

HEMLOCK AND HEMLOCK WOOLLY ADELGID: PAST RESEARCH, CURRENT FINDINGS, AND FUTURE DIRECTIONS IN A TROUBLED NORTH AMERICAN TREE-PEST SYSTEM

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Hemlock woolly adelgid (HWA) (*Adelges tsugae*) was first introduced to the East Coast of North America in the 1950's and has since spread throughout roughly half of the native range of its primary host, eastern hemlock (hemlock; *Tsuga canadensis*), which is under threat of extirpation due to this insect. Here, we summarize past and current work that our research group has undertaken and address future research directions and management concerns in this system. Over the past several years, one aspect of our research has been investigating HWA-hemlock interactions and HWA interactions with other hemlock herbivores. Adelgid infestation results in a “hypersensitive-like” response in hemlock foliage, with the accumulation of reactive oxygen species, certain amino acids, hormones, defensive metabolites and enzymes, and increased volatile emissions, a response that more resembles pathogen infection than herbivore attack. The infestation of HWA additionally results in deleterious phenological, growth, and belowground effects on hemlock. Adelgid interacts with other native and exotic hemlock herbivores, presumably due to the manipulation of host physiology, and appears to make hemlock more attractive to certain herbivores. Our research group has also led efforts to develop HWA-resistance in hemlock. Unfortunately, decades-long efforts to develop effective biological controls have not yet proven effective on highly susceptible eastern hemlocks. However, hundreds of hemlock trees have been found persisting in HWA-decimated forests throughout the East Coast, and some have remained healthy for decades. We are leading efforts to screen persisting trees for elevated levels of resistance and to propagate trees to supply stakeholders, tree breeders, and scientists with resistant germplasm. We also utilize these trees to develop phenotyping assays for the rapid identification of resistance in the field. We strongly advocate for the development of resistance and the breeding of resistant hemlocks as part of a long-term management strategy for hemlock.

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