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By Ken Langeland

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Bird photo by Ken Langeland.

Fruit photo by Chris Lockhart.

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This issue of Wildland Weeds represents my first as editor, with Tom Fucigna as assistant editor. I would like to raise a frosty glass to the able editorship of Amy Ferriter, who began with the Winter 1997 Charter Issue and proceeded all the way through the Spring 2002 issue. Thank you, Amy, for all of your hard work! I look forward to editing Wildland Weeds with the energetic assistance of Tom, and hope that we can contribute to this important publication.

My first chosen task was to prepare an index to the issues of Wildland Weeds under Amy’s editorship. This should prove a useful tool both to Tom and I, as new editors, and to the readers and contributors of Wildland Weeds. It also illustrates the wide array of topics and plant species covered in these pages so far.

I thank those who contributed to this issue and look forward to working with future contributors, the editorial committee, and the members of FLEPPC. Please feel free to contact me regarding ideas you may have for future issues of Wildland Weeds.

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Introduction

Plants use various strategies for dispersing seeds and a thorough understanding of how dispersal occurs for invasive, exotic species is essential if we want to understand and control their spread. There may be several reasons why a particular species is designated as a FLEPPC Category I plant, but without a reliable dispersal mechanism, a species will not become a problem beyond a local scale.

We have examined the literature to see what is known about vertebrate-assisted seed dispersal of FLEPPC Category I species, and were surprised to find how few dispersers have been adequately verified. Identification of dispersal agents seems to lean heavily on assumptions and little on testing. Moreover, while there is a basic understanding of this type of dispersal, there often seems to be a lack of knowledge of important subtleties. Consequently, the purpose of this article is to provide a basic explanation of vertebrate-assisted seed dispersal and, using examples from literature involving exotic species, to illustrate when the process has been misapplied or not fully understood.

Vertebrate-assisted seed dispersal

Ecologists recognize several reasons why seed dispersal is important to plants. First, because sites suitable for growth vary in space and time, plants must be able to colonize new areas as conditions change. Second, dispersal beyond the parental canopy is a means of avoiding competition with the parent and siblings. Finally, dispersal from the parent is important because some predators of seeds (e.g., rodents, insects, or microbes) often concentrate their efforts under parent plants where food density is highest.

For most plants, mechanisms have evolved for their seeds to be dispersed beyond the range of their branches. Usually these are fairly straightforward processes, such as by wind or water. Two strategies involve animals carrying seeds either externally or internally, termed ectozoochory and endozoochory, respectively. Ectozoochoric fruits or seeds attach to animals with hooks, barbs, or sticky secretions, while endozoochoric fruits usually entice animals with a meal of some sort. In the simplest example of endozoochory, an animal eats a fleshy fruit and later expels an undamaged seed away from the parent plant.

Simple, yet confusing, terminology

It is important to remember that the terms fruit and seed are not synonymous, and that it is confusing when they are used interchangeably in the literature. Also, fruit consumption does not guarantee seed dispersal. Granivorous birds consume seeds, and this is referred to as predation because the seeds are rendered non-viable. Frugivorous birds consume fruit, which can include the skin, pulp and seed(s). The seeds can be expelled in a viable state and this activity is referred to as seed dispersal if the seed has been carried away from the parent plant.

A loosely coevolved mutualism

Endozoochory is an example of a loosely coevolved mutualism. In this example, loosely coevolved means that most frugivores will eat many different fruits. Tight relationships between a specific fruit and frugivore are unusual, and are not known to occur for invasive plants. Indeed, widespread dispersal is successful for many exotic plant species because endozoochory is loose. Species that are dependent upon a specific disperser probably would not become a problem when introduced beyond their natural range. This type of seed dispersal represents a mutualism because both participants benefit; the frugivore with a meal and the plant with its seeds dispersed.

Following fruit consumption, seeds may be carried away from or dropped...
Chinese tallow (Sapium sebiferum) has fruit near the parent plant, with the latter resulting in no dispersal. Furthermore, studies have found that ingestion may increase (e.g. Braun and Brooks 1987), decrease (e.g. Smith 1975), or have no effect on (e.g. Panetta and McKee 1997) seed germination rates. In all of these instances the frugivore benefits, but for the relationship to be mutualistic, ingestion and seed passage must not have any negative consequences on germination. These two events, seeds either not being moved away from the parent plant or being damaged during consumption, may account for the majority of instances where seed dispersal is not successful.

Why fleshy fruit?
Endozoochoric fruits consist of a digestible outer layer surrounding at least one seed, and in the majority of cases this is a fleshy pericarp consisting of pulp and skin. Alternatively, some fruits possess an aril, a fleshy protruding appendage (e.g., earleaf acacia [Acacia auriculiformis]) that in some species completely surrounds the seed (e.g., carrotwood [Cupaniopsis anacardioides]).

