Beating the Australian Bush for Melaleuca's Enemies

A small, hard-working fly and its nematode companion may help stop the spread of melaleuca, a weedy, invasive tree that threatens to take over Florida's Everglades. Melaleuca outcompetes native plants and is blamed for environmental losses of up to $168 million yearly.

The beneficial fly, a member of the *Fergusonina* genus, is a natural enemy of melaleuca, or paper bark tree. The nematode—a transparent, microscopic worm—lives inside the fly. The duo may eventually join another biological control agent from Australia, the melaleuca leaf weevil, in an effort to halt melaleuca's Florida rampage.

ARS scientists with the Australian Biological Control Research Laboratory in Indooroopilly—just outside of Brisbane and about 500 miles north of Sydney—collected the golden-brown *Fergusonina* fly from throughout its native range in Australia. Their laboratory, outdoor, and greenhouse tests determined that the insect attacks melaleuca exclusively and poses no risk to other plants.

"That's one of the most important challenges this fly has to meet if it is ever going to be released outdoors in Florida," notes laboratory director John A. Goolsby, an ARS entomologist. His team was the first to single out the insect, nicknamed the "melaleuca bud gall fly," as a potential natural control of the aggressive melaleuca.

In their experiments, Goolsby and coworkers with Australia's Commonwealth Scientific and Industrial Research Organization, or CSIRO, caged the little fly on test plants to see if it could successfully attack them. The procedure is known as host-specificity testing.

"We found that this *Fergusonina* species is unlikely to survive and reproduce on any species other than *Melaleuca quinquenervia*, the plant that's on the move in Florida," Goolsby says. This information was critical to garnering approval by the State of Florida to ship thousands of *Fergusonina* flies to Gainesville for further testing by ARS colleagues and University of Florida researchers. "We've now sent more than 28,000 *Fergusonina* flies to Gainesville," says Goolsby. Gary R. Buckingham, an ARS entomologist, heads that host-specificity testing. He's with the ARS Invasive Plant Research Laboratory's Gainesville team.

SUSAN WINERITER (K9402-1)

***Fergusonina* fly.**

The flies made the 9,200-mile trip inside melaleuca galls. These mostly marble-sized swellings appear shortly after the *Fergusonina* female lays her eggs in melaleuca buds. The tree forms the round, pinkish-red or green galls where buds would have otherwise developed into branches. Some of those branches would have produced flowers that are vital for new seed.

JIM PLASKOWITZ (K9389-20)

Scanning electron micrograph of *Fergusonina* fly eggs (the dropletlike structures) and associated juvenile *Fergusobia* nematodes in a melaleuca flower bud. Magnified about 350x.

Galls make a snug home in which the fly offspring and their nematode friends can develop. Both species feed on the fleshy interior of the gall.

To learn more about the *Fergusobia* nematode and—most importantly—to ensure it allies only with the *Fergusonina* fly that attacks *Melaleuca quinquenervia*, ARS entomologist Ted D. Center arranged for nematode expert Robin M. Giblin-Davis of the University of Florida to work in Australia on an intensive, 5-month stint. Center is in charge of the ARS Invasive Plant Research Laboratory, which is headquartered in Fort Lauderdale, Florida. In Australia, Giblin-Davis collaborated with Goolsby, Matthew F. Purcell, and Jeffrey Makinson at Indooroopilly, and with Kerrie A. Davies and Gary S. Taylor of the University of Adelaide.

Team Works In Tandem

"The fly and the nematode," says Giblin-Davis, "appear to have a mutually beneficial relationship. A well-known example of this kind of association is the wood-eating termite's relationship with cellulose-eating bacteria or protozoans that live in its gut. These organisms help the termite digest its food. In return, the termite provides protection for the bacteria and an opportunity for them to spread.

"In the fly-nematode partnership," Giblin-Davis explains, "the female fly helps ensure the nematode's survival by carrying nematode young in her ovaries and depositing them—along with her own eggs—into melaleuca buds. The nematode, in return, causes melaleuca to form galls, which offer food and shelter for the young of both species."

