Status and Impacts of the Melaleuca Biological Control Program

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The biological control program for ***Melaleuca quinquenervia*** (melaleuca), an invasive tree in South Florida, began in the mid 1980s with the hunt for natural enemies in the tree's native range in Australia. More than a decade later, two insects have successfully run the gauntlet of quarantine-based host specificity testing and emerged as promising biological control agents in the fight to tame melaleuca. Six years after the first biological control agent release, feeding by the two insects is having a dramatic effect on melaleuca throughout southern Florida.

The melaleuca biological control program is spearheaded by the USDA Agricultural Research Service (ARS) Invasive Plant Research Laboratory (IPRL) in Fort Lauderdale, and relies heavily on support from a number of other agencies, including the Army Corps of Engineers, the South Florida Water Management District (SFWMD), the University of Florida, the Florida Department of Environmental Protection (DEP), the Departments of Environmental Resource Management (DERM) in Broward and Miami-Dade Counties, and Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). As documented in the Melaleuca Management Plan (Laroche, 1999), the goal of the program was to complement removal efforts of land managers by slowing the spread of remaining infestations, thereby reducing the risk of new invasions and reinvasion of treated areas. To accomplish this, biological control agents were sought that would reduce melaleuca flowering and therefore seed production, and that would inhibit seedling growth and regrowth on cut stumps. This article describes how the two biological control agents already introduced for melaleuca management are meeting and even surpassing program goals.

[from top] Oxyops *weevil adult;* Oxyops *weevil larvae; Branch on right has been damaged by weevils.*

THE BIOLOGICAL CONTROL AGENTS

The first melaleuca biological control agent, the Australian melaleuca snout weevil ***Oxyops vitiosa***, was released in 1997 (Center et al., 2000). Both adult and larval stages of the weevil are foliage feeders, preferring tender new leaves (Purcell and Balciunas, 1994), although the majority of weevil damage is a result of larval feeding. Larvae feed externally, skeletonizing leaves by scraping tender tissue from the surface. Weevil-damaged leaves and branch tips dry out, become brittle, and break off.

The Australian psyllid ("SILL-id"), ***Boreioglycaspis melaleucae***, was the second melaleuca biological control agent introduced into South Florida, in 2002 (Wood and Flores, 2002). Like the weevil, the psyllid feeds on leaves and the immatures (nymphs) do most of the damage (Purcell et al., 1997). But unlike the weevil's chewing mode of feeding, the psyllid uses its piercing-sucking mouthparts to penetrate the leaf surface and feed on sap within the plant's phloem. The psyllid prefers to feed on tender foliage but will feed on older leaves as well, especially when psyllid populations are high and the amount of fresh foliage is limited. Psyllid nymphs secrete honey-dew, which hardens into small crystalline droplets. They also excrete white, waxy filaments that look like cotton when large quantities build up on plant surfaces. These white filaments, called flocculence, make detection of psyllids in the field easy despite their small size. Additional signs of psyllid feeding include leaf discoloration, which changes from yellow to red or brown, leaf desiccation and, ultimately, leaf drop.

[from top] Psyllid adult; Psyllid nymphs; Psyllid flocculence.

AGENT ESTABLISHMENT AND SPREAD

Both the melaleuca weevil and psyllid have readily established at release sites, particularly when releases coincided with a new flush of growth on the trees. The one notable exception is that weevil populations failed to establish in permanently aquatic habitats (Center et al., 2000). This is because the weevil spends part of its life cycle in the soil, falling to the ground to pupate. If the area is flooded for an extended period of time, the pupae drown. In contrast, the life cycle of the psyllid is completed entirely in the tree canopy where it is not affected by flooding.

After initial release and establishment, melaleuca biological control agents have the potential to spread unaided throughout melaleuca infested regions because both weevil and psyllid adults fly. Studies on the weevil estimated an average rate of spread of 0.6 miles per year (Pratt et al., 2003). At that rate, weevil populations were estimated to take 20 years to saturate Florida's melaleuca infestations. To expedite spread, a weevil collection and redistribution program was begun, organized by researchers at the IPRL, funded by DEP and DERM, and powered by labor from Student Conservation Association/AmeriCorps interns and the UF Cooperative Extension Service. The weevil redistribution program has so far collected almost 300,000 weevils and released them at 150 sites throughout southern and central Florida. Weevils are now present in at least half of the state's counties reported to have melaleuca infestations.