Chinese tallow (Sapium sebiferum) has fruit that seems to be quite unique. The fruits are capsules that at maturity split open to expose three large seeds covered in a white waxy coating. This substance is high in lipids (very energy-rich), and is a fairly good source of protein as well. Birds use the sides of their bills to scrape the wax from the seeds, often using a foot to hold the fruit against a branch. While this is usually done on the parent tree, fruits are occasionally carried to adjacent trees for scraping. The seed is dropped once the nutritious wax has been removed. This dispersal system means that many seeds are not dispersed, and those that are dispersed may not make it very far. This could be a consideration if one were to attempt to model the speed at which Chinese tallow expands its range. Moreover, because this is a novel dispersal system, the naive birds may have taken some time to learn how to utilize this new resource, and therefore contributed to a time lag before the tree became invasive.

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Deceptive appearances

Seeds of rosary pea (Abrus precatorius) are unusual in that they are mimetic, a trait shared with the native coral bean (Erythrina herbacea). The glossy, hard seeds are bright red, and not surrounded by pulp or skin. Instead, they mimic fleshy-pulped fruits in a game of deception, taking advantage of frugivorous birds to disperse their seeds with no compensatory reward.

Arillate fruits have their seeds dispersed in the same way as the more typical types (e.g. berries), so the difference may be of most importance to those working with plant anatomy or taxonomy.

The digestible material of a fruit has three main nutritional components: lipids, carbohydrates, and protein. Summer/early fall fruits tend to be higher in carbohydrates and water, while fall/winter fruits generally contain higher levels of lipids. Protein levels are usually low (perhaps nitrogen, a component of protein, is too important to the plant). Both birds and mammals feed on summer and early fall fruits, which are often sweet-tasting, while the lipid-rich fruits of fall and winter are mostly utilized by birds.

Many species of temperate fruiting plants in the Eastern U.S. set fruit in the fall, presumably to take advantage of migrating birds. These birds need energy to fuel migration, and fruits provide an easily assimilable and visible source. However, Florida’s natural communities may operate a bit differently because they are subject to the selective pressure of a large overwintering bird population rather than the passage of fall migrants (Skeate 1987). Much of the state has a temperate flora and hence most plant species produce fruit in the early fall. However, greater fruit biomass may be produced in the late fall and winter months (albeit by fewer plant species) when birds such as American robins (Turdus migratorius), cedar waxwings (Bombycilla cedrorum), gray catbirds (Dumetella carolinensis), and yellow-rumped warblers (Dendroica coronata) overwinter in Florida.

The time of the year that ripe fruits are on the plant could influence the direction of seed dispersal. For example, an invading plant that fruits in the spring may be most likely to experience a gradual northward population shift due to the spring migration of millions of birds. It should be remembered that each bird carries seeds a small distance at a time (depending upon flight speed and duration of seed retention), not for the thousands of miles of the whole migration route.

The dispersal process

Seed ingestion. For efficient flight it is essential that birds try to minimize unnecessary weight, for example, by eliminating heavy, indigestible seeds as quickly as possible. There are various mechanisms to get rid of seeds, and frugivorous birds can be divided into two groups: gulpers and mashers (Levey 1987). Gulpers are species that tend to swallow fruits whole, separate the seeds from the pulp internally, and then void the seeds at some distance from the parent plant (e.g., northern mockingbird [Mimus polyglottos]). Mashers tend to crush fruits in their bills, separating the seeds from the pulp and swallowing just the pulp (e.g., northern cardinal [Cardinalis cardinalis] and boat-tailed grackle [Quiscalus major]). Generally, birds with heavier conical bills are mashers while those with thinner bills are gulpers.

Where a masher removes the seed is important. Birds usually stay in the parent plant to accomplish this task (personal observation), thus seed dispersal has not occurred. But if the bird flies to another perch to remove the seed, seed dispersal will have occurred.

Seed deposition. How a gulper rids itself of seeds is also important relative to plant dispersal. The seed may be separated from the pulp in the stomach with the seed regurgitated, or separation can occur further along the digestive tract with the seed defecated. Birds are adept at this task and can regurgitate seeds that are cleaned of even the most adherent pulp. Since there is great variation among plant species in the adhesion of pulp to the seed, it is possible that the ease of this separation could influence fruit choice by frugivorous birds.

Murray et al. (1994) showed that there is a positive correlation between the distance over which a seed is dispersed and the length of time that a bird carries the seed. Thus, the mechanism of voidance can influence rates of expansion of plant populations because regurgitation is usually much quicker than defecation. Meyer and Witmer (1998) found that after fruit consumption by American robins, the mean seed defecation time of the
Ecologists have long tried to determine why fruits of some plant species are chosen in preference to others. The nutrient content of fruit flesh has an important influence on selection (lipids are particularly important for migrating birds), but many plants also produce distasteful secondary compounds (e.g., tannins, saponins). It seems contradictory that a plant with fleshy fruit that appears to be attractive for frugivores, would contain compounds that deter consumption. However, this deterrence may be intended for another type of organism. Moist fruit pulp is an ideal habitat for a variety of microorganisms which, if unrestrained, may cause seed mortality or make fruits distasteful to potential dispersers. Researchers at the University of Florida (Cipollini & Levey 1997a, 1997b) isolated secondary compounds from different Solanum species and tested them on microbes and frugivores. While these distasteful compounds significantly slowed fungal growth, they also discouraged consumption by frugivorous animals.