The female *Fergusonina* fly lays an average of 24 white,

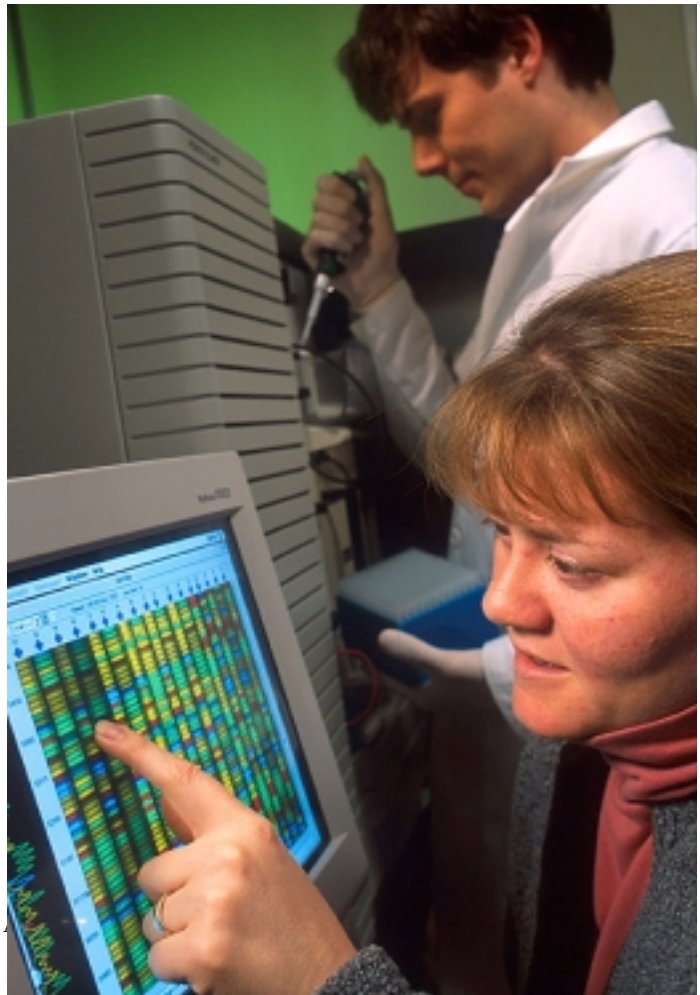
dropletlike eggs, accompanied by about 76 nematode young. While in the melaleuca buds, the nematodes develop into females that reproduce without mating. The females produce a new generation of both sexes. Within a few days, these young nematodes mate. The mated females slip harmlessly into the developing *Fergusonina* fly females and lay their eggs inside her. When the nematode eggs hatch, the new little nematodes travel to the fly's ovaries—then exit her body when she lays her eggs some 3 days later.

To find out if other flies and their nematode partners inhabit *Melaleuca quinquenervia,* Giblin-Davis traveled more than 8,000 miles through Australia, collecting flies and nematodes from melaleuca, eucalyptus, and other closely related plants. In addition to his own examinations, and those of Davies and Taylor, Giblin-Davis sent specimens for analysis to Sonja J. Scheffer of ARS' Systematic Entomology Laboratory in Beltsville, Maryland, and W. Kelley Thomas at the University of Missouri, Kansas City.

"DNA analyses and other tests by these scientists," says Center, "clearly show that the *Fergusonina* fly and *Fergusobia* nematode collected from *Melaleuca quinquenervia* are genetically different from other fly-nematode pairs that attack other melaleucas and eucalypts. Apparently, these teams have evolved to live, eat, and reproduce only within a particular plant species." If the fly and nematode pass host-specificity tests in Florida, ARS scientists will likely seek federal and state permission to turn the pair loose at melaleuca-infested sites throughout the Everglades.

Systematist Sonja Scheffer and technician Matt Lewis use an automated DNA sequencer to obtain genetic data for investigating relationships between *Fergusonina* flies and *Fergusobia* nematodes.

KEITH WELLER (K9389-3)



SUSAN WINERITER (K9402-2)

Melaleuca galls make a snug home where *Fergusonina* fly offspring and *Fergusobia* nematodes can develop.

"We'll probably begin at sites where the melaleuca leaf weevil—also known as the melaleuca snout beetle or *Oxyops vitiosa*—isn't living, so we can evaluate these biological control agents independently of one another," says Center. Four years ago, ARS scientists in Florida and Australia and their collaborators were the first to complete the extensive research needed before the small, grey-brown beetle could be put to work to curb melaleuca in the United States.

"Since 1997," Center says, "we've placed more than 53,000 melaleuca snout beetles in and around the Everglades. Many beetle colonies are now thriving. We think the *Fergusonina* fly and the *Fergusobia* nematode would complement the beetle's work, and significantly strengthen our attack on melaleuca."—By **Marcia Wood** and **Jesús García,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at http://www.nps.ars.usda.gov.

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