FEATURE | THE PLANET

Tiny, Murderous Wasps Are Fighting The Bizarre Effects Of Climate Change

Michigan's Pokagon Band of Potawatomi Indians refused to stand by and watch as a weird green bug chewed through their sacred trees

by Liana Aghajanian

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ABOUT TEN YEARS AGO, the black ash trees that had long been a familiar fixture of suburban Detroit started turning yellow, getting thin, and dying off. It was a strange, almost surreal phenomenon, given that the species is particularly hardy—individual specimens are known to enjoy centuries-long lifespans. And for the Pokagon Band of Potawatomi Indians, the tree was part of a vital basket-making tradition dating back at least a thousand years. So when distressed black ashes started sprouting unusual, fast-growing shoots along their trunks as a means of self-preservation, local arborists called David Roberts for help diagnosing the problem.

To Roberts, Michigan State University plant pathologist and horticulture agent for Southeast Michigan, the answer was initially obvious: ash yellows, a relatively common bacterial disease. But, when he stripped away the bark on a black ash sample, he discovered a much more insidious culprit: a never-before-seen white beetle larvae that was chewing its way through the tree's insides and blocking off any incoming nutrients.

From feral pigs to fire ants, invasive species have been accidentally and intentionally emigrating to America with their human counterparts for centuries, rapidly spreading across new habitats devoid of natural predators. And in recent years, these outsiders have been given a surprisingly effective tool in their efforts to take over: climate change. As weather warms, invasive species are spreading further than ever before, often harmfully transforming entire ecosystems in the process. To vulnerable native populations like the Pokagon, invasive species arguably pose a threat more elusive than the Dakota Access Pipeline to the Standing Rock Sioux—but it's every bit as destructive to the land, the economy, and the culture.

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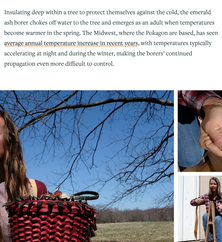
What was that odd little larvae? Roberts had no idea until a glimmering green beetle-like adult insect emerged from an ash tree in his lab at MSU, several months after he began his initial research. The bug proved nearly impossible to identify. Roberts reached out to experts from the Smithsonian Institute in Washington, D.C., and the London Natural History Museum, yet no one could decipher the creature's identity. But, when the samples reached entomologist and beetle specialist Eduard Jendek from the Institute of Zoology at the Slovak Academy of Sciences in Bratislava, Slovakia, they were at last correctly identified as *Agrilus planipennis Fairmaire*, originally named in 1888 by French entomologist Léon Fairmaire. Back in Michigan, scientists came up with a name that would be a little friendlier to the layperson, eventually settling on "emerald ash borer."



APHIS laboratory director Benjamin Siegel holds a live emerald ash borer.

Once its existence was official, "You might say all hell broke loose," says Roberts. "Everyone became interested in it. There were several tours a week for a while, and many of the scientists who saw this thought this was going to be the next major invasion."

Deborah McCullough, a professor in the department of entomology at Michigan State University who also worked on the investigation, certainly did. She recalls heading out to the field with Roberts and taking a chainsaw to a black ash, peeling off some bark, and finding an astonishing population of ash borers in the tree. She came home that night and told her husband that this could be "a big deal. ... I had never heard of anything attacking ash trees of that density anywhere," she says.

Roberts' team postulated that a few borers had first arrived—at least a decade before being discovered in Michigan in 2002—on crates from their native China, where ash trees are naturally more resistant. New populations were created when people unwittingly transported infested ash trees as firewood across state lines. By the time Roberts identified the bug, there was no way of stopping it. It had already spread across the Canadian border and was on its way to Ohio, Maryland, Indiana, and Virginia.

Midway through 2015, 25 states and two Canadian provinces confirmed outbreaks. The U.S. Forest Service estimates that emerald ash borer costs add up to at least $1 billion each year. The tiny pest, which leaves an oddly brilliant craftwork beneath the bark it eats from the inside out, is now responsible for the destruction of over 50 million ash trees, an impact is so severe that the emerald ash borer's reign has been compared to the devastating spread of Dutch elm disease, which wiped out forests after being introduced in 1928 via imported lumber.

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Insulating deep within a tree to protect themselves against the cold, the emerald ash borer chokes off water to the tree and emerges as an adult when temperatures become warmer in the spring. The Midwest, where the Pokagon are based, has seen average annual temperature increase in recent years, with temperatures typically accelerating at night and during the winter, making the borers' continued propagation even more difficult to control.