Although these interactions initially appear detrimental to the dispersal of a plant, there may be important consequences in the whole plant community. Fruit with secondary compounds may be retained on the plants for many weeks, due to resistance to microbes and distaste to frugivores. Since few plants produce fruit in the spring, those with fruit that persists until then may provide the only food source for birds on their spring migration. Similarly, for non-migratory birds such as northern mockingbirds, these persistent, least-preferred fruits may be crucial for surviving a cold, or extended, north Florida winter.

Other compounds may influence seed dispersal without reducing the consumption of fruit. It has been proposed by Murray et al. (1994) that some fruit may contain laxative compounds that hasten the defecation of seeds before they are damaged in the bird’s gut. Also, many plants produce distasteful or toxic chemicals in the seeds themselves, to encourage seed ejection and deter seed predation (e.g., the bitter taste in apple seeds is due to cyanide compounds).

Native shrub *Viburnum dentatum* was 58 minutes versus a mean regurgitation time of 19 minutes. Although these authors studied both voidance methods for one type of seed using a single bird species, it is more typical that each bird species will exclusively either regurgitate or defecate seeds of a particular size. It is likely that birds preferentially regurgitate seeds, so as to eliminate unnecessary weight as quickly as possible. However, smaller seeds are more likely to be defecated because they are not as easily separated from the pulp in the bird’s crop.

In our own feeding trials with the fruit of *Ardisia crenata* (containing seeds of approximately 5mm diameter), northern mockingbirds typically regurgitate the seeds, while cedar waxwings will defecate them. Recognizing that many factors in addition to size influence which bird species feed on which fruits (e.g., fruit color, exposure on the plant), it can be hypothesized that as a result of different voidance methods, the rates of expansion of a plant species could be influenced by which bird species tend to feed on its fruits.
Seed viability. The mutualism is only complete if an undamaged, viable seed is dispersed. Seeds may be damaged either in the bill or digestive tract. Such damage may improve germination for hard-coated seeds that need scarification before they can germinate, or it can cause seed mortality. The severity of damage may increase with the length of time a seed is retained in the bird’s digestive tract (Murray et al. 1994). Thus, there may be a trade-off for the plant between the distance seeds are carried prior to defecation (improving seed dispersal), and the proportion of seed remaining viable (reducing seed dispersal).

In addition to frugivorous birds feeding on fruit pulp, granivorous birds may feed on the seeds of fruits. The house finch (Carpodacus mexicanus) is historically a western U.S. species that, following introduction into New York City in the 1940’s, expanded its range into Florida. These finches are granivorous, and as such are seed predators. While they are commonly observed feeding on fruits, often they are actually cracking the seeds and feeding on the entire fruit (skin, pulp, and seeds). Similarly, with a gizzard that is capable of crushing pecans and acorns, wild turkeys (Meleagris gallopavo) and other members of the order Galliformes often digest the seeds, rendering them non-viable. An observation of these species feeding on fruits can easily be misinterpreted as seed dispersal rather than seed predation.

Seed dispersal verification
Thus, a conclusive determination of endozoochoric seed dispersal by birds requires verification that the seeds are 1) ingested, 2) carried away from the parent plant, and 3) voided in a viable condition. Observation of fruit consumption does not distinguish between seed dispersal and predation.
seed predation (van der Pijl 1972). However, documentation of seedlings distant from the rest of the plant population and in sites frequented by birds (e.g., under tree roosts; along fence lines) is an indication that bird dispersal is likely (McDonnell and Stiles 1983).

**Categories of verification**

In an attempt to determine how many vectors of vertebrate-assisted seed dispersal for FLEPPC Category I plants have been verified, we searched the literature but were disappointed to find the evidence somewhat limited. Literature searches were aided by using Langeland and Craddock Burks Identification & Biology of Non-Native Plants in Florida’s Natural Areas (1998). We used their species accounts to find citations pertaining to seed dispersal, and performed our own searches for additional references. Though by no means complete, we believe our list is a representative sample of what exists in the literature. These accounts were then assigned to categories based on the dispersal mechanism and extent of verification. Of the 62 species covered by Langeland and Craddock Burks, 30 produce fruits that appear to be (mostly) endozoochoric, making this dispersal mechanism the most utilized by Category I species (Table 1). For seeds thought to be dispersed by birds or mammals, our categories were based on whether: 1) seed viability was assessed for voided seeds, 2) claims of dispersal agents were based only on observations of fruit consumption, or 3) they contained probable erroneous information.

