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The Quarterly Journal of the Florida Native Plant Society

Palmetto

Growing Plant Scientists • Ferns in Space • Invasive Plant Control at ORCA

Top: This fossil *Cooksonia pertoni* from Scotland's Rhynie Chert looks remarkably similar to the familiar fern ally *Psilotum nudum*. Photo by Dr. Hans Steur. **Bottom:** *Psilotum nudum* is often found growing in Florida's swampy areas. Photo by George Rogers.

Psilotum looks like a fossil

Ancient oceans shaped the landscape of Seabranch Preserve State Park near Hobe Sound, Florida, and the result for visitors is an accessible variety of natural communities – everything from xeric sand pine scrub to low, wet, swampy, shadowy, ferny, prehistoric forest. My unscientific rule of thumb is: the swampier the woods, the more primitive they are. The swampy lands in Seabranch look like a museum dinosaur diorama with ferns taller than a person, tree trunks festooned with dangly mossy things, and a lush carpet of primordial ooze only a salamander might love. Here is a venue to see plants we think of as primitive, if you define "primitive" as representing a particularly ancient plant group.

The Seabranch swamp is a wonderland of liverworts, which are about as primitive as a land plant can be. Mosses are likewise ancient, ferns are too, and bald cypress is no evolutionary spring chicken. We are glancing back to plant groups that are, in rough terms, four times older than flowering plants and 400 times older than humans.

Today's swampy encounters take the imagination back 400 million years to the early Devonian Period. Looking down from space a modern alien wouldn't recognize the Devonian Earth. Europe and Asia were a single continent. So were Africa, India, Australia and Antarctica. And, creeping forth from the ancient seas, plants had only recently invaded the land.

Despite the passage of almost half a billion years, you might be surprised how much we know about the early land plants thanks to exquisite fossils preserving anatomical details over the eons. The most famous Devonian plant fossil site is called the Rhynie Chert near Aberdeen, Scotland, where an entire swamp is so perfectly mineralized it looks like a stone-wizard waved his magic wand just yesterday.

The structure of these ancient plants shows distinctive, evenly forked, Y-shaped branching, in contrast with the uneven branching patterns characteristic of modern plant stems. Ancient plants had no roots, although underground rhizomes were fashionable. And, as remains true of modern ferns and the so-called fern allies, ancient land plants reproduced by spores rather than by flowers, fruits, and seeds. The spore cases were either on the tips or the sides of the stems. (A spore differs from a seed in many ways, principally by being merely a single cell).

Whisk-fern (*Psilotum nudum*), native to a good part of Florida, would have been comfortably at home in the Rhynie Chert. *Psilotum* has no flowers, fruits, or seeds. The branching is evenly Y-shaped in the prehistoric fashion, and the spores occupy little pillboxes along the side of the stem. It looks nothing like a modern plant; instead, it looks like the ancient fossils.

Life is never straightforward. DNA and other studies undermine the idea of *Psilotum* as a diehard from Devonian times. DNA places it among the ferns, so in contemporary classifications it is one. So why a plant that looks like it's straight out of Rhynie doesn't show exactly the expected relationships is a wee conundrum for future botanists. In the meantime, in my mind it jumped right out of the rocks.

If you're wondering about spores, by the way, as in ferns and other fern allies, and certainly also in the prehistoric land plants, they don't germinate like a seed and replicate the parent plant. *Psilotum* spores germinate into a tiny, completely underground generation living off of subterranean fungal symbiosis. The baby *Psilotum*, technically called the gametophyte, looks like a root without the rest of the plant. You'll never see one. But it's not so hard to find the parent *Psilotum* hanging out of the broken leaf bases on cabbage palms, or occasionally on moist hummocks in the swamp. And there is even an easier way to visit Jurassic Park – these plants are often found as weeds springing forth from plant nursery flowerpots.

***Psilotum nudum* (Whisk Fern)**

Habitat: Terrestrial in wet woods, swamps, mesic hammocks, on and around tree bases, commonly those of the sabal palm (*Sabal palmetto*); also epiphytic on logs and in the forks of trees.

Distribution: From the central Panhandle counties of Gulf, Leon, and Wakulla, eastward, southward and throughout the peninsula.

Psilotum nudum was discovered in Florida in the late 1800s. The specific epithet, *nudum*, was originally conferred by Linnaeus, means "bare" and refers to the plant's leafless stems.

From: *The Ferns of Florida* by Gil Nelson

Further Reading

For a more technical overview of *Psilotum*, including its similarity to the Rhynie Flora, see: Bidlack, J., and S. Janskey. Stern's Introductory Plant Biology, 13th Ed. McGraw Hill, NY. 2014. [P. 392-394.]

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Editorial Content
We welcome articles on native plant species and related conservation topics, as well as high-quality botanical illustrations and photographs. Contact the editor for guidelines, deadlines and other information.

Features

ON THE COVER:
The endangered scrub blazing star (*Liatris ohlingerae*). Photo by Eric Menges. See article on page 4.

Donations are needed for the 2017 Conservation Grants

Conservation Grants are funded through targeted donations from individuals and chapters. Please help support important projects throughout Florida that promote the preservation, conservation, and restoration of Florida's rare or imperiled native plant taxa and rare or imperiled native plant communities. A list of Conservation Grant awards and project updates is available on the FNPS website:
http://www.fnps.org/what-we-do/conservation_grants

Dr. Eric S. Menges and Stacy A. Smith
Archbold Biological Station

Growing Plant Scientists

Fig. 1: Interns Michael Blaha, Kaitlin Griffith, and Emma Sass measure the sizes of Florida rosemary (*Ceratiola ericoides*). Photo by Stephanie Koontz.