Jannie and her daughter Jamie Brown strip black ash tree bark in their front yard in Shelbyville, Michigan. The Browns are members of the Pokagon Band of Potawatomi, who make baskets out of black ash tree bark. The bark is pounded, stripped, and softened in order to make intricate baskets.

Emerald ash borers have destroyed 90 percent of the trees that once populated the ancestral lands of the Pokagon in Southwest Michigan. For the Brown family, part of the Pokagon Band of Potawatomi, the loss still stings. "We had so many trees. It was easy just to go out there and choose. It's sad now when you go out there, you can just see all the dead trees are pretty much the black ash trees in the swamp," says 24-year-old Jamie, as she strips black ash bark in the backyard of her home in Shelbyville, Michigan.

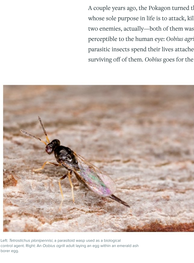
Jamie learned how to make baskets when she was just 8 years old from her uncle Ed Pigeon, who learned from his own parents, and so on. Together, the family has gone into the woods on the tribe's ancestral lands to choose the perfect tree that would eventually be transformed into sacred ceremonial baskets. The Pokagon's use of the tree can be traced back to a tribal leader named Black Elk, who received instructions in a vision to turn the trees into baskets—along with making sure that when he died, his ashes would be burned and scattered in the woods. So the legend goes, from his ashes, a new tree would rise.

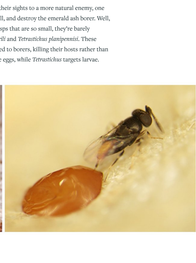
Pokagon baskets—made by pounding ash trunks until the tree gives way to thin, pliable layers that are then soaked and looped together—are more than a revered ritual for families like the Browns, who make income from selling their craftwork. The tree Jamie is working on has knots, and would not normally be an appropriate choice. But finding any trees, let alone those suitable for basket making, has become infeasible.

Like many Native Americans, the Pokagon practice "seven-generation stewardship," essentially a proactive look at how the present can impact the future. Rather than stand by and watch as their cultural heritage is decimated by an insect only 10 millimeters long, they decided to join forces with scientists to implement an experimental plan to restore the black ash tree.

Three years ago, their only defense was a toxic insecticide called Tree-Age. The Pokagon have treated approximately 5,500 trees with Tree-Age, which is lethal to the emerald ash borer through ingestion via bark. Administration of the insecticide requires a special permit and training and only protects trees for around two years. It also isn't necessarily safe for basket makers—contact with it on eyes and clothing is harmful—nor is it financially and logistically sustainable to treat all the trees. A single liter costs $520.

A couple years ago, the Pokagon turned their sights to a more natural enemy, one whose sole purpose in life is to attack, kill, and destroy the emerald ash borer. Well, two enemies, actually—both of them wasps that are so small, they're barely perceptible to the human eye: *Oobius agrili* and *Tetrastichus planipennis*. These parasitic insects spend their lives attached to borers, killing their hosts rather than surviving off of them. *Oobius* goes for the eggs, while *Tetrastichus* targets larvae.





Left: *Tetrastichus planipennis*, a parasitoid wasp used as a biological control agent. Right: An *Oobius agrili* adult laying an egg within an emerald ash borer egg.

The Pokagon first learned how to weaponize these insects from a team of scientists in a lab about 40 miles from Detroit in the town of Brighton, after the tribe received a grant from the United States Animal and Plant Health Inspection Service to treat hundreds of black ash trees. Run by APHIS, part of the U.S. Department of Agriculture, the Plant Protection and Quarantine Biological Control production facility lab—the only one of its kind in the United States— is dedicated to rearing parasites to kill the emerald ash borer across several states. The lab vigorously tents and breeds *Oobius* and *Tetrastichus*, as well as two other wasps, *Spathius agrili* and *Spathius galinae*, the latter of which is from Russia and was approved for rearing and releasing at the lab this year.

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Located just off Grand River Avenue, the lab looks like an average office building from the outside. Inside, a staff of 11 works feverishly, darting between several humid, cold, and room temperature lockers, containing both borers and the species of insects identified as the best defense against them. The process for rearing and preparing the wasps for dispatch starts in a hot and humid basement where rows of barrels are filled with borer-infested ash tree logs, donated mostly by members of the public from various places in Michigan, as so many black ash trees have been destroyed that it can take scientists up to three hours to travel to the nearest viable specimens. Researchers collect around 100 to 150 of the borers from the logs every day and use their eggs and larvae to rear the parasitic wasps.