**Dispersal and viability confirmed**

Dispersal vectors have been studied in detail for species such as Brazilian pepper (Schinus terebinthifolius) (Panetta and McKee 1997, Ewel et al. 1982), tropical soda apple (Solanum viarum) (Akanda et al. 1995), and Chinese ligustrum (Ligustrum sinense) (Montaldo 1993). Panetta and McKee (1997) fed Brazilian pepper fruits to captive birds and compared germination rates of defecated seeds to those that were manually depulped, finding no difference. Ewel et al. (1982) observed Brazilian pepper seedlings sprouting in mammal scat but, while verifying mammals as dispersal agents, such reports often fail to distinguish the mammalian species. Mammal scat, whether from raccoon (Procyon lotor), Virginia opossum (Didelphis virginiana), red fox (Vulpes vulpes), or gray fox (Urocyon cinereoargenteus), is difficult to key out to species, especially when consisting of seeds.
Observations of fruit consumption

Another category is of simple reports of fruit consumption. For example, Martin et al. (1951) and Handley (1945) report consumers for Japanese honeysuckle (Lonicera japonica) fruits, Kellung (1997) for nandina (Nandina domestica), and Nelson (1994) for Chinaberry (Melia azederach) fruits. However, of these reports, not one mentions subsequent seed dispersal. Reports such as these should be interpreted with caution, because consumption does not necessarily imply seed dispersal. As a case in point, Langeland and Burks (1998) cited Morton (1980) as reporting that Australian pine (Casuarina equisetifolia) is dispersed by birds (especially exotic parrots and parakeets). However, what Morton wrote is that the birds feed on the seeds of these trees, and this is the correct statement. Australian pine seeds are winged samaras (like maple fruit) that implies wind dispersal, and as such these seeds lack a fleshy coating. Parrots or any other birds feeding on these seeds would be responsible for seed predation rather than dispersal.

Missing or erroneous evidence

There are also authors that report birds as seed dispersers, but with no mention of any direct evidence, as Morton (1982) did for day jessamine (Cestrum diurnum), and Cronk and Fuller (1995) for strawberry guava (Psidium cattleianum). What information such statements are based upon is unclear, but they may rely on uncited or unpublished material, untested assumptions, or lack of knowledge of the complexities of bird - plant interactions.

Finally, there are reports that are likely in error. Cronk and Fuller (1995) reported that kudzu (Pueraria lobata) is dispersed by birds and mammals, but it is likely that neither disperses the seeds. As many legumes do, kudzu produces fruits in the form of a pod that splits open when dry to release its seeds. While it is possible that seeds could be dispersed by mammals grazing on the plant, there is no reason for birds to eat the pods. Conversely, rooting at the nodes along the creeping branches and intentional planting by humans are the primary modes of dispersal in the U.S. (D. Orr, North Carolina State University, 2001 personal communication). Any seed dispersal occurring may be accomplished by the plant alone: with branches up to sixty feet long, the plant is capable of delivering seeds at a significant distance from its own roots. However, it is considered that nearly the entire seed crop produced by kudzu falls prey to beetles. Consequently, in the U.S. seed production in the field is insignificant (D. Orr, pers. comm.).

Conclusion

How a plant disperses its propagules beyond the reach of its branches is a problem that most species must solve. Animals are dispersal vectors for many plant species, ferrying seeds either internally or externally. Unlike the species-specific relationships that are sometimes seen with plants and their pollinators, dispersal relationships are usually general in nature. Thus, when a plant that relies upon endozoochory for seed dispersal is introduced outside it's native range, it is likely that suitable vertebrate dispersers will be available. However, it should be remembered that not all occurrences of fruit-eating result in seed dispersal. A better understanding of the process may lead to greater objectivity in the conclusions that we draw from our observations.

Acknowledgments

We thank Doug Levey for his comments on seed dispersal and frugivory.

Literature Cited


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R01-000-012 (4/02) cii
Proper Uses of FLEPPC’s List of Invasive Species

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Introduction

Floridians’ awareness of problems caused by invasive plant species is rapidly increasing as a result of public education efforts by the Florida Exotic Pest Plant Council (FLEPPC) and others. We must now accept the responsibility to ensure that information pertaining to invasive plant species is factual and correctly interpreted, and to maintain constructive relationships with others who may be affected, such as the horticulture industry.

County and City Commissions are increasingly asked to help protect natural areas from invasive plant species by adopting into ordinance the entire “Florida Exotic Pest Plant Council’s List of Invasive Species” (FLEPPC List) or certain species because they are on the list. These measures may take the form of exemptions to tree cutting ordinances, plant species prohibited from inclusion in landscaping plans, or mandatory removal of certain species. FLEPPC is often asked to provide support in the form of letters or expert witness when adoption of such measures is being considered. The purpose and appropriate uses of the FLEPPC List in tree and landscape ordinances are discussed in this article.

History and Purpose of the FLEPPC List

FLEPPC’s early focus was on organizing to manage melaleuca, but efforts soon evolved into a broader focus on all invasive exotic plant species in the state. The FLEPPC List Committee was established to bring plant experts together to list and prioritize all of the state’s invasive plant species. The first list was made public in 1991 and has been refined and revised every two years as more information has been collected. The purpose of the FLEPPC List has been clearly stated since its publication and has always been published along with each subsequent printing and update. In general, the stated purpose is to focus attention on the problems associated with invasive plant species, inform resource managers about which species need to be monitored, and to help managers set priorities for management. Although certain plants on the FLEPPC List are regulated by local, state, or federal statute, it is not intended that all species on the List should be prohibited everywhere in Florida. Certainly, species on the FLEPPC List may be worth considering for inclusion in a local ordinance, but additional information should always be gathered during the decision-making process for a particular city or county.