How are scientists made? Certainly it is a process, often beginning with childhood experiences and progressing through undergraduate education, graduate degrees, and jobs with universities, government agencies, or non-profits. At one time, the break between undergraduate and graduate school might have been a road trip or a summer job painting houses. These days, many aspiring scientists take a year or two for internships or temporary jobs that provide useful skills in their field of study.

Post-baccalaureate internships can provide research experience that is more in-depth than possible in undergraduate semesters that are packed with classes. We work in the plant ecology program at Archbold Biological Station in south-central Florida, where our research focuses on plant population biology, fire ecology and conservation of rare and endemic plant species. Our internships provide one of the most in-depth research internship experiences available anywhere, by having participants carry out an independent research project (from selecting and designing research to analyzing and presenting results). For budding botanists and ecologists, the chance to conduct field research at a biological station can propel them in new directions as they segue to graduate school and beyond.

Scientific Research Skills

Plant ecology internships at Archbold Biological Station provide varied experience assisting on long-term scientific research projects (Fig. 1). For example, we have been studying the interactions between the dominant shrub, Florida rosemary (*Ceratiola ericoides*), and endangered herbaceous plants such as Highlands scrub Hypericum (*Hypericum cumulicola*), scrub blazing star (*Liatris ohlingerae*) and wedgeleaf eryngo (*Eryngium cuneifolium*) through a series of observational studies and field experiments. Florida rosemary is a strong competitor with other shrubs through chemical interference (allelopathy; Hewitt and Menges 2008) and by creating a deep and dense root system. The exclusion of shrubs leaves gaps among the Florida rosemary plants that are key microhabitats for a suite of endangered plants (Menges et al. 2008).

Studying Rare Species

The interns at Archbold become intimately acquainted with dozens of rare plants and animals, a fantastic benefit of working in the biodiversity hotspot that is the Lake Wales Ridge. Depending on the time of year, they may be counting flower heads on scrub blazing star (*Liatris ohlingerae*, Fig. 2), collecting fruits of Florida ziziphus (*Ziziphus celata*), caring for Garrett's mint (*Dicerandra christmanii*) cuttings slated for an experimental introduction, or searching for seedlings of Highlands scrub Hypericum (*Hypericum cumulicola*) in a germination experiment (Fig. 3). Helping with these projects in the field and entering and checking data in front of the computer, they are able to see how scientific information can inform land management and conservation.

Appreciating Long-Term Data

Most of the interns in Archbold's plant ecology program are in their early 20s. Imagine their surprise to find that some of our datasets are older than they are! For example, our data on the scrub pawpaw (*Asimina obovata*; Fig. 4) goes back to 1994, and some datasets are even more ancient. Interns can see how the data they collect in 2016 compares to data in past years. Was the high seed germination related to a wet spring? When was this site last burned? An appreciation of temporal patterns is key to understanding ecological dynamics and evolutionary patterns.

Fig. 2: The endangered scrub blazing star (*Liatris ohlingerae*) has served as the subject of many intern projects and led to several scientific papers (Weekley et al. 2008, Kettenring et al. 2009). Photo by Eric Menges.

Fig. 3: Intern Kathyrn Tisshaw gets down close to the ground to spot tiny seedlings of the endangered Highlands scrub Hypericum (*Hypericum cumulicola*) in a field experiment. Photo by Olivia Karas.

Fig. 4: Interns Julia Gehring and Ryann Cressey show some love to scrub pawpaw (*Asimina obovata*), one of our long-term study species and the subject of an earlier intern project and publication (Levitt et al. 2013). Photo by Cari Ficken.

Fig. 5: Sarah Hicks Dean, like many interns at Archbold, got firsthand experience with the application of prescribed fire. Sarah later published a paper based on this fire (Dean et al. 2015), before obtaining her Ph.D. from the University of New Mexico. Photo by Eric Menges.

Learning about and using fire

One unique aspect of an internship at Archbold is the chance to do research and participate in prescribed fire. Most interns receive training and subsequently on-the-ground experience in lighting and holding prescribed fires (Fig. 5). They also, in some cases, can work with our land manager in creating experimental fires to answer their burning research questions.

Independent Research

Many internships consist largely of helping scientists or conservationists with ongoing activities. But at Archbold, half of the interns' time is devoted to conducting an independent project. For most, it is the most substantial scientific endeavor of their young lives, and it often informs them whether a research career is right for them. With advice from older scientists, interns select a project, frame hypotheses, design the study, collect and analyze data, present a seminar, and write a report. Many intern projects become scientific publications. For interns who subsequently apply to graduate school, this research experience is a key selling point to potential faculty advisors (Fig. 6).

Talks at the FNPS Annual Conference

For the past three years (2014-2016), the Florida Native Plant Society's Annual Conference has provided a wonderful opportunity for our interns. Longtime FNPS Science Advisory Committee Chair Dr. Paul Schmalzer has ably organized a scientific session and encouraged our interns to participate (Fig. 7). Presenting their research in talks, interacting with native plant enthusiasts of all stripes, and being exposed to Florida ecosystems on field trips has been an experience that has helped in their personal and professional growth.

Fig. 6: Interns Cari Ficken, Caitlin Kailin and Anna Peschel are a picture of merriment after a day of field work. All three followed their internships with meaningful jobs or graduate school. About three-forth of interns in the plant ecology program at Archbold Biological Station move on to graduate school. Photo by Sarah Haller Crate.

Fig. 7: Interns Kathyrn Tisshaw, Louise Barton, and Olivia Karas are all smiles before their talks at the Florida Native Plant Society's Annual Conference in May 2016. Photo by Eric Menges.

