

Taking Down Climbing Fern— Biological Control of *Lygodium microphyllum*

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Old World climbing fern (*Lygodium microphyllum*) has been the subject of biological control research by the US Department of Agriculture—Agricultural Research Service (USDA-ARS) Invasive Plant Research Laboratory since 1997. The research has been possible because of the partnerships between the Invasive Plant Research Laboratory and two State of Florida agencies, the South Florida Water Management District and the Department of Environmental Protection, which provide essential funding. Old World climbing fern is thought to be an appropriate subject for biological control for a number of reasons: 1) It is a serious exotic weed with few natural enemies in Florida; 2) The plant has no recognized value in Florida; 3) It is not a weed in its native range; 4) Preliminary surveys found promising insect enemies; 5) The weed has few native or economic relatives in Florida and the surrounding region that could become accidental targets for biological control agents.

Although Old World climbing fern has a large native range (occurring in much of the Old World tropics), we have focused on Australia and Southeast Asia because these regions have the highest diversity of *Lygodium* species. Higher numbers of congeneric plants in the same area often have higher numbers of insects associated with them. In all, two mite and twenty insect species were found feeding on several *Lygodium* species. Of these, six to eight may have potential as biocontrol agents of Old World climbing fern. The majority of the *Lygodium* herbivores are Lepidoptera (moths), while Coleoptera (beetles) and Hemiptera (true bugs) were less represented. Given the amount of survey work, the number of herbivore species found was small and they generally occurred at low densities. The paucity of herbivores is not specific to Old World climbing fern, but has been noted for most ferns. Indeed, ferns were once thought to be almost free of insect herbivores. Nonetheless, eight years of surveys have revealed a number of potentially useful agents, although few diseases were encountered.

Pyralid moths and an eriophyid gall mite, all from the fern's Australian/Asian range, were prioritized for further study and have since undergone extensive evaluation. Host-specificity testing was conducted in the USDA-ARS Australian Biological Control Laboratory in Brisbane (a cooperative laboratory with Commonwealth Scientific and Research Organization (CSIRO) in Australia) and in the Florida Division of Plant Industry quarantine facility in Gainesville, where part of the Invasive Plant Research Laboratory is located.

The first agent, *Austromusotima camptozonale*, was officially released on February 14, 2005 at Jonathan Dickinson State Park in Martin County, Florida. This Australian species is one of a complex of pyraloid moths that has evolved with *Lygodium* ferns. The larvae eat

the leaves of the fern and, at high densities, can completely defoliate it. The moth can produce a generation every month during the summer and every 2–3 months in the winter depending on temperature. Host-specificity testing showed it to be a very narrow specialist, able to use only a few *Lygodium* fern species. It is a tropical insect unable to survive in the temperate part of eastern North America where the only native *Lygodium* (*L. palmatum*) grows. It also was unable to use any of the four *Lygodium* species native to the Caribbean. In 2005, 12,000 moths were reared and released into a nursery site and research plots. Releases were made in field cages and in the open. Breeding occurred in the field but no definitive evidence of the moth's establishment outside of the cages has yet been obtained. We are beginning another release effort to try to colonize this moth in the wild. The Florida Department of Environmental Protection is providing funding for this mass rearing and release program.

The second agent, the eriophyid gall mite, *Floracarus perrepare*, is native to Australia and tropical Asia. Adult feeding on new leaves causes the leaf margin to roll and thicken, forming a leaf roll gall into

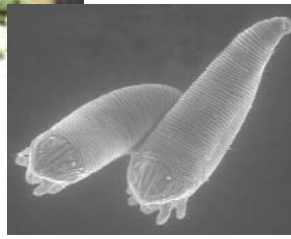


Austromusotima camptozonale adult

which eggs are laid and a colony of mites develops. Galls can be physiological sinks, using up photosynthate normally used by the fern for new growth. Potted plant studies showed that mite infestation reduced climbing fern growth. Host-specificity testing showed the mite to be a narrow specialist with host races (subgroups that have narrower host ranges than the species as a whole) limited to two *Lygodium* species including Old World climbing fern. A release petition was submitted in February 2004, and in November 2004 the federal interagency scientific review body, the Technical Advisory Group for Biological Control of Weeds, recommended to USDA-APHIS (Animal and Plant Health Inspection Service), the permitting agency, that the mite be released. In December 2004, a draft Environmental Assessment was written on the mite's release and submitted to the USDA-APHIS. Although the mite is exceptionally safe, the USDA-APHIS has yet to issue a release permit but is expected to do so in 2006.