Prohibited Plant Lists

Prohibiting species from sale or use can cause economic hardship and changes of well-established cultural practices. Before prohibiting species from sale or use, it is imperative that adequate information exists on the degree of invasiveness, the local threat to the environment, and the economic and cultural impacts. Species are placed on the FLEPPC List after being nominated and voted upon by the FLEPPC List Committee because they have been observed to be invasive in natural areas of the state, particularly in parks and preserves. The statement, “... does not rely on economic severity or geographic range of the problem,” means that an invasive species does not have to be extremely costly to control or occur in all regions before it is listed. Also, the FLEPPC List does not address the economic importance of a species to the horticulture trade. Species to be addressed in local regulation should be considered on the basis of locally developed criteria, such as the species’ local occurrence, severity, or potential to spread further, plus the local economic and cultural impacts.

When asked to assist with identifying plant species to be prohibited by local ordinance, FLEPPC encourages the use of the FLEPPC List as a first step to identify species, with additional information then included in making any final decision. FLEPPC members should assist local staff in determining those species from the FLEPPC List that are invasive within the jurisdiction of the particular ordinance or in nearby natural areas, and species that are potentially invasive in that geographic region. The FLEPPC occurrence database is a good source of information to determine geographic range and occurrence. A second useful source is the University of South Florida’s online Atlas of Florida Vascular Plants.

Local growers and landscapers, as members of a potentially affected constituency, should be involved in determining what plant species are listed in local ordinances. While prohibiting invasive plant species from landscapes to limit the source of propagules is one method of protecting natural areas, the economic impact of prohibiting a commercially important species and the cultural impact of eliminating a popular landscape species is of concern to growers and landscapers. These groups understandably will raise opposition to prohibiting these economically or culturally important species. It is important for land managers to work together with local staff, growers and landscapers to find compromises to present to their lawmaking bodies as a unified voice. When agreement cannot be reached, it is then up to the lawmaking body to decide what compromises to make based on economic and environmental considerations.

Since its first public availability, the FLEPPC List has caused concern within the horticulture industry because some species that occur on the list are also important in the trade. The FLEPPC/FNGA Liaison Committee has made great strides in working with the nursery industry to discourage sales of certain plant species on the FLEPPC List, including ones that are still sold commercially but are not considered important in the trade. These plants, hopefully, can be easily agreed upon at the local level as plants to be prohibited. Additional species could be agreed upon based on discussions...
between natural resource managers and growers/landscapers at the local level.

Mandatory Removal
Ordinances that require mandatory removal of invasive species will invoke economic and, possibly, cultural hardships on citizens. Therefore, (as in the case of prohibiting invasive species from landscape plans) FLEPPC should encourage the use of the FLEPPC List as a first step to identify species. However, additional information beyond that needed for a species to be placed on the FLEPPC List is necessary for requiring mandatory removal of invasive species. Certain invasive species are very expensive to control; for others, methods may not be available that give consistent results. FLEPPC can assist local governments by providing information on severity of invasiveness, distribution, and the most cost effective control methods for species being considered for mandatory removal.

Exemption from Tree Removal
Many local governments have tree-cutting ordinances that require property owners to obtain permits before removing trees of certain size. If invasive exotic tree species are included, the ongoing efforts to encourage property owners to remove invasive plants from their property may be deterred. FLEPPC encourages local governments to eliminate such impediments by exempting exotic pest plants from tree-cutting permit requirements. Because tree removal in this case is a voluntary action and will not impose hardship on anyone, the entire FLEPPC List could be exempted from any tree-cutting permit ordinance. Even if species listed are not invasive in the specific region of Florida, these ordinances simply provide property owners with greater flexibility regarding their property.

FLEPPC Policy on Use of its Invasive Species List in Ordinance
While great care has been taken to formulate the FLEPPC list, care also must be given to how it is interpreted and used. FLEPPC encourages the use of the Invasive Species List for prioritization and implementation of management efforts by natural resource managers, in environmental education programs, and in voluntary removal programs. When species are to be prohibited in some capacity, or removal is to be required by law, FLEPPC encourages the use of its invasive species list as a first step to identify species to be considered. FLEPPC does not promote regulating species for the sole reason that they occur on the list. FLEPPC will continue to work with the horticulture and other industries to develop recommendations that discourage the sale and use of invasive species on the FLEPPC List. FLEPPC also will continue to develop and disseminate information pertaining to these invasive species.

