Under the canopy: Researchers study beech leaf disease in Pennsylvania forests

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Beech trees affected by beech leaf disease produce leaves with a distinctive banded pattern, according to Penn State researchers. Credit: Mihail Kantor

In the woods of the northeastern U.S., a strange disease is creeping through the canopies. Spreading quickly, it causes leaves and branches to wither and, in many cases, the tree to eventually die.

The arboreal ailment—beech leaf disease—currently has no known treatment or cure, putting large swaths of trees or even entire forests in jeopardy. But researchers in Penn State's College of Agricultural Sciences are on the case, spearheading ongoing efforts to learn more about the disease and how to combat it.

"This is a big problem for our forests, as well as the trees in our own backyards," said Cristina Rosa, associate professor of plant virology. "Many species of wildlife depend on beech trees for food and shelter, in addition to the Pennsylvania citizens who value the forests for recreation. It's vital that we learn more about this disease and how, eventually, to overcome it."

While beech leaf disease first was observed in Ohio in 2012, it is now particularly widespread in Pennsylvania, with all 67 counties currently affected, said Mihail Kantor, assistant research professor of nematology. Early symptoms of the disease include a dark green banding pattern between the veins of leaves before more severe symptoms spread to the rest of the tree.

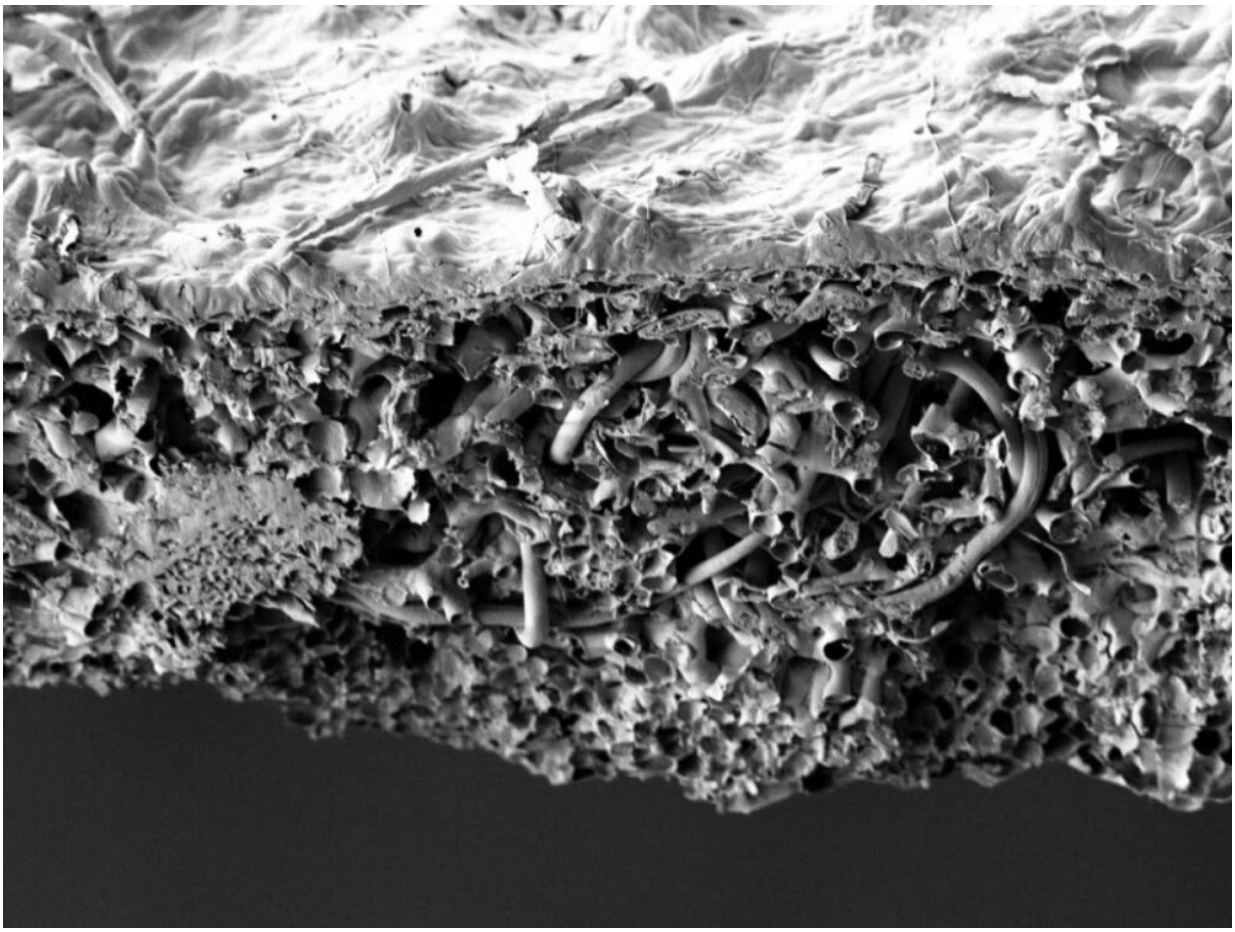
While the exact cause and mechanism of the disease is under investigation, Kantor said researchers now know that infection with beech leaf disease is associated with a particular species of nematode—tiny worms that feed on plant cells, bacteria, fungi and other microscopic creatures.

