ScienceDaily
Your source for the latest research news

Web address:
http://www.sciencedaily.com/releases/2007/10/071012084128.htm

Invasive Plant Secretes Acid To Kill Nearby Plants And Spread

ScienceDaily (Oct. 15, 2007) — Scientists at the University of Delaware have uncovered a hidden weapon that one of the most invasive wetland plants in the United States uses to silently and efficiently “bump off” its neighbors.

UD plant biologist Harsh Bais (left) and postdoctoral researcher Thimmaraju Rudrappa examine a specimen of Phragmites, one of the most invasive plants in the U.S. (Credit: Photo by Kathy F. Atkinson)

The invasive strain of Phragmites australis, or common reed, believed to have originated in Eurasia, exudes from its roots an acid so toxic that the substance literally disintegrates the structural protein in the roots of neighboring plants, thus toppling the competition.

“Phragmites is taking over the marsh world,” said UD plant biologist Harsh Bais. “It's a horticultural disaster.”

In Delaware alone, the tall, tasseled grass has overtaken tens of thousands of acres of wetlands, decreasing biodiversity, reducing the food and habitat available to wildlife, and altering wetland hydrology, transforming marshes once dissected by tidal creeks and open pools into much drier systems with dense monocultures of the plant.

Bais, who led the project, is an assistant professor of plant and soil sciences in UD's College of Agriculture and Natural Resources and holds an appointment at the Delaware Biotechnology Institute. His collaborators included postdoctoral researcher Thimmaraju Rudrappa, undergraduate student Justin Bonstall, and marine botanists John Gallagher and Denise Seliskar, who co-direct the Halophyte Biotechnology Center in UD's College of Marine and Earth Studies.

The results of the research are reported in the Journal of Chemical Ecology.

Bais is an expert on allelopathy, in which one plant produces a chemical to inhibit the growth of another plant. He refers to these plants with the capability to wage chemical warfare as “natural killers.”

Walnut trees, pine trees, ferns and sunflowers are among the plants that release harmful chemicals to prevent other plants from growing too close to them.

However, Phragmites uses this strategy not so much to keep other plants away, but to aggressively conquer them and invade new territory.

“We've seen this capability in a number of invasive plants that have come from Eurasia, such as garlic mustard,” Bais said. “The roots exude a toxin that kills native plants.”

In laboratory analyses at the Delaware Biotechnology Institute, Rudrappa and Bais used activated charcoal, the material in aquarium filters, to sequester secretions from both invasive and native Phragmites plants. The charcoal attracts and traps organic chemicals.

The scientists identified the toxin produced by Phragmites as 3,4,5-trihydroxybenzoic acid. Also known as gallic acid, it is

used for tanning leather, to formulating astringents.

“It's nasty stuff,” Bais said. “If you get some of it on your skin, you definitely know it.”

The toxin works, Bais said, by targeting tubulin, the structural protein that helps plant roots to maintain their cellular integrity and grow straight in the soil. Within 10 minutes of exposure to the toxin in the lab, the tubulin of a marsh plant under siege starts to disintegrate. Within 20 minutes, the structural material is completely gone.

“When the roots collapse from the acid, the plant loses its integrity and dies,” Bais noted. “It's like having a building with no foundation--it's on its way to self-destruction.”

The native Phragmites also secretes the toxin, but the exotic strain releases much higher concentrations, which could be a key to its dominance, Bais said.

Today in Delaware, stands of native Phragmites are few and far between. Bais credits Gallagher and Seliskar, who have conducted extensive research on the plant, for growing sterile cultures of the native and exotic strains for his lab tests.

“This research reveals another weapon in the arsenal that Phragmites uses to overtake marshland,” Seliskar said.

“Screening large numbers of marsh plants to identify those that are naturally resistant to invasive Phragmites may be one avenue for preserving the native strain, as well as controlling the invasive's spread,” Bais noted.

With the current discovery in hand, Bais said he hopes to pursue further research to pinpoint exactly how the invasive Phragmites has become such a “super weed.” Such information could help scientists and environmental managers gain a foothold in halting Phragmites' rapid advance across the United States.

“We now know this plant secretes a toxin underground, but could it have a partner in crime?” Bais asks. “Could there be some kind of microbe, a deleterious pathogen, that is associated with this plant? And does this plant use changing environmental systems to its advantage? We just don't know the answers yet, but we'd like to find out.”

The research was sponsored by the Experimental Program to Stimulate Competitive Research (EPSCoR), a partnership of the National Science Foundation, the state of Delaware and Delaware's institutions of higher education. The program is managed by UD's Delaware Biotechnology Institute.

Adapted from materials provided by University of Delaware.