The importance of range dynamics of insects and pathogens in forest ecosystems

Christelle Robinet, Patrick C Tobin

available for 10 alien and 19 native forest pests. Most species showed range expansion as a result of higher temperatures, whereas very few showed retraction at the rear edge of their distribution. The expansion rates varied greatly among species, and seemed to be generally higher for alien species, in both forestry and agriculture. Ecological phenomena behind differences in expansion among insect species are discussed and potential mitigation measures are suggested.

Influence of increasing summer temperatures on range dynamics of an invasive forest pest and its host tree. Mech, A., Gandhi, K. (*University of Georgia, USA; angmech@uga.edu; kjgandhi@uga.edu*), Tobin, P. (*U.S. Forest Service, USA; ptobin@fs.fed.us*), Teskey, R. (*University of Georgia, USA; rteskey@uga.edu*), Rhea, J. (*U.S. Forest Service, USA; rrhea@fs.fed.us*).

Warmer temperatures predicted under current climate change models are expected to have an overall positive effect on the success of invasive forest pests by increasing biological attributes such as survivability, geographic range, and fecundity. These changes in life history factors may then result in negative cascading effects on forested ecosystems. Cold temperatures are an abiotic limiting factor used for predicting forest pest distributions, and consequently in determining the range where host trees will be protected and maintained. However, heat may also be a limiting factor for invasive insects that undergo aestivation, or summer diapause, such as the exotic hemlock woolly adelgid (*Adelges tsugae*, HWA), which is causing widespread mortality of eastern hemlock (*Tsuga canadensis*) in eastern North America. We examined the thermal ecology of HWA in the southernmost limit of the eastern hemlock range by determining HWA survivorship under increasing temperature regimens and heat waves. Results showed a positive correlation between increasing temperatures and duration and HWA mortality. In response to lower HWA densities, hemlock trees exhibited signs of possible tolerance rather than the anticipated rapid dieback and mortality. This study shows the potential of climate change to maintain pockets of eastern hemlock at the southernmost edge of their natural range.

The importance of range dynamics of insects and pathogens in forest ecosystems. Robinet, C. *(National Institute for Agricultural Research (INRA), France; christelle.robinet@orleans.inra.fr*), Tobin, P. (*U.S. Forest Service, USA; ptobin@fs.fed.us*).

Assessing the range dynamics of a forest insect or pathogen species reveals whether the species is declining or not. Based on the status of the species (endangered versus invasive), appropriate measures could be taken to preserve forest health and biodiversity. Despite the differences in the goals between invasion ecology and conservation biology, many of underlying mechanisms that affect range dynamics are similar. For example, factors such as climate suitability, host availability, and presence of natural enemies, competitors or mutualists, could potentially affect the distribution ranges of both invasive and endangered species. Furthermore, at range borders, both endangered and invading populations are often at low densities and subject to stochasticity, loss of individuals to emigration, and Allee effects. In a changing world, the effects of climate change on these range dynamics should be also carefully considered. In this paper, we explore abiotic and biotic factors as individual drivers of the changes in species' distribution ranges, their interaction, and their implications in terms of forest ecosystem functioning in the face of stochasticity and uncertainty.

Modeling spatial spread of pine wilt disease: an individual-based approach. Takasu, F. (*Nara Women's University, Japan; takasu@ics.nara-wu.ac.jp*).

Pine wilt disease is caused by a pinewood nematode with a *Monochamus* beetle as a vector that distributes the nematode to healthy trees. The disease has been expanding worldwide and has brought severe damage to pine trees in some areas in eastern Asia. Considering the beetle life cycle, it is likely that the Allee effect operates for the beetle reproduction and that complete eradication of the beetle is not necessarily essential to stop the disease, i.e., once the beetle local density is lowered less than a threshold, they are doomed to be locally extinct. Previous models of pine wilt disease have shown that the functional form of the beetle dispersal kernel, i.e., how far beetles disperse, critically affects the disease expansion. In this talk, I revisit this problem using individual-based modeling in which mechanistic interactions of beetles and pine trees are explicitly considered and explore how to stop the disease expansion, e.g., by setting a barrier zone where potential healthy trees are removed. Based on individual-based simulations, effective control measures to eradicate the disease will be discussed.

Supraoptimal temperatures restrict and retract the distribution range of the gypsy moth. Tobin, P. (*U.S. Forest Service, USA; pc.tobin@gmail.com*), Gray, D. (*Canadian Forest Service, Canada; David.Gray@nrcan-rncan.gc.ca*), Liebhold, A. (*U.S. Forest Service, USA; aliebhold@fs.fed.us*).

The shifting, expansion, and retraction of species distribution ranges hold critical implications to both invasion ecology and conservation biology. Biotic and abiotic factors are known to influence a species' range, and much recent attention has been given to the role that climate and changes in climate could play in affecting range dynamics. We used a 20-year spatially referenced dataset on gypsy moth, *Lymantria dispar* (L.), invasion dynamics to document range expansion, stasis, and retraction across a fairly narrow latitudinal region in Virginia and West Virginia, USA. Across this region, we also observed significant differences in the amount of exposure above the optimal temperature for *L. dispar* larval and pupal development. Temperature regimes in the coastal plain of Virginia, where the *L. dispar* range has retracted, were significantly warmer than those in the Appalachian mountains of Virginia and West Virginia, where *L. dispar* has expanded its range. Our analyses at a smaller spatial scale confirmed a statistically negative association between exposure time above the optimal temperature for *L. dispar* larvae and pupae, and the rate of *L. dispar* invasion spread over the 20-year period. This work highlights the importance of supraoptimal temperatures on the range dynamics of a non-native invasive insect.

G-18 Research on pathway risk management and phytosanitary policy to prevent invasions of forest insects and pathogens

Organizers: Eckehard Brockerhoff (Scion, New Zealand), Andrew Liebhold (U.S. Forest Service) & Jolanda Roux (FABI/University of Pretoria, South Africa)

Facilitating international trade and preventing forest pest invasions: progress and the challenge ahead. Brockerhoff, E. (*Scion, New Zealand; eckehard.brockerhoff@scionresearch.com*), Liebhold, A. (*U.S. Forest Service, USA; aliebhold@fs.fed.us*), Roux, J. *(FABI, University of Pretoria, South Africa; jolanda.roux@fabi.up.ac.za*).