Moving On

The main goal of internships at Archbold Biological Station, including those in the plant ecology program, is to provide relevant scientific experiences that can prepare young scientists for a range of careers. In fact, Archbold has supported more than 500 interns and the plant ecology program more than 120. The intern that traveled the furthest was Orou Gaoue Gande (Fig. 8), who left his native Benin to work at Archbold in 2003, co-authoring a publication on the endangered scrub mint *Dicerandra frutescens* (Menges et al.

Fig. 8: Orou Gaoue Gande (above, in 2003) and Betsey Boughton (below, in 2015).

2006). He later obtained his Ph.D. and is now a professor at the University of Hawaii, specializing in research on sustainable harvest of non-timber forest products. One former intern who stayed close to home was Betsey Boughton. After her intern project on ecotones in the Florida scrub landscape (Boughton et al. 2006), Betsey earned her Ph.D. at the University of Central Florida. She later became a program director at the MacArthur Agro-ecology Research Center, a division of Archbold Biological Station. Betsey's current research includes studying ways to maintain biodiversity in working landscapes.

The success that Orou and Betsey have enjoyed is not unusual among former interns. Other former plant ecology interns have faculty positions at major universities such as the University of Texas, the University of Idaho, Utah State University, and the University of Central Florida. Others are focusing on teaching undergraduates at such schools as Governor's State University, University of the Pacific, Susquehanna University, and William Jewell College. Former Archbold interns are also working for federal and state agencies (USFWS, St. Johns River Water Management District, Wisconsin DNR), non-profits (NatureServe), or research institutions (Savannah River Ecology Lab). Still others are middle and high school teachers, journalists, and entrepreneurs.

For more information on internships in plant ecology at Archbold, check http://www.archbold-station.org/html/research/plant/plantinternship.html

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About the Authors

Dr. Eric S. Menges is the program director of the plant ecology program at Archbold Biological Station. He has studied plants in Florida scrub since 1988 and supervised 112 research interns.

Stacy A. Smith has been a research assistant in the plant ecology program at Archbold Biological Station since 2006. Her research focuses on population ecology, reproductive biology and restoration ecology.

FERNS IN SPACE

by Christopher Krieg and Sandy Saunders

Nothing was certain that Thursday morning in 1997. Unforgiving winds, scattered rainstorms and dense cloud cover threatened the launch of Space Shuttle Discovery (mission code STS-85) at Florida's Kennedy Space Center. When a short window of favorable conditions opened, Discovery blasted off, carrying some of the most advanced technology of the day into space, including an atmosphere-sensing satellite and advanced robotics. Discovery's payload also included something else – one of the most spectacular biological specimens on Earth – a specimen that continues to astound biologists to this day. On Thursday, August 7, 1997, at 10:41 a.m. EDT, *Pleopeltis polypodioides* became the first fern to be launched into space.

Above: *Pleopeltis polypodioides* has evolved a remarkable ability to cope with a water-limited environment. On the left, the fern's fronds are fully hydrated; photo by Bob Peterson. On the right, in response to a lack of water, the fronds shrivel; photo by Mary Keim.

Why, you might be asking, was NASA interested in sending a fern into space? Is this fern exceedingly rare or unusual? No, it isn't rare; in fact, it is actually quite common. But it does have some unusual characteristics that make it a good candidate for voyaging in space. *Pleopeltis polypodioides* has a wide distribution across most of the southeastern United States, including Florida. It is an epiphyte, a plant that uses another plant for physical support, and is commonly found living on the branches of oak, magnolia and elm trees, where there is no soil and limited water. This fern does not parasitize its host. Instead, it gets all its resources from rainfall, air and canopy leaf litter. One can imagine that this ecological niche with no soil and little water is a stressful place for most plants, and in Florida, this habitat can experience dramatic swings from wet to dry.

Pleopeltis polypodioides has evolved a remarkable ability to cope with this water-limited environment. This fern exhibits an extreme form of poikilohydry, which is the ability to tolerate dramatic changes in internal water status, in response to temporal changes in environmental conditions. During periods of drought, the once-green fronds of this fern shrivel into a stiff brown cluster. Where most plants die almost immediately upon loss of 15% of their water content, this fern can lose up to 97% of its water content and still survive. A single individual can remain in the dried, retracted state for more than 100 years and rehydrate leaves when favorable conditions return. This resurrection is one of the most extreme forms of desiccation tolerance on Earth. No wonder NASA scientists were interested. This spectacular physiological adaptation has earned *P. polypodioides* the common name resurrection fern.

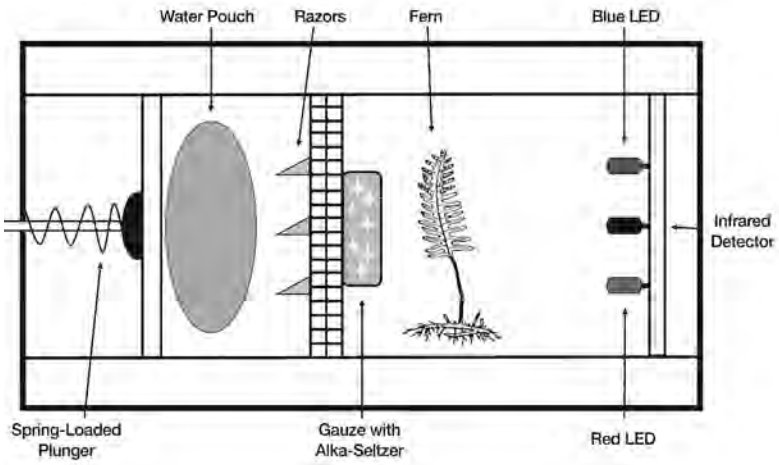
There are multiple mechanisms that allow this fern and other poikilohydrous plants to survive large losses in water content. For example, dehydrated cells collapse as they lose water, and without a healthy cytoplasm, the leaves are more vulnerable to excess sunlight or photo-damage. In order to protect against this type of damage, many poikilohydrous plants produce proteins that help maintain the integrity of cells. These stress-specific proteins, such as late embryogenesis abundant proteins (LEAs), dehydration induced proteins (DHAs) and heat shock proteins (HSPs), have been shown to increase the elasticity of cellular structures and reduce damage during dehydration. These proteins improve the function of plant cells, resist the breakdown of important functions such as photosynthesis, and aid in the resurrection of a desiccated plant when rehydrated.

