Lygodium in Florida

AN OVERVIEW

by John C. Volin, Florida Atlantic Univeristy

Florida made international headlines recently when a large exotic Burmese python was found dead after swallowing a native six-foot alligator in the Florida Everglades. Such dominant exotic species are becoming more common and increasingly threaten Florida's fragile ecosystems. Public awareness of invasive species is heightened when they are as large and noticeable as the Burmese python. However, there are more insidious invasive species that may cause even greater harm to native ecosystem processes and functions, but rarely garner the same attention among the public. This is particularly true when the invasive species is a plant, and the plant makes the habitat look like a lush jungle paradise.

This special edition of *Wildland Weeds* is focused on the invasion of Florida's environment by two introduced climbing ferns, *Lygodium microphyllum* and *L. japonicum*, commonly known as Old World climbing fern and Japanese climbing fern, respectively. They both sound like something in a Carl Hiaasen novel; if only they were fiction. Like the Burmese python, they both choke and smother their victims. Like so many of Hiaasen's characters, they are opportunistic, ruthless and ready for a fight—a fight they are apparently winning.

Both ferns are quickly becoming among the worst invasive plant species to enter the Florida peninsula. *Lygodium microphyllum*, a native to wet tropical and subtropical regions of the Old World, was first observed as a naturalized plant on the southeast coast of Florida in 1966 (Beckner 1968) and has since spread to a variety of habitats. It is particularly known for its dominance and subsequent collapse of numerous tree islands in Arthur R. Marshall Loxahatchee National Wildlife Refuge. *Lygodium microphyllum* is currently estimated to occupy roughly 300,000 acres of natural lands across central and southern Florida (see *An Explosion in Slow Motion*, this issue).

A landscape model developed in my laboratory at Florida Atlantic University shows that, in the absence of aggressive control measures, *L. microphyllum* infestations could exceed the current combined coverage of the top five most invasive species in Florida by 2014 (Volin et al. 2004). The annual freezing temperatures in northern Florida will likely limit its spread inland, although this species could become established along both northern coasts. *Lygodium japonicum*, on the other hand, is more "at home" in the central and northern part of Florida as well as north into the Carolinas and west to Texas. Nonetheless, it is only a matter of time before this more temperate species gains a foothold in southern Florida. Of the two species, *L. microphyllum* has been studied more intensely because of its more immediate threat to the native Florida ecosystems.

This issue of *Wildland Weeds* is a snapshot of the work that land managers and scientists are currently conducting to gain insight into these two species. Amy Ferriter (Boise State University) will discuss a landscape scale monitoring (SRF) program and will include the most up-to-date monitoring results for the central and south Florida region. Kristina Serbesoff-King (The Nature Conservancy) will introduce the Central Florida Lygodium Strategy and outline the project's objectives. Bob Pemberton (USDA Agricultural Research Service) will provide an update on lygodium biocontrol releases and discuss some exciting new biocontrol prospects. Results from a recent cross-site spore contamination study will be presented by Jeff Hutchinson (University of Florida). Jonathan Taylor (Everglades National Park) will discuss the National Park Service's experiences dealing with remote infestations. Chris Lockhart (Florida Natural Areas Inventory) will discuss the FNAI region-wide treatment survey. Finally, Andi Van Loan (Florida Division of Forestry) will provide an overview of the issues concerning *L. japonicum* in northern Florida. Additionally, the revised 2006 *Lygodium micophyllum* Management Plan is provided on the CD-ROM included with this issue.

Since 1998, my colleagues, students and I have conducted a series of studies in order to gain a better understanding of why *L. microphyllum* does so well in its introduced Florida habitat. We have considered the reproductive biology of the species, its whole plant growth and physiology under different environmental conditions, its community ecology, and its landscape spread. Currently, scientists from several institutions in the U.S. have developed collaborative research with colleagues from scientific institutions in Australia and are comparing *L. microphyllum* growth in its native Australian habitat versus its non-native Florida habitat. What we have found reads, in some case, like science fiction, especially with regard to its reproduction, which appears to be tailor-made for an invasive alien species.

