Biocontrol Down Under

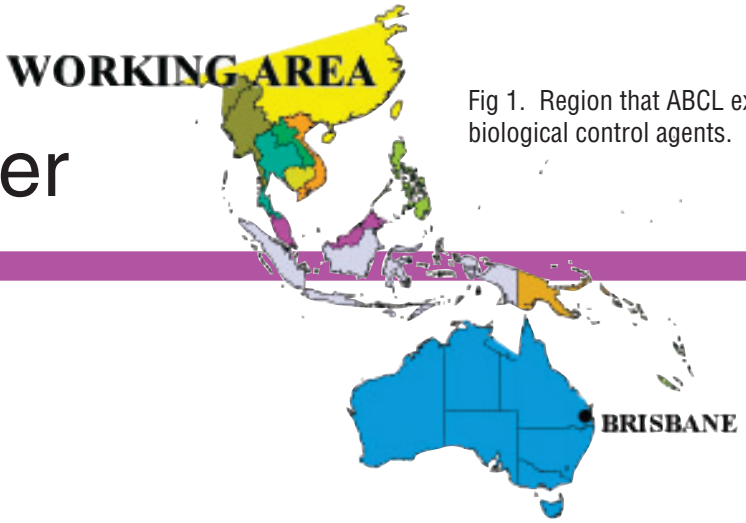

Fig 1. Region that ABCL explores for biological control agents.

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'Down Under', the staff of the Australian Biological Control Laboratory (ABCL) are actively searching natural areas of Australia and Southeast Asia for insects and other organisms which feed on plant species that are invasive in Florida. Based in Brisbane, 14,000 miles away from the Southeastern USA, the ABCL is operated by the U.S. Department of Agriculture, Agricultural Research Service (USDA-ARS), hosted by the Commonwealth Industrial and Science Research Organisation (CSIRO Australia), and collaborating closely with USDA-ARS researchers at the Invasive Plant Research Laboratory in Ft. Lauderdale and Gainesville, Florida.

Many familiar Florida weeds such as the paperbark tree (*Melaleuca quinquenervia*), Old World climbing fern (*Lygodium microphyllum*), carrotwood, (*Cupaniopsis anacardioides*) and Australian pine (*Casuarina* spp.) are native to this area of Australia. However, the native distribution of many of weed species in this region continues northward from Australia into tropical and subtropical Southeast Asia, including Indonesia, Malaysia, Thailand, Vietnam, Papua New Guinea, New Caledonia, and southern China. ABCL scientists explore this entire region to find the most promising biological control agents (Fig. 1).

Research conducted at ABCL follows a sequence of events involving

Fig 2abcd. The ABCL has excellent research facilities including field plots, greenhouses, biocontrol quarantine, and specialized laboratories for entomology and plant pathology.

determination of the native distribution of a weedy plant species, exploration for natural enemies, DNA fingerprinting of newly discovered species, ecology of the agents and their weed hosts, field host-range surveys, and ultimately preliminary host-range screening of candidate agents. Our research determines what regulates the plant in its native environment, which brings to light the full array of potential biological control agents. Organisms with a narrow host range and good regulatory potential are intensively investigated further. The data we gather on potential agents is combined with information about the ecology of the weed where it is invasive. Our stateside USDA-ARS collaborators use a science-based process to make the final decision on which organisms are best suited to be biological control agents. This dual-continent approach ensures the most successful outcome.

Fig 3. Pictured here is Alex Racelis (ARS-Ft. Lauderdale) collecting seed rain samples from a native stand of *Melaleuca quinquenervia* in Queensland for comparative ecological studies.

Currently, we are conducting research on *Melaleuca quinquenervia* and *Lygodium microphyllum*. The biological control program for *M. quinquenervia* was initiated in 1985, and one insect, the melaleuca weevil, *Oxyops vitiosa* was released in 1997 and several additional agents have been exported to Florida and are in various stages of final quarantine screening. The biocontrol program for *L. microphyllum* was started in 1998. One agent, the leaf-defoliating moth *Cataclysta camptozonale*, was shipped to Florida in 1999 for quarantine screening. Several potential agents from Australia and Southeast Asia are currently being evaluated. (Fig. 2abcd) (Fig 3)

Ask the Readers

A note from Dr. Ted Center

Biological control projects against invasive weeds require a long-term commitment of resources. These resources, though, are generally limited so only a few projects can be undertaken at any one time. As a result, target selection must be prioritized so that funding, facilities, and personnel are allocated to address the most critical needs. The target chosen, though, isn't always the worst weed, because priorities sometimes conflict. The selection process often balances the need for control against the potential for success. As a result, a biological control approach might be more appropriate against a weed of lesser importance than a more severe one, simply because the likelihood of success is greater. In such cases, targeting the lesser problem becomes a more judicious use of resources.