When the resurrection fern was launched into space, NASA performed an experiment to study the remarkable "resurrection" in the absence of gravity, and the restoration of photosynthesis. The experiment used a technique called chlorophyll fluorescence to assess the health and function of important photosynthetic reactions. Chlorophyll is a photosynthetic pigment that is produced in all green plants during biologically active periods but breaks down in plants that are dead or in dormant states. Light energy absorbed by chlorophyll is used in three ways: 1) to produce chemical energy, 2) to be dissipated as heat, and 3) to be fluoresced or re-emitted as red and near-infrared light. By using short, bright flashes of light, and measuring the small amount of re-emitted light using an infrared detector, scientists can measure the activity of chlorophyll pigments. By association, this measurement can be used to monitor plant activity.

Wait a second – photosynthesis requires light, water and carbon dioxide. How did NASA engineers design such an experiment in a place without air or liquid water? (We encourage you to stop here and think how you might accomplish this.)

NASA constructed a small module to contain all of these necessary components. Water was kept in a pouch that was punctured by razor blades using a spring-loaded plunger. This

Left: Space Shuttle Discovery STS-85 blasting off from Florida's Kennedy Space Center carrying a unique botanical specimen into space. NASA photo.



Above: NASA performed an onboard experiment to study the ability of the fern to "resurrect" and photosynthesize in the absence of gravity. The experiment used a technique called chlorophyll fluorescence to assess the health and function of important photosynthetic reactions. NASA constructed a small module to contain the fern, as well as all the requirements for photosynthesis - light, water and carbon dioxide.

water was then absorbed by an adjacent gauze pad, in contact with the desiccated fern specimen. The gauze pad also contained a crushed Alka-Seltzer tablet that released carbon dioxide upon hydration. Growth LEDs were used to emit blue wavelength light, inducing chloroplast relocation for maximum light absorption. These growth LEDs were switched on for a two-day growth period in the chamber, following the release of water and carbon dioxide, to allow for successful resurrection. A red LED was flashed to induce chlorophyll fluorescence in the fern specimen. This fluorescence was then measured using an infrared detecting photodiode. Fluorescence measurements were taken before, after, and during experimentation to monitor chlorophyll activity during periods of desiccation and subsequent resurrection.

And the results were, well… stellar. As it turns out, the resurrection fern can rapidly rehydrate and recover in zero gravity. Chlorophyll fluorescence dramatically increased after each growth period and gradually decreased to baseline following dormancy, similar to experiments performed on Earth. While it is true that NASA astronauts and engineers performed this far-out experiment, the project itself had very different beginnings. In fact, the idea started in a South Carolina middle school classroom, and students gathered the sample that was flown on the Shuttle from a backyard on Seabrook Island, South Carolina.

In Florida, we have the privilege to observe this remarkable species of fern in its natural environment; a plant that has been to space, exhibits an extreme physiological adaptation, and serves as an example for engineers in creating synthetic materials. Who would have thought that so many amazing credentials would be held by a small fern?

The truth is, ferns have a surprisingly large array of amazing adaptations, allowing them to survive in stressful conditions. There are even xerophytic (drought-adapted) ferns that are perfectly suited to living in desert conditions. Ferns are the second most diverse group of vascular plants, with many examples of poikilohydry. Interestingly, there are currently no known poikilohydrous seed-only plants.

Since the first fern in space, there have been several other projects that investigate fern biology in zero gravity. On the next episode of "Ferns in Space" perhaps we will learn about the partnership between NASA's Ames Research Center and Purdue University centered on a small spacecraft called SporeSat. Launched aboard SpaceX-3, SporeSat was deployed into orbit on April 18, 2014, and is being used to conduct biological experiments and investigate the effect of gravity on the reproductive spores of the aquatic fern *Ceratopteris richardii*. It turns out that *C. richardii* spores can sense and respond to gravity only a few hours after germination.

Because Florida has more species of ferns than any other state in the continental U.S., we can easily step outside and explore other species within this spectacular group of plants. If you want to see resurrection with your own eyes, find a resurrection fern on a nearby nature trail or tree branch during a dry spell and watch what happens once it is drenched with rain. Over the span of a few hours, the fern will come back to life. Far-out!

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Image Information

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Christopher Krieg is a Ph.D. student in the Department of Biology at the University of Florida. His research spans topics from physiological ecology, genetics, and evolution of plants, particularly in ferns. It is said that he can hear a whisper of the word "fern" from a mile away.

Sandy Saunders is a recent B.S. in Biology graduate from the University of Florida.

BOOKS of NOTE

Central Florida Wildflowers

Review by Craig N. Huegel

Roger L. Hammer
Paperback, 256 pages
Falcon Guides (2016)
$24.95 ISBN-10: 1493022156

Florida has produced few naturalists this past half-century that match Roger Hammer's flora and fauna knowledge and possibly no one with his zeal for educating us about it. Combine this with his superb photographic skills and you have yet another addition to his legacy of thoughtful and exquisitely produced books. Since first hearing that Roger was working on a wildflower book for Central Florida, I have been waiting for its publication. The wait was well worth it.