Ferns are ancient species when it comes to reproduction, as they spread by spores instead of by seeds. Spores, which are similar in size to pollen grains, cost the plant very little energy to produce. At some *L. microphyllum*-dominated sites in Florida, over a billion airborne spores were estimated to be present (Volin et al. 2004). The hurricanes of 2005 undoubtedly spread copious amounts of spores throughout the southern peninsula, and we should expect a whole new generation of tiny tenacious ferns starting to climb into delicate tree island canopies in the coming years.

Lygodium, from the Greek *lygodes*, meaning flexible, in reference to the twining rachis.

Ferns reproduce in one of three ways: a single spore develops by itself into a plant; two spores from the same parent plant reproduce by one fertilizing the other; or two spores from two different parent plants reproduce. Ferns are conservative in that they typically adopt only one of these three reproductive strategies. Instead, Lott et al. (2003) found that both *L. microphyllum* and *L. japonicum* can produce plants by all three methods. The strength of this reproductive approach is that it only takes one spore to travel a long distance from its parent plant to establish in a new area, and once established the plant has a greater exchange of genetic information through reproducing via cross fertilization with other established plants. As if this were not advantageous enough, *L. microphyllum* has an additional component to its reproduction. It was found that the first spore to germinate produces a pheromone that impacts nearby spores as well as other nearby younger germinates. In the case of the nearby spore, the pheromone promotes its germination; in both cases, the pheromone determines their sex. Since the earlier germinate is almost always a female and the pheromone that is produced by this germinate causes the younger ones to become only male, cross-fertilization is assured (Lott et al. 2003).

Along with this flexible reproductive strategy, we also found that *L. microphyllum* maintains a high and continuous spore production throughout the year (Volin et al. 2004). In addition, it grows rapidly at both high and low light levels at a young stage. Young plants grown in only 20% full sunlight grew just as much as plants grown in 50% as well as 80% full sunlight (Lott and Volin, unpublished data). Thus, in intact understory environments with low light levels, new young germinates can grow quickly. Therefore, where most invasive species need disturbed habitats in which to establish, *L. microphyllum* appears to have no problem establishing in intact native environments, such as tree islands in the Everglades and the cypress forests of the Big Cypress Swamp. On *L. microphyllum*-dominated sites in the Big Cypress Swamp, we found the fern particularly suited to the naturally wet conditions of the swamp. Unfortunately, the wetter hydrological conditions that are being sought after through the Comprehensive Everglades Restoration Plan will actually make the environment even more conducive to the establishment of *L. microphyllum*.

Little is known about the growth and physiology of *L. microphyllum* within its native range, but the fern appears to be a comparatively benign constituent of its native range communities. The key question is what limits the growth and spread of *L. microphyllum* in its native range as compared to its non-native range. To answer this question, with funding from both the Florida Department of Environmental Protection and the South Florida Water Management District, my colleagues and I are currently conducting coupled controlled and field studies of this species in both its native environment in Queensland, Australia and in southern Florida.

It could be that in the new Florida environment the fern thrives because it no longer has the insects and diseases with which it coevolved in its native environment, something known as the *release from natural enemies hypothesis* (Elton 1958). In collaborative biological control efforts through the USDA and CSIRO (Commonwealth Scientific and Research Organization) in Australia, exploratory surveys for natural enemies of *L. microphyllum* have identified relatively few insect herbivores, from which Goolsby et al. (2003) suggest that enemy release may be less important in fern invasions. However, progress has been made with the release of the pyraloid moth, *Austromusotima camptozonale*, in February 2005, and the discovery of other potential biocontrol agents (see *Taking Down Climbing Fern—Biological Control of Lygodium microphyllum*, this issue). To date, there are no biological control insects approved for *L. japonicum*. In fact, much more needs to be understood about the ecology of this species.

Together, these two climbing ferns are of great concern for Florida's native environment. What follows in this special issue represents a big step forward in the understanding of these invasive species.

References available from the author at jvolin@fau.edu.

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