Ash tree species likely will survive emerald ash borer beetles, but just barely

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Researchers began measuring the decline of ash trees in the Penn State plantation in 2012, shortly after emerald ash borers arrived there, and they measured it every year through 2017. The effect of the insect was devastating. Credit: Kim Steiner, Penn State

"Lingering ash." That's what the U.S. Forest Service calls the relatively few green and white ash trees that survive the emerald ash borer onslaught. Those trees do not survive by accident, and that may save the species, according to Penn State researchers, who conducted a six-year study of ash decline and mortality.

The research shows some ash trees have varying degrees of resistance to the strangely beautiful, invasive beetle from Asia. The study is unique because it took place at a plantation of ash trees planted on Penn State's University Park campus in the mid-1970s.

"We found that genetic variation exists in trees from around the country, and through time—especially as the emerald ash borer population collapses because host trees are rapidly disappearing—the resistance that we observed will likely ensure the survival of the species," said Kim Steiner, professor of forest biology, College of Agricultural Sciences.shredded

Genetics moderated the rapidity with which emerald ash borers injured and killed trees, researchers learned. This suggests that some ash genotypes, especially on favorable sites, will survive.

Steiner, who also is director of The Arboretum at Penn State, collected seeds from wild green ash trees in 27 states and Canadian provinces in the fall of 1975. He grew the seedlings for two years before methodically planting 2,100 of them, all 12 feet apart, in a seven-acre plot. Mixed in were a small number of white ash trees.

Steiner conducted a provenance trial—moving trees that had evolved in different climates to one location and carefully monitoring their growth and other characteristics—with the goal of understanding how species adapt to their environments. over the last few decades, researchers maintained the plantation to study the effects of climate change on trees.

The ash plantation, with nearly all the trees dead and deteriorating, is now being overrun by plant growth, as this recent photo shows. Credit: Lake Graboski, Penn State

This little-known ash plantation off Porter Road near the Penn State's Swine Research Facility—the largest collection of green ash germplasm in one location in the world—may play a role in saving the species.

"We began measuring the decline in 2012, shortly after emerald ash borers arrived in the plantation, and we measured it every year through 2017," said Steiner. "The effect of the insect was devastating. As of August of this year, only 13 trees remained of the 1,762 that were alive when the emerald ash borer arrived."

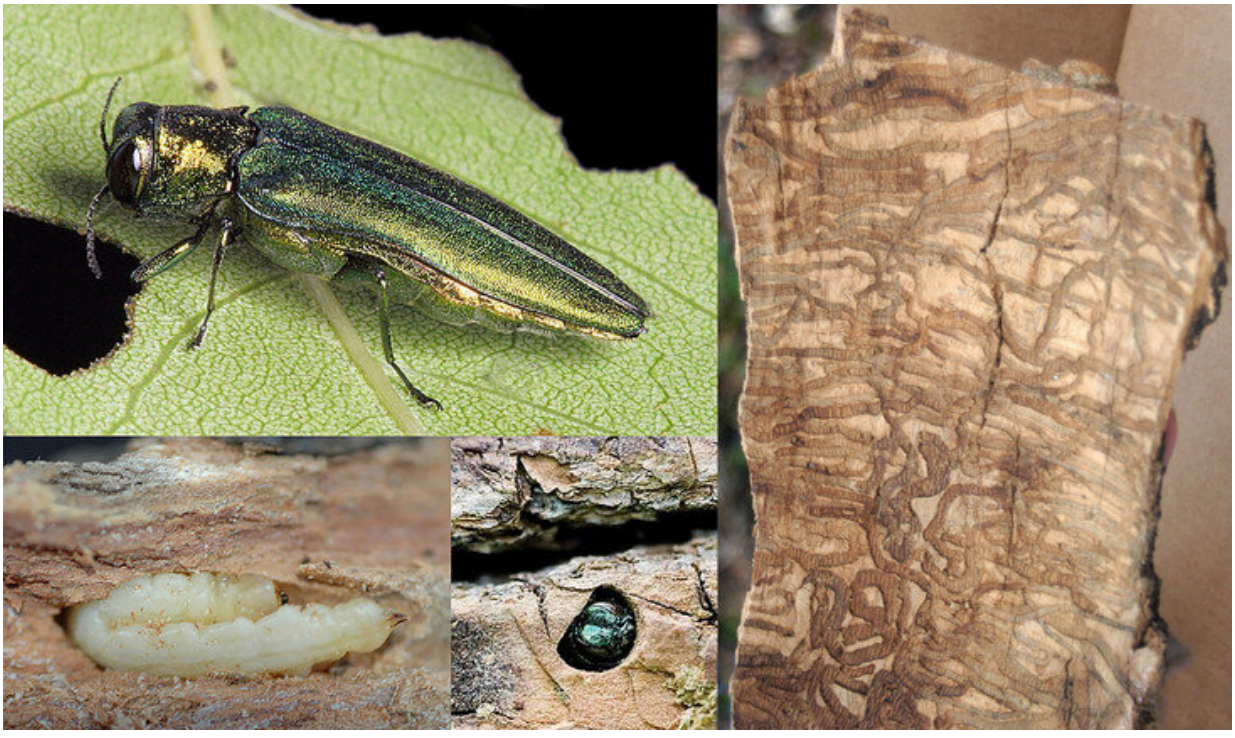
Although final destruction was nearly complete, genetics moderated the