Why *this* book? There are numerous superb wildflower field guides written to help us identify the flowers we find afield. Falcon Guides has published many that I use on a routine basis, but with several thousand species in our native flora, none is as complete as might be desired. That is one of the strengths of this new book, as with others in the Falcon Guides series. With a sharp focus on Central Florida, *Central Florida Wildflowers* is able to maintain its spotlight on a regional flora – both its common and its unique species. It's the latter that I find most laudable in Roger's publication. *Central Florida Wildflowers* is not a simple repackaging of work done by others; it includes a great many Central Florida species that are not part of previous wildflower books. Roger has crisscrossed the state, putting thousands of miles on his vehicle, capturing the rare endemics, the somewhat obscure, and the species that make this part of the state different floristically. In its pages, you will still find common tickseed (*Coreopsis leavenworthii*), blanketflower (*Gaillardia pulchella*), and other ubiquitous species found in every wildflower guide, but you will also find species that you may not be aware of. Species such as Manasota pawpaw (*Asimina manasota*) and Highlands goldenaster (*Chrysopsis highlandsensis*) grace its pages, as do all of our Central Florida balms (*Dicerandera* spp.). There are a great many species that no one else has ever captured in print. Roger has done all of us a great service by capturing their images and making us all aware of their presence. I may not stumble on these wildflowers in my routine travels, but I now have a resource to alert me to look for them and high-quality photos to help me in their identification should I do so.

That is the second point that should be made regarding this book: Roger is a gifted photographer. He is meticulous about his photography. Each image is crisply focused and each is expertly composed. All of us that dabble in nature photography can learn something from examining Roger's pictures. These are not simply "point and click" photos. Each image was clearly and carefully considered before pressing the shutter button. The result is to our benefit. *Central Florida Wildflowers* is a gorgeous book to browse through and one to use to make some targeted excursions afield. It helped me make a new bucket list of wildflowers I wish to see.

Lastly, I love this book for the special touches that Roger brings to the text. His descriptions are clear and concise, based on his many years of field experience. As he has done in previous works focusing on South Florida, Roger provides us with just a bit more than simple life-history information. Each species is given a "Comment" section that describes the etymology of its Latin name as well as other interesting facts that help the reader to better appreciate it. Although this is a field guide, *Central Florida Wildflowers* is also a good read.

No book comes without some faults, however, and I have one for this book that I think should be mentioned. For some unexplained reason, Falcon Guides made the decision not to index these wildflowers separately by Latin name as they have done in every other guide of theirs in my home library. Though the scientific names are included in parentheses following the indexed common names, not including them separately makes using the index significantly more difficult than it had to be. As many of Roger's most interesting plants have "common" names that are not in common use, some extra thumbing through the text is required to locate the plant.

Finding plants in the text has been made easier by their arrangement in sections based on flower color and then alphabetically by the Latin family name. In the field, confronted by an unknown wildflower, it is usually the flower that draws our attention to its presence. This text arrangement gives all of us a head start in putting a name to our unknown.

If you share my love of Florida flora, particularly its wildflowers, you will find this book to be indispensable and a worthy addition to your library. I thank Roger for taking the great many hours he obviously invested in this work in order to make this information available to the rest of us.

About the Reviewer

Craig N. Huegel, adjunct biology professor at St. Petersburg College and owner of Hawthorn Hill Native Wildflowers, is the author of three native plant books published by the University Press of Florida. His most recent book is *Native Florida Plants for Shady Landscapes.*

Controlling Invasive Plants at Oslo Riverfront Conservation Area

Diane LaRue, Ken Gonyo, Jean Romano, and Susan Warmer

Introduction to Oslo Riverfront Conservation Area (ORCA)

ORCA is located along the Indian River Lagoon in southern Indian River County on the north and south sides of Oslo Road. North ORCA is jointly-owned by the St. Johns River Water Management District and Indian River County (IRC), while South ORCA properties are co-owned by IRC and the Florida Communities Trust. Several types of native Florida habitats are represented within the conservation area (Table 1).

Table 1: Habitats at Orca

Habitat	North ORCA	South ORCA	ORCA "Link"	Total Acres
Mesic hammock	40	21	6	67
Scrubby pine flatwoods	24			24
Coastal wetlands	233			233
Estuarine wetlands/transitional		72		72
Freshwater wetlands	1	20		21
Xeric scrub		25		25
TOTAL	298	138	6	442

ORCA's main trail, the Herb Kale Nature Trail, meanders through several habitats including oak hammocks, scrubby pine flatwoods and a coastal wetlands habitat with a canoe dock and an observation platform popular with bird-watchers. Several other trails branch off the main trail, including one that leads to the spot where the "Awesome Pine" once stood. In its prime this tree was documented as the largest slash pine (*Pinus elliottii*) in the world, before being toppled in 2004 by back-to-back hurricanes. Just past the spot where the champion pine stood is an old quarry which is now freshwater wetlands. This trail is currently closed to the public, but is included in ORCA's habitat restoration activities (Fig. 1).

ORCA's mesic or maritime hammock is at a mature stage of growth and is dominated by large live oaks (*Quercus virginiana*), some of which may be hundreds of years old. Native groundcover and understory species abound, but several exotic invasive species have found a home there as well (Fig. 2).

ORCA's scrubby pine flatwoods is at a slightly higher elevation and consists mostly of native species with a few exotics present. The impounded coastal wetlands managed by mosquito control contain many native species, but these areas are also are plagued by exotics, including large Brazilian pepper trees (*Schinus terebinthifolius*).