Downy rose myrtle is a case in point. Tony Wright, of the USDA-ARS Australian Biological Control Laboratory, investigates natural enemies of various invasive plants that originated in Southeast Asia, including downy rose myrtle. He and his collaborators from Thailand have observed severely damaged downy rose myrtle plants and have found a number of potential biological control agents. This has led them to believe that the potential for successfully controlling downy rose myrtle is quite high. However, we know very little about this plant, particularly with regard to the damage that it causes or the extent of the problem. We are therefore seeking advice and guidance from resource managers. Is downy rose myrtle enough of a problem to warrant a full-scale biological control project? Is there sufficient interest on the part of land and resource managers for such a project? Would there be opposition to a project?

Conflicts of interest must be considered. Downy rose myrtle fruits purportedly provide a source of jelly and jam and it is purportedly grown for that purpose in some areas. It also might still be a valued landscape ornamental. We therefore need more information on potential conflicts of interest that might arise should we begin a project. Any information that you can provide would be appreciated. It can be sent me at the following:

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Melaleuca quinquenervia, the broadleaf paperbark tree

Since the early 1900s, melaleuca has invaded over half a million acres in southern Florida. Because melaleuca is native to Australia, scientists at the ABCL have been searching since the mid-1980s for insects in this country to topple melaleuca.

One of the insects discovered, the melaleuca snout beetle, *Oxyops vitiosa*, was released at many sites in Florida in 1997. Massive numbers of these weevils have been recovered from several sites (Center *et al*.

2000) and many have been released elsewhere. In their wake they have left behind hundreds of thousands of heavily damaged melaleuca saplings.

The melaleuca psyllid, *Boreioglycaspis melaleucae*, is a sap-sucking insect that has the potential to kill saplings. Both the adults and the nymphs feed on melaleuca, injecting toxic saliva before sucking the predigested sap. The juveniles form shelters beneath white flocculant threads excreted by these nymphs. Heavily infested trees take on the appearance of being smothered in snow. Eventually trees begin to wither under the onslaught of the psyllid, and many fail to recover. This insect has completed testing in quarantine and release in Florida is expected in the near future.

Quarantine host testing has also been completed on the defoliating sawfly, *Lophyrotoma zonalis*. Hundreds of thousands of larvae of *L. zonalis* infest trees in parts of northern Australia, stripping every leaf from the besieged trees. The vigor and flowering of the affected trees are significantly reduced. This sawfly completes its development on the tree and emerging adults are very mobile. This should enable this promising agent to colonize melaleuca in even the most remote wetland areas of Florida. Recently, concerns have been raised over the potential of this insect to poison animals that eat them, as the larvae carry toxins that are unique to several sawfly species related to *L. zonalis*. Further trials have been requested, and to that end over thirty thousand sawfly larvae have been specially hand picked from trees in far north Queensland, Australia (Fig. 4) to be used in toxicology studies of livestock.

One of the most promising new agents is the gall-making fly, *Fergusonina* sp. This fly and its symbiotic nematode attack melaleuca by galling leaf and flower buds that could limit branch growth and seed production (Goolsby *et al*. 2000). Through a concerted effort in the later half of 2000, 7000 galls were collected in Australia for shipment to the Gainesville quarantine where emerging flies were used in screening tests. So far the insects appear to be sufficiently host specific to allow release, though testing is incomplete.

Fig 4. Matthew Purcell collecting *Lophyrotoma zonalis* sawfly larvae from a melaleuca tree in north Queensland.

Fig 5. Melaleuca flower bud which was has been consumed by the larvae of the tip-feeding moth, *Holocola* sp.

Research efforts are now being driven toward developing agents that could diminish the vast reproductive potential of melaleuca. Research conducted in collaboration with ABCL staff by Van, Rayachattery and Center (ARS-Ft. Lauderdale) compared reproductive potential of melaleuca trees in Florida and Australia. This work demonstrated that abortion of flower buds was a significant factor in reducing the regenerative potential of *M. quinquenervia* in its native habitat. Much of the flower abortion appears to be caused by small moth larvae that bore through buds and immature inflorescences which terminates flower formation and ultimately curtails seed development. At least one species, *Holocola* sp. (Fig. 5) attacks both leaves and flowers, allowing it to persist year round without dying out following the flowering season, an important factor if it is be released as and agent in Florida. Attempts will be made colonize and evaluate these moths over the next year.

Lygodium microphyllum, Old World climbing fern

The native distribution of *L. microphyllum* extends from Australia northward through the tropics and subtropics of Southeast Asia. Other species of *Lygodium* are present too including *L. japonicum, L. flexuosum,* and *L. reticulatum*. The diversity of species in the genus *Lygodium* and the abundance of suitable habitat make this area ideal to explore for biological control agents. Tony Wright (CSIRO/ABCL) leads the exploration in Southeast Asia and John Goolsby (ABCL) covers Australia. Intensive fieldwork has already revealed more than 20 species of insects and mites feeding on the fern. However, many parts of Australia and Southeast Asia are still unexplored so the potential for more agents from this region is high.

