

Volume 31: Number 3 > 2014

The Quarterly Journal of the Florida Native Plant Society



Palmetto



Rare Plant Conservation at Bok Tower Gardens ● Yaupon Redeemed ● The Origin of Florida Scrub Plant Diversity

The Origin of Florida Scrub Plant Diversity

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One cannot help but to be amazed by the biological diversity of the Florida scrub habitats. These striking ecosystems host many species of plants and animals found nowhere else in the world and contribute to the biological importance of Florida.

Given the region's unique diversity and the constant threat of habitat loss, we need to understand how these communities formed, what species call these habitats home, and how they can be preserved for future generations. Because much has been written on preserving and managing these habitats (for example, Weekley 2006), here I discuss more fundamental questions regarding the origins of Florida scrub plant diversity, such as how did the scrub habitats form, why are they so different than the surrounding areas, and where did the unique assemblage of plant species come from?

Geological events have shaped the Florida scrub habitat over millions of years. The sandy soils that define these habitats have their origins in the eroding southern Appalachian Mountains and southeastern coastal plains, where sedimentation moved southward over millions of years and ultimately covered the Florida Platform (Scott 1997). Sea levels have also fluctuated over time, shaping and reshaping Florida's coastline (Scott 1997). As climates changed and prehistoric ice sheets melted, sea levels rose as high as 20 meters above our present level, covering most but not all of modern day Florida. It was during this time that the current sand ridges began forming as the seas carved ridges and sand washed ashore to form dunes (Schmidt 1997). At the sea's highest level, the central inland ridges (for example, the Lake Wales Ridge) formed – these are the highest and oldest sand ridges in Florida (U.S. Fish and Wildlife Service 1999). When the seas were at their highest, this area formed island chains that were likely a refuge for species that inhabited Florida before the seas rose and available habitats disappeared. As the sea level lowered, additional north-south orientated sand ridges were later formed outward from the central ridge by the same process. This process continues today, where the coastal dunes are reminiscent of the early inland dunes.

One feature that makes the Florida scrub so interesting is that despite it being located in a subtropical region, it really is a xerophytic (= species adapted to desert-like environments) flora that is dominated by dwarfed oaks and conifers. The sandy soils



Figure 1: Scrub and sandhill communities in Florida. **A.** Atlantic coastal scrub **B.** sand pine scrub **C.** oak scrub **D.** sandhill habitat of the Brooksville Ridge. Note the lack of a continuous tree canopy and continuous ground cover that defines scrub habitat and that all of these habitats have been fire-suppressed.

that are common to these habitats are low-nutrient soils that hold little water due to a lack of clay and organic compounds. Despite substantial rainfall within this region, it is the soil properties that are responsible for the xerophytic vegetation, creating a habitat that favors species adapted to being water-stressed. Florida scrub plant species often have thick leathery leaves that are narrow and can be covered in hairs or a thick waxy coating. These morphological traits are common adaptations to prevent water loss from evaporation and are found in xerophytic plants worldwide.

It is the scrub plant species that give this habitat its unique appearance (Figure 1), where the evergreen scrub species contrast vibrantly against the white sands. Species that are common to Florida scrub and make up a large percentage of the biomass include oaks (*Quercus geminata*, *Q. myrtifolia*, *Q. inopina*, and *Q. chapmanii*), sand pine (*Pinus clausa*), scrub rosemary (*Ceratiola ericoides*), palmettos (*Sabal etonia* and *Serenoa repens*), and a host of more rare herbaceous and shrubby species (see Weekley [2006] for a detailed account of these species). Over 40 species of plants are considered endemic to these habitats, and about half of these species are threatened or endangered. Scrub habitats

B



D



also host numerous endemic animal species, such as the Florida scrub jay, many of which share similar evolutionary histories as plant species and are also threatened or endangered due to the same reasons outlined below.

Not all Florida scrub habitats are the same in soil conditions, history, or species composition. Florida scrub has been divided into inland, coastal, and panhandle scrub (Myers 1990), although numerous other regions can and have been subdivided even further (for example, “rosemary scrub” that is dominated by *Ceratiola ericoides* and “sand pine scrub” that is dominated by *Pinus clausa*). There is a clear relationship between the Florida scrub habitats and the sandhill habitats, which share many of the same species or relatives, in addition to ecological properties. Indeed, these habitats are remnants of the Gulf Coast corridor, a thorn-scrub and savannah habitat that spanned from western North America to peninsular Florida (Emslie 1998). Some ecologists regard sandhill and scrub habitats as being the same, although contemporary ecological properties and species composition differ among them. Sandhill habitats often include species such as *Pinus palustris*, *Quercus laevis*, *Q. laurifolia*, and *Q. geminata*. These habitats can also contain species that are close relatives to inland and coastal scrub, suggesting habitat connections are important to species diversity. The genus *Paronychia* (nailworts; Caryophyllaceae; Figure 2) is a good example of a

group of plants that has close relatives on the interior, coastal, and panhandle scrub, as well as the numerous sandhill ridges that occur throughout the state. The island-like distribution of these ridges appear to be important in *Paronychia*, and may have been responsible for historically isolating populations of plants that have since evolved to become species.