The trail entrance for South ORCA leads through xeric scrub with mostly native species appropriate to this habitat. Along a drainage ditch, native hammock species are intermixed with exotic invasive plants.

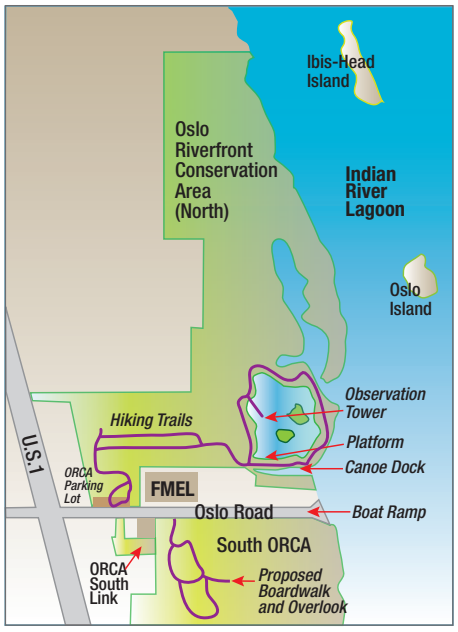

Fig. 1: Location of ORCA with current and proposed trails.

Fig. 2: Typical hammock trail scene at North ORCA.

Our Beginnings: The Volunteer Stewardship Classes

Each year, a free volunteer stewardship class is offered by the Florida Medical Entomology Laboratory, University of Florida (http://fmel.ifas.ufl.edu) and the Pelican Island Audubon Society (http://www.pelicanislandaudubon.org). This 6-week class provides an introduction to the Indian River Lagoon and its upland habitats. Each session includes indoor and outdoor activities, and ORCA serves as a field classroom. Class participants are asked to make a commitment to share their knowledge in a way that suits their interests and availability. Options for volunteering at ORCA include leading nature walks, performing trail maintenance and working to control invasive pest plants. Qualified volunteers can also become classroom teachers, Boy Scout or Girl Scout leaders, or even volunteer at other conservation organizations.

How We Began our Volunteer Contribution

Efforts to control invasive plants at ORCA began in 2011 when Janice Broda asked for a participant from the Volunteer Stewardship Class to lead others in the removal of fruit from shoebutton ardisia (*Ardisia elliptica*) along the Herb Kale Trail. Diane LaRue offered to lead the group and Ken Gonyo agreed to help. Diane says, "Prior to Ken and me meeting with clippers and bags, I walked off the trail a bit and thought, easy, a couple of hours should do it. Here we are four years later with a dedicated team of four volunteers (Susan Warmer and Jean Romano joined us the following year) meeting every Wednesday morning for three hours, and we are still at it. We still laugh at the idea that 'a couple of hours should do it'."

Control of *Ardisia elliptica* began adjacent to the main trail, gradually moving off-trail and into the quarry/wetlands area. Volunteers collected fruit, manually removed small plants, and sprayed the larger trunks with herbicide. Seedling control required patience. Observation indicated that *A. elliptica* grew roughly waist high (about two years old) before flowering and setting fruit. By waiting, volunteers needed to remove fewer plants and they were easy to pull out, especially in moist soil.

Continuing Our Efforts

During the first year, efforts to remove invasive woody trees and shrubs were expanded to include carrotwood (*Cupaniopsis anacardioides*), umbrella tree (*Schefflera actinophylla*) and Brazilian pepper (*Schinus terebinthifolius*). The second year, Surinam cherry (*Eugenia uniflora*), caesarweed (*Urena lobata*), rosary pea (*Abrus precatorius*), bishopwood (*Bischofia javanica*) and cattley guava (*Psidium cattleianum*) were targeted. By the third year, cogon grass (*Imperata cylindrica*) and giant panicum (*Panicum maximum*) were added to the list. In 2015 an expansion of wild balsam apple (*Momordica charantia*) occurred and volunteers began pulling down vines and removing plants to get it under control. Work is now proceeding off the trails, requiring bushwhacking deep into the brush to get at exotic invasive plant species, wherever they may be.

Ongoing vigilance is needed to remove seedlings of invasive species and in the effort to control air potato (*Dioscorea bulbifera*), which has gotten a grip at ORCA. Volunteer Steve Goff made air potato his mission, spending nearly every Sunday morning for the past several years collecting bulbils, sometimes with help but often alone. Such efforts have helped control the spread of these harmful plants.

Tuberous sword fern (*Nephrolepis cordifolia*) forms large patches that choke out native vegetation. First, we clear out around existing native species so they can flourish and then gradually work deeper into the infested areas (Fig. 3). Continual follow-up and hand pulling is needed to keep sword fern from returning.

Although invasive control efforts are expanded to new areas of ORCA each year, monitoring areas already treated to spot new infestations remains important. We recently discovered and vouchered a council tree (*Ficus altissima*) at ORCA, and removed scratchthroat (*Ardisia crenata*), which was located in an area with nearby development. Two occurences of climbing fern (*Lygodium* spp), were spotted and were treated immediately, preventing the spread of this dreaded species.

Fig. 3: Clearing the understory of invasive sword fern makes larger invasive plants like Brazilian pepper accessible for removal, creates open space and provides light so native seedlings can grow.

Control Techniques

A few basic control techniques are employed. Smaller plants are manually pulled out and the plant laid upside down so the roots will dry out, eliminating the possibility of re-establishment. Fruits of some plants are removed, bagged and carried out for disposal, an important step. A plastic bag of shoebutton ardisia fruit that was left in the field to rot not only became home to an ant's nest but the seeds inside germinated, creating a new source of plants (Fig. 4). Now, the fruit of shoebutton ardisia, ceasarweed and rosary pea are bagged and removed from the site.