Like the borer, these parasitoids come from China, where natural enemies keep both predator and prey in balance. Ben Slager, who runs the APHIS lab, says it helps when species co-evolve. "We definitely have predators here that go after emerald ash borers, but not with the same specificity as these do."

At left, a lab scientist handles parasitic wasps reared at the APHIS facility in Brighton, Michigan. The lab wears four different wasps being used as biological controls against the emerald ash borer. At center and pictured at right, director Benjamin Slager checks infested logs.

Production, testing, and release of the wasps tends to occur between May and September, with thousands of parasitoids provided free of charge to state governments from Louisiana to Colorado. Last year, the lab shipped a million parasitoids via UPS, and thousands of them arrived at the office of Bogosian, the natural resources manager of the Pokagon Band. The parasitoids arrive in a Styrofoam box, tucked into another cardboard box, via standard mail. A cool pack accompanies the package to keep it from overheating, along with explicit instructions on how to safely handle the bags.

Over the last two years, Bogosian, walking through thick mud, has set 50,000 wasps on the Pokagon's lands, with croaking frogs providing the soundtrack of the Pokagon's forest, where remnants of dead ash trees haunt the landscape. In China, he says, the wasps typically only kill sick or weak borers—a biologically normal, sustainable process. "That's what the parasite introductions are for—the hope is to create something like that here, where we have these natural controls on them, rather then throwing our hands up and saying there's nothing we can do."

After investing more than a decade on the fate of the black ash, McCullough is cautious about how much of a difference the wasps will make, describing the current black ash situation as bleak. "It's an option," she says. "I know a lot of money is being invested in those parasitoids for release. I think it's important to realize they're not going to have a dramatic effect, at least not right away."

Research bears this out. In a 2015 study published in the *Journal of Ecology* using wasps reared in the lab, scientists observed a 90 percent decline in densities of live borer larvae in infested ash trees at two plots from 2009 to 2014. Though no significant differences were found in adult borer density, the decline in larvae density was correlated with the presence of *Tetrastichus planipennisi*, the same wasp the Pokagon are released on their land.

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The lab estimates it will be seven years before wasps will make a demonstrable effect on the emerald ash borer. Determining the impact from these releases are also very laborious to gather and take years of collecting before analysis can begin, says Slager. Bogosian will work with the APHIS team to monitor the impact of the wasps through early 2018. Fortunately, what has come back from initial releases is promising, with 10 states reporting that the parasitoids are starting to take hold and spread, according to Slager. "It's the next generations of trees that will have the greatest benefit."

As Bogosian, natural resources manager for the Pokagon Band of Potawatomi, checks a parasitoid wasp release point on Intar land in Dowagiac, Michigan. The Pokagon are releasing parasitoids on their land, in hopes of helping future generations of black ash trees, which are important to their cultural survival.

This type of biological control gives hope to tackling many other harmful invasive species, which often cannot be eradicated from the environments they inhabit. After years of research and testing, scientists are introducing natural and new predators that will specifically go after invasive species. In 1986, the invasive flower purple loosestrife was controlled using the Galerucella leaf-eating beetle. A fungus from Japan, first introduced in 1910, is being used to eradicate invasive gypsy moth populations.

As of last month, out of 83 Michigan counties, only three were not subject to quarantine rules prohibiting the moving of firewood, where violators would face penalties up to $250,000 and five years in jail. Borer infestations have recently been reported in cities in Kentucky, Maryland, Minnesota, and beyond. McCullough says she recently returned from London, where she spoke to colleagues who confirmed that scientists from Western Europe to Russia are now very concerned that they're facing their own borer infestations.

The Browns, however, are optimistic. "God has everything in its time, so if they die, there's going to be something else for us to do," Jamie says. That hopeful spirit is replicated in the black ash tree itself, which, in a last ditch effort to carry on, always expels its seeds before it dies. Several of those saplings will sprout, life emerging from death, the sacred legend of Black Elk carrying on. ●

Parasitic wasp photography via Wikimedia commons by USDA-APHIS, Jian Duan and Stephen Ausmus. All other photography by Keegan Shamlian.

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