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Agave sisalana Perrine

by Karen Brown, University of Florida, Center for Aquatic and Invasive Plants, 7922 N.W. 71st Street, Gainesville, FL 32653; kpb@mail.ifas.ufl.edu

Introduction

Agaves are often associated with the alcoholic beverages tequila (produced from A. tequilana) and mescal (produced from A. salmiana and other species). Agave sisalana Perrine is known for its fiber production, and is commonly known as “sisal” or “sisal hemp”. It is the primary agave cultivated for fiber in eastern Africa, Brazil, India, and various countries in Asia. In the first half of the twentieth century, sisal supplied about 70 percent of the world’s long hard plant fibers (Nobel 1994). The fibers run the entire length of the leaves, which can grow to five feet, and have been used for rope, twine, nets, upholstery padding, carpet pads, blankets, baskets, jewelry, sandals, clothing, fish stringers, musical instruments, ceremonial objects, construction material, paper pulp, and even dart boards (Nobel 1994). Although sisal is native to Mexico, commercial hard fiber from Mexico is produced primarily from henequen (A. fourcroydes) and lechuguilla (A. lechuguilla). According to Nobel (1988), A. sisalana was exported from Mexico in the 19th century and formed the basis of fiber industries in Indonesia, the Philippines and, in the 20th century, East Africa. Later, Mexico prohibited the export of the plant to protect its own fiber industry but, by then, plants were available in Florida, having been imported and established by Dr. Henry Perrine (Morton 1952, Nobel 1994, Trelease 1913). Nobel reports that 1,000 bulbils were sent from Florida to Germany in 1893. Bulbils are young plantlets, usually at least four inches in length, that occur on the inflorescence and can be planted directly in the soil. Approximately 200 bulbils survived the trip and 62 survived the ensuing trip to German East Africa (now Tanzania). Within five years, these plants multiplied into 63,000 starter plants for large plantations in Tanzania, Kenya, Mozambique and Uganda. These plantations eventually supplied approximately half of the world’s hard fiber (Nobel 1988, 1994). By the early 20th century, A. sisalana also was cultivated in India, Southeast Asia, many Pacific islands, and Australia (Nobel 1988).

Origin of Agave sisalana

The genus Agave was established by Linnaeus in 1753 and contains approximately 136 species in the Agavaceae family (Nobel 1988). Agaves are native to North America, with their center of origin in present-day Mexico (Gentry 1982, Nobel 1988). Gentry reports that the “origin of Agave sisalana is uncertain. Because it was originally exported from Mexico via the port of Sisal in Yucatan, it has long been erroneously reported as of

Field reports

Agave sisalana Perrine, commonly known as sisal hemp, is on the FL-EPPC Category II list of invasive species. According to a FL-EPPC database search in January 2002, there were 24 field reports for this species, with the most reports coming from Dade County (7), followed by Monroe County (5), Martin (4), Palm Beach (3), Lee (2), Broward (2) and Sarasota (1). Lee County leads in acreage reported at 600 acres, followed by Martin at 84, Monroe at 34, and Broward at 19. However, only 7 of the 24 field reports included estimates of acreage. Of the 15 density estimates provided, one “dense monoculture” was reported in Dade County, one in Sarasota County, and one in Monroe County. All other density estimates were “scattered plants.” The University of South Florida’s online Atlas of Florida Vascular Plants (www.plantatlas.usf.edu/), which is based on vouchered herbarium specimens, lists Agave sisalana in Brevard, Manatee, Lee, Collier, Monroe, Dade and Martin counties, (i.e. it lists specimens in 3 counties not listed in FL-EPPC field reports (Brevard, Manatee, and Collier), while FL-EPPC has field reports for 3 counties not listed in the online atlas (Palm Beach, Broward, and Sarasota.)
WILDLAND WEEDS

Yucatan origin. However, no botanical collections of the plant have ever been made in Yucatan, and botanists who have worked in Yucatan have told me they did not find the plant there.”

Fiber plantations in Yucatan are reported to be henequen, *Agave fourcroydes*. Residents in the neighboring state of Chiapas grow *Agave sisalana* as fence rows and for fiber, which is made into rope, nets, hammocks, and other functional items. Gentry states that the “occupation appeared indigenous and, since this is the only area in which *A. sisalana* has been observed and regularly employed in the village complex, I regard the area as a likely place of origin.”

**Growth of Agave**

Gentry describes *Agave sisalana* as a sexually sterile clone, probably of hybrid origin, due to its general inability to produce seed and by its chromosomes. He also notes that night temperatures of 24-25° F (-5° C) often cause leaf “burn” and dieback. Nobel (1994) reports that sisal grows best on free-draining non-saline soils, and that in regions of Kenya and Tanzania with 1200 millimeters of rainfall per year (similar to Florida’s range of from 1000 to 1,500 millimeters per year), *A. sisalana* has a total above-ground dry weight productivity of about 20 tons per hectare per year. Under plantation conditions, *A. sisalana* produces about 220 leaves per plant before the emergence (referred to as “bolting”) of the 5-6 meter high inflorescence at about seven years of age (Nobel 1994). Leaves can be harvested after two years of age, which will postpone the “bolting” for 15-20 years. After “bolting”, the plant dies.