Our policy is to minimize the use of herbicide and only use it in dry weather. Woody invasive plants are treated with triclopyr using a basal bark treatment. For plants with larger trunks, a hack and squirt method was used, but we are also experimenting with girdling the trunks of trees that do not appear to sucker or re-sprout. For more information on control see Table 2.

Returning Natives

It is gratifying to see native species move into treated areas. A wetland where huge Brazilian pepper trees once overtopped mangroves and giant leather fern now provides conditions

Fig. 4: A carpet of shoebutton ardisia seedlings surrounds a bag which had been filled with fruit and left in the field.

where native ruderals have established. One year after treatment, the ground had a carpet of pepper seedlings, but by year two the few seedlings that survived were replaced by late blooming thoroughwort (*Eupatorium serotinum*), dog fennel (*E. capillifolium*), and hemp vine (*Mikania scandens*). Possum grape (*Cissus verticillata*) has covered the dead limbs and our access path (Fig. 5). On the other side of the bridge that crosses this wetland, ragweed (*Ambrosia artemisiifolia*), *E. serotinum,* annual Florida pellitory (*Parietaria floridana*), black mangrove (*Avicennia germinans*) and giant leather fern are expanding. Nearby, sweetscent (*Pluchea odorata*) can be seen (Fig. 6), and hammock sites where large invasive species have been removed are filling in with native vines and shrubs such as wild coffee, myrsine and marlberry (Fig. 7).

Keeping Track

Due to our lack of experience using GIS or access to GIS software, Diane LaRue used Google Earth to map our efforts. 300 acres of ORCA North were gridded into blocks approximately 100 x 100 meters, and each block was given a letter to identify it as a section. These were further subdivided into west and east and/or north and south. Google Earth allows all kinds of information to be mapped, and the treated areas are color-coded by year.

Table 2: Exotic Invasive Plant Species at ORCA

Common Name	Scientific Name	FLEPPC	Control Method
Air potato	*Dioscorea bulbifera*	I	Pull down vines, collect tubers
Bishopwood	*Bischofia javanica*	I	Pull small ones, basal bark or hack and squirt larger ones
Brazilian pepper	*Schinus terebinthifolius*	I	Pull small ones, basal bark or hack and squirt larger ones
Caesarweed	*Urena lobata*	I	Remove fruit, and pull out
Carrotwood	*Cupaniopsis anacardioides*	I	Pull small ones, basal bark larger ones
Cattley guava	*Psidium cattleianum*	I	Pull small ones, basal bark larger ones
Climbing senna	*Senna pendula*	I	Pull out by the roots
Cogongrass	*Imperata cylindrica*	I	Foliar: glyphosate
Giant panicum, Guinea grass	*Panicum maximum*	II	Foliar: glyphosate
Guava	*Psidium guajava*	I	None
Lantana	*Lantana camara*	I	None
Large-flowered Mexican clover	*Richardia grandiflora*	II	None
Para grass	*Urochola mutica*	I	Foliar: glyphosate
Peruvian primrosewillow	*Ludwigia peruviana*	I	None; only one spot /drainage ditch
Phasey bean	*Macroptilium lathyroides*	II	Pull out by roots
Rattlebox	*Sesbania punicea*	II	Pull out by roots
Queen palm	*Syagrus romanzoffiana*	II	None
Rosary pea	*Abrus precatorius*	I	Pull vines, small seedlings, remove fruit
Senegal date palm	*Phoenix reclinata*	II	Scheduled for removal
Shoebutton ardisia	*Ardisia elliptica*	I	Pull small ones, basal bark larger ones
Surinam cherry	*Eugenia uniflora*	I	Pull small ones, basal bark larger ones
Twinleaf solanum	*Solanum diphyllum*	II	Pull small ones, basal bark larger ones
Torpedograss	*Panicum repens*	I	Foliar: glyphosate
Tuberous sword fen	*Nephrolepsis cordifolia*	I	Pull out by roots
Umbrella tree	*Schefflera actinophylla*	I	Pull small ones, basal bark larger ones
Wedelia	*Sphagneticola trilobata*	II	Foliar, glyphosate
Wild balsam apple	*Momordica charantia*	II	Pull down vines and pull out roots
Woman's tongue	*Albizia lebbeck*	I	Basal bark

Due to ongoing efforts, each year we see fewer invasive plants. Ken Gonyo, who leads guided walks at ORCA almost has trouble finding exotic species to point out. New volunteers still join the effort, and some, like Sam Chancellor, who primarily works on air potato control, have contributed large amounts of time. Volunteers have learned to identify new plants, marveled at the adaptability of nature and its interconnectedness, and eliminated thousands of invasive plants from the ORCA and FMEL properties. It is exciting to be able to view the changing plant communities as the rising sea level affects species distribution on a grand scale as well as from the effects of our work. We like to think our efforts could serve as a model for other conservation areas.

Additional Reading

To learn more about ORCA, including information on the 2017 volunteer class, visit Janice Broda's blog, *Our ORCA* at https://ourorca.wordpress.com/

Fig. 5: A dense stand of tiny pepper seedlings has been replaced by native ruderal species.

Fig. 6: *Pluchea odorata* filling in an area cleared of invasive species.

Fig. 7: After a bishopwood tree was killed, the area which had been densely shaded began to fill in with wild coffee.

Call for Research Track Papers and Poster Presentations - Florida Native Plant Society 2017 Conference

The Florida Native Plant Society Annual Conference will be held at Westgate River Ranch Resort, River Ranch, Florida, May 17-21, 2017. The Research Track of the Conference will include presented papers and a poster session on Friday, May 19, and Saturday, May 20.