rapidity with which emerald ash borers injured and killed trees, noted Lake Graboski, Steiner's assistant, who earned a master's degree in ecology at Penn State.

"This suggests that some ash genotypes, especially on favorable sites, will survive with lower densities of emerald ash borer beetles on the landscape," he said.

The fact that some trees survived longer means there are heritable genetic differences among trees from different populations and seed parents, Steiner added.

"For the first time, this study demonstrated that there is genetic variation that could be captured in a breeding program to improve resistance to emerald ash borer in both white ash and green ash species," he said.



Four views of the emerald ash borer, the invasive insect that is wiping out green and white ash trees: adult beetle (top, left) pupa found under the bark (lower left) beetle peering out of a characteristic D-shaped hole that they bore, and a section of a dead ash tree, showing how the insects girdle and kill a tree by boring under the bark. Credit: DAVID CAPPAERT/BUGWOOD.ORG, GREG HOOVER/PENN STATE, MISSOURI DEPARTMENT OF CONSERVATION, WISCONSIN DEPARTMENT OF NATURAL RESOURCES

There are three kinds of resistance to insects commonly exhibited by trees, Steiner explained, and more research will be needed to determine which ones the ash trees may be deploying. One is avoidance, when a tree doesn't attract the adult females that are flying between the trees as they look for a place to lay their eggs. A tree may accomplish this by not emitting a chemical signal the insects are homing in on.

The second is surviving attack. Adults lay insect eggs on a tree, the larvae hatch and the insects grow into adulthood, all the while causing damage, but the tree is vigorous enough to withstand that injury.

The third mode of resistance involves the tree producing compounds—or alternately, not producing compounds—that reduce the likelihood the larvae will survive to adulthood, either by actively killing the larvae or by not offering the nourishment they need.

The irony of addressing a modern-day ecological disaster, such as the emerald ash borer invasion, with research done in a 43-year-old experimental plantation intended to serve an entirely different purpose, was not lost on Graboski.

"Dr. Steiner planted those ash trees long before I was born, and the ultimate fate of the ash species may not be decided in my lifetime

because the trees must evolve to survive attacks by the invasive beetles," said Graboski. "That is just the reality of working with trees."

Penn State students Jennifer Berkebile, Mackenzie Kessenich and Chao Ma; and K. S. Knight, J. L. Koch and M. E. Mason, U.S. Department of Agriculture Forest Service, Northern Research Station in Delaware, Ohio, also were involved in the research, published recently in *Biological Invasions*.

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