Foreign exploration for *L. microphyllum* agents is carried out year round. Seasonal variation effects the abundance of insect species, so it is important to visit sites regularly in order to collect the maximize diversity of herbivores, especially in the tropics. The wet season, December through February makes it very difficult to get to many field sites. During 'the wet', rivers rise, billabongs fill with water and estuarine crocodiles swim upstream in search of food and nesting

sites. You don't step out into the bush of Australia without some advanced planning and good advice from the locals. The fern grows luxuriantly during the wet, which coincides with a peak in insect activity. During this year's wet season we will be collecting in the monsoon rainforests in the Ord River area of Western Australia, and the lowland jungle habitat of Bukit Timah in Singapore.

Back in Brisbane, candidate agents are reared and tested for their ability to feed and reproduce on selected test plant species. Dr. Bob Pemberton (ARS-Ft. Lauderdale) developed a preliminary host test list, which includes most of the Florida fern species that are closely related to *Lygodium* or important commercially in the horticultural trade. Agents that show high specificity in these tests are exported to Dr. Gary Buckingham (ARS) at the Florida Biological Control Laboratory in Gainesville for final quarantine screening. The leaf defoliating pyralid moth, *Cataclysta camptozonale* is currently under study in the Gainesville quarantine. (Fig 6)

Fig 6. The pyralid moth, *Cataclysta camptozonale* was collected from in southeast Queensland and is being evaluated as potential biological control agent of *Lygodium microphyllum*.

One of the agents that shows excellent promise is an eriophyid mite, *Floracarus* sp. The mite feeds on the young growth, inducing the formation of fleshy tissue, which causes the pinnae (leaves) to curl. The mites live inside the curled leaf feeding on the fleshy gall-like tissue. Eggs are laid inside the curl, with the entire lifecycle taking 12 days at 27 degrees C. *Floracarus* sp. feeding appears to be associated with leaf necrosis and debilitation of the plant (Fig 7ab). We have noticed that after bush fires, *L. microphyllum* regrows vigorously and *Floracarus* sp. exists below detection levels. In time mites recolonize the *Lygodium* patches and the symptoms of plant disease and decline begin to reappear. We are conducting field chemical exclusion tests to investigate the relationship between *Floracarus* sp. and plant health. Replicated field tests will measure biomass production with and without the mite. The goal of the field research is to determine the effect *Floracarus* sp. might have on *L. microphyllum* if it was released in Florida.

Potential Weed Targets

Several other weeds important to Florida and the Southeastern U.S. are native to Australia and/or Southeast Asia including: Japanese climbing fern (*Lygodium japonicum*), Chinese tallow (*Triadica sebifera* (= *Sapium sebiferum*)), carrotwood (*Cupaniopsis anacardioides*), Australian pine (*Casuarina* spp.), skunkvine (*Paederia foetida*), downy rose myrtle (*Rhodomyrtus tomentosa*), hydrilla (*Hydrilla verticillata*), schefflera (*Schefflera actinophylla*) and Chinese privet (*Ligustrum* spp.). Biological control programs could be developed for these species. Some species such as carrotwood and schefflera are valuable ornamentals. Biological control agents which target plant reproduction only may be best suited to limiting their invasive characteristics, while still preserving their use in ornamental horticulture.

Environmentally adapted plant flora coupled with globalization of trade and travel between Australasia and the Southeastern U.S. is now and will continue to be the cause of many serious weed invasions. The Australian Biological Control Laboratory is committed to research and development of biological control solutions for U.S. weeds of Australian and Southeast

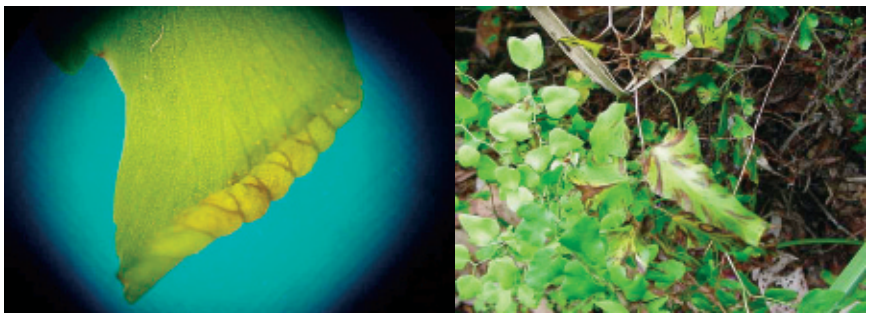

Fig 7a. The characteristic leaf-curling of *Lygodium microphyllum* that is caused by the eriophyid mite, Floracarus sp.

Fig 7b. Leaf necrosis and debilitation of *Lygodium microphyllum* associated with infestations of the mite Floracarus sp.

Asian origin. Our research is critical because not only does biological control offer the safest and most cost-effective approach to long-term management of widespread, invasive weeds, but in some instances it is the only viable control option.

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