**The United States Sisal Trust**

The United States Sisal Trust was a company (ca. 1919) organized to develop and grow sisal commercially in south Florida. According to a brochure for the company, 22,400 acres of land in Dade County (Florida City) were to be developed into a plantation, 10,000 acres of which was to be devoted to sisal production. 750,000 plants were grown in a nursery to supply the first unit of 1,000 acres. The expected market for the sisal was American farmers who needed “binder twine, rope and other cordage.” The brochure for this company states that 220,000 tons were imported into the U.S. in one year, primarily from Mexico, Cuba and the Bahama Islands. The company intended to capitalize on this market. The brochure goes on to describe the introduction of sisal into south Florida:

“The first sisal plants in Florida were introduced at Indian Key in the year 1826 by Dr. Henry Perrine, American Consul at Campeche, Yucatan, who applied for and received from the United States Government a grant of a township of land conditioned upon its being planted to this product. Later the Indians murdered him and drove his family away. A few years later Mrs. R.V. Carpenter, who lives four miles south of Miami gathered a number of these plants from the Perrine grant and planted them at her home overlooking Biscayne Bay at Coconut Grove. From these original plants others have been set out as ornaments all over Dade County, and as far north as Jupiter. A large number being recently planted for ornamental purposes at the entrance of the palatial home of James Deering in the city of Miami, where they are seen to thrive on rock walls and fences without practically any soil.”

The advent of synthetic fibers during and after World War II severely depressed the natural fiber industry and many plantations failed or were converted to other crops. Current attempts to boost the economic returns of sisal cultivation include research
into uses for leaf pulp by-products and sap.

Agave in the Literature

Following are some of the more interesting and unusual citations found on Agave sisalana in the scientific journal literature. The wide ranging list covers research from Oribatid mites to the invasion of sandy beachfronts to electrical behavior of fibers to permethrin-impregnated sisal curtains to mushroom cultivation to toothbrush sticks to an Olduvai skull.


Groh, K., Artho, A., Biedermann, M., et al (1993) Contamination of hazelnuts and chocolate by mineral oil from jute and sisal bags. Zeitschrift fuer Lebensmittel Untersuchung und Forschung 197(4):370-374. “Before spinning, jute and sisal fibres are treated with a batching oil commonly consisting of a raw material oil fraction. Such oil is transferred to foods packed into jute or sisal bags, i.e. primarily cocoa beans, hazelnuts, coffee, almonds, oil seeds, and rice.”

Gupta, R.K., Agarwal, M.C., Joshee, P. (1997) Phenotypic stability of Agave species on boulderly wastelands (riverbed) of Doon Valley. Indian Forester 123(4):331-337. “Agave sisalana was found to be the only stable Agave species and hence could be recommended for mass adoption on boulder wastelands of a Doon Valley.”


Hartmann, A. et al. (1997) Input of major nutrients under monocropping sisal in Tanzania. Land Degradation and Development 8(4):305-310. “Much more nitrogen was lost from the topsoil than can be explained by the nutrient balance, indicating significant losses.”


Ludlow-Wiechers, B., Ojeda, L. (1983) Input and Output of major nutrients under monocropping sisal in Tanzania. Land Degradation and Development 8(4):305-310. “Much more nitrogen was lost from the topsoil than can be explained by the nutrient balance, indicating significant losses.”


Natural resource managers in central and south Florida may encounter the invasive exotic Agave sisalana, sisal hemp, in coastal middens, thickets, or hammocks, the common habitats of two endemic species. False sisal, Agave decipiens, and wild century plant, Agave neglecta. With only a little practice, though, the target invasive is easily distinguished from these endemics. False sisal, found in the Keys and mostly the southwest peninsular coast, has relatively narrow leaves (5-10 cm), and the leaves are concave or cupped, with margins bearing regularly spaced, conspicuous recurved (hooked) prickles. The more rare wild century plant, known from three counties, has broad leaves (20-25 cm wide) that are concave, with straight margins bearing numerous close, minute prickles. Sisal hemp leaves are around 10 cm wide, flat, and usually smooth on the margin, with no prickles, or just a few tiny ones. Other characters differ as well, but these are easy ones for novice agave lovers and haters.

– K.C. Burks, Invasive Plant Mgt., Florida DEP
Parsche, F. (1993) Peculiarities on the incisors in the mandible of the skull Olduvai I. Homo 44(1):30-36. “This can be interpreted as an indication that at least this individual used his teeth as a “tool” for treating plant fibres.”

References:

Chapter 5
“Well... Once, upon a morning dreary, I walked with something on my head and though I sought to ignore the source, I wound up talking to the bird instead, I chatted with the fowl who fouled my head.

There, upon that humid morning, standing at the shallow shore Came a raven, droop-seed dropping, defecating on the forest floor Seeds were dropping, seedlings popping, falling to the forest floor Sternly, I addressed the raven: Drop those seeds here nevermore! Poop not upon this forest floor!