This nematode species, Litylenchus crenatae mccannii, was previously found to be associated with trees suffering from the disease.

"Based on data from a research collaboration with scientists from the U.S. Department of Agriculture's Agricultural Research Service, we know the nematodes enter the buds and feed on the leaves while they're still developing within the bud, which can cause morphological changes in the leaf," Kantor said. "And then, when the buds open, the nematodes can spread among the leaves. But we're not sure if the nematodes are the only ones causing the disease, or if, for example, they somehow facilitate other pathogens to enter the plant cells and cause the infections."

To help better understand the disease, the researchers are currently examining how beech leaf disease is affecting trees in Pennsylvania's Allegheny National Forest. In collaboration with the U.S. Forest Service, they identified 50 sites within the forest that contained beech trees.

Andrew Miles, a graduate student in plant biology, took the lead in traveling to the sites last fall to gather data on what symptoms were present and their severity.



While the exact cause and mechanism of beech leaf disease is under investigation, researchers now know that infection with beech leaf disease is associated with a particular species of nematode — tiny worms that feed on plant cells, bacteria, fungi and other microscopic creatures, pictured here on a cross-section of a leaf with a highly disorganized mesophyll layer visible in the interior. Credit: Mihail Kantor

"Because the Allegheny Forest is Pennsylvania's only national forest, it's really important for recreation and ecologically," Miles said. "My grandfather has hunted there since the 1930s, and he's also noticed those distinctive bands in the forest canopy. So, people who utilize the forest for recreation are starting to get very concerned."

Using this data from more than 200 trees, Miller created a disease severity map to illustrate the spread and intensity of beech leaf disease across the forest. The researchers found that about 90% of the sites—including very remote locations and different types of wooded areas—contained trees that were infected with beech leaf disease.

As part of the project, the research team also examined the differences between infected and noninfected leaves on a microbial level, an effort led by Sharifa Crandall, assistant professor of soilborne disease dynamics and management.

"Microbes interact directly with plants and the environment and are a critical component of tree health," Crandall said. "Fungi and bacteria, for example, can have beneficial or pathogenic interactions with plants, just like the microbes on our skin and digestive tract. We wanted to understand which microbial community members are associated with beech leaf disease and what we can hypothesize about their function."

The team took tissue from both infected and noninfected leaves that were gathered from different sites in the Allegheny National Forest and identified specific groups of bacteria and fungi that were associated with the disease.

One finding was a direct correlation between the bud and leaf microbiome in diseased tissue, where shifts in the composition occur before the bud breaks and the leaf emerges. This, according to the researchers, indicates that the stage at which leaves develop in the bud could have a role in shaping the interaction between the host microbiome and/or beech leaf disease pathogens.

While they have some explanations, the researchers said, they still have many questions to answer to understand the disease. For example, they will repeat the microbiome analysis over the spring and early summer to

see if results differ from those found in the fall. Additionally, while scientists know that nematodes are present in trees infected with beech leaf disease, they're not clear about how nematodes travel through the canopy.

Crandall said it's important for the public, as well as the scientific community, to continue to push for more studies, in addition to their ongoing research.

"Beech leaf disease is a significant threat to our hardwoods in Pennsylvania and in the northeastern U.S.," she said. "Beech forests provide habitat for wildlife and important ecosystem services, such as erosion control and carbon storage, and are important to humans for recreation, including natural spaces for rest and repose."

Provided by Pennsylvania State University

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