Characterization of Variation and Mechanisms of Resistance and Susceptibility of Asian and North American Ash Species to Emerald Ash Borer

PRINCIPAL INVESTIGATOR:
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PROJECT OBJECTIVES:
Emerald ash borer (*Agrilus planipennis*, EAB) has killed millions of white, green, and black ash trees since its accidental introduction from Asia. As EAB continues to spread it threatens the very existence of ash in North America. EAB, however, does not devastate its native hosts in Asia. Our working hypothesis is that Asian ashes are resistant because they possess targeted defenses to EAB by virtue of their long coevolutionary history. The objectives of this study were to determine why EAB is such an aggressive killer of North American ash trees, to confirm Asian as species as a source of resistance genes, and to identify mechanisms by which Asian ashes resist EAB. Specific objectives include:

1. Document interspecific variation in resistance/susceptibility of major North American and Asian species of ash to EAB in a replicated, experimental ash plantation.
2. Characterize mechanisms of resistance/susceptibility of ash species to EAB, focusing on defensive chemistry (secondary metabolites) of phloem tissue.

ACCOMPLISHMENTS:
A replicated ash planting was established at the epicenter of the EAB infestation southeast Michigan in 2003 to compare resistance of native and Asian ashes to EAB. The planting included the North American white (*Fraxinus americana)* and green ash (*F. pennsylvanica*), and the Asian species Manchurian ash (*F. mandshurica*), with which EAB shares an evolutionary history in Asia. Manchurian ash was found to be more resistant to EAB than were the North American species, with is consistent with the hypothesis that Asian ashes are a source of resistance genes which have been selected for over the course of their long coevolutionary history with EAB (Rebek et al. 2008). Furthermore, phloem tissue of Manchurian ash was found to contain classes of phenolics (hydroxy coumarins) not present in North American species that may be responsible for conferring this resistance (Eyles et al. 2007).

A comparative proteomics approach is being utilized to isolate and identify defense genes that are expressed in ash phloem that may be associated with resistance to EAB. To date, we have documented major differences in one dimensional protein profiles between resistant and susceptible ash species. All ash species share two major bands at ~50 kDa and ~15 kDa, but Chinese and Manchurian ash have unique bands at ~30 kDa and ~40 kDa. Proteins of interest have been isolated, and once they are sequenced, the next step will be to design primers for the corresponding genes so that those can be used as potential markers for resistance, which will lead to identification of genes that may be directly associated with EAB resistance.

TECHNOLOGY TRANSFER/IMPACT:
Identification of resistance mechanisms will facilitate screening, selection, and/or breeding of ash trees that are resistant to EAB. If resistance traits that may be present in North American ashes in low frequencies can be identified, they could be used to select for or breed resistant individuals. If they are not, such traits could potentially be introgressed (i.e. bred) from resistant Asian ash species into susceptible North American species, utilizing the approach used successfully to blight resistance into American chestnut.

Publications

Eyles, A., W. Jones, K. Riedl, D. Cipollini, S. Schwartz, K. Chan, D.A. Herms, and P. Bonello. 2007. Comparative phloem chemistry of Manchurian (*Fraxinus mandshurica*) and two North American Ash species (*F. americana* and *F. pennsylvanica*). *Journal of Chemical Ecology* 33:1430-1448.

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Herms, D.A., D. Smitley, E.J. Rebek, P. Bonello, and D. Cipolinni. 2008. Interspecific variation in resistance of ash to emerald ash borer. In: *Proceedings of the Emerald Ash Borer Research and Technology Development Meeting, Oct 23-24, 2007, Pittsburgh, Pennsylvania*, pp. 34-35. USDA Forest Health Technology Enterprise Team, FHTET-2008-07. 123 pp.

Presentations

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