Much smaller and lighter than weevils, psyllids are dispersing as far as 6.8 miles per year, with an average rate of spread of 4.3 miles per year (Paul Pratt, unpublished). To expedite the landscape level impacts of psyllid populations, a collection and redistribution program also is underway for this insect. As of the fall of 2003, more than 450,000 psyllids have been released at 26 sites in Florida. The psyllid now appears to be as ubiquitous as the weevil, if not more so.

IMPACTS

In addition to the introduction and establishment of agents, a critical phase of a biological control program is follow up research on post-release activity of the agents. Scientists at the IPRL are currently quantifying impacts of melaleuca biological control agents on the target tree and surrounding vegetation, and determining how to most effectively integrate biological control with conventional control methods as detailed in the Melaleuca Management Plan.

Melaleuca on right was exposed to biocontrol insects while trees on left were protected with insecticide applications. Trees were of similar size when study began.

As part of the approval and permitting process for release, both the melaleuca weevil and psyllid underwent rigorous laboratory studies to insure they would damage only melaleuca and pose no threat to desirable plants or native vegetation (Balciunas et al., 1994; Purcell et al., 1997; Wineriter et al., 2003). Following release and establishment of the two agents in Florida, garden plots and field studies were conducted to confirm that the insects' specificity for melaleuca as a host in the laboratory held true in the field as well. Results from these studies showed that the biological control agents consistently selected melaleuca over other species for egg laying and feeding. When adult melaleuca weevils, for instance, were placed directly onto foliage of native plants (i.e., *Myrica cerifera*, *Eugenia rhombea*, *Calyptranthes pallens*, etc.) 78% of the insects dispersed in search of melaleuca trees within 3 hours and all abandoned the plants within 32 hours. While adult weevils may rest temporarily on native plants, sustained feeding or oviposition (completion of development) on native species has not been observed after three years of field assessments. Consistent with quarantine testing results, minor weevil feeding does occur on the Australian bottlebrush trees *Melaleuca* (=*Callistemon*) *viminalis* and *M. rigidis*.

Psyllid flocculuence and feeding damage on melaleuca flowers.

Undamaged melaleuca flower (left) and weevil-damaged flower.

Because melaleuca exhibits terminal growth, with new vegetative and reproductive buds emerging at branch tips, the biological control agents' feeding preference for new tips was predicted to hinder both growth and flowering of trees. In an ongoing study of biological control agent impacts on melaleuca saplings, trees that were not protected with insecticides and growing under drier, west coast conditions increased in height only 9.8% in 23 months and produced no flowers. Trees growing in wetter, east coast conditions increased in height by 22.6% during the same period and produced an average of 0.3 flowers per tree. In contrast, trees that were protected from the biological control agents with insecticides and growing under drier conditions increased in height more than 100% and produced an average of 4.6 flowers per tree. Finally, trees growing under wet conditions and protected with insecticides were able to increase their height by 127.2% and produce an average of 34 flowers per tree during the study period.

A separate study found that weevil feeding alone can reduce flowering and subsequent seed production by as much as 80% on mature melaleuca trees. Similar studies have shown that insect damaged melaleuca trees are 36 times less likely to reproduce than undamaged trees. For those few damaged trees that did reproduce in the study, the size of the flowers and number of seed capsules were greatly reduced as compared to undamaged trees.

An ongoing study to evaluate the integration of biological control agents with mechanical control shows that insect feeding on melaleuca stump regrowth (coppices) reduces plant biomass by more than 55% as compared to those protected from the insects. Similarly, in a separate study conducted in a cattle pasture, the combination of biological control and occasional mowing reduced the density of coppicing stumps by approximately 80% in less than five years.

Herbivory by the biological control agents also is proving to significantly reduce seedling and sapling survivorship. One study found that feeding by the psyllid alone resulted in as much as 65% seedling mortality after just three generations of the insect (~4 months). Preliminary analysis from a comparison of melaleuca stand density at Holiday Park in Broward County before (1996) and after (2003) insect release indicated that insects caused over 70% defoliation and 83% mortality of young melaleuca seedlings and saplings. This high mortality of juvenile trees directly interferes with natural regeneration of melaleuca stands at the insect release sites.