Damage from *F. perrepa* galling



The lygodium gall mite, *Floracarus perrepa*, adults

The third agent, and second pyralid moth, *Neomusotima conspurcatalis*, is native to tropical Asia east to northern Australia. The damage, biology and host specificity are all similar to those of *A. camptozonale*. In Australia it does well during the hot season, whereas *A. camptozonale* develops higher numbers during the cooler winter. The research was completed late in 2004 and in May 2005, a release petition was submitted to the Technical Advisory Group for Biological Control of Weeds. A decision is expected early in 2006.

What Next?

With completion of the research necessary to apply for the release in Florida of above natural enemies, attention is focusing on other potential agents. Several are now under investigation in Singapore, Australia, and Florida.

Of considerable interest are two species of pyralid moths that bore into the stems of *Lygodium*. One, *Siamusotima aranea*, attacks *L. flexuosum* in Thailand and the other, an apparently undescribed species from Singapore, attacks Old World climbing fern. The stem above the boring larvae is killed because the vascular tissue is cut. However, rearing these moths in quarantine has proved a challenge and attempts in both Australia and Florida have so far been unsuccessful. Larval development takes many months and the larvae seem to require larger stem diameters than can be easily obtained with potted plants.



Neomusotima conspurcatalis adult

There are also questions about host races and taxonomy. These moths are the highest priority for research for the overseas part of the program. An entomologist from our Australian Biological Control Laboratory has been placed in Singapore to work on the *Siamusotima* species that attacks Old World climbing fern. This expensive work is possible due to a special grant from the US Department of the Interior through Everglades National Park.

A sawfly, *Neostrombocerus albicomus*, was brought into the Division of Plant Industry quarantine facility in Gainesville, Florida during the summer of 2005 for host specificity testing. We recognized the potential of this leaf feeding sawfly early in the project but could not rear it. Our Thai cooperater, Dr. Amporn Winotai, discovered that the insect would not mate in small cages. We now successfully rear the sawfly in large cages and preliminary host specificity testing indicates that *N. albicomus* probably has a narrow enough diet to be safely released in Florida. The sawfly has multiple generations per year and is a vigorous feeder on Old World climbing fern leaves.

Other insect natural enemies found include a thrips, *Octothrips lygodii*, which damages the leaves. The thrips is probably a specialist but opinions on the value of thrips as potential biological control agents vary. A brown leaf disease found in Sri Lanka needs to be identified and possibly evaluated.

Prospects

It is expected that *A. camptozonale* will establish in Florida. How much impact it has on Old World climbing fern will depend largely on the mortality that it experiences from ants and parasitic wasps that attack related pyralid moths. This biocontrol agent is not expected to be a 'silver bullet', however, and a suite of agents will be needed to subdue Old World climbing fern. We hope to add the mite, *F. perrepa*, and the second moth, *Neomusotima conspurcatalis*, in 2006. It is not possible to predict what impact they will have, but the combined effects of these agents acting in somewhat different ways may help reduce the abundance of the weed.



Lygodium sawfly *Neostrombocerus albicomus*, adult and eggs



N. albicomus leaf feeding larvae

As noted, other potential agents are in the pipeline. The stem-boring moths may hold the most promise if they can be successfully reared and evaluated.

Old World climbing fern is a very challenging problem for any kind of control effort, but its great environmental damage makes it a most worthy target for all our efforts.

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