# Reducing the threat of emerging infectious diseases of forest trees - Mini Review

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## Abstract

Exotic forest pathogens may threaten native ecosystems. Although there is little chance to eradicate the pathogens once established, their spread may be limited through efficient and sustainable management practices only when factors driving the invasion are known. Here, we review the factors determining pathogen invasiveness and provide guidelines to identify them.

Emerging infectious diseases (EIDs) of forest trees are commonly caused by exotic invasive pathogens and are on the rise as a consequence of increasing international trade and movement of people among and within continents. The threat posed by EIDs is potentially high: although evidence on total extinction of hosts by invasive pathogens is still scant, economic losses linked to invasive forest pathogens are generally high, and when extensive tree mortality occurs, long-term effects may include consequences on the evolution of host species and changes in the forest tree species composition and structure, with cascading effects on all components of ecosystems [1]. Additionally, local extinction of a host species from a portion of its natural range is a strong possibility.

Most EIDs of forest trees are caused by exotic fungi and fungal-like organisms primarily introduced through living plants and secondarily through wood [1, 2]. In the last few decades, movement of soil has become a pathway of introduction of growing importance [1], especially for soil-borne pathogens characterized by resting propagules (e.g. *Oomycetes*).

Accurate prediction of the likely locations of new introductions is crucial and may enable a suitable allocation of resources in monitoring programmes for early detection of newly introduced pathogens [3]. Once a forest pathogen has been introduced, eradication may be attempted, provided the exotic organism has not extensively established and spread in the new area. However, recent statistics show that less than 1% of invasive forest pathogens have been eradicated [1], suggesting eradication is a rarely feasible and successful option. In general, EIDs are not identified soon enough. Costs of eradication programmes are prohibitive and large-scale interventions are beyond our current abilities, independently of the financial resources available [4]. Since eradication of exotic tree pathogens often requires eradication of their hosts, efforts may even not be fully desirable given their ecological side effects [4].

While economic and social factors are crucial drivers of the introduction of foreign species [3], naturalization and invasiveness mostly depend on phylogenetic and ecological factors [1]. Invasiveness of fungal pathogens of forest trees may be linked to factors including their ruderal nature, their ability to survive in the absence of a host or favourable conditions, their transmission mode, and their phenotypic plasticity. Strain virulence, host specificity, host abundance, demography, phytosociology and variation in susceptibility may also be key drivers of invasions as they have been identified as important factors to predict invasiveness of several plant pathogens [1]. Hybridization between exotic and native interfertile species or between two exotic species may also be a determinant of invasions as hybrids may occasionally undergo host species jumps [1], hybridization may allow for horizontal gene transfer of virulence genes, or because hybrid vigour may result in heightened virulence.

Understanding the factors underlying a successful invasion would allow us to improve our predictions of patterns and rates of microbial invasions. Although complex and interrelated, factors determining invasiveness of forest pathogens may be grouped into two broad categories or scenarios. The first refers to the relative susceptibility of naïve hosts, i.e. the likelihood of host infection by a pathogen that did not co-evolve in the same region as the host, while the second focuses on a pathogen's ability to be transmitted from an infected to an uninfected host [5]. Understanding which one of the above scenarios best explains the biological invasion allows for the implementation of the most effective control strategy. For instance, if high host susceptibility is driving the invasion, a successful control strategy may include breeding for resistance, selective removal of more susceptible individuals, planting of more tolerant or resistant ones, and increasing landscape-level barriers among susceptible hosts by either intermixing them with resistant species or simply increasing the distance among them. On the other hand, if transmission is a major driver of the invasion, the above strategies would have limited effects, and a different approach may be needed to curtail establishment, survival and production of infectious inoculum. Protection of trees through the application of chemical or biological treatments, thinning or pruning to increase air circulation thereby reducing relative humidity and the ability of fungal pathogens to sporulate and infect trees, and sanitation practices targeted at eliminating infected hosts and other substrates colonized by the pathogen, may be effective control strategies to implement when invasiveness is determined by the pathogen's transmission potential.

Although observations and experiments comparing exotic organisms in their introduced and native ranges have provided insights into the factors driving plant and animal invasions [6], a more reliable approach to disentangle factors driving the invasion of forest pathogens may rely on the comparative analyses of epidemiology and ecology of invasive pathogens and of native related ones present in the invasion area, provided they share the same infection biology and life cycle. Both experimental approaches are likely to be needed to improve our understanding of exotic forest diseases [6].

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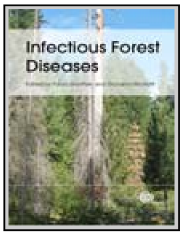


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