But lo, he looked at me and laughed – cawed, guffawed and queried me ‘Dare you command us creatures who, led by hunger, take our succor of a tree that you abhor?’
I must do what I must do, and so I feast and fill my crop, and when digested, I must drop, droppings to the forest floor.
No harm intending, just a meal ending. The seeds fall to the forest floor’

But I rebuffed him – ‘Nevermore!’
‘This tree that feeds you and the seeds you, uh, deposit on the forest floor do not belong here, they are wrong here, they take the place of trees of yore...’

The Raven only laughed once more, and croaked these words: ‘You men dishevel nature and expect me to ignore? This fruit is sweet and I must eat. I’ll eat the fruits that I adore. It’s you must yank them evermore. It’s you must plant them nevermore...’

He dropped this scat upon my hat and then flew off to eat some more...

So I stand here, hat in hand, a crappy-hatted soggy man, and although the raven I implored, that bird will listen never more The answer’s clear, the seed is here, the raven spreads it ever more. It’s time for man the truth to see - that only we can stop that tree...”

“Number 467”
“Yep, that’s me” – he stepped forward and picked up his tray, tipping his encrusted cap to the wide-eyed boy behind the counter.

She coughed insistently, and he turned to listen. “Thank you for that very complete and ever-so-artistic response,” she muttered through clenched teeth. “Now, would you please go outside and scrape that off your hat?”

Sheepishly, he grinned and complied. No doubt, the surrounding patrons (inchring towards the door) would never see a carrotwood tree or a water-bound crow in the same way. She stepped forward to retrieve her lunch off the counter, and thought “What a wonderful fool that mortal be...”

An excerpt from “The Adventures of Hack Garlon and his buxom sidekick Squirr.”

WILDLAND WEEDS
The fourth annual Southeast Exotic Pest Plant Council (SE-EPPC) Symposium was hosted by the Tennessee EPPC April 3-5 in Nashville. The focus of the symposium was “Rescuing Our Natural Heritage.” Gordon Brown gave the keynote address on Implementation of the National Management Plan. Mr. Brown serves as liaison with the U.S. Department of Interior Bureaus and the National Invasive Species Council. He works with international, state and private partners to build support for local action. In his address, he described how policy is being developed to recognize and address the ways in which species alien to American ecosystems are harming our natural systems, economic enterprises, and human health.

In recounting the recent history of invasive plant policy development, Mr. Brown stated that scientists’ letters to vice president Gore in 1998 spurred the 1999 Executive Order on Invasive Species. The Executive Order authorized a federal interagency task force that is continuing to develop and recommend actions regarding invasive species.

He further reported how invasive species are transforming the American landscape as native species are replaced with alien species. Ecological systems and cycles that we take for granted are shutting down. Financial and ecological damage is estimated at $137 billion per year (Pimentel, Bioscience, Jan 2000). The greatest impacts to our natural areas have been ranked as habitat loss, alien species, pollution, over-harvesting, and disease (Wilcove, Rebuilding the Ark, 1996). Alien invasions are held to be the second greatest cause of endangered species listings. Brown held that bringing stakeholders together is crucial. The problem is bad and getting worse.

The Executive Order spurred existing Executive Office departments to examine their programs to determine whether their activities are contributing to this issue. The National Invasive Species Council (NISC) was created from federal departments and was mandated to draft a management plan that will be updated every two years. The NISC is directed to provide leadership on these issues; promote actions at local, state, tribal and ecosystem levels; and to recommend measures to enhance international cooperation. Another goal is development of National Environmental Policy Act (NEPA) guidelines related to invasive species.

Among the finished management plan’s recommendations are implementation of effective detection and rapid response, prevention, leadership and cooperation. Also, the Invasive Species Advisory Committee recommended creation of an invasive species “czar,” a $50 million fund for early detection and rapid response, and screenings for invasive species. The screening program is expected to be ready in two years and, like current security inspection, much of the screening will take place overseas before invasive species enter the US. Other goals include closing authorities gaps; establishing competitive grants programs; using public lands as models for stewardship; developing incentives for international help with invasive species management, including reviews of existing foreign assistance; increasing educational and information management programs; and establishing industry codes of conduct for invasive species.

Further information on the national invasive species initiatives can be found at: www.invasivespecies.gov.

Elsewhere during the three day symposium, field trips illustrated invasive species management programs in various settings, and other speakers reported on federal, state, and local invasive species management and research programs. Attendees successfully networked during an excellent evening social enhanced with live jazz accompaniment. Also, when the podium went dark, attendees enjoyed Nashville’s spirited entertainment and nightlife.

The SE-EPPC board of directors modified the group’s bylaws as follows: representation on the board of directors was changed to one representative from each active chapter; the SE-EPPC coordinator position was abolished; $2,000 in funds left by the coordinator was dedicated for any member to attend future meetings representing SE-EPPC. Brian Bowen was elected president and Kristen Gounaris was elected secretary. The vice president and treasurer positions need nominations (which can be sent to president Bowen at bbowen@mail.state.tn.us).

Great efforts by the conference committee resulted in a highly informative and, hopefully, formative 4th symposium. All are to be commended for helping guide SE-EPPC into its future.

Mike Bodle
Roving Reporter
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