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EDITED AND REVIEWED BY
Juan A. Martin,
Polytechnic University of Madrid, Spain

*CORRESPONDENCE
Isabel Alvarez Munck
✉ isabel.munck@usda.gov

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Editorial: Foliar, shoot, stem and rust diseases of trees IUFRO 2022

Isabel Alvarez Munck[1]*, Julio Javier Diez-Casero[2], Salvatore Moricca[3], Philippe Tanguay[4] and Pierluigi Bonello[5]

[1]Forest Health Protection, Forest Service (USDA), Durham, NH, United States, [2]Higher Technical School of Agrarian Engineering, University of Valladolid, Palencia, Spain, [3]Department of Agricultural, Food, Environmental, and Forest Sciences and Technologies (DAGRI), Plant Pathology and Entomology Division, University of Florence, Florence, Italy, [4]Laurentian Forestry Centre, Natural Resources Canada, Canadian Forest Service, Quebec, QC, Canada, [5]Department of Plant Pathology, College of Food, Agricultural, and Environmental Sciences, The Ohio State University, Columbus, OH, United States

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Editorial on the Research Topic
Foliar, shoot, stem and rust diseases of trees IUFRO 2022

Foliar, shoot, stem and rust diseases can cause devastating damage to their tree hosts through a variety of mechanisms: (1) reduction in photosynthetic capacity, (2) loss of apical dominance leading to stem deformities, (3) lower amounts of soil nutrients and water transported to the crown (wilts) and from the crown to the roots (blights and cankers), and (4) girdling and mechanical failure. Altered precipitation regimes / drought/temperature patterns due to climate change further compound such negative outcomes by often increasing host susceptibility and pathogen virulence.

In this volume, several articles examine several of these diseases with a contemporary as well as global perspective. In Burns et al. we learn that, between 2004 and 2017, the rate of mortality of limber pine (*Pinus flexilis*), surveyed in 106 long-term monitoring plots established in critical high elevation ecosystems in western North America, exceeded the rate of recruitment and growth. They determined that this was due to combined damage by white pine blister rust (WPBR), bark beetles, and climate change. This is important knowledge, because limber pine is a foundational species in those ecosystems. The authors conclude that disease and insect management will be vital to the sustainability of this critical tree species. However, this is easier said than done. As Munck et al. report, management of pests and diseases can be done, but can also be quite challenging. They studied the effects of silvicultural treatments in the eastern U.S. on WPBR, white pine weevil, foliar pathogens and Caliciopsis canker in white pine (*Pinus strobus*) stands, and found that treatments providing partial shading, reduced overstory stem density, and soil scarification to encourage pine regeneration improved the health of residual trees compared to untreated controls. Complete removal of the overstory had the added benefit of creating seral habitat utilized by many songbird species.

WPBR is certainly important, but other pine stem rusts (*Cronartium* and *Peridermium* spp.), *Melampsora* rusts and eucalyptus rust, have also caused economic and ecological losses on continental scales. One more example is provided by the *Melampsora* rust Ramsfield et al. recently reported on laurel

willow (*Salix pentandra*) in Alberta, Canada. The fungus was identified as *Melampsora epitea* and is capable of infecting catkins and stems, in addition to leaves, thus increasing inoculum pressure and potentially affecting regeneration. The authors were able to rapidly identify the species thanks to specimens maintained in a mycological herbarium, highlighting the critical value of such repositories. Anger et al. also report a first rust record, *Melampsoridium asiaticum,* this time on ironwood (*Carpinus caroliniana*) and hophornbeam (*Ostrya virginiana*) in the southeastern Unites States. The authors used morphological and molecular data from field and, once again, herbarium samples to identify the pathogen. The disease is of unknown origin. Because of its recent discovery, the impact of this disease is unknown and merits further monitoring.

In addition to identifying and characterizing novel diseases, this issue also discusses important detection and control strategies. For example, Bourgault et al. developed a DNA-based RPA-CRISPR/Cas12a assay for the detection of *Bretziella fagacearum*, the causal agent of oak wilt. While less sensitive than qPCR, it is specific, field-implementable, and rapid, thus helping democratize and accelerate diagnostics, all invaluable aspects of invasive species management. Meanwhile, Sánchez-Gómez et al. present promising data for the control of pine wood nematode, the causal agent of pine wilt, a disease of global concern. In particular, they demonstrate that the fungal species, *Beauveria* spp. or their mycotoxin, beauvericin, have strong *in vitro* nematicidal effects. Staying with nematodes, McIntire begins to alleviate our lack of knowledge of the physiological effects of *Litylenchus crenatae mccannii* (the causal agent of beech leaf disease - BLD) on American beech (*Fagus grandifolia*). Specifically, this article shows significant relationships between BLD symptom severity and leaf gas exchange and physiological leaf traits that lead to decrease growth, vigor, and long-term survival, all of which will likely compromise the significant ecosystem services provided by diseased American beech.

Pathogens don't act in a vacuum, they are part of a microbial milieu, the phytobiome, which also includes non-pathogenic species, known as endophytes. Endophytes play an important role in disease defense strategies; however, how the plant's health status affects the endophytic communities is not known. Diez-Hermano et al. used metabarcoding to profile the fungal endophytic communities of four declining Mediterranean tree species and found indicator genera that were present only in declining trees. Declining Mediterranean trees are also discussed in Benigno et al., who report known and new harmful fungal and oomycete pathogens that are becoming more aggressive and widespread on *Fraxinus* species (ash) as a likely consequence of climate change, causing tree mortality, loss of natural regeneration and the retreat of some ash species from less favorable sites. This is a stark warning of things to come as climate warming shifts host-parasite interactions in favor of the infectious agent.

Finally, while this Research Topic is all about diseases that affect above ground organs, we cannot forget that trees are unitary systems that are subject to diseases below ground as well, and those can have major effects on how serious above ground diseases can become. Diez-Hermano et al. investigated whether declining tree species in Mediterranean forests were associated with specific rhizosphere fungal communities. They found high overall diversity (674 genera) of fungal species but no evidence of known root pathogens in the declining areas. Paired with the study by Benigno et al., this suggests that, even though the two studies were conducted in different countries, Mediterranean forest decline may be due to a combination of environmental factors and pathogens acting above, rather than below, ground.

Taken together, these articles contribute to many aspects of aboveground tree pathology while advancing our understanding of very critical groups of tree diseases, a body of knowledge that we will need to keep refining as we attempt to deal with an unpredictable world in this age of climate and global changes.

Author contributions

IM: Conceptualization, Writing – original draft, Writing – review & editing. JD-C: Writing – original draft, Writing – review & editing. SM: Writing – original draft, Writing – review & editing. PT: Writing – original draft, Writing – review & editing. PB: Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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