Some Florida scrub species occur nowhere else in the world, but where did their ancestors come from? Three areas seem the most likely. Species could have come from desert areas in western North America, spreading into Florida along the Gulf Coast corridor during the Pleistocene as glaciers expanded and sea levels lowered. Such a pattern is found with many species of birds and reptiles (Morgan and Emslie 2010). On the other hand, perhaps scrub species originated from eastern North America and have adapted to these habitats from temperate or subtropical ancestors, as is common with many mammal species (Morgan and Emslie 2010). Species could have alternatively

Continued on page 14

A



B



Figure 2: *Paronychia* diversity in scrub habitats. **A.** *Paronychia chartacea* is a Florida scrub endemic that occurs only along the Lake Wales Ridge. Its closest relative, *P. chartacea* ssp. *minima*, occurs in sandy soils along karst lakes in the Panhandle. **B.** *Paronychia hemiarioides* occurs in looser sandy soils on the Lake Wales and Mount Dora Ridges.

dispersed from areas outside of North America, such as from the Caribbean, as is common with tropical birds and bats (Emslie 1998, Morgan and Emslie 2010). To answer this question, we must investigate the genetic and geographic patterns of scrub species and their relatives for clues of how and where these species evolved. Some studies have pointed to scrub species being derived from eastern North American species. We have found that *Paronychia*, for example, appears to have had its roots in eastern North American soils before colonizing peninsular Florida. Lewton's polygala (*Polygala lewtonii*) and scrub holly (*Ilex opaca* var. *arenicola*) also evolved onto scrub from eastern progenitors (Germain-Aubrey et al. 2014). Lewton's polygala was estimated to be in Florida by the Pliocene, supporting the idea that high elevations in central Florida were a refuge for plant lineages as sea levels rose (Germain-Aubrey et al. 2014). The jury is still out on the majority of species that call the Florida scrub home. Species like *Ziziphus celata*, *Eriogonum longifolium* var. *gnaphalifolium*, and *Nolina brittoniana*, for example, all have close western relatives (Weekley 2006), suggesting some past connections. The biogeographic origin of other species, such as scrub plum (*Prunus geniculata*) and scrub bay (*Persea borbonia* var. *humilis*), were inconclusively identified, although they were determined to have been in Florida before the sea levels rose (Germain-Aubrey et al. 2014). It is likely that scrub species diversity is from an eclectic mix of regions that have diversified into peninsular Florida at different times over millions of years, but we must wait for additional studies to shed light on the origins of other scrub species before we have a complete picture of its complex history.

It is quite common to find “for sale” signs posted in front of remnant scrub habitat that is nested among developed or otherwise modified land. We are quickly selling off our scrub habitat, which is why areas that have been set aside for preservation like the Ocala National Forest, Archbold Biological Station, Tiger Creek Preserve, Jonathan Dickinson State Park, and others are so important to the persistence of scrub endemic species. Private, local, state, and federal agencies have taken a community conservation approach, setting aside tracts of land in order to preserve the entire scrub ecosystem. The importance of this endeavor in preserving the many different types of scrub and sandhill habitat cannot be overstated.

Another major threat to scrub communities is fire suppression (U.S. Fish and Wildlife Service 1999, Weekley 2006, Menges 2007). Fire naturally occurs in these communities, helping to shape species composition, which have adapted to the naturally occurring fires every 10 to 100 years (U.S. Fish and Wildlife Service 1999). Fire management has shown great promise in preserving and promoting threatened and endangered scrub species by encouraging seed release, seed germination through the seed bank that amasses in the soil, removing large woody plants, and by opening new areas for plants to grow (Menges 2007). Botanists have also been hard at work studying the genetics

of the plants in order to manage plants in a way to optimize the success of generating offspring by controlled breeding or planting (Gitzendanner et al. 2012). All of these efforts are important and will determine whether future generations will also be able to appreciate the unique and inspiring Florida scrub habitats.

Scrub habitats are unique not only at the worldwide scale, but also at the local level. These habitats have formed over millions of years through many different geological and biological events, all of which have contributed to the uniqueness of the flora. Scrub and sandhill habitats coincide with sand ridges, many of which have very different histories and ecological properties, suggesting that we not only need to be concerned with studying and protecting these habitats as a whole, but we also need to be cognizant of the diversity within and among the subregions and recognize the importance of each and every one.

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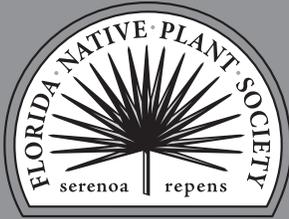
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Acknowledgements

I thank the Florida Native Plant Society, Tulane University Center for Engaged Learning and Teaching, and the Newcomb Institute for funding our study on the diversification of *Paronychia*. I thank my collaborators Sophie Kontur and Hannah Wilson, as well as Kenneth Wray and Jon Moore for their many thoughtful comments.

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The purpose of the Florida Native Plant Society

is to conserve, preserve, and restore the native plants and native plant communities of Florida.

Official definition of native plant:

For most purposes, the phrase Florida native plant refers to those species occurring within the state boundaries prior to European contact, according to the best available scientific and historical documentation. More specifically, it includes those species understood as indigenous, occurring in natural associations in habitats that existed prior to significant human impacts and alterations of the landscape.



The Palmetto

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