in the public and press, rightly so, as yet another invasive pathogen spreads across the continent threatening the stability of one of our iconic trees and the forest ecosystems it inhabits, from Russia to Northern Spain, from Greece to Finland. As interest focuses to a great extent on this particular problem, however, we must not lose sight of the many other invasive pathogens that are currently spreading in Europe (Santini et al. 2013), some of which have long been known, others recognised rather recently. Arguably, we can trace invasions by *Phytophthora cinnamomi* and *P. cambivora* back to the early 19th Century, although it is difficult to be precise over this time span, particularly as spontaneous generation remained the perceived 'cause' of plant problems, amongst others, at that time. After the debunking of spontaneous generation, however, it eventually became clearer that microorganisms cause disease in plants and animals. At the same time, it was recognised that pathogens could be transported around the world by various means, not least of which was through human activities.

We now assume, with considerable justification that the arrival of *H. fraxineus* in Europe – probably in the 1980s – resulted from an inadvertent co-transport of the pathogen on ash tissues, although the precise cause remains unclear. Sadly, this mode of arrival of invasive pathogens in regions and continents distant from their evolutionary origins is all too common (Fisher et al. 2012; Santini et al. 2013).

Highlights of this issue

The following set of papers is focused on several other invasive pests and pathogens that have entered Europe, some recently, one over 50 years ago. For example, the pathogen causing the current epidemic of Dutch elm disease, *Ophiostoma novo-ulmi*, first entered Europe though British ports in the early-mid 1960s on consignments of elm logs from North America. A previous epidemic of elm wilt, caused by *Ophiostoma ulmi*, had swept through Europe in the early-mid 20th Century, but many trees either recovered from the infection, or proved of low susceptibility. The appearance of a second pathogen causing Dutch elm disease, however, led to the deaths of millions of elms, and threatens the genus with extinction in Europe. The disease is still spreading in the northern-most areas of Europe. Pecori et al. (2017), however, highlight the use of selection and breeding in the fight against Dutch elm disease in Italy, where there have been some successes in crossing Asian elms against European *Ulmus* species to produce hybrids of suitable form and growth rates to utilize in southern Europe. Dutch elm disease is still causing much destruction of trees in northern Europe, however, as illustrated in the paper by Menkis et al. (2017), in which attempts were made to slow disease spread by applying decay fungi in an attempt to kill stumps of felled elms, thereby preventing resprouting and perpetuation of the presence of host tissues susceptible to beetle attack and, subsequently, infection by *O. novo-ulmi*. This method was not of particular practical value, although it is clear that choice of fungus to kill the stumps must be considered carefully.

Two pathogens causing leaf blights of *Buxus sempervirens* entered Europe (Henricot et al. 2000), probably in the 1990s, and have spread very rapidly through natural and cultivated populations of this valuable understory shrub since then. *Buxus sempervirens* is the main understory woody species in the forests of north-east Turkey, but is being very badly damaged by *Calonectria pseudonaviculata* and *C. henricotiae* (Lehtijarvi et al. 2017) in that region. As with many invasive pathogens, the two *Calonectria* species are proving extremely difficult to manage, and boxwood is now considered endangered. The same problem is also wreaking havoc in the forests of Georgia and Iran.

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Pitch canker of pine poses a massive threat to the future of pine forests in Europe (Bezos et al. 2017). It also attacks *Pseudotsuga menziesii.* Transmitted via seed, the pathogen is proving extremely difficult to detect in pathways of introduction, but appears to colonize plants in nurseries, often asymptomatically. The pathogen is then transported to forest sites on the young plants. Although established only in Spain and Portugal (solely in forest nurseries so far in Portugal), given the massive area of various pine species in Europe, the disease is clearly a major threat, particularly to coastal pine forests, where relative humidity is conducive to disease development. Again, this disease is proving rather recalcitrant to mitigation measures.

Over the past 20-25 years, Dothistroma needle blight (DNB), caused by *Dothistroma septosporum* and, in more limited locations, *D. pini*, have increased massively in overall importance, also threatening the integrity of pine forests and plantations throughout Europe (and beyond). It appears to infect most pines (if not all), along with several *Picea* spp. and *Cedrus.* The paper herein, by Lazarevic et al. (2017), extends the number of known host species varieties on which DNB occurs, and increases the knowledge of the pines affected in Montenegro.

Pests discussed in this collection of papers include the ash black sawfly, *Tomostethus nigritus* (Meshkova et al. 2017) and the emerald ash borer, *Agrilus planipennis*. *Tomostethus nigritus* has spread greatly in Europe recently, although populations fluctuate over years. Although not usually a lethal pest to European ash, the sawfly adds another layer to the woes faced in Europe by *Fraxinus excelsior*. In contrast, the emerald ash borer (Selikhovin et al. 2017, Musolin et al. 2017) is highly destructive, as witnessed in invaded regions in North America and around Moscow. As with *H. fraxineus, A. planipennis* is native to Far East Asia, including the far east of Russia itself. It is, nevertheless, not native in the European parts of Russia, from where the problem is now spreading westwards. Already recorded on the borders of Belarus and Ukraine, it is highly likely that the insect will continue to migrate westwards, where it will decimate the populations of *Fraxinus excelsior* remaining after ash dieback. It is essential, therefore, that any attempts to develop ash resistant to *H. fraxineus* also take the emerald ash borer into account.

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