Researchers are invited to submit abstracts on research related to native plants and plant communities of Florida, including preservation, conservation, and restoration. Presentations are planned to be 20 minutes in total length (15 min. presentation, 5 min. questions).

Abstracts of not more than 200 words should be submitted as a MS Word file by e-mail to Paul A. Schmalzer, paul.a.schmalzer@nasa.gov by February 1, 2017. Include title, affiliation, and address. Indicate whether you will be presenting a paper or poster.

FNPS 2017 Endowment Grant Research Awards and Conservation Grant Awards

The Florida Native Plant Society maintains an Endowment Research Grant program for the purpose of funding research on native plants. These are small grants ($1,500 or less), awarded for a 1-year period, and intended to support research that forwards the mission of the Florida Native Plant Society, which is "to promote the preservation, conservation, and restoration of the native plants and native plant communities of Florida."

FNPS Conservation Grants support applied native plant conservation projects in Florida. These grants ($5,000 or less) are awarded for a 1-year period. These projects promote the preservation, conservation, or restoration of rare or imperiled native plant taxa and rare or imperiled native plant communities. To qualify for a Conservation Grant, the proposed project must be sponsored by an FNPS Chapter.

Application guidelines and details are on the FNPS Web site (www.fnps.org), click on 'Participate/Grants and Awards'. Questions regarding the grant programs should be sent to info@fnps.org.

Application deadline for the 2017 Awards is March 3, 2017. Awards will be announced at the May 2017 Annual Conference at the Westgate River Ranch Resort, River Ranch, Florida. Recipients do not have to be present at the Conference to accept an award.

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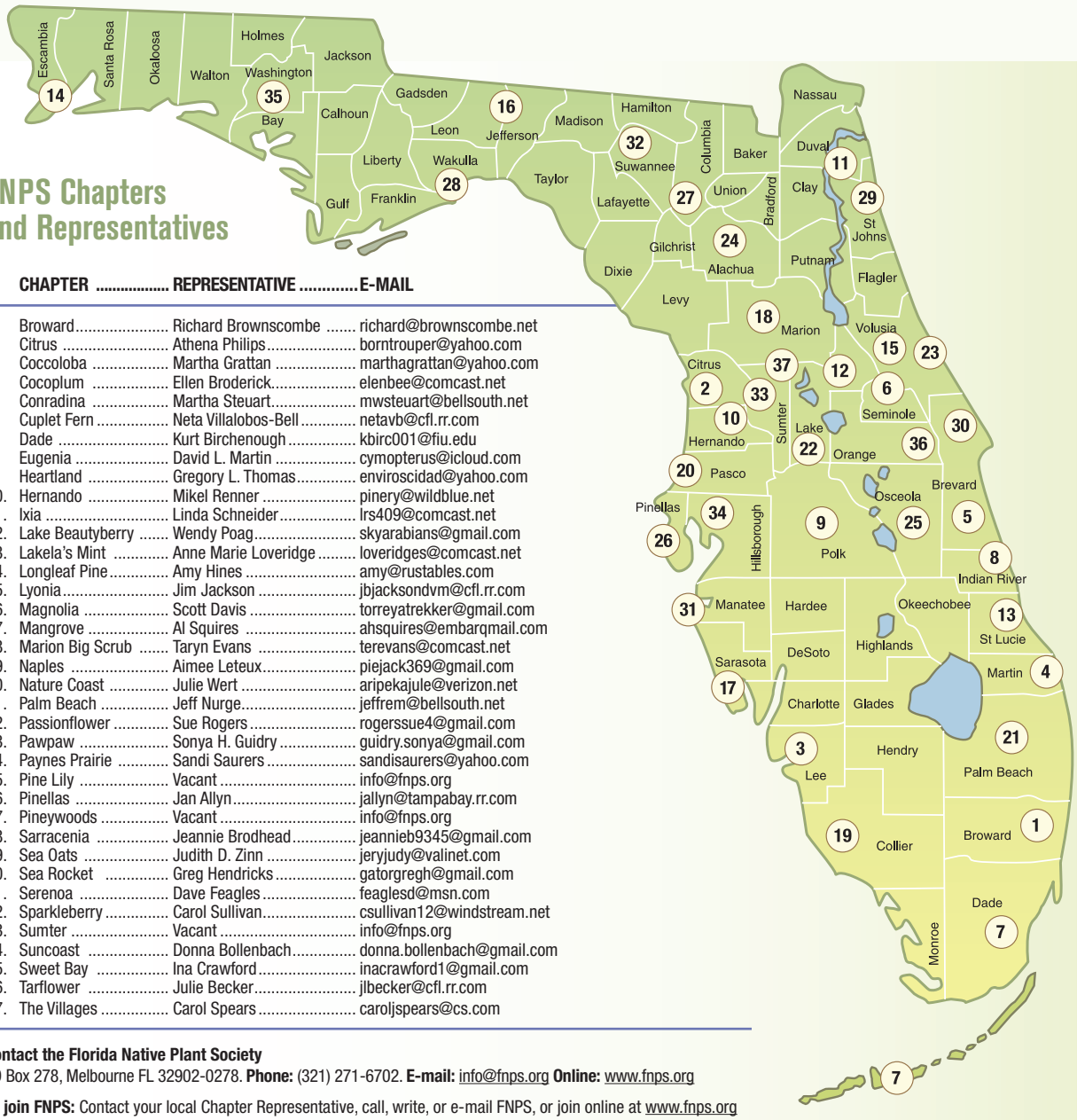

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