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Reductions in melaleuca canopy and tree density is followed by an increase in regeneration of various grasses and plants in the genera *Ardisia, Baccharis*, *Blechnum*, *Cephalanthus*, *Cladium, Ctenitis*, *Dryopteris*, *Eugenia, Ficus*, *Ilex*, *Myrica*, *Myrsine*, *Persea*, *Schinus,* and *Woodwardia*.

These research results indicate the melaleuca biological control program is accomplishing its objectives. Significant reductions in flower and seed production, leaf canopy, stand density, and survival and biomass of seedlings, saplings, and stump regrowth add up to a reduction in the invasiveness of melaleuca in much of South Florida.

SIGNIFICANCE FOR MANAGEMENT

But what does it all mean for land managers making treatment decisions? In addition to research results, observations from managers in the field indicate the biological control program is reducing melaleuca's invasive potential. Consequently, in areas most impacted by biological control it may be justified to reduce reliance on conventional tactics, such as herbicide applications, for containment.

Vegetation management crews with the SFWMD report seeing evidence of the biological control agents throughout their melaleuca treatment areas. They find that follow-up treatments are often postponed or in some cases unnecessary. In some areas, the efficacy of aerial herbicide treatments has improved. Francois Laroche of the SFWMD observed that as trees become stressed by insect feeding, they continually push new foliage, which is more susceptible to herbicide activity than mature leaves. Laroche thinks melaleuca's herbicide susceptibility may also be increased by better herbicide penetration as a result of weevil leaf scarring. Both Laroche and Jonathan Taylor with Everglades National Park report less flowering in melaleuca treatment areas. Taylor believes the negative impact of the agents on melaleuca reproduction, particularly in the East Everglades Acquisition Area at the far northeast corner of the park, is allowing him to better focus on removal of mature trees.

BIOLOGICAL CONTROL ON PRIVATE PROPERTY

One of the benefits of the biological control program is that the insects are self-sustaining – they can reproduce and disperse on their own. The insects and their impacts therefore have the potential to spread to all types of lands invaded by melaleuca, providing some level of control even in areas not being actively managed, including private properties.

Recently, the IPRL has received inquiries from homeowners about landscape melaleuca trees in poor health. Some people calling to find out what is damaging their melaleuca trees welcome the insects' assistance in ridding their property of the invasive trees. Others, however, are not so pleased. Insect feeding damage has reduced the amount of shade provided by the trees and made them thoroughly unattractive, so all of melaleuca's arguably redeeming qualities have been lost. In addition, the psyllid flocculence, although innocuous, can be a nuisance. Consequently, many people who previously had no desire to remove melaleuca from their properties are now anxious to get rid of it.

This recent flurry of public attention to melaleuca provides an opportunity to remind the public that melaleuca is listed by both state and federal agencies as a prohibited, noxious weed, that great effort and expenditure have gone into controlling it on public lands, and that any progress made in the fight against melaleuca is threatened as long as it continues unchecked on private lands. Moreover, the surge of interest in melaleuca removal among the private sector, if turned into action, could provide a big boost to areawide melaleuca management efforts on both public and private properties. Unfortunately, melaleuca removal is cost prohibitive for many small landowners and homeowners. Cost-sharing or similar incentive programs could go a long way towards encouraging these citizens to do their part in the fight against melaleuca.

For more information on the melaleuca biological control program and its impacts, contact the scientists at USDA-ARS IPRL, 3205 College Avenue, Ft. Lauderdale, FL 33314; (954) 475-0541; www.weedbiocontrol.org

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LOBATE LAC SCALE AND MELALEUCA

In parts of Broward and Miami-Dade Counties, a third insect, the lobate lac scale *Paratachardina lobata,* is attacking melaleuca. Unlike the melaleuca weevil and psyllid, the lobate lac scale is not part of the biological control program. Rather, lobate lac scale is yet another invasive, exotic pest threatening the ecosystems of Florida. The scale has a very broad host range, attacking well over 100 different woody plants, including native species, horticultural and agricultural cultivars. The scale is inconspicuous, appearing as tiny, brown, bow tie shaped bumps on stems and branches. The damage it causes, however, can be quite noticeable, including defoliation, branch dieback, and death. Even though damage to melaleuca by the scale may not be of concern, the fact that melaleuca is a host to lobate lac scale and can serve as a reservoir for further infestations of more desirable plants increases the importance of continuing to remove this invasive tree from the landscape.